

PHYSICS

QUESTION BANK

PART-1

ADVANCED QUESTION BANK

WITH DETAILED INSTANT SOLUTIONS

PRACTICE ORIENTED CATEGORISATIONS

CHAPTERWISE AND TOPICWISE REFERENCE WITH EACH QUESTION

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PART 1. PHYSICS QUESTION BANK

Q1. The density of material in CGS system of units is 4g/cm^3 . In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be

- (a) 0.4 (b) 40
(c) 400 (d) 0.04

Ans: (b)

Solution: In CGS system, $d = 4 \frac{\text{g}}{\text{cm}^3}$

The unit of mass is 100g and unit of length is 10 cm, so

$$\text{density} = \frac{4 \left(\frac{100\text{g}}{100} \right)}{\left(\frac{10}{10} \text{cm} \right)^3} = \left(\frac{4}{100} \right) \frac{(100\text{g})}{(10\text{cm})^3}$$

$$= \frac{4}{100} \times (10)^3 \cdot \frac{100\text{g}}{(10\text{cm})^3} = 40 \text{ unit}$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q2. A rod PQ of mass M and length L is hinged at end P. The rod is kept horizontal by a massless string tied to point Q as shown in figure. When string is cut, the initial angular acceleration of the rod is



- (a) $\frac{g}{L}$ (b) $\frac{2g}{L}$
(c) $\frac{2g}{3L}$ (d) $\frac{3g}{2L}$

Ans: (d)

Solution: Weight of the rod will produce the torque

$$\tau = mg \frac{L}{2} = I \alpha = \frac{ML^2}{3} \left[1_{\text{rod}} = \frac{ML^2}{3} \right]$$

Hence, angular acceleration $\alpha = \frac{3g}{2L}$

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q3. A simple pendulum performs simple harmonic motion about $x = 0$ with an amplitude a and time period T . The speed of the pendulum at $x = \frac{a}{2}$ will be:

- (a) $\frac{\pi a}{T}$
(b) $\frac{3\pi^2 a}{T}$
(c) $\frac{\pi a \sqrt{3}}{T}$
(d) $\frac{\pi a \sqrt{3}}{2T}$

Ans: (c)

Solution: Speed $v = \omega \sqrt{a^2 - x^2}$ at $x = \frac{a}{2}$

$$v = \omega \sqrt{a^2 - \frac{a^2}{4}} = \omega \sqrt{\frac{3a^2}{4}} = \frac{2\pi a \sqrt{3}}{T \cdot 2} = \frac{\pi a \sqrt{3}}{T}$$

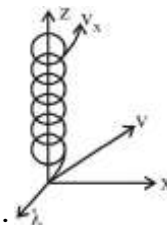
Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q4. Under the influence of a uniform magnetic field a charged particle is moving in a circle of radius R with constant speed v . The time period of the motion

- (a) depends on both R and v
(b) is independent of both R and v
(c) depends on R and not on v
(d) depends on v and not on R

Ans: (b)



Solution:

When a test charge q_0 enters a magnetic field $\vec{B}$ directed along z -axis, with a velocity $\vec{v}$ making angles θ with the z -axis. The time period of the motion is independent of R and v .

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q5. An electron of mass m and a photon have same energy E . The ratio of de-Broglie wavelengths associated with them is :

- (a) $\frac{1}{c} \left(\frac{E}{2m} \right)^{\frac{1}{2}}$
(b) $\left(\frac{E}{2m} \right)^{\frac{1}{2}}$
(c) $c(2mE)^{\frac{1}{2}}$
(d) $\frac{1}{xc} \left(\frac{2m}{E} \right)^{\frac{1}{2}}$

Ans: (a)

Solution: For electron De-Broglie wavelength,

$$\lambda_e = \frac{h}{\sqrt{2mE}}$$

For photon $E = pc$

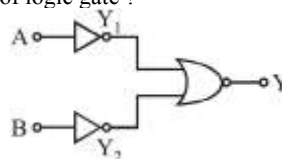
$$\Rightarrow \text{De-Broglie wavelength, } \lambda_{ph} = \frac{hc}{E}$$

$$\therefore \frac{\lambda_e}{\lambda_{ph}} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \left(\frac{E}{2m} \right)^{\frac{1}{2}} \frac{1}{c}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

Q6. Which logic gate is represented by the following combination of logic gate ?



(a) NAND

- (b) AND
(c) NOR
(d) OR

Ans: (b)

Solution: First two gates are NOT gates and the last gate is NOR gate.

Thus, $y_1 = \bar{A}$, $y_2 = \bar{B}$ and $y = \overline{y_1 + y_2}$

The truth table corresponding to this is as follows:

A	B	$y_1 = \bar{A}$	$y_2 = \bar{B}$	$y_1 + y_2$	$y = \overline{y_1 + y_2}$	A . B
0	0	1	1	1	0	0
0	1	1	0	1	0	0
1	0	0	1	1	0	0
1	1	0	0	0	1	1

Thus the combination of gate represents AND gate.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q7. The time dependence of a physical quantity p is given by $p = p_0 \exp(-\alpha t^2)$, where α is a constant and t is the time. The constant α

- (a) is dimensionless (b) has dimensions T^{-2}
(c) has dimensions T^2 (d) has dimensions of p

Ans: (b)

Solution: In $p = p_0 \exp(-\alpha t^2)$, αt^2 dimensionless

$$\therefore \alpha = \frac{1}{t^2} = \frac{1}{T^2} = [T^{-2}]$$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q8. A solid homogeneous sphere of mass M and radius R is moving on a rough horizontal surface, partly rolling and partly sliding. During this kind of motion of the sphere

- (a) total kinetic energy is conserved
(b) the angular momentum of the sphere about the point of contact with the plane is conserved
(c) only the rotational kinetic energy about the centre of mass is conserved
(d) angular momentum about the centre of mass is conserved.

Ans: (b)

Solution: Angular momentum about the point of contact with the surface includes the angular momentum about the centre. Due to friction linear momentum is conserved.

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q9. A wave travelling in the +ve x -direction having displacement along y -direction as 1m , wavelength $2\pi\text{m}$ and frequency $\frac{1}{\pi}\text{Hz}$ is represented by

- (a) $y = \sin(2\pi x - 2\pi t)$
(b) $y = \sin(10\pi x - 20\pi t)$
(c) $y = \sin(2\pi x + 2\pi t)$
(d) $y = \sin(x - 2t)$

Ans: (d)

Solution: As $Y = A \sin(\omega t - kx + \phi)$

$$\omega = 2\pi f = \frac{2\pi}{\pi} = 2 \quad [\because f = \frac{1}{\pi}]$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{2} = 1 \quad [\because \lambda = 2\pi]$$

$$\therefore Y = 1 \sin(2t - x + \phi) \quad [\because A = 1\text{m}]$$

Chapter: Waves
[Topic: Basic of Waves]

Q10. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is double and the number of turns per cm is halved, the new value of the magnetic field is

- (a) $4B$
(b) $B/2$
(c) B
(d) $2B$

Ans: (c)

Solution: $B = \mu_0 ni$

$$B_1 = (\mu_0) \left(\frac{n}{2}\right) (2i) = \mu_0 ni = B$$

$$\Rightarrow B_1 = B$$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q11. Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57V . The threshold frequency of the materials is :

- (a) $4 \times 10^{15}\text{Hz}$ (b) $5 \times 10^{15}\text{Hz}$
(c) $1.6 \times 10^{15}\text{Hz}$ (d) $2.5 \times 10^{15}\text{Hz}$

Ans: (c)

Solution: $n \rightarrow 2 - 1$

$$E = 10.2\text{eV}$$

$$KE = E - \phi$$

$$Q = 10.20 - 3.57$$

$$h\nu_0 = 6.63\text{eV}$$

$$\nu_0 = \frac{6.63 \times 1.6 \times 10^{-19}}{6.67 \times 10^{-34}} = 1.6 \times 10^{15}\text{Hz}$$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q12. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1s and 2s is :

- (a) $\frac{3}{2}A + 4B$ (b) $3A + 7B$
(c) $\frac{3}{2}A + \frac{7}{3}B$ (d) $\frac{A}{2} + \frac{B}{3}$

Ans: (c)

Solution: Given : Velocity

$$V = At + Bt^2 \Rightarrow \frac{dx}{dt} = At + Bt^2$$

By integrating we get distance travelled

$$\Rightarrow \int_0^x dx = \int_1^2 (At + Bt^2) dt$$

Distance travelled by the particle between 1s and 2s

$$x = \frac{A}{2} (2^2 - 1^2) + \frac{B}{3} (2^3 - 1^3) = \frac{3A}{2} + \frac{7B}{3}$$

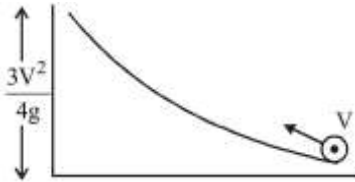
Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q13. A small object of uniform density rolls up a curved surface with an initial velocity ' v '. It reaches upto a

maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is a [2013]

- (a) solid sphere
- (b) hollow sphere
- (c) disc
- (d) ring

Ans: (c)



Solution:

From law of conservation of mechanical energy

$$\frac{1}{2} I \omega^2 + 0 + \frac{1}{2} m v^2 = m g \times \frac{3v^2}{4g}$$

$$\Rightarrow \frac{1}{2} I \omega^2 = \frac{3}{4} m v^2 - \frac{1}{2} m v^2$$

$$= \frac{m v^2}{2} \left(\frac{3}{2} - 1 \right)$$

$$\text{or, } \frac{1}{2} I \frac{v^2}{R^2} = \frac{m v^2}{4} \text{ or, } I = \frac{1}{2} m R^2$$

Hence, object is a disc.

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q14. A standing wave is represented by $y = A \sin(100t) \cos(0.01x)$, where y and A are in millimetre, t in seconds and x is in metre. Velocity of wave is

- (a) 10^4 m/s
- (b) 1 m/s
- (c) 10^{-4} m/s
- (d) not derivable from above data

Ans: (a)

Solution: The wave equation is $y = A \sin(\omega t) \cos(kx)$;

$$c = \omega/k = 100/0.01 = 10^4 \text{ m/s.}$$

Chapter: Waves

[Topic: Basic of Waves]

Q15. When a charged particle moving with velocity $\vec{v}$ is subjected to a magnetic field of induction $\vec{B}$, the force on it is non-zero. This implies that

- (a) angle between $\vec{v}$ and $\vec{B}$ can have any value other than 90°
- (b) angle between $\vec{v}$ and $\vec{B}$ can have any value other than zero and 180°
- (c) angle between $\vec{v}$ and $\vec{B}$ is either zero or 180°
- (d) angle between $\vec{v}$ and $\vec{B}$ is necessarily 90°

Ans: (b)

Solution: Force on a particle moving with velocity v in a magnetic field B is $F = q(\vec{v} \times \vec{B})$

If angle between $\vec{v}$ & $\vec{B}$ is either zero or 180° , then value of F will be zero as cross product of $\vec{v}$ and $\vec{B}$ will be zero. So option (b) is correct.

Chapter: Moving Charges and Magnetic Field

[Topic: Force & Torque on a Current Carrying Conductor]

Q16. The photoelectric work function for a metal surface is 4.125 eV. The cut off wavelength for this surface is

- (a) 4125 Å
- (b) 3000 Å
- (c) 6000 Å
- (d) 2062.5 Å

Ans: (b)

Solution: Let λ_0 be cut off wavelength.

$$\text{Work function} = \frac{hc}{\lambda_0} = 4.125 \times 1.6 \times 10^{-19}$$

$$\lambda_0 = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{4.125 \times 1.6 \times 10^{-19}} = 3000 \text{ Å}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q17. A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

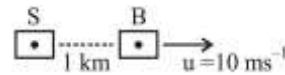
- (a) 40 ms^{-1}
- (b) 25 ms^{-1}
- (c) 10 ms^{-1}
- (d) 20 ms^{-1}

Ans: (d)

Solution: Let v be the relative velocity of scooter w.r.t bus as $v = v_s - v_B$

$$v = \frac{1000}{100} = 10 \text{ ms}^{-1} \Rightarrow v_B = 10 \text{ ms}^{-1}$$

$$\therefore v_s = v + v_B,$$



$$= 10 + 10 = 20 \text{ ms}^{-1}$$

$$\therefore \text{velocity of scooter} = 20 \text{ ms}^{-1}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Relative Velocity]

Q18. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R , the radius of the planet would be

- (a) $\frac{1}{2} R$
- (b) $2 R$
- (c) $4 R$
- (d) $\frac{1}{4} R$

Ans: (a)

Solution: $g = \frac{GM}{R^2}$. Also, $M = d \times \frac{4}{3} \pi R^3$

$$g = G \frac{4}{3} d \pi R$$

$$\text{At the surface of planet, } g_p = \frac{4}{3} G (2d) \pi R'$$

$$\text{At the surface of the earth } g_e = \frac{4}{3} G d \pi R$$

$$g_e = g_p \Rightarrow dR = 2dR' \Rightarrow R' = R/2$$

Chapter: Gravitation

[Topic: Acceleration due to Gravity]

Q19. A closed organ pipe (closed at one end) is excited to support the third overtone. It is found that air in the pipe has

- (a) three nodes and three antinodes
- (b) three nodes and four antinodes
- (c) four nodes and three antinodes

(d) four nodes and four antinodes

Ans: (d)

Solution: Third overtone has a frequency $7n$, which means $L = \frac{7\lambda}{4}$ = three full loops + one half loop, which would make four nodes and four antinodes.

Chapter: Waves

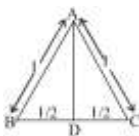
[Topic: Beats, Interference & Superposition of Waves]

Q20. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet such that $\vec{B}$ is in the plane of the coil. If due to a current i in the triangle a torque τ acts on it, the side l of the triangle is

- (a) $\frac{2}{\sqrt{3}} \left(\frac{\tau}{Bi} \right)^{\frac{1}{2}}$ (b) $2 \left(\frac{\tau}{\sqrt{3}Bi} \right)^{\frac{1}{2}}$
 (c) $\frac{2}{\sqrt{3}} \left(\frac{\tau}{Bi} \right)$ (d) $\frac{1}{\sqrt{3}} \frac{\tau}{Bi}$

Ans: (b)

Solution: $\tau = MB \sin\theta$
 $\tau = iAB \sin 90^\circ$



$$\therefore A = \frac{\tau}{iB}$$

Also, $A = \frac{1}{2} (BC) (AD)$

$$\text{But } \frac{1}{2} (BC) (AD) = \frac{1}{2} (l) \sqrt{\tau^2 - \left(\frac{1}{2}\right)^2}$$

$$= \frac{\sqrt{3}}{4} l^2$$

$$\therefore \frac{\sqrt{3}}{4(l)^2} = \frac{\tau}{Bi}$$

$$\therefore l = 2 \left(\frac{\tau}{\sqrt{3}Bi} \right)^{\frac{1}{2}}$$

Chapter: Magnetism and Matter
[Topic: Magnetism, Gauss's Law]

Q21. An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze . Then the distance of closest approach for the alpha nucleus will be proportional to

- (a) $\frac{1}{Ze}$
 (b) v^2
 (c) $\frac{1}{m}$
 (d) $\frac{1}{v^4}$

Ans: (c)

Solution: Kinetic energy of alpha nucleus is equal to electrostatic potential energy of the system of the alpha particle and the heavy nucleus. That is,

$$\frac{1}{2}mv^2 = \frac{1}{4\pi\epsilon_0} \frac{q_\alpha Ze}{r_0}$$

where r_0 is the distance of closest approach

$$r_0 = \frac{2}{4\pi\epsilon_0} \frac{q_\alpha Ze}{mv^2}$$

$$= r_0 \propto Ze \propto q_\alpha \propto \frac{1}{m} \propto \frac{1}{v^2}$$

Hence, correct option is (c).

Chapter: Atoms

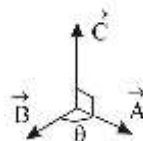
[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q22. If the angle between the vectors $\vec{A}$ and $\vec{B}$ is θ , the value of the product $(\vec{B} \times \vec{A}) \cdot \vec{A}$ is equal to [2005]

- (a) $BA^2 \sin\theta$
 (b) $BA^2 \cos\theta$
 (c) $BA^2 \sin\theta \cos\theta$
 (d) zero

Ans: (d)

Solution: $(\vec{B} \times \vec{A}) \cdot \vec{A} = \vec{C} \cdot \vec{A} = CA \cos 90^\circ = 0$.



Chapter: Kinematics Motion in a Plane
[Topic: Vectors]

Q23. A particle of mass m is thrown upwards from the surface of the earth, with a velocity u . The mass and the radius of the earth are, respectively, M and R . G is gravitational constant and g is acceleration due to gravity on the surface of the earth. The minimum value of u so that the particle does not return back to earth, is

- (a) $\sqrt{\frac{2GM}{R}}$
 (b) $\sqrt{\frac{2GM}{R^2}}$
 (c) $\sqrt{2gR^2}$
 (d) $\sqrt{\frac{2GM}{R^2}}$

Ans: (a)

Solution: The velocity u should be equal to the escape velocity. That is,

$$u = \sqrt{2gR}$$

$$\text{But } g = \frac{GM}{R^2}$$

$$u = \sqrt{2 \frac{GM}{R^2} R} \Rightarrow \sqrt{\frac{2GM}{R}}$$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q24. A vehicle, with a horn of frequency n is moving with a velocity of 30 m/s in a direction perpendicular to the straight line joining the observer and the vehicle. The observer perceives the sound to have a frequency $n + n_1$. Then (if the sound velocity in air is 300 m/s)

- (a) $n_1 = 10n$
 (b) $n_1 = 0$
 (c) $n_1 = 0.1n$
 (d) $n_1 = -0.1n$

Ans: (b)

Solution: As the source is not moving towards or away from the observer in a straight line, so the Doppler's effect will not be observed by the observer.

Chapter: Waves

[Topic: Musical Sound & Doppler's Effect]

Q25. A coil of resistance 400Ω is placed in a magnetic field. If the magnetic flux ϕ (wb) linked with the coil varies with time t (sec) as $\phi = 50t^2 + 4$. The current in the coil at $t = 2$ sec is :

- (a) 0.5 A (b) 0.1 A
(c) 2 A (d) 1 A

Ans: (a)

Solution: According, to Faraday's law of induction

$$\text{Induced e.m.f. } \varepsilon = -\frac{d\phi}{dt} = -(100t)$$

Induced current i at $t = 2$ sec.

$$= \left| \frac{\varepsilon}{R} \right| = + \frac{100 \times 2}{400} = +0.5A$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q26. The Bohr model of atoms

- (a) predicts the same emission spectra for all types of atoms
(b) assumes that the angular momentum of electrons is quantised
(c) uses Einstein's photoelectric equation
(d) predicts continuous emission spectra for atoms

Ans: (b)

Solution: In Bohr's model, angular momentum is quantised i.e $l = n \left(\frac{h}{2\pi} \right)$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q27. A missile is fired for maximum range with an initial velocity of 20 m/s. If $g = 10 \text{ m/s}^2$, the range of the missile is

- (a) 40 m (b) 50 m
(c) 60 m (d) 20 m

Ans: (a)

Solution: For maximum range, the angle of projection, $\theta = 45^\circ$.

$$\therefore R = \frac{u^2 \sin 2\theta}{g} = \frac{(20)^2 \sin(2 \times 45^\circ)}{10} = \frac{400 \times 1}{10} = 40 \text{ m.}$$

Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q28. The approximate depth of an ocean is 2700 m. The compressibility of water is $45.4 \times 10^{-11} \text{ Pa}^{-1}$ and density of water is 10^3 kg/m^3 . What fractional compression of water will be obtained at the bottom of the ocean ?

- (a) 1.0×10^{-2} (b) 1.2×10^{-2}
(c) 1.4×10^{-2} (d) 0.8×10^{-2}

Ans: (b)

Solution: Compressibility of water,

$$K = 45.4 \times 10^{-11} \text{ Pa}^{-1}$$

density of water $P = 10^3 \text{ kg/m}^3$

depth of ocean, $h = 2700 \text{ m}$

We have to find $\frac{\Delta V}{V} = ?$

As we know, compressibility,

$$K = \frac{1}{B} = \frac{\left(\frac{\Delta V}{V} \right)}{P} \quad (P = \rho gh)$$

So, $(\Delta V/V) = K\rho gh$

$$= 45.4 \times 10^{-11} \times 10^3 \times 10 \times 2700 = 1.2258 \times 10^{-2}$$

Chapter: Mechanical Properties of Fluids

[Topic: Pressure, Density Pascal's Law & Archimedes' Principle]

Q29. Intensity of an electric field (E) depends on distance r , due to a dipole, is related as

- (a) $E \propto \frac{1}{r}$
(b) $E \propto \frac{1}{r^2}$
(c) $E \propto \frac{1}{r^3}$
(d) $E \propto \frac{1}{r^4}$

Ans: (c)

Solution: Intensity of electric field due to a Dipole

$$E = \frac{p}{4\pi\epsilon_0 r^3} \sqrt{3 \cos^2 \theta + 1} \Rightarrow E \propto \frac{1}{r^3}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q30. An inductor may store energy in

- (a) its electric field
(b) its coils
(c) its magnetic field
(d) both in electric and magnetic fields

Ans: (c)

Solution: An inductor stores energy in its magnetic field.

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications]

Q31. The mass number of a nucleus is

- (a) sometimes less than and sometimes more than its atomic number
(b) always less than its atomic number
(c) always more than its atomic number
(d) sometimes equal to its atomic number

Ans: (d)

Solution: In case of hydrogen atom,
Mass number = atomic number

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q32. When a body moves with a constant speed along a circle

- (a) its velocity remains constant
(b) no force acts on it
(c) no work is done on it
(d) no acceleration is produced in it

Ans: (c)

Solution: On circular motion, the force acts along the radius and displacement at a location is perpendicular to the radius i.e., $\theta = 90^\circ$

$$\text{As work done} = \vec{F} \cdot \vec{S} = FS \cos 90^\circ = 0$$

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q33. Steam at 100°C is passed into 20 g of water at 10°C . When water acquires a temperature of 80°C , the mass of water present will be:

[Take specific heat of water = $1 \text{ cal g}^{-1} ^{\circ}\text{C}^{-1}$ and latent heat of steam = 540 cal g^{-1}]

- (a) 24 g (b) 31.5 g
(c) 42.5 g (d) 22.5 g

Ans: (d)

Solution: According to the principle of calorimetry.

Heat lost = Heat gained

$$mL_v + m_s \Delta\theta = m_w s_w \Delta\theta$$

$$\Rightarrow m \times 540 + m \times 1 \times (100 - 80)$$

$$= 20 \times 1 \times (80 - 10)$$

$$\Rightarrow m = 2.5 \text{ g}$$

Therefore total mass of water at 80°C

$$= (20 + 2.5) \text{ g} = 22.5 \text{ g}$$

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q34. A hollow metal sphere of radius 10 cm is charged such that the potential on its surface is 80 V. The potential at the centre of the sphere is

- (a) zero (b) 80 V
(c) 800 V (d) 8 V

Ans: (b)

Solution: Potential at the centre of the sphere

= potential on the surface = 80 V.

Chapter: Electrostatic Potential and capacitance

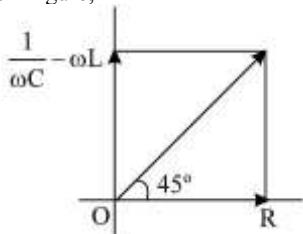
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q35. In a circuit, L, C and R are connected in series with an alternating voltage source of frequency f . The current leads the voltage by 45° . The value of C is

- (a) $\frac{1}{\pi f(2\pi fL - R)}$
(b) $\frac{1}{2\pi f(2\pi fL - R)}$
(c) $\frac{1}{\pi f(2\pi fL + R)}$
(d) $\frac{1}{2\pi f(2\pi fL + R)}$

Ans: (d)

Solution: From figure,



$$\tan 45^{\circ} = \frac{\frac{1}{\omega C} - \omega L}{R}$$

$$\Rightarrow \frac{1}{\omega C} - \omega L = R$$

$$\Rightarrow \frac{1}{\omega C} = R + \omega L \left(\omega = \frac{2\pi}{T} = 2\pi f \right)$$

$$C = \frac{1}{\omega(R + \omega L)} = \frac{1}{2\pi f(R + 2\pi fL)}$$

Chapter: Alternating Current

[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q36. The binding energy of deuteron is 2.2 MeV and that of ^4_2He is 28 MeV. If two deuterons are fused to form one ^4_2He , then the energy released is

- (a) 23.6 MeV (b) 19.2 MeV
(c) 30.2 MeV (d) 25.8 MeV

Ans: (a)

Solution: ${}_1\text{D}^2 \rightarrow {}_2\text{He}^4$

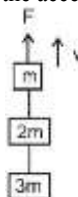
$$\text{Energy released} = 28 - 2 \times 2.2 = 23.6 \text{ MeV}$$

(Binding energy is energy released on formation of Nucleus)

Chapter: Nuclei

[Topic: Mass-Energy & Nuclear Reactions]

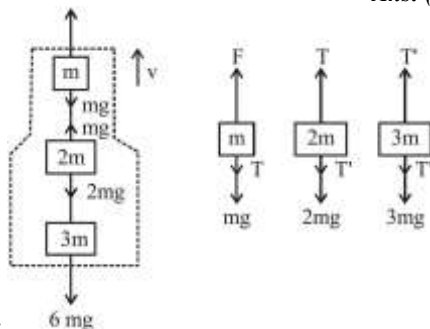
Q37. Three blocks with masses m , $2m$ and $3m$ are connected by strings as shown in the figure. After an upward force F is applied on block m , the masses move upward at constant speed v . What is the net force on the block of mass $2m$? (g is the acceleration due to gravity)



- (a) 2 mg
(c) 6 mg

- (b) 3 mg
(d) zero

Ans: (d)



Solution:

From figure

$$F = 6 \text{ mg,}$$

As speed is constant, acceleration $a = 0$

$$\therefore 6 \text{ mg} = 6ma = 0, F = 6 \text{ mg}$$

$$\therefore T = 5 \text{ mg, } T' = 3 \text{ mg}$$

$$T'' = 0$$

F_{net} on block of mass $2m$

$$= T - T' - 2 \text{ mg} = 0$$

Alternate :

$$\because v = \text{constant}$$

so, $a = 0$, Hence, $F_{\text{net}} = 0$

Chapter: Dynamics Laws of Motion

[Topic: Motion of Connected Bodies, Pulleys]

Q38. A black body is at temperature of 500 K. It emits energy at rate which is proportional to

- (a) $(500)^4$ (b) $(500)^3$
(c) $(500)^2$ (d) 500

Ans: (a)

Solution: According to Stefan's Law $E = \sigma eAT^4$
 $E \propto T^4$; so, $E \propto (500)^4$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q39. The capacity of a parallel plate condenser is $10 \mu\text{F}$ when the distance between its plates is 8 cm. If the distance between the plates is reduced to 4 cm then the capacity of this parallel plate condenser will be

- (a) $5 \mu\text{F}$ (b) $10 \mu\text{F}$
(c) $20 \mu\text{F}$ (d) $40 \mu\text{F}$

Ans: (c)

Solution: $C = 10 \mu\text{F}$, $d = 8 \text{ cm}$

$C' = ?$, $d' = 4 \text{ cm}$

$$C = \frac{A\epsilon_0}{d} \Rightarrow C \propto \frac{1}{d}$$

If d is halved then C will be doubled.

Hence, $C' = 2C = 2 \times 10 \mu\text{F} = 20 \mu\text{F}$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q40. The electric and the magnetic field associated with an E.M. wave, propagating along the +z-axis, can be represented by

- (a) $[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}]$
(b) $[\vec{E} = E_0\vec{k}, \vec{B} = B_0\hat{j}]$
(c) $[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}]$
(d) $[\vec{E} = E_0\hat{j}, \vec{B} = B_0\vec{k}]$

Ans: (a)

Solution: E.M. wave always propagates in a direction perpendicular to both electric and magnetic fields. So, electric and magnetic fields should be along +X- and +Y-directions respectively. Therefore, option (a) is the correct option.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q41. A radio isotope 'X' with a half life 1.4×10^9 years decays to 'Y' which is stable. A sample of the rock from a cave was found to contain 'X' and 'Y' in the ratio 1 : 7. The age of the rock is :

- (a) 1.96×10^9 years (b) 3.92×10^9 years
(c) 4.20×10^9 years (d) 8.40×10^9 years

Ans: (c)

Solution: As $\frac{N_x}{N_y} = \frac{1}{7}$ (Given)

$$\Rightarrow \frac{N_x}{N_x + N_y} = \frac{1}{8} = \left(\frac{1}{2}\right)^3$$

Therefore, age of the rock

$$t = 3T_{1/2} = 3 \times 1.4 \times 10^9 \text{ yrs} = 4.2 \times 10^9 \text{ yrs.}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q42. A car is negotiating a curved road of radius R . The road is banked at an angle θ . the coefficient of friction

between the tyres of the car and the road is μ_s . The maximum safe velocity on this road is :

- (a) $\sqrt{gR^2 \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$
(b) $\sqrt{gR \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$
(c) $\sqrt{\frac{g}{R} \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$
(d) $\sqrt{\frac{g}{R^2} \frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}}$

Ans: (b)

Solution: On a banked road,

$$\frac{V_{\max}^2}{R_g} = \left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta} \right)$$

Maximum safe velocity of a car on the banked road

$$V_{\max} = \sqrt{Rg \left[\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta} \right]}$$

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

Q43. A mass of diatomic gas ($\gamma = 1.4$) at a pressure of 2 atmospheres is compressed adiabatically so that its temperature rises from 27°C to 927°C . The pressure of the gas in final state is

- (a) 28 atm (b) 68.7 atm
(c) 256 atm (d) 8 atm

Ans: (c)

Solution: $T_1 = 273 + 27 = 300\text{K}$

$T_2 = 273 + 927 = 1200\text{K}$

For adiabatic process,

$$P^{1-\gamma} T^\gamma = \text{constant}$$

$$\Rightarrow P_1^{1-\gamma} T_1^\gamma = P_2^{1-\gamma} T_2^\gamma$$

$$= \left(\frac{P_2}{P_1} \right)^{1-\gamma} = \left(\frac{T_2}{T_1} \right)^\gamma$$

$$\Rightarrow \left(\frac{P_2}{P_1} \right)^{1-\gamma} = \left(\frac{T_2}{T_1} \right)^\gamma$$

$$\left(\frac{P_2}{P_1} \right)^{1-1.4} = \left(\frac{1200}{300} \right)^{1.4}$$

$$\left(\frac{P_2}{P_1} \right)^{-0.4} = (4)^{1.4}$$

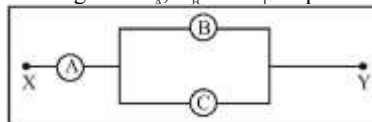
$$\left(\frac{P_2}{P_1} \right)^{0.4} = 4^{1.4}$$

$$P_2 = P_1 4^{\left(\frac{1.4}{0.4}\right)} = P_1 4^{\left(\frac{7}{2}\right)}$$

$$= P_1 (2)^7 = 2 \times 128 = 256 \text{ atm}$$

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q44. A, B and C are voltmeters of resistance R , $1.5 R$ and $3R$ respectively as shown in the figure. When some potential difference is applied between X and Y, the voltmeter readings are V_A , V_B and V_C respectively. Then



- (a) $V_A \neq V_B = V_C$
 (b) $V_A = V_B \neq V_C$
 (c) $V_A \neq V_B \neq V_C$
 (d) $V_A = V_B = V_C$

Solution: Effective resistance of B and C

$$\frac{R_B \cdot R_C}{R_B + R_C} = \frac{1.5R \times 3R}{1.5R + 3R} = \frac{4.5R^2}{4.5R} = R$$

i.e., equal to resistance of voltmeter A.

In parallel potential difference is same so, $V_B = V_C$ and in series current is same

So, $V_A = V_B = V_C$

Ans: (d)

Chapter: Current Electricity
[Topic: Combination of Resistances]

Q45. Match the corresponding entries of column-1 with column-2 (Where m is the magnification produced by the mirror):

Column-1 Column-2

(P) $m = -2$ (A) Convex mirror

(Q) $m = -\frac{1}{2}$ (B) Concave mirror

(R) $m = +2$ (C) Real image

(S) $m = +\frac{1}{2}$ (D) Virtual image

(a) $P \rightarrow B$ and C, $Q \rightarrow B$ and C, $R \rightarrow B$ and D, $S \rightarrow A$ and D.

(b) $P \rightarrow A$ and C, $Q \rightarrow A$ and D, $R \rightarrow A$ and B, $S \rightarrow C$ and D

(c) $P \rightarrow A$ and D, $Q \rightarrow B$ and C, $R \rightarrow B$ and D, $S \rightarrow B$ and C

(d) $P \rightarrow C$ and D, $Q \rightarrow B$ and D, $R \rightarrow B$ and C, $S \rightarrow A$ and D

Ans: (a)

Solution: Magnitude $m = +ve \Rightarrow$ virtual image

$m = -ve \Rightarrow$ real image

magnitude of magnification,

$|m| > 1 \Rightarrow$ magnified image

$|m| < 1 \Rightarrow$ diminished image

Chapter - Ray Optics and Optical
[Topic: Plane, Spherical Mirror & Reflection of Light]

Q46. Half-lives of two radioactive substances A and B are respectively 20 minutes and 40 minutes. Initially, the samples of A and B have equal number of nuclei. After 80 minutes the ratio of remaining numbers of A and B nuclei is

- (a) 1 : 16 (b) 4 : 1
 (c) 1 : 4 (d) 1 : 1

Ans: (c)

Solution: $80 = 20 \times n_A = n_A = 4$

$80 = 40 \times n_B = n_B = 2$

$$\frac{N_A}{N_B} = \frac{\left(\frac{1}{2}\right)^4}{\left(\frac{1}{2}\right)^2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q47. A person holding a rifle (mass of person and rifle together is 100 kg) stands on a smooth surface and fires 10 shots horizontally, in 5 s. Each bullet has a mass of 10 g with a muzzle velocity of 800 ms^{-1} . The final velocity

acquired by the person and the average force exerted on the person are

- (a) -1.6 ms^{-1} ; 8 N (b) -0.08 ms^{-1} ; 16 N
 (c) -0.8 ms^{-1} ; 8 N (d) -1.6 ms^{-1} ; 16 N

Ans: (c)

Solution: According to law of conservation of momentum

$$MV + mnv = 0$$

$$\Rightarrow V = \frac{-mNv}{M} = \frac{-0.01 \text{ kg} \times 10 \times 800 \text{ m/s}}{100}$$

$$\Rightarrow -0.8 \text{ m/s}$$

According to work energy theorem,

Average work done = Change in average kinetic energy

$$\text{i.e., } F_{av} \times S_{av} = \frac{1}{2} m V_{rms}^2$$

$$\Rightarrow \frac{F_{av} V_{max} t}{2} = \frac{1}{2} m \frac{V_{rms}^2}{2}$$

$$\Rightarrow F_{av} = 8 \text{ N}$$

Chapter: Work, Energy and Power
[Topic: Energy]

Q48. The temperature of source and sink of a heat engine are 127°C and 27°C respectively. An inventor claims its efficiency to be 26%, then:

- (a) it is impossible
 (b) it is possible with high probability
 (c) it is possible with low probability
 (d) data are insufficient.

Ans: (a)

$$\text{Solution: } \eta = 1 - \frac{300}{400} = \frac{100}{400} = \frac{1}{4}$$

$$\eta = \frac{1}{4} \times 100 = 25\%$$

Hence, it is not possible to have efficiency more than 25%.

Chapter: Heat & Thermodynamics

Q49. Consider the following two statements:

(A) Kirchhoff's junction law follows from the conservation of charge.

(B) Kirchhoff's loop law follows from the conservation of energy.

Which of the following is correct?

- (a) Both (A) and (B) are wrong
 (b) (a) is correct and (B) is wrong
 (c) (a) is wrong and (B) is correct
 (d) Both (A) and (B) are correct

Ans: (d)

Solution: Junction law follows from conservation of charge and loop law is the conservation of energy

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q50. When a biconvex lens of glass having refractive index 1.47 is dipped in a liquid, it acts as a plane sheet of glass. This implies that the liquid must have refractive index.

- (a) equal to that of glass
 (b) less than one
 (c) greater than that of glass
 (d) less than that of glass

Solution: $\frac{1}{f} = \left(\frac{\mu_g}{\mu_m} - 1\right) \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
 If $\mu_g = \mu_m$, then $\frac{1}{f} = (1 - 1) \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
 $\Rightarrow \frac{1}{f} = 0 \rightarrow \text{infinity}$

This implies that the liquid must have refractive index equal to glass.

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

PART 2. PHYSICS QUESTION BANK

Q51. In forward biasing of the p-n junction

- (a) the positive terminal of the battery is connected to p-side and the depletion region becomes thick
- (b) the positive terminal of the battery is connected to n-side and the depletion region becomes thin
- (c) the positive terminal of the battery is connected to n-side and the depletion region becomes thick
- (d) the positive terminal of the battery is connected to p-side and the depletion region becomes thin

Ans: (d)

Solution: In forward biasing of the p-n junction, the positive terminal of the battery is connected to p-side and the negative terminal of the battery is connected to n-side. The depletion region becomes thin.

Chapter: Semiconductor Electronics Materials, Devices [Topic: Solids, Semiconductors and P-N Junction Diode]

Q52. An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine?

- (a) 400 W
- (b) 200 W
- (c) 100 W
- (d) 800 W

Ans: (d)

Solution: Amount of water flowing per second from the pipe

$$= \frac{m}{\text{time}} = \frac{m}{\ell} \cdot \frac{\ell}{t} = \left(\frac{m}{\ell}\right) v$$

Power = K.E. of water flowing per second

$$= \frac{1}{2} \left(\frac{m}{\ell}\right) v \cdot v^2$$

$$= \frac{1}{2} \left(\frac{m}{\ell}\right) v^3$$

$$= \frac{1}{2} \times 100 \times 8 = 400 \text{ W}$$

Chapter: Work, Energy and Power

[Topic: Power]

Q53. 0 g of a gas occupies 22.4 litres at NTP. The specific heat capacity of the gas at constant volume is 5.0 JK^{-1} . If the speed of sound in this gas at NTP is 952 ms^{-1} , then the heat capacity at constant pressure is (Take gas constant $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$)

Ans: (a)

(a) $7.5 \text{ JK}^{-1} \text{ mol}^{-1}$

(b) $7.0 \text{ JK}^{-1} \text{ mol}^{-1}$

(c) $8.5 \text{ JK}^{-1} \text{ mol}^{-1}$

(d) $8.0 \text{ JK}^{-1} \text{ mol}^{-1}$

Ans: (d)

Solution: Molar mass of the gas = 4g/mol

Speed of sound

$$V = \sqrt{\frac{\gamma RT}{m}} \Rightarrow 952 = \sqrt{\frac{\gamma \times 3.3 \times 273}{4 \times 10^{-3}}}$$

$$\Rightarrow \gamma = 1.6 = \frac{16}{10} = \frac{8}{5}$$

$$\text{Also, } \gamma = \frac{C_p}{C_v} = \frac{8}{5}$$

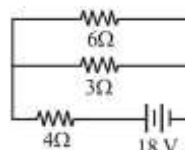
$$\text{So, } C_p = \frac{8 \times 5}{5} = 8 \text{ JK}^{-1} \text{ mol}^{-1}$$

[$C_v = 5.0 \text{ JK}^{-1}$ given]

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q54. The total power dissipated in watts in the circuit shown here is



(a) 40

(b) 54

(c) 4

(d) 16

Ans: (b)

Solution: Power dissipated = P

$$= \frac{V^2}{R} = \frac{(18)^2}{6} = 54 \text{ W}$$

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q55. The angle of a prism is 'A'. One of its refracting surfaces is silvered. Light rays falling at an angle of incidence $2A$ on the first surface returns back through the same path after suffering reflection at the silvered surface. The refractive index μ , of the prism is :

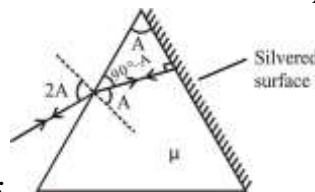
(a) $2 \sin A$

(b) $2 \cos A$

(c) $\frac{1}{2} \cos A$

(d) $\tan A$

Ans: (b)



Solution:

According to Snell's law $\mu = \frac{\sin i}{\sin r}$

$$\Rightarrow (1) \sin 2A = (\mu) \sin A \Rightarrow \mu = 2 \cos A$$

Chapter - Ray Optics and Optical

[Topic: Prism & Dispersion of Light]

Q56. An alternating current can be converted into direct current by a

(a) transformer

(b) dynamo

(c) motor

(d) rectifier

Ans: (d)

**Solution: Chapter: Semiconductor Electronics
Materials, Devices**

**[Topic: Solids, Semiconductors and P-N Junction
Diode]**

Q57. The co-efficient of restitution e for a perfectly elastic collision is

- (a) 1 (b) 0
(c) ∞ (d) -1

Ans: (a)

Solution: $e = |v_1 - v_2| / |u_1 - u_2|$ which is 1 for a perfectly elastic collision.

Chapter: Work, Energy and Power

**[Topic: Centre of Mass, Centre of Gravity & Principle
of Moments]**

Q58. Which one of the following statements is true for the speed v and the acceleration a of a particle executing simple harmonic motion?

- (a) When v is maximum, a is zero
(b) When v is maximum, a is maximum
(c) Value of a is zero, whatever may be the value of v
(d) When v is zero, a is zero

Solution: (d) In S.H.M., $v_{\max} = A\omega = A(2\pi f)$

$$f = \frac{v_{\max}}{2\pi A} = \frac{31.4}{2(3.14) \times 5} = 1 \text{ persec.}$$

Chapter: Oscillation

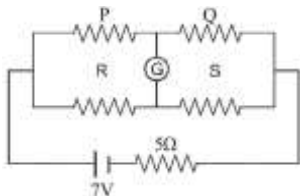
**[Topic: Displacement, Phase, Velocity & Acceleration
of SHM]**

Q59. The resistance of the four arms P, Q, R and S in a Wheatstone's bridge are 10 ohm, 30 ohm, 30 ohm and 90 ohm, respectively. The e.m.f. and internal resistance of the cell are 7 volt and 5 ohm respectively. If the galvanometer resistance is 50 ohm, the current drawn from the cell will be

- (a) 0.2 A (b) 0.1 A
(c) 2.0 A (d) 1.0 A

Ans: (a)

Solution: Given : $V = 7 \text{ V}$
 $r = 5\Omega$



$$R_{eq} = \frac{40 \times 120}{40 + 120} \Omega$$

$$I = \frac{V}{R} = \frac{7}{5 + \frac{40 \times 120}{40 + 120}} = \frac{7}{5 + 30} = \frac{1}{5} = 0.2 \text{ A.}$$

Chapter: Current Electricity

**[Topic: Wheatstone Bridge & Different Measuring
Instruments]**

Q60. In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A

monochromatic light wavelength 500 nm is used. What will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern?

- (a) 0.1 mm (b) 0.5 mm
(c) 0.02 mm (d) 0.2 mm

Ans: (d)

Solution: Here, distance between two slits,

$$d = 1 \text{ mm} = 10^{-3} \text{ m}$$

distance of screen from slits, $D = 1 \text{ m}$

wavelength of monochromatic light used,

$$\lambda = 500 \text{ nm} = 500 \times 10^{-9} \text{ m}$$

width of each slit $a = ?$

Width of central maxima in single slit pattern $= \frac{2\lambda D}{a}$

Fringe width in double slit experiment $\beta = \frac{\lambda D}{d}$

$$\text{So, required condition } \frac{10\lambda D}{d} = \frac{2\lambda D}{a}$$

$$\Rightarrow a = \frac{d}{5D} = \frac{1}{5} \times 10^{-3} \text{ m} = 0.2 \text{ mm}$$

Chapter - Wave Optics

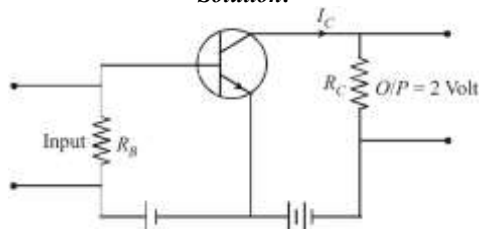
[Topic: Young's Double Slit Experiment]

Q61. In a CE transistor amplifier, the audio signal voltage across the collector resistance of $2\text{k}\Omega$ is 2V. If the base resistance is $1\text{k}\Omega$ and the current amplification of the transistor is 100, the input signal voltage is :

- (a) 0.1 V (b) 1.0 V
(c) 1 mV (d) 10 mV

Ans: (d)

Solution:



The output voltage, across the load R_C

$$V_o = I_C R_C = 2$$

The collector current (I_C)

$$I_C = \frac{2}{2 \times 10^3} = 10^{-3} \text{ Amp}$$

Current gain (β)

$$(\beta) \text{ current gain} = \frac{I_C}{I_B} = 100$$

$$I_B = \frac{I_C}{100} = \frac{10^{-3}}{100} = 10^{-5} \text{ Amp}$$

Input voltage (V_i)

$$V_i = R_B I_B = 1 \times 10^3 \times 10^{-5} = 10^{-2} \text{ Volt}$$

$$V_i = 10 \text{ mV}$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q62. The unit of permittivity of free space, ϵ_0 is

- (a) $\text{Coulomb}^2/(\text{Newton-metre})^2$
(b) $\text{Coulomb}/\text{Newton-metre}$
(c) $\text{Newton-metre}^2/\text{Coulomb}^2$
(d) $\text{Coulomb}^2/\text{Newton-metre}^2$

Ans: (d)

Solution: $\epsilon_0 = \frac{q^2}{(r^2)4\pi F}$

$\Rightarrow$ unit of ϵ_0 is (coulomb)²/ newton-metre²

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q63. Two discs are rotating about their axes, normal to the discs and passing through the centres of the discs. Disc D_1 has 2 kg mass and 0.2 m radius and initial angular velocity of 50 rad s⁻¹. Disc D_2 has 4kg mass, 0.1 m radius and initial angular velocity of 200 rad s⁻¹. The two discs are brought in contact face to face, with their axes of rotation coincident. The final angular velocity (in rad s⁻¹) of the system is

- (a) 40 (b) 60
(c) 100 (d) 120

Ans: (c)

Solution: Given: $m_1 = 2 \text{ kg}$, $m_2 = 4 \text{ kg}$

$r_1 = 0.2 \text{ m}$, $r_2 = 0.1 \text{ m}$

$\omega_1 = 50 \text{ rad s}^{-1}$, $\omega_2 = 200 \text{ rad s}^{-1}$

As, angular momentum, $I_1 \omega_1 = I_2 \omega_2 = \text{Constant}$

$$\therefore W_f = \frac{I_1 \omega_1 + I_2 \omega_2}{I_1 + I_2} = \frac{\frac{1}{2} m_1 r_1^2 \omega_1 + \frac{1}{2} m_2 r_2^2 \omega_2}{\frac{1}{2} m_1 r_1^2 + \frac{1}{2} m_2 r_2^2}$$

By putting the value of m_1 , m_2 , r_1 , r_2 and solving we get = 100 rad s⁻¹

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q64. A block of mass M is attached to the lower end of a vertical spring. The spring is hung from a ceiling and has force constant value k . The mass is released from rest with the spring initially unstretched. The maximum extension produced in the length of the spring will be:

- (a) 2 Mg/k (b) 4 Mg/k
(c) Mg/2k (d) Mg/k

Ans: (d)

Solution: Restoring force, $f' = -kx$

where x is the extension produced in the spring.

Weight of the mass acting downward = Mg .

In equilibrium

$kx = Mg$ or $x = \frac{Mg}{k}$

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q65. An electron moves in a circular orbit with a uniform speed v . It produces a magnetic field B at the centre of the circle. The radius of the circle is proportional to

- (a) $\sqrt{\frac{B}{v}}$
(b) $\frac{B}{v}$
(c) $\sqrt{\frac{v}{B}}$
(d) $\frac{v}{B}$

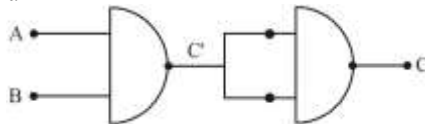
Solution: $r = \frac{mv}{qB} \Rightarrow r \propto \frac{v}{B}$

Ans: (d)

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q66. The output from a NAND gate is divided into two in parallel and fed to another NAND gate. The resulting gate is a



- (a) NOT gate
(b) AND gate
(c) NOR gate
(d) OR gate

Ans: (b)

Solution: $C' = \overline{A \cdot B} = C = \overline{\overline{A \cdot B}} = A \cdot B$

Hence the resultant gate is AND gate.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Digital Electronics and Logic Gates]

Q67. Turpentine oil is flowing through a tube of length $= \frac{1}{N} \times \frac{1}{10} \text{ cm} = \frac{1}{10N}$ and radius r .

The pressure difference between the two ends of the tube is p . The viscosity of oil is given by

$$\eta = \frac{p(r^2 - x^2)}{4vl}$$

where v is the velocity of oil at a distance x from the axis of the tube. The dimensions of η are

- (a) $[M^0 L^0 T^0]$ (b) $[MLT^{-1}]$
(c) $[ML^2 T^{-2}]$ (d) $[ML^{-1} T^{-1}]$

Ans: (d)

Solution: $h = \frac{p(r^2 - x^2)}{4vl} = \frac{[ML^{-1} T^{-2}][L^2]}{[LT^{-1}][L]}$
 $= [ML^{-1} T^{-1}]$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q68. Two discs of same moment of inertia rotating about their regular axis passing through centre and perpendicular to the plane of disc with angular velocities ω_1 and ω_2 . They are brought into contact face to face coinciding the axis of rotation. The expression for loss of energy during this process is:-

- (a) $\frac{1}{4} I(\omega_1 - \omega_2)^2$
(b) $I(\omega_1 - \omega_2)^2$
(c) $\frac{1}{8} I(\omega_1 - \omega_2)^2$
(d) $\frac{1}{2} I(\omega_1 + \omega_2)^2$

Ans: (a)

Solution: Here, $I\omega_1 + I\omega_2 = 2I\omega$

$\Rightarrow \omega = \frac{\omega_1 + \omega_2}{2}$

$(K.E.)_i = \frac{1}{2} I\omega_1^2 + \frac{1}{2} I\omega_2^2$

$(K.E.)_f = \frac{1}{2} \times 2I\omega^2 = I \left(\frac{\omega_1 + \omega_2}{2} \right)^2$

Loss in K.E. = $(K.E.)_i - (K.E.)_f = \frac{1}{4} I(\omega_1 - \omega_2)^2$

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q69. Two waves are represented by the equations $y_1 = a \sin(\omega t + kx + 0.57)$ m and $y_2 = a \cos(\omega t + kx)$ m, where x is in meter and t in sec. The phase difference between them is

- (a) 1.0 radian (b) 1.25 radian
(c) 1.57 radian (d) 0.57 radian

Ans: (a)

Solution: Here, $y_1 = a \sin(\omega t + kx + 0.57)$

and $y_2 = a \cos(\omega t + kx)$

$$= a \sin\left[\frac{\pi}{2} + (\omega t + kx)\right]$$

Phase difference, $\Delta\phi = \phi_2 - \phi_1$

$$= \frac{\pi}{2} - 0.57$$

$$= \frac{3.14}{2} - 0.57$$

$$= 1.57 - 0.57$$

$$= 1 \text{ radian}$$

Chapter: Waves

[Topic: Basic of Waves]

Q70. A wire carries a current. Maintaining the same current it is bent first to form a circular plane coil of one turn which produces a magnetic field B at the centre of the coil. The same length is now bent more sharply to give a double loop of smaller radius. The magnetic field at the centre of the double loop, caused by the same current is

- (a) $4B$ (b) $B/4$
(c) $B/2$ (d) $2B$

Ans: (a)

Solution: Let I be current and l be the length of the wire.

For Ist case : $B = \frac{\mu_0 I n}{2r} = \frac{\mu_0 I \times \pi}{l}$ where $2\pi r = l$ and $n = 1$

For IInd Case : $l = 2(2\pi r') \Rightarrow r' = \frac{l}{4\pi}$

$$B' = \frac{\mu_0 n I}{2r'} = \frac{\mu_0 2I}{2 \frac{l}{4\pi}} = \frac{4\mu_0 I \pi}{l} = 4B$$

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q71. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is :

- (a) 1 : 4 (b) 1 : 2
(c) 1 : 1 (d) 1 : 5

Ans: (b)

Solution: According to Einstein's photoelectric effect, the K.E. of the radiated electrons

$$K.E._{\max} = E - W$$

$$\frac{1}{2} m v_1^2 = (1 - 0.5) \text{ eV} = 0.5 \text{ eV}$$

$$\frac{1}{2} m v_2^2 = (2.5 - 0.5) \text{ eV} = 2 \text{ eV}$$

$$\frac{v_1}{v_2} = \sqrt{\frac{0.5}{2}} = \frac{1}{\sqrt{4}} = 1:2$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q72. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$ where b and n are constants and x is the position of the particle. The acceleration of the particle as a function of x , is given by:

- (a) $-2nb^2 x^{-4n-1}$ (b) $-2b^2 x^{-2n+1}$
(c) $-2nb^2 e^{-4n+1}$ (d) $-2nb^2 x^{-2n-1}$

Ans: (a)

Solution: According to question,

$$V(x) = bx^{-2n}$$

$$\text{So, } \frac{dv}{dx} = -2nbx^{-2n-1}$$

Acceleration of the particle as function of x ,

$$a = v \frac{dv}{dx} = bx^{-2n} \{b(-2n)x^{-2n-1}\}$$

$$= -2nb^2 x^{-4n-1}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

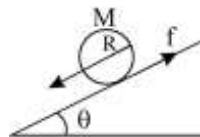
Q73. A drum of radius R and mass M , rolls down without slipping along an inclined plane of angle θ . The frictional force

- (a) dissipates energy as heat
(b) decreases the rotational motion
(c) decreases the rotational and translational motion
(d) converts translational energy to rotational energy

Ans: (d)

Solution: Net work done by frictional force when drum rolls down without slipping is zero.

$$W_{\text{net}} = 0$$



$$W_{\text{trans.}} + W_{\text{rot.}} = 0; \Delta K_{\text{trans.}} + \Delta K_{\text{rot.}} = 0$$

$$\Delta K_{\text{trans.}} = -\Delta K_{\text{rot.}}$$

i.e., converts translation energy to rotational energy.

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q74. Which of the following equations represent a wave?

- (a) $y = A \sin \omega t$
(b) $y = A \cos kx$
(c) $y = A \sin (at - bx + c)$
(d) $y = A (\omega t - kx)$

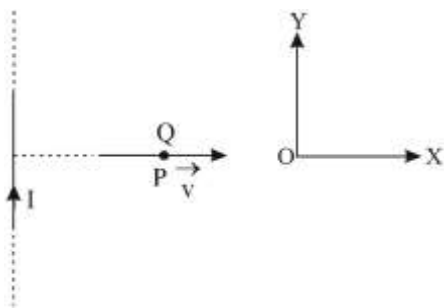
Ans: (c)

Solution: $y = A \sin (at - bx + c)$ represents a wave, where a may correspond to ω and b may correspond to k .

Chapter: Waves

[Topic: Basic of Waves]

Q75. A very long straight wire carries a current I . At the instant when a charge $+Q$ at point P has velocity $\vec{v}$, as shown, the force on the charge is



- (a) along oy
(b) opposite to oy
(c) along ox
(d) opposite to ox

Solution: The direction of $\vec{B}$ is along $(-\hat{k})$

$\therefore$ The magnetic force

$$\vec{F} = Q(\vec{v} \times \vec{B}) = Q(v\hat{i}) \times B(-\hat{k}) = QvB\hat{j}$$

$\Rightarrow \vec{F}$ is along OY.

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q76. In a photo-emissive cell, with exciting wavelength λ , the fastest electron has speed v . If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be

- (a) $(3/4)^{1/2} \cdot v$
(b) $(4/3)^{1/2} \cdot v$
(c) less than $(4/3)^{1/2} \cdot v$
(d) greater than $(4/3)^{1/2} \cdot v$

Ans: (d)

$$\text{Solution: } \frac{1}{2}mv^2 = \frac{hc}{\lambda} - W_0 \text{ or } \frac{hc}{\lambda} = \frac{1}{2}mv^2 + W_0 \text{ and}$$

$$\frac{1}{2}mv_1^2 = \frac{hc}{\left(\frac{3\lambda}{4}\right)} - W_0$$

$$= \frac{4}{3} \left(\frac{1}{2}mv^2 + W_0 \right) - W_0$$

$$\text{So, } v_1 \text{ is greater than } v \left(\frac{4}{3} \right)^{\frac{1}{2}}.$$

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q77. A train of 150 metre long is going towards north direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards south direction parallel to the railway track. The time taken by the parrot to cross the train is

- (a) 12 sec (b) 8 sec
(c) 15 sec (d) 10 sec

Ans: (d)

Solution: Relative velocity of parrot w.r.t the train
 $= 10 - (-5) = 15 \text{ ms}^{-1}$.

Time taken by parrot to cross the train

$$= \frac{150}{15} = 10 \text{ s}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q78. The acceleration due to gravity on the planet A is 9 times the acceleration due to gravity on planet B. A man jumps to a height of 2m on the surface of A. What is the height of jump by the same person on the planet B?

- (a) $\frac{2}{3}$ m (b) $\frac{2}{9}$ m
(c) 18 m (d) 6 m

Ans: (c)

Solution: Applying conservation of total mechanical energy principle

$$\frac{1}{2}mv^2 = mg_A h_A = mg_B h_B$$

$$= g_A h_A = g_B h_B$$

$$= h_B = \left(\frac{g_A}{g_B} \right) h_A = 9 \times 2 = 18 \text{ m}$$

Chapter: Gravitation

[Topic: Acceleration due to Gravity]

Q79. A source of unknown frequency gives 4 beats/s, when sounded with a source of known frequency 250 Hz. The second harmonic of the source of unknown frequency gives five beats per second, when sounded with a source of frequency 513 Hz. The unknown frequency is

- (a) 246 Hz (b) 240 Hz
(c) 260 Hz (d) 254 Hz

Ans: (d)

Solution: When sounded with a source of known frequency fundamental frequency

$$= 250 \pm 4 \text{ Hz} = 254 \text{ Hz or } 246 \text{ Hz}$$

$$2^{\text{nd}} \text{ harmonic if unknown frequency (suppose) } 254 \text{ Hz} = 2 \times 254 = 508 \text{ Hz}$$

As it gives 5 beats

$$\therefore 508 + 5 = 513 \text{ Hz}$$

Hence, unknown frequency is 254 Hz

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q80. Current i is flowing in a coil of area A and number of turns N , then magnetic moment of the coil, M is

- (a) NiA
(b) $\frac{Ni}{A}$
(c) $\frac{Ni}{\sqrt{A}}$
(d) $N^2 Ai$

Ans: (a)

Solution: Magnetic moment linked with one turn $= iA$

$$\text{Magnetic moment linked with } N \text{ turns} = iNA \text{ amp-m}^2.$$

Here, A = Area of current loop.

Chapter: Magnetism and Matter

[Topic: Magnetism, Gauss's Law]

Q81. In a Rutherford scattering experiment when a projectile of charge Z_1 and mass M_1 approaches a target nucleus of charge Z_2 and mass M_2 , the distance of closest approach is r_0 . The energy of the projectile is

- (a) directly proportional to $Z_1 Z_2$
(b) inversely proportional to Z_1

- (c) directly proportional to mass M_1
 (d) directly proportional to $M_1 \times M_2$

Ans: (a)

Solution: The kinetic energy of the projectile is given by

$$\frac{1}{2}mv^2 = \frac{Ze(2e)}{4\pi\epsilon_0 r_0} = \frac{Z_1 Z_2}{4\pi\epsilon_0 r_0}$$

 Thus energy of the projectile is directly proportional to Z_1, Z_2

Chapter: Atoms

[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q82. If $|\vec{A} \times \vec{B}| \Rightarrow \sqrt{3}\vec{A} \cdot \vec{B}$ then the value of $|\vec{A} + \vec{B}|$ is

- (a) $(A^2 + B^2 + \sqrt{3}AB)^{\frac{1}{2}}$
 (b) $(A^2 + B^2 + AB)^{\frac{1}{2}}$
 (c) $(A^2 + B^2 + \frac{AB}{\sqrt{3}})^{\frac{1}{2}}$
 (d) $A + B$

Ans: (b)

Solution: $|\vec{A} \times \vec{B}| = AB\sin\theta$

$$\vec{A} \cdot \vec{B} = AB\cos\theta$$

$$|\vec{A} \times \vec{B}| = \sqrt{3}\vec{A} \cdot \vec{B} \Rightarrow AB\sin\theta = \sqrt{3}AB\cos\theta$$

$$\text{or, } \tan\theta = \sqrt{3}, \therefore \theta = 60^\circ$$

$$|\vec{A} + \vec{B}| = \sqrt{A^2 + B^2 + 2AB\cos 60^\circ}$$

$$= \sqrt{A^2 + B^2 + AB}$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q83. The radii of circular orbits of two satellites A and B of the earth, are $4R$ and R , respectively. If the speed of satellite A is $3V$, then the speed of satellite B will be:

- (a) $3V/4$ (b) $6V$
 (c) $12V$ (d) $3V/2$

Ans: (b)

Solution: Orbital velocity of a satellite in a circular orbit of radius a is given by

$$v = \sqrt{\frac{GM}{a}}$$

$$= v \propto \sqrt{\frac{1}{a}}$$

$$= \frac{v_2}{v_1} = \sqrt{\frac{a_1}{a_2}}$$

$$v_2 = v_1 \sqrt{\frac{4R}{R}} = 2v_1 = 6V$$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q84. A star, which is emitting radiation at a wavelength of $5000 \text{ \AA}$, is approaching the earth with a velocity of $1.50 \times 10^6 \text{ m/s}$. The change in wavelength of the radiation as received on the earth is

- (a) $0.25 \text{ \AA}$ (b) $2.5 \text{ \AA}$
 (c) $25 \text{ \AA}$ (d) $250 \text{ \AA}$

Ans: (c)

Solution: Given : Wavelength (λ) = $5000 \text{ \AA}$

velocity of star (v) = $1.5 \times 10^6 \text{ m/s}$.

We know that wavelength of the approaching star (λ') = $\lambda \frac{c-v}{c}$

$$\text{or, } \frac{\lambda'}{\lambda} = \frac{c-v}{c} = 1 - \frac{v}{c}$$

$$\text{or, } \frac{v}{c} = 1 - \frac{\lambda'}{\lambda} = \frac{\lambda - \lambda'}{\lambda} = \frac{\Delta\lambda}{\lambda} \text{ . Therefore,}$$

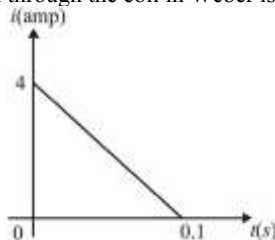
$$\Delta\lambda = \lambda \times \frac{v}{c} = 5000 \times \frac{1.5 \times 10^6}{3 \times 10^8} = 25 \text{ \AA}$$

[where $\Delta\lambda$ = Change in the wavelength]

Chapter: Waves

[Topic: Musical Sound & Doppler's Effect]

Q85. In a coil of resistance 10Ω , the induced current developed by changing magnetic flux through it, is shown in figure as a function of time. The magnitude of change in flux through the coil in Weber is :



- (a) 8 (b) 2
 (c) 6 (d) 4

Ans: (b)

Solution: The charge through the coil = area of current-time ($i-t$) graph

$$q = \frac{1}{2} \times 0.1 \times 4 = 0.2 \text{ C}$$

$$q = \frac{\Delta\phi}{R} \therefore \text{Change in flux } (\Delta\phi) = q \times R$$

$$q = 0.2 = \frac{\Delta\phi}{10}$$

$$\Delta\phi = 2 \text{ Weber}$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q86. Energy E of a hydrogen atom with principal quantum number n is given by $E = -13.6/n^2 \text{ eV}$. The energy of photon ejected when the electron jumps from $n = 3$ state to $n = 2$ state of hydrogen is approximately

- (a) 1.9 eV (b) 1.5 eV
 (c) 0.85 eV (d) 3.4 eV

Ans: (a)

Solution: $\Delta E = E_3 - E_2$

$$= \frac{-13.6}{3^2} - \frac{-13.6}{2^2}$$

$$= 13.6 \left\{ \frac{1}{4} - \frac{1}{9} \right\} \text{ eV} = 1.9 \text{ eV}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q87. A projectile is fired at an angle of 45° with the horizontal. Elevation angle of the projectile at its highest point as seen from the point of projection is

- (a) 60°
 (b) $\tan^{-1} \left(\frac{1}{2} \right)$

(c) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(d) 45°

Ans: (b)

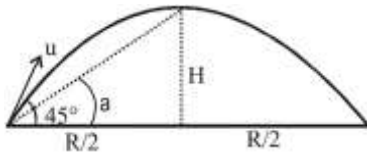
Solution: $H = \frac{u^2 \sin^2 45^\circ}{2g} = \frac{u^2}{4g} \dots (1)$

$R = \frac{u^2 \sin 90^\circ}{g} = \frac{u^2}{g}$

$\frac{R}{2} = \frac{u^2}{2g} \dots (2)$

$\tan \alpha = \frac{H}{\frac{R}{2}}$

$= \frac{\frac{u^2}{4g}}{\frac{u^2}{2g}} = \frac{1}{2} \alpha = \tan^{-1}\left(\frac{1}{2}\right)$



Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q88. In rising from the bottom of a lake, to the top, the temperature of an air bubble remains unchanged, but its diameter gets doubled. If h is the barometric height (expressed in m of mercury of relative density ρ) at the surface of the lake, the depth of the lake is

- (a) $8 \rho h$ m (b) $7 \rho h$ m
(c) $9 \rho h$ m (d) $12 \rho h$ m

Ans: (b)

Solution: $(h\rho g + H \times 1 \times g) \frac{4}{3} \pi r^3 = h\rho g \times \frac{4}{3} \pi (2r)^3$

This gives $H = 7h\rho$

Chapter: Mechanical Properties of Fluids

[Topic: Pressure, Density Pascal's Law & Archimedes' Principle]

Q89. The formation of a dipole is due to two equal and dissimilar point charges placed at a

- (a) short distance
(b) long distance
(c) above each other
(d) none of these

Ans: (a)

Solution: Dipole is formed when two equal and unlike charges are placed at a short distance.

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q90. The total charge induced in a conducting loop when it is moved in a magnetic field depends on

- (a) the rate of change of magnetic flux
(b) initial magnetic flux only
(c) the total change in magnetic flux
(d) final magnetic flux only

Ans: (c)

Solution: $e = \frac{d\phi}{dt}; i = \frac{e}{R} = \frac{1}{R} \frac{d\phi}{dt}$

Total charge induced $= \int i dt = \int \frac{1}{R} \frac{d\phi}{dt} \cdot dt$

$= \frac{1}{R} \int_{\phi_1}^{\phi_2} d\phi = \frac{1}{R} (\phi_2 - \phi_1)$

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications]

Q91. The volume occupied by an atom is greater than the volume of the nucleus by a factor of about

[2003]

- (a) 10^{15} (b) 10^1
(c) 10^5 (d) 10^{10}

Ans: (a)

Solution: $V \propto r^3 = V_{\text{atom}} = \frac{r_{\text{atom}}^3}{r_{\text{nucleus}}^3} \times V_{\text{nucleus}}$

But $\frac{r_{\text{nucleus}}}{r_{\text{atom}}} = \left(\frac{1}{10^5}\right)^3$

Hence, $V_{\text{atom}} = 10^{15} \times V_{\text{nucleus}}$

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q92. A boat is sent across a river with a velocity of 8 km h^{-1} . If the resultant velocity of boat is 10 km h^{-1} , then the velocity of the river is

- (a) 12.8 km h^{-1} (b) 6 km h^{-1}
(c) 8 km h^{-1} (d) 10 km h^{-1}

Ans: (b)

Solution: $v_r = \sqrt{v_R^2 - v_B^2} = \sqrt{10^2 - 8^2} = 6 \text{ km h}^{-1}$

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q93. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using

[2013]

- (a) Wien's displacement law
(b) Kirchhoff's law
(c) Newton's law of cooling
(d) Stefan's law

Ans: (a)

Solution: Wein's displacement law

According to this law

$\lambda_{\text{max}} \propto \frac{1}{T}$

or, $\lambda_{\text{max}} \times T = \text{constant}$

So, as the temperature increases λ decreases.

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q94. The potential energy of particle in a force field is

$U = \frac{A}{r^2} - \frac{B}{r}$, where A and B are positive constants and r is the distance of particle from the centre of the field. For stable equilibrium, the distance of the particle is :

- (a) $B/2A$ (b) $2A/B$
(c) A/B (d) B/A

Ans: (b)

Solution: for equilibrium

$\frac{dU}{dr} = 0 \Rightarrow \frac{-2A}{r^3} + \frac{B}{r^2} = 0$

$r = \frac{2A}{B}$

for stable equilibrium

$\frac{d^2U}{dr^2}$ should be positive for the value of r .

here $\frac{d^2U}{dr^2} = \frac{6A}{r^4} - \frac{2B}{r^3}$ is +ve value for

$$r = \frac{2A}{B} \text{ So}$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q95. A coil of 40 henry inductance is connected in series with a resistance of 8 ohm and the combination is joined to the terminals of a 2 volt battery. The time constant of the circuit is

[2004]

- (a) 20 seconds (b) 5 seconds
 (c) 1/5 seconds (d) 40 seconds

Ans: (b)

Solution: Time constant is L/R

Given, $L = 40H$ & $R = 8\Omega$

$\therefore \tau = 40/8 = 5 \text{ sec.}$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q96. In the reaction, ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n}$, if the binding energies of ${}^2_1\text{H}$, ${}^3_1\text{H}$ and ${}^4_2\text{He}$ are respectively, a , b and c (in MeV), then the energy (in MeV) released in this reaction is

- (a) $a + b + c$
 (b) $a + b - c$
 (c) $c - a - b$
 (d) $c + a - b$

Ans: (c)

Solution: ${}^2_1\text{H}$ and ${}^3_1\text{H}$ requires a and b amount of energies for their nucleons to be separated.

${}^4_2\text{He}$ releases c amount of energy in its formation i.e., in assembling the nucleons as nucleus.

Hence, Energy released $= c - (a + b) = c - a - b$

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q97. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration 1.0 m/s^2 . If $g = 10 \text{ ms}^{-2}$, the tension in the supporting cable is

- (a) 8600 N (b) 9680 N
 (c) 11000 N (d) 1200 N

Ans: (c)

Solution: Total mass $= (60 + 940) \text{ kg} = 1000 \text{ kg}$

Let T be the tension in the supporting cable, then

$$T - 1000g = 1000 \times 1$$

$$\Rightarrow T = 1000 \times 11 = 11000 \text{ N}$$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q98. If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor of

- (a) 2 (b) 4
 (c) 8 (d) 16

Ans: (d)

Solution: Amount of energy radiated $\propto T^4$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q99. Energy stored in a capacitor is

- (a) $\frac{1}{2} QV$
 (b) QV
 (c) $\frac{1}{QV}$
 (d) $\frac{2}{QV}$

Ans: (a)

Solution: Energy stored in capacitor

$$= \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q}{V} V^2 (Q = CV)$$

$$= \frac{1}{2} QV$$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q100. Which of the following statement is false for the properties of electromagnetic waves?

- (a) Both electric and magnetic field vectors attain the maxima and minima at the same place and same time.
 (b) The energy in electromagnetic wave is divided equally between electric and magnetic vectors
 (c) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave
 (d) These waves do not require any material medium for propagation.

Ans: (c)

Solution: Electromagnetic waves are the combination of mutually perpendicular electric and magnetic fields. So, option (c) is false.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

PART 3. PHYSICS QUESTION BANK

Q1. The half life of a radioactive isotope 'X' is 20 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio of 1 : 7 in a sample of the given rock. The age of the rock is estimated to be

- (a) 60 years (b) 80 years
 (c) 100 years (d) 40 years

Ans: (a)

Solution: The value of x is $\frac{1}{8}$

$$= \frac{x_0}{8} = \frac{x_0}{2^3} \Rightarrow t = 3T = 3 \times 20 = 60 \text{ years}$$

Hence the estimated age of the rock is 60 years

Alternate : $X \rightarrow Y$ at $t = 0$, 0 at $t = tN_0 - N$

$$\frac{N}{N_0 - N} = \frac{1}{7} = \frac{N}{N_0} = \frac{1}{8}$$

$$t = 3T$$

$$= 3 \times 20 = 60 \text{ years}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q2. What is the minimum velocity with which a body of mass m must enter a vertical loop of radius R so that it can complete the loop ?

- (a) $\sqrt{gR}$
(b) $\sqrt{2gR}$
(c) $\sqrt{3gR}$
(d) $\sqrt{5gR}$

Ans: (d)

Solution: To complete the loop a body must enter a vertical loop of radius R with the minimum velocity $v = \sqrt{5gR}$.

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

Q3. If ΔU and ΔW represent the increase in internal energy and work done by the system respectively in a thermodynamical process, which of the following is true?

- (a) $\Delta U = -\Delta W$, in an adiabatic process
(b) $\Delta U = \Delta W$, in an isothermal process
(c) $\Delta U = \Delta W$, in an adiabatic process
(d) $\Delta U = -\Delta W$, in an isothermal process

Ans: (a)

Solution: By first law of thermodynamics,
 $\Delta Q = \Delta U + \Delta W$

In adiabatic process, $\Delta Q = 0$

$$\therefore \Delta U = -\Delta W$$

In isothermal process, $\Delta U = 0$

$$\therefore \Delta Q = \Delta W$$

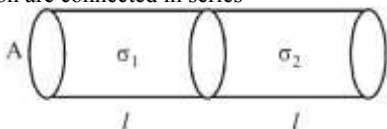
Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q4. Two metal wires of identical dimension are connected in series. If σ_1 and σ_2 are the conductivities of the metal wires respectively, the effective conductivity of the combination is :

- (a) $\frac{\sigma_1 + \sigma_2}{2\sigma_1\sigma_2}$
(b) $\frac{\sigma_1 + \sigma_2}{\sigma_1\sigma_2}$
(c) $\frac{\sigma_1\sigma_2}{\sigma_1 + \sigma_2}$
(d) $\frac{2\sigma_1\sigma_2}{\sigma_1 + \sigma_2}$

Ans: (d)

Solution: In figure, two metal wires of identical dimension are connected in series



$$R_{eq} = \frac{l}{\sigma_1 A} + \frac{l}{\sigma_2 A} = \frac{l_{eq}}{\sigma_{eq} A_{eq}}$$

$$\frac{2l}{\sigma_{eq} A} = \frac{l}{A} \left(\frac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2} \right)$$

$$\therefore \sigma_{eq} = \frac{2\sigma_1\sigma_2}{\sigma_1 + \sigma_2}$$

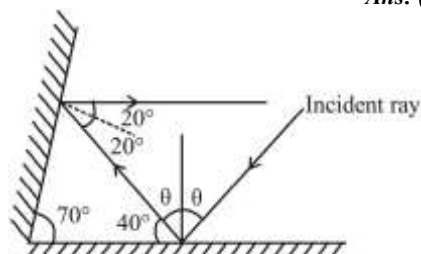
Chapter: Current Electricity
[Topic: Combination of Resistances]

Q5. Two plane mirrors are inclined at 70° . A ray incident on one mirror at angle θ after reflection falls on second mirror and is reflected from there parallel to first mirror. The value of θ is

[NEET Kar. 2013]

- (a) 50°
(b) 45°
(c) 30°
(d) 55°

Ans: (a)



Solution:

From fig. $40^\circ + \theta = 90^\circ \therefore \theta = 90^\circ - 40^\circ = 50^\circ$

Chapter - Ray Optics and Optical
[Topic: Plane, Spherical Mirror & Reflection of Light]

Q6. The activity of a radioactive sample is measured as 9750 counts per minute at $t = 0$ and as 975 counts per minute at $t = 5$ minutes. The decay constant is approximately

- (a) 0.922 per minute
(b) 0.691 per minute
(c) 0.461 per minute
(d) 0.230 per minute

Ans: (c)

Solution: $\frac{dN}{dt} = KN$

$$9750 = KN_0 \dots\dots\dots (1)$$

$$975 = KN \dots\dots\dots (2)$$

Dividing (1) by (2)

$$\frac{N}{N_0} = \frac{1}{10}$$

$$K = \frac{2.303}{t} \log \frac{N_0}{N} = \frac{2.303}{5} \log 10$$

$$= 0.4606 = 0.461 \text{ per minute}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q7. A particle with total energy E is moving in a potential energy region $U(x)$. Motion of the particle is restricted to the region when

[NEET Kar. 2013]

- (a) $U(x) > E$
(b) $U(x) < E$
(c) $U(x) = 0$
(d) $U(x) \leq E$

Ans: (d)

Solution: As the particle is moving in a potential energy region.

$\therefore$ Kinetic energy ≥ 0

And, total energy $E = \text{K.E.} + \text{P.E.}$

$$\Rightarrow U(x) \leq E$$

Chapter: Work, Energy and Power

[Topic: Energy]

Q8. A reversible engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by 62°C , the efficiency of the engine is doubled. The temperatures of the source and sink are

- (a) 99°C , 37°C (b) 80°C , 37°C
(c) 95°C , 37°C (d) 90°C , 37°C

Ans: (a)

Solution: Initially the efficiency of the engine was $\frac{1}{6}$ which increases to $\frac{1}{3}$ when the sink temperature reduces by 62°C .

$$\eta = \frac{1}{6} = 1 - \frac{T_2}{T_1}, \text{ when } T_2 = \text{sink temperature}$$

$T_1 = \text{source temperature}$

$$= T_2 = \frac{5}{6} T_1$$

Secondly,

$$\frac{1}{3} = 1 - \frac{T_2 - 62}{T_1} = 1 - \frac{T_2}{T_1} + \frac{62}{T_1} = 1 - \frac{5}{6} + \frac{62}{T_1}$$

$$\text{or, } T_1 = 62 \times 6 = 372\text{K} = 372 - 273 = 99^\circ\text{C}$$

$$\& T_2 = \frac{5}{6} \times 372 = 310\text{K} = 310 - 273 = 37^\circ\text{C}$$

Chapter: Heat & Thermodynamics

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q9. The thermo e.m.f E in volts of a certain thermocouple is found to vary with temperature difference θ in $^\circ\text{C}$ between the two junctions according to the relation

$$E = 30\theta - \frac{\theta^2}{15}$$

The neutral temperature for the thermocouple will be

- (a) 30°C (b) 450°C
(c) 400°C (d) 225°C

Ans: (d)

$$\text{Solution: } E = 30\theta - \frac{\theta^2}{15}$$

For neutral temperature, $\frac{dE}{d\theta} = 0$

$$0 = 30 - \frac{2}{15}\theta$$

$$\therefore \theta = 15 \times 15$$

$$= 225^\circ\text{C}$$

Hence, neutral temperature is 225°C .

Chapter: Current Electricity

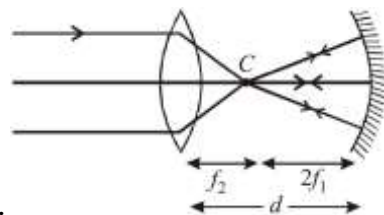
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q10. A concave mirror of focal length ' f_1 ' is placed at a distance of ' d ' from a convex lens of focal length ' f_2 '. A beam of light coming from infinity and falling on this convex lens-concave mirror combination returns to infinity.

The distance ' d ' must equal :

- (a) $f_1 + f_2$ (b) $-f_1 + f_2$
(c) $2f_1 + f_2$ (d) $-2f_1 + f_2$

Ans: (c)



Solution:

$$d = f_2 + 2f_1$$

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q11. If a small amount of antimony is added to germanium crystal

- (a) it becomes a p-type semiconductor
(b) the antimony becomes an acceptor atom
(c) there will be more free electrons than holes in the semiconductor
(d) its resistance is increased

Ans: (c)

Solution: When small amount of antimony (pentavalent) is added to germanium crystal then crystal becomes n-type semiconductor. Therefore, there will be more free electrons than holes in the semiconductor.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q12. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional force are 10% of energy. How much power is generated by the turbine? ($g = 10 \text{ m/s}^2$)

- (a) 8.1 kW (b) 10.2 kW
(c) 12.3 kW (d) 7.0 kW

Ans: (a)

Solution: Given, $h = 60\text{m}$, $g = 10 \text{ ms}^{-2}$,
Rate of flow of water = 15 kg/s

$\therefore$ Power of the falling water

$$= 15 \text{ kgs}^{-1} \times 10 \text{ ms}^{-2} \times 60 \text{ m} = 900 \text{ watt.}$$

Loss in energy due to friction

$$= 9000 \times \frac{10}{100} = 900 \text{ watt.}$$

$\therefore$ Power generated by the turbine

$$= (9000 - 900) \text{ watt} = 8100 \text{ watt} = 8.1 \text{ kW}$$

Chapter: Work, Energy and Power

[Topic: Power]

Q13. The mean free path of molecules of a gas, (radius ' r ') is inversely proportional to :

- (a) r^3 (b) r^2
(c) r (d) $\sqrt{r}$

Ans: (b)

$$\text{Solution: Mean free path } \lambda_m = \frac{1}{\sqrt{2}\pi d^2 n}$$

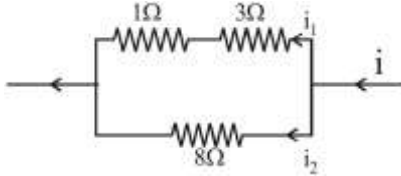
where d = diameter of molecule and $d = 2r$

$$\therefore \lambda_m \propto \frac{1}{r^2}$$

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q14. Power dissipated across the 8Ω resistor in the circuit shown here is 2 watt. The power dissipated in watt units across the 3Ω resistor is



- (a) 1.0 (b) 0.5
(c) 3.0 (d) 2.0

Ans: (c)

Solution: Power = $V \cdot I = I^2 R$

$$i_2 = \sqrt{\frac{\text{Power}}{R}} = \sqrt{\frac{2}{8}} = \sqrt{\frac{1}{4}} = \frac{1}{2} \text{ A}$$

Potential over $8\Omega = Ri_2 = 8 \times \frac{1}{2} = 4\text{V}$

This is the potential over parallel branch. So,

$$i_1 = \frac{4}{1} = 1 \text{ A}$$

Power of $3\Omega = i_1^2 R = 1 \times 1 \times 3 = 3\text{W}$

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q15. Rainbow is formed due to a combination of [2000]

- (a) dispersion and total internal reflection
(b) refraction and absorption
(c) dispersion and focussing
(d) refraction and scattering

Ans: (a)

Solution: Rainbow is formed due to combination of total internal reflection and dispersion.

Chapter - Ray Optics and Optical

[Topic: Prism & Dispersion of Light]

Q16. In forward bias, the width of potential barrier in a p-n junction diode

- (a) increases
(b) decreases
(c) remains constant
(d) first '1' then '2'

Ans: (b)

Solution: We know that in forward bias of p-n junction diode, when positive terminal is connected to p-type diode, the repulsion of holes takes place which decreases the width of potential barrier by striking the combination of holes and electrons.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q17. Which of the following statements are correct ? [2017]

- (A) Centre of mass of a body always coincides with the centre of gravity of the body
(B) Centre of mass of a body is the point at which the total gravitational torque on the body is zero

(C) A couple on a body produce both translational and rotation motion in a body

(D) Mechanical advantage greater than one means that small effort can be used to lift a large load

- (a) (A) and (B)
(b) (B) and (C)
(c) (C) and (D)
(d) (B) and (D)

Ans: (d)

Solution: Centre of mass may or may not coincide with centre of gravity. Net torque of gravitational pull is zero about centre of mass.

$$\tau_g = \Sigma \tau_i = \Sigma r_i \times m_{ig} = 0$$

Mechanical advantage, $M.A. = \frac{\text{Load}}{\text{Effort}}$

If $M.A. > 1 \Rightarrow \text{Load} > \text{Effort}$

Chapter: System of Particles and Rotational Motion

[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q18. Two simple harmonic motions act on a particle. These harmonic motions are $x = A \cos(\omega t + \delta)$, $y = A \cos(\omega t + \alpha)$ when $\delta = \alpha + \frac{\pi}{2}$, the resulting motion is

- (a) a circle and the actual motion is clockwise
(b) an ellipse and the actual motion is counterclockwise
(c) an ellipse and the actual motion is clockwise
(d) a circle and the actual motion is counterclockwise

Ans: (d)

Solution: $x = A \cos(\omega t + \delta)$

$$y = A \cos(\omega t + \alpha) \dots (1)$$

When $\delta = \alpha + \frac{\pi}{2}$

$$x = A \cos\left(\frac{\pi}{2} + \omega t + \alpha\right)$$

$$x = -A \sin(\omega t + \alpha) \dots (2)$$

Squaring (1) and (2) and then adding

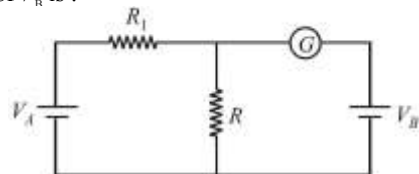
$$x^2 + y^2 = A^2 [\cos^2(\omega t + \alpha) + \sin^2(\omega t + \alpha)]$$

or $x^2 + y^2 = A^2$, which is the equation of a circle. The present motion is anticlockwise.

Chapter: Oscillation

[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q19. In the circuit shown the cells A and B have negligible resistances. For $V_A = 12\text{V}$, $R_1 = 500\Omega$ and $R = 100\Omega$ the galvanometer (G) shows no deflection. The value of V_B is :



- (a) 4 V (b) 2 V
(c) 12 V (d) 6 V

Ans: (b)

Solution: Since deflection in galvanometer is zero so current will flow as shown in the above diagram.

$$\text{current } I = \frac{V_A}{R_1 + R} = \frac{12}{500 + 100} = \frac{12}{600}$$

So $V_B = IR = \frac{12}{600} \times 100 = 2V$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q20. Two slits in Young's experiment have widths in the ratio 1 : 25. The ratio of intensity at the maxima and minima in the interference pattern, $\frac{I_{\max}}{I_{\min}}$ is:

- (a) $\frac{121}{49}$
 (b) $\frac{121}{9}$
 (c) $\frac{4}{9}$
 (d) $\frac{9}{4}$

Ans: (d)

Solution: The ratio of slits width = $\frac{1}{25}$ (given)

$$\therefore \frac{I_1}{I_2} = \frac{25}{1}$$

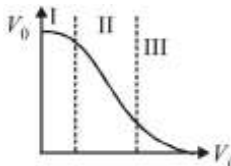
$$I \propto A^2 \Rightarrow \frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} = \frac{25}{1} \text{ or } \frac{A_1}{A_2} = \frac{5}{1}$$

$$\frac{A_{\max}}{A_{\min}} = \frac{A_1 + A_2}{A_1 - A_2} = \frac{5 + 1}{5 - 1} = \frac{6}{4} = \frac{3}{2}$$

$$\therefore \frac{I_{\max}}{I_{\min}} = \frac{A_{\max}^2}{A_{\min}^2} = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q21. Transfer characteristics [output voltage (V_0) vs input voltage (V_i)] for a base biased transistor in CE configuration is as shown in the figure. For using transistor as a switch, it is used :
 [2012]



- (a) in region III
 (b) both in region (I) and (III)
 (c) in region II
 (d) in region (I)

Ans: (b)

Solution: I $\rightarrow$ ON

II $\rightarrow$ OFF

In IInd state it is used as an amplifier it is active region.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q22. The unit of the Stefan-Boltzmann's constant is

- (a) W/m^2K^4 (b) W/m^2
 (c) W/m^2K (d) W/m^2K^2

Ans: (a)

Solution: $E = \sigma AT^4$

E is energy dissipated per second.

$$\sigma = \frac{E}{AT^4} = \frac{\text{Watt}}{m^2K^4}$$

Chapter: Units and Measurement

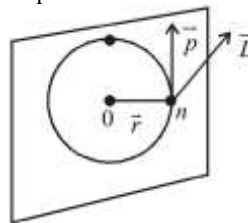
[Topic: Dimensions of Physical Quantities]

Q23. When a mass is rotating in a plane about a fixed point, its angular momentum is directed along :
 [2012]

- (a) a line perpendicular to the plane of rotation
 (b) the line making an angle of 45° to the plane of rotation
 (c) the radius
 (d) the tangent to the orbit

Ans: (a)

Solution: $\vec{L} = \vec{r} \times \vec{p}$



By right hand screw rule, the direction of $\vec{L}$ is $\perp$ to the plane containing $\vec{r}$ & $\vec{p}$.

The mass is rotating in the plane, about a fixed point, thus this plane will contain $\vec{r}$ & $\vec{p}$ and the direction of $\vec{L}$, will be $\perp$ to the this plane.

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q24. A point performs simple harmonic oscillation of period T and the equation of motion is given by $x = a \sin(\omega t + \pi/6)$. After the elapse of what fraction of the time period the velocity of the point will be equal to half of its maximum velocity?

- (a) T/8 (b) T/6
 (c) T/3 (d) T/12

Ans: (d)

Solution: We have $x = a \sin\left(\omega t + \frac{\pi}{6}\right)$

$$\therefore \text{Velocity, } v = \frac{dx}{dt} = a\omega \cos\left(\omega t + \frac{\pi}{6}\right)$$

Maximum velocity = $a\omega$

According to question,

$$\frac{a\omega}{2} = a\omega \cos\left(\omega t + \frac{\pi}{6}\right)$$

$$\text{or, } \cos\left(\omega t + \frac{\pi}{6}\right) = \frac{1}{2} = \cos 60^\circ \text{ or } \cos \frac{\pi}{3}$$

$$\Rightarrow \omega t + \frac{\pi}{6} = \frac{\pi}{3}$$

$$\omega t = \frac{\pi}{3} - \frac{\pi}{6} \text{ or, } \omega t = \frac{\pi}{6}$$

$$\text{or, } \frac{2\pi}{T} \cdot t = \frac{\pi}{6} \Rightarrow t = \frac{T}{12}$$

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q25. A charged particle moves through a magnetic field in a direction perpendicular to it. Then the

- (a) velocity remains unchanged
 (b) speed of the particle remains unchanged
 (c) direction of the particle remains unchanged
 (d) acceleration remains unchanged

Ans: (b)

Solution: Magnetic force acts perpendicular to the velocity. Hence speed remains constant.

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q26. If the kinetic energy of the particle is increased to 16 times its previous value, the percentage change in the de-Broglie wavelength of the particle is :

- (a) 25 (b) 75
(c) 60 (d) 50

Ans: (b)

Solution: As we know

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} \quad (\because P = \sqrt{2mKE})$$

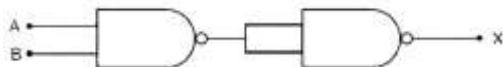
$$\text{or } \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}} = \sqrt{\frac{16K}{K}} = \frac{4}{1}$$

Therefore the percentage change in de-Broglie wavelength = $\frac{1-4}{4} \times 100 = -75\%$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

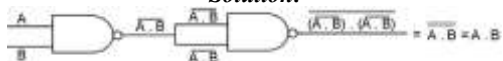
Q27. The output(X) of the logic circuit shown in figure will be



- (a) $X = \overline{A \cdot B}$
(b) $X = A \cdot B$
(c) $X = A + B$
(d) $X = \overline{A} + \overline{B}$

Ans: (b)

Solution:



i.e., output $X = A \cdot B$

Truth Table

A	B	X
0	0	0
1	0	0
0	1	0
1	1	1

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Digital Electronics and Logic Gates]

Q28. P represents radiation pressure, c represents speed of light and S represents radiation energy striking unit area per sec. The non zero integers x, y, z such that $P^x S^y c^z$ is dimensionless are

- (a) $x = 1, y = 1, z = 1$ (b) $x = -1, y = 1, z = 1$
(c) $x = 1, y = -1, z = 1$ (d) $x = 1, y = 1, z = -1$

Ans: (c)

Solution: Try out the given alternatives.

When $x = 1, y = -1, z = 1$

$$P^x S^y c^z = P^1 S^{-1} c^1 = \frac{Pc}{S}$$

$$= \frac{[L^{-1}T^{-2}][LT^{-1}]}{\left[\frac{ML^2T^{-2}}{L^2T}\right]} = [M^0L^0T^0]$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q29. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre ?

- (a) $15 MR^2/32$ (b) $13 MR^2/32$
(c) $11 MR^2/32$ (d) $9 MR^2/32$

Ans: (b)

Solution: Moment of inertia of complete disc about point 'O'.

$$I_{\text{Total disc}} = \frac{MR^2}{2}$$

Mass of removed disc

$$M_{\text{Removed}} = \frac{M}{4} \quad (\text{Mass} \propto \text{area})$$

Moment of inertia of removed disc about point 'O'.

I_{Removed} (about same perpendicular axis)

$$= I_{\text{cm}} + mx^2$$

$$= \frac{M \left(\frac{R}{2}\right)^2}{4} + \frac{M}{4} \left(\frac{R}{2}\right)^2 = \frac{3MR^2}{32}$$

Therefore the moment of inertia of the remaining part of the disc about a perpendicular axis passing through the centre,

$$I_{\text{Remaining disc}} = I_{\text{Total}} - I_{\text{Removed}}$$

$$= \frac{MR^2}{2} - \frac{3}{32} MR^2 = \frac{13}{32} MR^2$$

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q30. Sound waves travel at 350 m/s through a warm air and at 3500 m/s through brass. The wavelength of a 700 Hz acoustic wave as it enters brass from warm air

- (a) decreases by a factor 10 (b) increases by a factor 20
(c) increases by a factor 10 (d) decreases by a factor 20

Ans: (c)

Solution: We have, $v = n\lambda$

$\Rightarrow v \propto \lambda$ (as n remains constant)

Thus, as v increases 10 times, λ also increases 10 times.

Chapter: Waves

[Topic: Basic of Waves]

Q31. Two long parallel wires P and Q are both perpendicular to the plane of the paper with distance of 5 m between them. If P and Q carry currents of 2.5 amp and 5 amp respectively in the same direction, then the magnetic field at a point half-way between the wires is

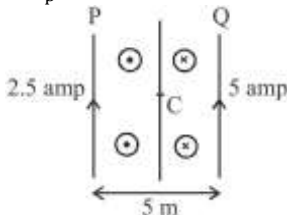
- (a) $\frac{3\mu_0}{2\pi}$
(b) $\frac{\mu_0}{\pi}$
(c) $\frac{\sqrt{3}\mu_0}{2\pi}$
(d) $\frac{\mu_0}{2\pi}$

Ans: (d)

Solution: When the current flows in both wires in the same direction then magnetic field at half way due to the wire P,

$$\vec{B}_P = \frac{\mu_0 I_1}{2\pi r_1} = \frac{\mu_0 I_1}{\pi \cdot 5} = \frac{\mu_0}{2\pi} \text{ (where } I_1 = 2.5 \text{ amp)}$$

The direction of $\vec{B}_P$ is downward



Magnetic field at half way due to wire Q

$$\vec{B}_Q = \frac{\mu_0 I_2}{2\pi r_2} = \frac{\mu_0}{\pi} \text{ [upward]}$$

[where $I_2 = 2.5 \text{ amp.}$]

Net magnetic field at half way

$$\vec{B} = \vec{B}_P + \vec{B}_Q = -\frac{\mu_0}{2\pi} + \frac{\mu_0}{\pi} = \frac{\mu_0}{2\pi} \text{ (upward)}$$

Hence, net magnetic field at midpoint = $\frac{\mu_0}{2\pi}$

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q32. Photoelectric emission occurs only when the incident light has more than a certain minimum

- (a) power
- (b) wavelength
- (c) intensity
- (d) frequency

Ans: (d)

Solution: For occurrence of photoelectric effect, the incident light should have frequency more than a certain minimum which is called the threshold frequency (ν_0).

$$\text{We have, } \frac{1}{2} m v^2 = h\nu - h\nu_0$$

For photoelectric effect emission $\nu > \nu_0$

where ν is the frequency of the incident light.

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q33. The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time 't' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

[NEET Kar. 2013]

- (a) 2 m
- (b) 4 m
- (c) zero
- (d) 6 m

Ans: (c)

$$\text{Solution: } \because t = \sqrt{x} + 3$$

$$\Rightarrow \sqrt{x} = t - 3 \Rightarrow x = (t - 3)^2$$

$$v = \frac{dx}{dt} = 2(t - 3) = 0$$

$$\Rightarrow t = 3$$

$$\therefore x = (3 - 3)^2$$

$$\Rightarrow x = 0.$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q34. A solid cylinder of mass m and radius R rolls down an inclined plane of height h without slipping. The speed of its centre of mass when it reaches the bottom is

- (a) $\sqrt{(2gh)}$
- (b) $\sqrt{\frac{4gh}{3}}$
- (c) $\sqrt{\frac{3gh}{4}}$
- (d) $\sqrt{\frac{4g}{h}}$

Ans: (b)

$$\text{Solution: K.E.} = \frac{1}{2} I \omega^2 + \frac{1}{2} m v^2$$

$$\text{KE.} = \frac{1}{2} \left(\frac{1}{2} m r^2 \right) \omega^2 + \frac{1}{2} m v^2$$

$$= \frac{1}{4} m v^2 + \frac{1}{2} m v^2 = \frac{3}{4} m v^2$$

Now, gain in K.E. = Loss in P.E.

$$\frac{3}{4} m v^2 = mgh \Rightarrow v = \sqrt{\left(\frac{4}{3}\right) gh}$$

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q35. A wave of frequency 100 Hz is sent along a string towards a fixed end. When this wave travels back after reflection, a node is formed at a distance of 10 cm from the fixed end of the string. The speeds of incident (and reflected) waves are

- (a) 5 m/s
- (b) 10 m/s
- (c) 20 m/s
- (d) 40 m/s

Ans: (c)

Solution: As fixed end is a node, therefore, distance between two consecutive nodes

$$= \frac{\lambda}{2} = 10 \text{ cm.}$$

$$\lambda = 20 \text{ cm} = 0.2 \text{ m}$$

$$\text{As } v = n\lambda \therefore v = 100 \times 0.2 = 20 \text{ m/s}$$

Chapter: Waves

[Topic: Basic of Waves]

Q36. A particle having charge q moves with a velocity $\vec{v}$ through a region in which both an electric field $\vec{E}$ and a magnetic field $\vec{B}$ are present. The force on the particle is

- (a) $q\vec{E} + q(\vec{B} \times \vec{v})$
- (b) $q\vec{E} \cdot (\vec{B} \times \vec{v})$
- (c) $q\vec{v} + q(\vec{E} \times \vec{B})$
- (d) $q\vec{E} + q(\vec{v} \times \vec{B})$

Ans: (d)

$$\text{Solution: Force due to electric field} = q\vec{E}$$

$$\text{Force due to magnetic field} = q(\vec{v} \times \vec{B})$$

$$\text{Net force experienced} = q\vec{E} + q(\vec{v} \times \vec{B})$$

Chapter: Moving Charges and Magnetic Field

[Topic: Force & Torque on a Current Carrying Conductor]

Q37. The 21 cm radio wave emitted by hydrogen in interstellar space is due to the interaction called the hyperfine interaction in atomic hydrogen. The energy of the emitted wave is nearly [1998]

- (a) 10^{-17} J (b) 1 J
(c) 7×10^{-8} J (d) 10^{-24} J

Ans: (d)

$$\text{Solution: } E = h\nu = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{0.21} = \frac{6.6}{7} \times 10^{-24} = 0.94 \times 10^{-24} \text{ J}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q38. A stone falls freely under gravity. It covers distances h_1 , h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1 , h_2 and h_3 is

- (a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$
(b) $h_2 = 3h_1$ and $h_3 = 3h_2$
(c) $h_1 = h_2 = h_3$ (d) $h_1 = 2h_2 = 3h_3$

Ans: (a)

$$\text{Solution: } \because h = \frac{1}{2}gt^2$$

$$\therefore h_1 = \frac{1}{2}g(5)^2 = 125$$

$$h_1 + h_2 = \frac{1}{2}g(10)^2 = 500$$

$$\Rightarrow h_2 = 375$$

$$h_1 + h_2 + h_3 = \frac{1}{2}g(15)^2 = 1125$$

$$\Rightarrow h_3 = 625$$

$$h_2 = 3h_1, h_3 = 5h_1$$

$$\text{or } h_1 = \frac{h_2}{3} = \frac{h_3}{5}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q39. Assuming earth to be a sphere of uniform density, what is the value of 'g' in a mine 100 km below the earth's surface? (Given, $R = 6400$ km)

[2001]

- (a) 9.65 m/s^2 (b) 7.65 m/s^2
(c) 5.06 m/s^2 (d) 3.10 m/s^2

Ans: (a)

Solution: We know that effective gravity g' at depth below earth surface is given by

$$g' = g \left(1 - \frac{d}{R} \right)$$

$$\text{Here, } d = 100 \text{ km, } R = 6400 \text{ km,}$$

$$\therefore g' = 9.8 \left(1 - \frac{100}{6400} \right) = 9.65 \text{ m/s}^2$$

Chapter: Gravitation

[Topic: Acceleration due to Gravity]

Q40. Two sources P and Q produce notes of frequency 660 Hz each. A listener moves from P to Q with a speed of 1 ms^{-1} . If the speed of sound is 330 m/s, then the number of beats heard by the listener per second will be

- (a) zero (b) 4
(c) 8 (d) 2

Ans: (b)

$$\text{Solution: } \frac{\Delta f}{f} = \frac{v}{c}$$

$$\Rightarrow \frac{\text{Beats}}{f} = \frac{v}{c} \Rightarrow \text{Beats} = \frac{2fv}{c} = 4.$$

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q41. A bar magnet, of magnetic moment $\vec{M}$, is placed in a magnetic field of induction $\vec{B}$. The torque exerted on it is

- (a) $\vec{M} \cdot \vec{B}$ (b) $-\vec{M} \cdot \vec{B}$
(c) $\vec{M} \times \vec{B}$ (d) $\vec{B} \times \vec{M}$

Ans: (c)

Solution: We know that when a bar magnet is placed in the magnetic field at an angle θ , then torque acting on the bar magnet (τ)

$$= MB \sin \theta = \vec{M} \times \vec{B}.$$

Note : This torque τ has a tendency to make the axis of the magnet parallel to the direction of the magnetic field.

Chapter: Magnetism and Matter

[Topic: Magnetism, Gauss's Law]

Q42. J.J. Thomson's experiment demonstrated that [2003]

- (a) the e/m ratio of the cathode-ray particles changes when a different gas is placed in the discharge tube
(b) cathode rays are streams of negatively charged ions
(c) all the mass of an atom is essentially in the nucleus
(d) the e/m of electrons is much greater than the e/m of protons

Ans: (b)

Solution: Cathode rays are streams of negatively charged ions

Chapter: Atoms

[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q43. The vector sum of two forces is perpendicular to their vector differences. In that case, the forces

- (a) cannot be predicted
(b) are equal to each other
(c) are equal to each other in magnitude
(d) are not equal to each other in magnitude

Ans: (c)

$$\text{Solution: } \vec{P} = \text{vector sum} = \vec{A} + \vec{B}$$

$$\vec{Q} = \text{vector difference} = \vec{A} - \vec{B}$$

Since $\vec{P}$ and $\vec{Q}$ are perpendicular

$$\therefore \vec{P} \cdot \vec{Q} = 0 \Rightarrow (\vec{A} + \vec{B}) \cdot (\vec{A} - \vec{B}) = 0$$

$$\Rightarrow A^2 = B^2 \Rightarrow |\vec{A}| = |\vec{B}|$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q44. Two satellites of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2 . Which one of the following statements is true?

- (a) The potential energies of earth satellites in the two cases are equal.
 (b) S_1 and S_2 are moving with the same speed.
 (c) The kinetic energies of the two satellites are equal.
 (d) The time period of S_1 is four times that of S_2 .

Ans: (b)

Solution: Since orbital velocity of satellite is

$v = \sqrt{\frac{GM}{r}}$, it does not depend upon the mass of the satellite.

Therefore, both satellites will move with same speed.

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q45. Two trains move towards each other with the same speed. The speed of sound is 340 m/s. If the height of the tone of the whistle of one of them heard on the other changes $9/8$ times, then the speed of each train should be

- (a) 20 m/s (b) 2 m/s
 (c) 200 m/s (d) 2000 m/s

Ans: (a)

Solution: Here, $v' = \frac{9}{8}v$

Source and observer are moving in opposite direction, therefore, apparent frequency

$$v' = v \times \frac{(v + u)}{(v - u)}$$

$$\frac{9}{8}v = v \times \frac{340 + u}{340 - u}$$

$$= 9 \times 340 - 9u = 8 \times 340 + 8u$$

$$= 17u = 340 \times 1 \Rightarrow u = \frac{340}{17} = 20 \text{ m/sec.}$$

Chapter: Waves

[Topic: Musical Sound & Doppler's Effect]

Q46. In which of the following systems will the radius of the first orbit ($n = 1$) be minimum?

- (a) Hydrogen atom
 (b) Doubly ionized lithium
 (c) Singly ionized helium
 (d) Deuterium atom

Ans: (b)

Solution: $r \propto \frac{1}{Z}$; $Z(=3)$ is maximum for Li^{2+} .

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

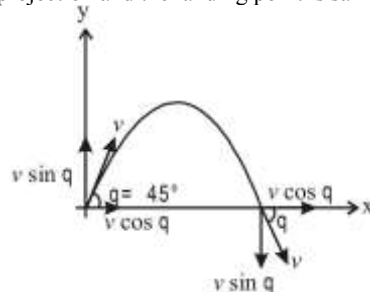
Q47. A particle of mass m is projected with velocity v making an angle of 45° with the horizontal. When the particle lands on the level ground the magnitude of the change in its momentum will be:

[2008]

- (a) $2mv$
 (b) $\frac{mv}{\sqrt{2}}$
 (c) $mv\sqrt{2}$
 (d) zero

Ans: (c)

Solution: The magnitude of the resultant velocity at the point of projection and the landing point is same.



Clearly, change in momentum along horizontal (i.e. along x-axis)

$$= mv \cos \theta - mv \cos \theta = 0$$

Change in momentum along vertical (i.e. along y-axis) =

$$mv \sin \theta - (-mv \sin \theta)$$

$$= 2mv \sin \theta = 2mv \times \sin 45^\circ$$

$$= 2mv \times \frac{1}{\sqrt{2}} = \sqrt{2}mv$$

Hence, resultant change in momentum = $\sqrt{2}mv$

Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q48. The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of 100 cm^3 of water under a pressure of 100 atmosphere will be

- (a) 0.4 cm^3 (b) $4 \times 10^{-5} \text{ cm}^3$
 (c) 0.025 cm^3 (d) 0.004 cm^3

Ans: (a)

Solution: $K = \frac{1}{\frac{\Delta V}{V \Delta P}}$. Here, $P = 100 \text{ atm}$,

$K = 4 \times 10^{-5}$ and $V = 100 \text{ cm}^3$.

Hence, $\Delta V = 0.4 \text{ cm}^3$

Chapter: Mechanical Properties of Fluids

[Topic: Fluid Flow, Reynold's Number & Bernoulli's Principle]

Q49. An electric dipole, consisting of two opposite charges of $2 \times 10^{-6} \text{ C}$ each separated by a distance 3 cm is placed in an electric field of $2 \times 10^5 \text{ N/C}$. Torque acting on the dipole is

- (a) $12 \times 10^{-1} \text{ Nm}$ (b) $12 \times 10^{-2} \text{ Nm}$
 (c) $12 \times 10^{-3} \text{ Nm}$ (d) $12 \times 10^{-4} \text{ Nm}$

Ans: (c)

Solution: Charges (q) = $2 \times 10^{-6} \text{ C}$, Distance (d) = 3 cm = $3 \times 10^{-2} \text{ m}$ and electric field (E) = $2 \times 10^5 \text{ N/C}$. Torque (τ) = $q.d$.

$$E = (2 \times 10^{-6}) \times (3 \times 10^{-2}) \times (2 \times 10^5)$$

$$= 12 \times 10^{-3} \text{ N-m.}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q50. The current in self inductance $L = 40 \text{ mH}$ is to be increased uniformly from 1 amp to 11 amp in 4 milliseconds. The e.m.f. induced in the inductor during the process is

- (a) 100 volt (b) 0.4 volt
 (c) 4.0 volt (d) 440 volt

Solution: $e = L \frac{di}{dt}$
 Given that $L = 40 \times 10^{-3} \text{ H}$,
 $di = 11 \text{ A} - 1 \text{ A} = 10 \text{ A}$
 and $dt = 4 \times 10^{-3} \text{ s}$

$$\therefore e = 40 \times 10^{-3} \times \left(\frac{10}{4 \times 10^{-3}} \right) = 100 \text{ V}$$

Chapter: Electromagnetic
[Topic: Alternating Current, Voltage & Power]

PART 4. PHYSICS QUESTION BANK

Q51. M_n and M_p represent mass of neutron and proton respectively. If an element having atomic mass M has N -neutron and Z -proton, then the correct relation will be

- (a) $M < [NM_n + ZM_p]$
- (b) $M > [NM_n + ZM_p]$
- (c) $M = [NM_n + ZM_p]$
- (d) $M = N[M_n + M_p]$

Ans: (a)

Solution: Given : Mass of neutron = M_n
 Mass of proton = M_p ; Atomic mass of the element = M ;
 Number of neutrons in the element = N and number of protons in the element = Z . We know that the atomic mass (M) of any stable nucleus is always less than the sum of the masses of the constituent particles.

Therefore, $M < [NM_n + ZM_p]$.

X is a neutrino, when β -particle is emitted.

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q52. An electric fan has blades of length 30 cm measured from the axis of rotation. If the fan is rotating at 120 rpm, the acceleration of a point on the tip of the blade is

- (a) 1600 ms^{-2}
- (b) 47.4 ms^{-2}
- (c) 23.7 ms^{-2}
- (d) 50.55 ms^{-2}

Ans: (c)

Solution: Centripetal acc. = $\omega^2 r = 4\pi^2 v^2 r$

$$= 4 \times (3.14)^2 \times \frac{120}{60} \times \frac{30}{100} = 23.7 \text{ ms}^{-2}$$

$$[\because \omega = 2\pi v]$$

Chapter: Kinematics Motion in a Plane
[Topic: 1st, 2nd & 3rd Laws of Motion]

Q53. Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2 , respectively. If the rate of heat conduction in rod 1 is four times that in rod 2, then

- (a) $K_1 A_1 = K_2 A_2$
- (b) $K_1 A_1 = 4K_2 A_2$
- (c) $K_1 A_1 = 2K_2 A_2$
- (d) $4K_1 A_1 = K_2 A_2$

Ans: (b)

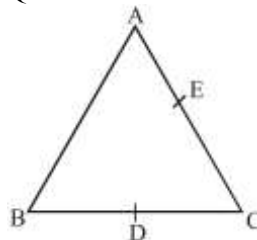
Solution: $Q_1 = 4Q_2$ (Given)

$$\Rightarrow \frac{K_1 A_1 \Delta t}{L} = 4 \frac{K_2 A_2 \Delta t}{L} \Rightarrow K_1 A_1 = 4K_2 A_2.$$

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q54. Three charges, each $+q$, are placed at the corners of an isosceles triangle ABC of sides BC and AC, $2a$. D and E are the mid points of BC and CA. The work done in taking a charge Q from D to E is



- (a) $\frac{3qQ}{8\pi\epsilon_0 a}$
- (b) $\frac{qQ}{4\pi\epsilon_0 a}$
- (c) zero
- (d) $\frac{3qQ}{4\pi\epsilon_0 a}$

Ans: (c)

Solution: $AC = BC$

$$V_D = V_E$$

We have,

$$W = Q(V_E - V_D)$$

$$\Rightarrow W = 0$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q55. In a series resonant circuit, having L , C and R as its elements, the resonant current is i . The power dissipated in the circuit at resonance is

[2002]

- (a) $\frac{i^2 R}{(\omega L - \frac{1}{\omega C})}$
- (b) zero
- (c) $i^2 \omega L$
- (d) $i^2 R$

where ω is the angular resonance frequency.

Ans: (d)

Solution: At resonance $L\omega = \frac{1}{C\omega}$, $\omega = \frac{1}{\sqrt{LC}}$

$$\text{Current through circuit } i = \frac{E}{R}$$

$$\text{Power dissipated at Resonance} = i^2 R$$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q56. In any fission process, the ratio

$\frac{\text{mass of fission products}}{\text{mass of parent nucleus}}$ is [2005]

- (a) equal to 1
- (b) greater than 1
- (c) less than 1
- (d) depends on the mass of the parent nucleus

Ans: (c)

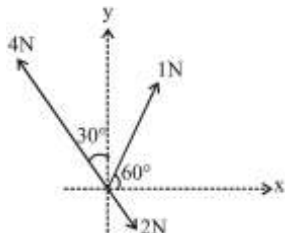
Solution: Binding energy per nucleon for fission products is higher relative to Binding energy per nucleon for parent nucleus, i.e., more masses are lost and are

obtained as kinetic energy of fission products. So, the given ratio < 1 .

Chapter: Nuclei

[Topic: Mass-Energy & Nuclear Reactions]

Q57.

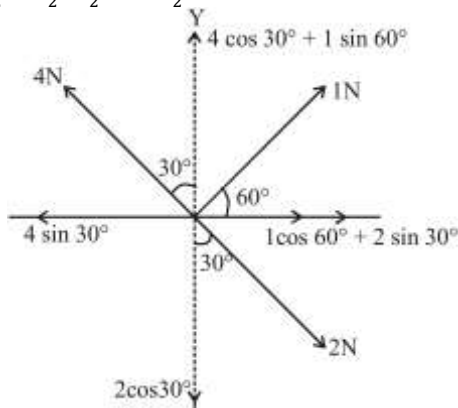


Three forces acting on a body are shown in the figure. To have the resultant force only along the y-direction, the magnitude of the minimum additional force needed is:

- (a) 0.5 N (b) 1.5 N
(c) $\frac{\sqrt{3}}{4}$ N (d) $\sqrt{3}$ N

Ans: (a)

Solution: The components of 1 N and 2N forces along + x axis = $1 \cos 60^\circ + 2 \sin 30^\circ$
 $= 1 \cdot \frac{1}{2} + 2 \cdot \frac{1}{2} = \frac{1}{2} + 1 = \frac{3}{2} = 1.5$ N



The component of 4 N force along -x-axis = $4 \sin 30^\circ = 4 \times \frac{1}{2} = 2$ N.

Therefore, if a force of 0.5N is applied along + x-axis, the resultant force along x-axis will become zero and the resultant force will be obtained only along y-axis.

Chapter: Dynamics Laws of Motion

[Topic: Motion of Connected Bodies, Pulleys]

Q58. Thermal capacity of 40 g of aluminium ($s = 0.2$ cal /g K) is

- (a) 168 joule/ $^\circ$ C (b) 672 joule/ $^\circ$ C
(c) 840 joule/ $^\circ$ C (d) 33.6 joule/ $^\circ$ C

Ans: (d)

Solution: Thermal capacity = $ms = 40 \times 0.2 = 8$ cal/ $^\circ$ C
 $= 4.2 \times 8$ J = 33.6 joules/ $^\circ$ C

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q59. A capacitor is charged to store an energy U . The charging battery is disconnected. An identical capacitor is

now connected to the first capacitor in parallel. The energy in each of the capacitor is

- (a) $U/2$ (b) $3U/2$
(c) U
(d) $U/4$

Ans: (a)

Solution: In Ist case when capacitor C connected with battery charged with the energy,

$U_1 = U$ (stored energy on capacitor).

In IInd case, after disconnection of battery similar capacitor is connected in parallel with Ist capacitor then $C_{eq} = C' = 2C$.

$$\text{Now } \frac{U_1}{U_2} = \frac{\frac{1}{2} \frac{q^2}{C}}{\frac{1}{2} \frac{q^2}{2C}} = \frac{C'}{C}$$

$$= \frac{2C}{C} (C' = 2C)$$

$$U_2 = \frac{U}{2}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q60. The electric field part of an electromagnetic wave in a medium is represented by $E_x = 0$;

$$E_y = 2.5 \frac{N}{C} \cos \left[\left(2\pi \times 10^6 \frac{\text{rad}}{\text{m}} \right) t - \left(\pi \times 10^{-2} \frac{\text{rad}}{\text{s}} \right) x \right];$$

$E_z = 0$. The wave is :

- (a) moving along x direction with frequency 10^6 Hz and wave length 100 m.
(b) moving along x direction with frequency 10^6 Hz and wave length 200 m.
(c) moving along - x direction with frequency 10^6 Hz and wave length 200 m.
(d) moving along y direction with frequency $2\pi \times 10^6$ Hz and wave length 200 m.

Ans: (b)

Solution: Comparing with the equation of wave.

$$E_y = E_0 \cos (\omega t - kx)$$

$$\omega = 2\pi f = 2\pi \times 10^6 \therefore f = 10^6 \text{ Hz}$$

$$\frac{2\pi}{\lambda} = k = \pi \times 10^{-2} \text{ m}^{-1}, \lambda = 200 \text{ m}$$

Chapter - Electromagnetic Waves

[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q61. α -particles, β -particles and γ -rays are all having same energy. Their penetrating power in a given medium in increasing order will be

[NEET Kar. 2013]

- (a) β , γ , α
(b) γ , α , β
(c) α , β , γ
(d) β , α , γ

Ans: (c)

Solution: Increasing order of penetrating power :

$$\alpha < \beta < \gamma.$$

For same energy, lighter particle has higher penetrating power.

Chapter: Nuclei

[Topic: Radioactivity]

Q62. Two stones of masses m and $2m$ are whirled in horizontal circles, the heavier one in radius $\frac{r}{2}$ and the lighter one in radius r . The tangential speed of lighter stone is n times that of the value of heavier stone when they experience same centripetal forces. The value of n is :

- (a) 3 (b) 4
(c) 1 (d) 2

Ans: (d)

Solution: According to question, two stones experience same centripetal force

$$\text{i.e. } F_{C_1} = F_{C_2}$$

$$\text{or, } \frac{mv_1^2}{r} = \frac{2mv_2^2}{\left(\frac{r}{2}\right)} \text{ or, } V_1^2 = 4V_2^2$$

$$\text{So, } V_1 = 2V_2 \text{ i.e., } n = 2$$

Chapter: Dynamics Laws of Motion

[Topic: Circular Motion, Banking of Road]

Q63. In thermodynamic processes which of the following statements is not true?

- (a) In an isochoric process pressure remains constant
(b) In an isothermal process the temperature remains constant
(c) In an adiabatic process $PV^\gamma = \text{constant}$
(d) In an adiabatic process the system is insulated from the surroundings

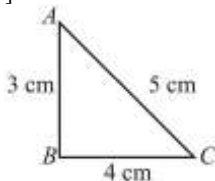
Ans: (a)

Solution: In an isochoric process volume remains constant whereas pressure remains constant in isobaric process.

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q64. A 12 cm wire is given a shape of a right angled triangle ABC having sides 3 cm, 4 cm and 5 cm as shown in the figure. The resistance between two ends (AB , BC , CA) of the respective sides are measured one by one by a multi-meter. The resistances will be in the ratio of [NEET Kar. 2013]



- (a) 3 : 4 : 5 (b) 9 : 16 : 25
(c) 27 : 32 : 35 (d) 21 : 24 : 25

Ans: (c)

Solution: Resistance is directly proportional to length

$$\frac{1}{R_{AB}} = \frac{1}{3} + \frac{1}{4+5} = \frac{(4+5)+3}{(3)(4+5)}$$

$$R_{AB} = \frac{3 \times (4+5)}{3+(4+5)} = \frac{27}{12}$$

Similarly,

$$R_{BC} = \frac{4 \times (3+5)}{4+(3+5)} = \frac{32}{12}$$

$$R_{AC} = \frac{5 \times (3+4)}{5+(3+4)} = \frac{35}{12}$$

$$\therefore R_{AB} : R_{BC} : R_{AC} = 27 : 32 : 35$$

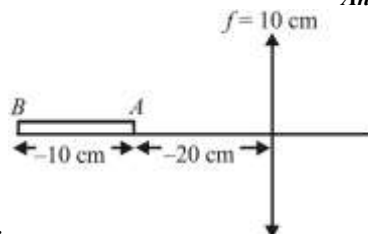
Chapter: Current Electricity

[Topic: Combination of Resistances]

Q65. A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is :

- (a) 10 cm (b) 15 cm
(c) 2.5 cm (d) 5 cm

Ans: (d)



Solution:

The focal length of the mirror

$$-\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

For A end of the rod the image distance

$$\text{When } u_1 = -20 \text{ cm}$$

$$\Rightarrow \frac{-1}{10} = \frac{1}{v_1} - \frac{1}{20}$$

$$\frac{1}{v_1} = \frac{-1}{10} + \frac{1}{20} = \frac{-2+1}{20}$$

$$v_1 = -20 \text{ cm}$$

For when $u_2 = -30 \text{ cm}$

$$\frac{1}{f} = \frac{1}{v_2} - \frac{1}{30}$$

$$\frac{1}{v_2} = \frac{-1}{10} + \frac{1}{30} = \frac{-30+10}{300} = \frac{-20}{300}$$

$$v_2 = -15 \text{ cm}$$

$$L = v_2 - v_1 = -15 - (-20)$$

$$L = 5 \text{ cm}$$

Chapter - Ray Optics and Optical

[Topic: Plane, Spherical Mirror & Reflection of Light]

Q66. A free neutron decays into a proton, an electron and

- (a) a beta particle
(b) an alpha particle
(c) an anti-neutrino
(d) a neutrino

Ans: (c)

$$\text{Solution: } {}_0n^1 \rightarrow {}_1p^1 + {}_{-1}e^0 + X$$

X must have zero charge and almost zero mass as electron is emitted. Hence X must be anti-neutrino.

Chapter: Nuclei

[Topic: Radioactivity]

Q67. The potential energy of a system increases if work is done

- (a) upon the system by a non conservative force
(b) by the system against a conservative force
(c) by the system against a non conservative force
(d) upon the system by a conservative force

Ans: (d)

Solution: When work is done upon a system by a conservative force then its potential energy increases.

Chapter: Work, Energy and Power

[Topic: Energy]

Q68. The efficiency of a Carnot engine operating between the temperatures of 100°C and -23°C will be

- (a) $\frac{100+23}{100}$
 (b) $\frac{100-23}{100}$
 (c) $\frac{373+250}{373}$
 (d) $\frac{373-250}{373}$

Ans: (d)

Solution: $\eta = 1 - \frac{T_1}{T_2}$

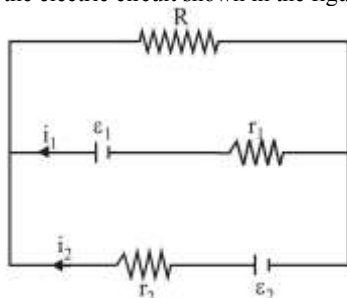
$T_1 = -23^\circ\text{C} = 250\text{ K}, T_2 = 100^\circ\text{C} = 373\text{ K}$

$$\eta = 1 - \frac{250}{373} = \frac{373 - 250}{373}$$

Chapter: Heat & Thermodynamics

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

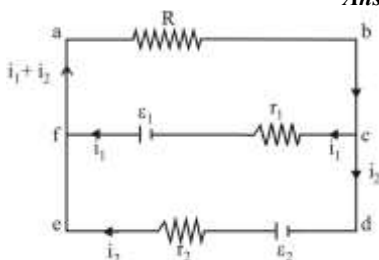
Q69. See the electric circuit shown in the figure.



Which of the following equations is a correct equation for it?

- (a) $\varepsilon_2 - i_2 r_2 - \varepsilon_1 - i_1 r_1 = 0$ (b) $-\varepsilon_2 - (i_1 + i_2) R + i_2 r_2 = 0$
 (c) $\varepsilon_1 - (i_1 + i_2) R + i_1 r_1 = 0$ (d) $\varepsilon_1 - (i_1 + i_2) R - i_1 r_1 = 0$

Ans: (d)



Solution:

Applying Kirchhoff's rule in loop **abcf**

$$\varepsilon_1 - (i_1 + i_2) R - i_1 r_1 = 0.$$

Chapter: Current Electricity

[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q70. A biconvex lens has a radius of curvature of magnitude 20 cm. Which one of the following options

best describe the image formed of an object of height 2 cm placed 30 cm from the lens?

- (a) Virtual, upright, height = 1 cm [2011]
 (b) Virtual, upright, height = 0.5 cm
 (c) Real, inverted, height = 4 cm
 (d) Real, inverted, height = 1 cm

Ans: (c)

Solution: $R = 20\text{ cm}$

$$h_o = 2$$

$$u = -30\text{ cm}$$

$$\text{We have, } \frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$= \left(\frac{3}{2} - 1 \right) \left[\frac{1}{20} - \left(-\frac{1}{20} \right) \right]$$

$$\Rightarrow \frac{1}{f} = \left(\frac{3}{2} - 1 \right) \times \frac{2}{20}$$

$$\therefore f = 20\text{ cm}$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{20} = \frac{1}{v} + \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{30} = \frac{10}{600}$$

$$v = 60\text{ cm}$$

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

$$h_i = \frac{v}{u} \times h_o = \frac{60}{30} \times 2 = -4\text{ cm}$$

So, image is inverted.

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q71. How much water, a pump of 2 kW can raise in one minute to a height of 10 m, take $g = 10\text{ m/s}^2$?

- (a) 1000 litres (b) 1200 litres
 (c) 100 litres (d) 2000 litres

Ans: (b)

Solution: $P = \frac{W}{t}$. Here, $P = 2\text{ kW} = 2000\text{ W}$.

$$W = Mgh = M \times 10 \times 10 = 100 M$$

and $t = 60\text{ s}$.

This gives, $M = 1200\text{ kg}$

Its volume = 1200 litre as 1 litre of water contains 1 kg of its mass.

Chapter: Work, Energy and Power

[Topic: Collisions]

Q72. The amount of heat energy required to raise the temperature of 1g of Helium at NTP, from $T_1\text{ K}$ to $T_2\text{ K}$ is

- (a) $\frac{3}{2} N_a k_B (T_2 - T_1)$
 (b) $\frac{3}{4} N_a k_B (T_2 - T_1)$
 (c) $\frac{3}{4} N_a k_B \frac{T_2}{T_1}$
 (d) $\frac{3}{8} N_a k_B (T_2 - T_1)$

Ans: (d)

Solution: From first law of thermodynamics

$$\Delta Q = \Delta U + \Delta W = \frac{3}{2} \cdot \frac{1}{4} R (T_2 - T_1) + 0$$

$$= \frac{3}{8} N_a k_B (T_2 - T_1) [\because K = \frac{R}{N}]$$

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q73. A 5–ampere fuse wire can withstand a maximum power of 1 watt in the circuit. The resistance of the fuse wire is

- (a) 0.04 ohm (b) 0.2 ohm
(c) 5 ohm (d) 0.4 ohm

Ans: (a)

Solution: $R = \frac{P}{I^2} = \frac{1}{25} = 0.04\Omega$

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q74. A ray of light is incident at an angle of incidence, i , on one face of prism of angle A (assumed to be small) and emerges normally from the opposite face. If the refractive index of the prism is μ , the angle of incidence i , is nearly equal to:

- (a) μA
(b) $\frac{\mu A}{2}$
(c) $\frac{A}{\mu}$
(d) $\frac{A}{2\mu}$

Ans: (a)

Solution: For normally emerge $e = 0$

Therefore $r_2 = 0$ and $r_1 = A$

Snell's Law for Incident ray's

$1 \sin i = \mu \sin r_1 = \mu \sin A$

For small angle

$i = \mu A$

Chapter - Ray Optics and Optical

[Topic: Prism & Dispersion of Light]

Q75. A depletion layer consists of

- (a) electrons
(b) protons
(c) mobile ions
(d) immobile ions

Ans: (d)

Solution: Depletion layer is formed by diffusion of holes and electrons from p -type semiconductor to n -type semiconductor and vice-versa. Hence, donor and acceptor atom get positive and negative charge leading to formation of p - n junction. Thus, donor and acceptor are immobile.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q76. Two persons of masses 55 kg and 65 kg respectively, are at the opposite ends of a boat. The length of the boat is 3.0 m and weighs 100 kg. The 55 kg man walks up to the 65 kg man and sits with him. If the boat is in still water the centre of mass of the system shifts by :

- (a) 3.0 m (b) 2.3 m
(c) zero (d) 0.75 m

Ans: (c)

Solution: There is no external force so centre of mass of the system will not shift

$$3. (a) X_{cm} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3}{m_1 + m_2 + m_3}$$

$$X_{cm} = \frac{300 \times (0) + 500(40) + 400 \times 70}{300 + 500 + 400}$$

$$X_{cm} = \frac{500 \times 40 + 400 \times 70}{1200}$$

$$X_{cm} = \frac{50+70}{3} = \frac{120}{3} = 40 \text{ cm}$$

Chapter: System of Particles and Rotational Motion

[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q77. A particle executing S.H.M. has amplitude 0.01m and frequency 60 Hz. The maximum acceleration of the particle is

- (a) $144 \pi^2 \text{ m/s}^2$ (b) $120 \pi^2 \text{ m/s}^2$
(c) $80 \pi^2 \text{ m/s}^2$ (d) $60 \pi^2 \text{ m/s}^2$

Ans: (a)

Solution: Amplitude (A) = 0.01 m, Frequency = 60 Hz

Maximum acceleration

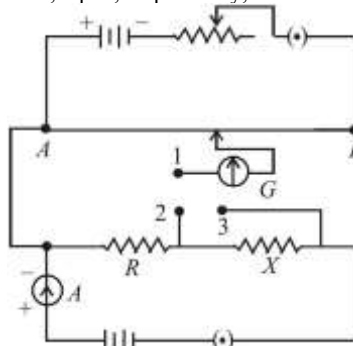
$= A\omega^2 = 0.01 \times (2\pi n)^2$

$= 0.01 \times 4\pi^2 \times 60 \times 60 = 144\pi^2 \text{ m/sec}^2$

Chapter: Oscillation

[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q78. A potentiometer circuit is set up as shown. The potential gradient, across the potentiometer wire, is k volt/cm and the ammeter, present in the circuit, reads 1.0 A when two way key is switched off. The balance points, when the key between the terminals (i) 1 and 2 (ii) 1 and 3, is plugged in, are found to be at lengths l_1 cm and l_2 cm respectively. The magnitudes, of the resistors R and X , in ohms, are then, equal, respectively, to



- (a) $k(l_2 - l_1)$ and $k l_2$ (b) $k l_1$ and $k(l_2 - l_1)$
(c) $k(l_2 - l_1)$ and $k l_1$ (d) $k l_1$ and $k l_2$

Ans: (b)

Solution: (i) When key between the terminals 1 and 2 is plugged in,

P.D. across $R = IR = k l_1$

$\Rightarrow R = k l_1$ as $I = 1A$

(ii) When key between terminals 1 and 3 is plugged in,

P.D. across $(X + R) = I(X + R) = k l_2$

$\Rightarrow X + R = k l_2$

$\therefore X = k(l_2 - l_1)$

$$\therefore R = kl_1 \text{ and } X = k(l_2 - l_1)$$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q79. In the Young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is K , (λ being the wave length of light used). The intensity at a point where the path difference is $\lambda/4$, will be:

- (a) K (b) $K/4$
 (c) $K/2$ (d) Zero

Ans: (c)

Solution: For path difference λ , phase difference = 2π rad.

For path difference $\frac{\lambda}{4}$, phase difference = $\frac{\pi}{2}$ rad.

As $K = 4I_0$ so intensity at given point where path difference is $\frac{\lambda}{4}$

$$K' = 4I_0 \cos^2\left(\frac{\pi}{4}\right) \left(\cos\frac{\pi}{4} = \cos 45^\circ\right)$$

$$= 2I_0 = \frac{K}{2}$$

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q80. The input resistance of a silicon transistor is 100 Ω . Base current is changed by 40 μA which results in a change in collector current by 2 mA. This transistor is used as a common emitter amplifier with a load resistance of 4 K Ω . The voltage gain of the amplifier is :

- (a) 2000 (b) 3000
 (c) 4000 (d) 1000

Ans: (a)

Solution: Voltage gain (A_v) = $\frac{V_{out}}{V_{in}} = \frac{I_{out}}{I_{in}} \times \frac{R_{out}}{R_{in}}$

$$A_v = \frac{2 \times 10^{-3}}{40 \times 10^{-6}} \times \frac{4 \times 10^3}{100} = 2 \times 100 = 2000$$

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q81. In a particular system, the unit of length, mass and time are chosen to be 10 cm, 10 g and 0.1 s respectively. The unit of force in this system will be equivalent to

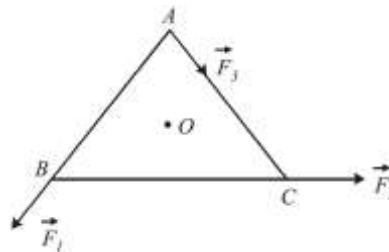
- (a) 0.1 N (b) 1 N
 (c) 10 N (d) 100 N

Ans: (a)

Solution: $[F] = MLT^{-2} = (10g)(10cm)(0.1s)^{-2}$
 $= (10^{-2}kg)(10^{-1}m)(10^{-1}s)^{-2} = 10^{-1}N$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q82. ABC is an equilateral triangle with O as its centre. $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$ represent three forces acting along the sides AB, BC and AC respectively. If the total torque about O is zero the magnitude of $\vec{F}_3$ is :



- (a) $F_1 + F_2$ (b) $F_1 - F_2$
 (c) $\frac{F_1 + F_2}{2}$ (d) $2(F_1 + F_2)$

Ans: (a)

Solution: $F_1 \times x + F_2 \times x = F_3 \times x$

$$F_3 = F_1 + F_2$$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q83. A mass of 2.0 kg is put on a flat pan attached to a vertical spring fixed on the ground as shown in the figure. The mass of the spring and the pan is negligible. When pressed slightly and released the mass executes a simple harmonic motion. The spring constant is 200 N/m. What should be the minimum amplitude of the motion so that the mass gets detached from the pan (take $g = 10 \text{ m/s}^2$)?



- (a) 10.0 cm
 (b) any value less than 12.0 cm
 (c) 4.0 cm
 (d) 8.0 cm

Ans: (a)

Solution: Mass gets detached at the upper extreme position when pan returns to its mean position.

At that point, $R = mg - m\omega^2 a = 0$

$$\text{i.e. } g = \omega^2 a$$

$$\Rightarrow a = g/\omega^2 = mg/k$$

$$= a = \frac{2 \times 10}{200} \left[\text{As } \omega^2 = \frac{k}{m} \right]$$

$$= a = \frac{1}{10\text{m}} = 10\text{cm}$$

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q84. In a certain region of space electric field $\vec{E}$ and magnetic field $\vec{B}$ are perpendicular to each other and an electron enters in region perpendicular to the direction of $\vec{B}$ and $\vec{E}$ both and moves undeflected, then velocity of electron is

- (a) $\frac{|\vec{E}|}{|\vec{B}|}$
 (b) $\vec{E} \times \vec{B}$
 (c) $\frac{|\vec{B}|}{|\vec{E}|}$

(d) $\vec{E} \cdot \vec{B}$

Ans: (a)

Solution: Electron moves undeflected if force exerted due to electric field is equal to force due to magnetic field.

$$q|\vec{v}||\vec{B}| = q|\vec{E}| \Rightarrow |\vec{v}| = \frac{|\vec{E}|}{|\vec{B}|}$$

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q85. The wavelength λ_e of an electron and λ_p of a photon are of same energy E are related by [2013]

- (a) $\lambda_p \propto \lambda_e$
 (b) $\lambda_p \propto \sqrt{\lambda_e}$
 (c) $\lambda_p \propto \frac{1}{\sqrt{\lambda_e}}$
 (d) $\lambda_p \propto \lambda_e^2$

Ans: (d)

Solution: As $P = \frac{E}{c}$

$$\lambda_p = \frac{hc}{E} \dots (i)$$

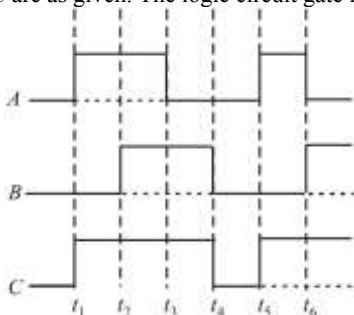
$$\lambda_e = \frac{h}{\sqrt{2mE}} \Rightarrow \lambda_e^2 = \frac{h^2}{2E} \dots (ii)$$

From equations (i) and (ii)

$$\lambda_p \propto \lambda_e^2$$

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q86. The figure shows a logic circuit with two inputs A and B and the output C . The voltage wave forms across A , B and C are as given. The logic circuit gate is :



- (a) OR gate
 (b) NOR gate
 (c) AND gate
 (d) NAND gate

Ans: (a)

Solution:

A	0	1	1	0
B	0	0	1	1
C	1	1	1	1

OR gate

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q87. The dimensional formula for permeability μ is given by

- (a) $MLT^{-2}A^{-2}$
 (c) $M^0L^2T^{-1}A^2$

- (b) M^0L^1T
 (d) None of the above

Ans: (a)

Solution: $\mu = \frac{B}{nI}$; $[B] = MT^{-2}A^{-1}$,

$$[n] = L^{-1}[I] = A$$

$$\left[\frac{B}{nI}\right] = [MLT^{-2}A^{-2}]$$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q88. Three identical spherical shells, each of mass m and radius r are placed as shown in figure. Consider an axis XX' which is touching to two shells and passing through diameter of third shell. Moment of inertia of the system consisting of these three spherical shells about XX' axis is

- (a) $3mr^2$



- (b) $\frac{16}{5}mr^2$

- (c) $4mr^2$

- (d) $\frac{11}{5}mr^2$

Ans: (c)

Solution: Moment of inertia of shell 1 along diameter

$$I_{\text{diameter}} = \frac{2}{3}MR^2$$

Moment of inertia of shell 2 = m . i of shell 3

$$= I_{\text{tangential}} = \frac{2}{3}MR^2 + MR^2 = \frac{5}{3}MR^2$$



So, I of the system along $x x'$

$$= I_{\text{diameter}} + (I_{\text{tangential}}) \times 2$$

$$\text{or, } I_{\text{total}} = \frac{2}{3}R^2 + \left(\frac{5}{3}MR^2\right) \times 2$$

$$= \frac{12}{3}MR^2 = 4MR^2$$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q89. A transverse wave is represented by $y = A \sin(\omega t - kx)$. For what value of the wavelength is the wave velocity equal to the maximum particle velocity?

- (a) $\frac{\pi A}{2}$
 (b) πA
 (c) $2\pi A$
 (d) A

Ans: (c)

Solution: $y = A \sin(\omega t - kx)$

Particle velocity,

$$v_p = \frac{dy}{dt} = A \omega \cos(\omega t - kx)$$

$$\therefore v_{pmax} = A \omega$$

$$\text{wave velocity} = \frac{\omega}{k}$$

$$\therefore A \omega = \frac{\omega}{k}$$

$$\text{i. e., } A = \frac{1}{k} \text{ But } k = \frac{2\pi}{\lambda}$$

$$\therefore \gamma = 2\pi A$$

Chapter: Waves
[Topic: Basic of Waves]

- Q90.** Magnetic field intensity at the centre of a coil of 50 turns, radius 0.5 m and carrying a current of 2 A is
 (a) $0.5 \times 10^{-5} \text{ T}$ (b) $1.25 \times 10^{-4} \text{ T}$
 (c) $3 \times 10^{-5} \text{ T}$ (d) $4 \times 10^{-5} \text{ T}$

Ans: (b)

Solution: We know that magnetic field at the centre of circular coil,

$$B = \frac{\mu_0 I n}{2r} = \frac{4\pi \times 10^{-7} \times 2 \times 50}{2 \times 0.5} = 1.25 \times 10^{-4} \text{ T}$$

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

- Q91.** The momentum of a photon of energy $h\nu$ will be [2011]
 (a) $h\nu/c$
 (b) $c/h\nu$
 (c) $h\nu$
 (d) $h\nu/c^2$

Ans: (a)

Solution: Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

- Q92.** A particle has initial velocity $(2\vec{i} + 3\vec{j})$ and acceleration $(0.3\vec{i} + 0.2\vec{j})$. The magnitude of velocity after 10 seconds will be :
 (a) $9\sqrt{2}$ units (b) $5\sqrt{2}$ units
 (c) 5 units (d) 9 units

Ans: (b)

Solution: $\vec{v} = \vec{u} + \vec{a}t$

$$\vec{v} = (2\vec{i} + 3\vec{j}) + (0.3\vec{i} + 0.2\vec{j}) \times 10 = 5\vec{i} + 5\vec{j}$$

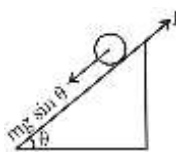
$$|\vec{v}| = \sqrt{5^2 + 5^2}$$

$$|\vec{v}| = 5\sqrt{2}$$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

- Q93.** A solid cylinder and a hollow cylinder both of the same mass and same external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first?
 (a) Both together
 (b) Solid cylinder
 (c) One with higher density
 (d) Hollow cylinder

Ans: (b)



Solution:

Torque, $I\alpha = f \cdot R$.

Using Newton's IInd law, $mg \sin \theta - f = ma$

$\therefore$ pure rolling is there, $a = R\alpha$

$$= mg \sin \theta - \frac{I\alpha}{R} = ma$$

$$= mg \sin \theta - \frac{Ia}{R^2} = ma \left(\because \alpha = \frac{a}{R} \right)$$

$$\text{or, acceleration, } a = \frac{mg \sin \theta}{\left(\frac{I}{R^2} + m \right)}$$

$$\text{Using, } s = ut + \frac{1}{2} at^2$$

$$\text{or, } s = \frac{1}{2} at^2 = t \alpha \frac{1}{\sqrt{a}}$$

t minimum means a should be more. This is possible when I is minimum which is the case for solid cylinder.

Therefore, solid cylinder will reach the bottom first.

Chapter: System of Particles and Rotational Motion
[Topic: Rolling Motion]

- Q94.** The temperature at which the speed of sound becomes double as was at 27°C is
 (a) 273°C (b) 0°C
 (c) 927°C (d) 1027°C

Ans: (c)

Solution: We have $c \propto \sqrt{T}$

$$\frac{c_1}{c_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\Rightarrow \frac{c_1}{2c_2} = \sqrt{\frac{(27 + 273)k}{T_2}}$$

$$\Rightarrow T_2 = 1200k = 927^\circ \text{C}$$

Chapter: Waves
[Topic: Basic of Waves]

- Q95.** Two long parallel wires are at a distance of 1 metre. Both of them carry one ampere of current. The force of attraction per unit length between the two wires is
 (a) $2 \times 10^{-7} \text{ N/m}$ (b) $2 \times 10^{-8} \text{ N/m}$
 (c) $5 \times 10^{-8} \text{ N/m}$ (d) 10^{-7} N/m

Ans: (a)

$$\text{Solution: } F = \frac{\mu_0}{4\pi} \times \frac{2I_1 I_2 l}{r} = 10^{-7} \times \frac{2 \times 1 \times 1 \times 1}{1}$$

$$= 2 \times 10^{-7} \text{ N/m.}$$

[This relates to the definition of ampere]

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

- Q96.** Light of wavelength $5000 \text{ \AA}$ falls on a sensitive plate with photo-electric work function of 1.9 eV . The kinetic energy of the photo-electrons emitted will be
 (a) 0.58 eV (b) 2.48 eV
 (c) 1.24 eV (d) 1.16 eV

Ans: (a)

Solution: $K.E. = h\nu - h\nu_0$
 $= \frac{hc}{\lambda} - h\nu_0 = \frac{12375}{5000} - 1.9$
 $= 2.48 - 1.9 = 0.58 \text{ eV}$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q97. A boy standing at the top of a tower of 20m height drops a stone. Assuming $g = 10 \text{ ms}^{-2}$, the velocity with which it hits the ground is

- (a) 10.0 m/s (b) 20.0 m/s
 (c) 40.0 m/s (d) 5.0 m/s

Ans: (b)

Solution: Here, $u = 0$

We have, $v^2 = u^2 + 2gh$

$$\Rightarrow v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20 \text{ m/s}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q98. A body weighs 72 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?

- (a) 32 N (b) 28 N
 (c) 16 N (d) 72 N

Ans: (a)

Solution: $mg = 72 \text{ N}$ (body weight on the surface)

$$g = \frac{GM}{R^2}$$

At a height $H = \frac{R}{2}$,

$$g' = \frac{GM}{\left(R + \frac{R}{2}\right)^2} = \frac{4GM}{9R^2}$$

Body weight at height $H = \frac{R}{2}$,

$$mg' = m \times \frac{4GM}{9R^2}$$

$$= m \times \frac{4}{9} \times g = \frac{4}{9} mg$$

$$= \frac{4}{9} \times 72 = 32 \text{ N}$$

Chapter: Gravitation

[Topic: Acceleration due to Gravity]

Q99. Two sources of sound placed close to each other are emitting progressive waves given by $y_1 = 4 \sin 600 \pi t$ and $y_2 = 5 \sin 608 \pi t$. An observer located near these two sources of sound will hear :

- (a) 4 beats per second with intensity ratio 25 : 16 between waxing and waning. (b) 8 beats per second with intensity ratio 25 : 16 between waxing and waning
 (c) 8 beats per second with intensity ratio 81 : 1 between waxing and waning (d) 4 beats per second with intensity ratio 81 : 1 between waxing and waning

Ans: (d)

Solution: $2\pi f_1 = 600 \pi$

$$f_1 = 300 \dots (1)$$

$$2\pi f_2 = 608 \pi$$

$$f_2 = 304 \dots (2)$$

$$|f_1 - f_2| = 4 \text{ beats}$$

$$\frac{I_{\max}}{I_{\min}} = \frac{(A_1 + A_2)^2}{(A_1 - A_2)^2} = \frac{(5+4)^2}{(5-4)^2} = \frac{81}{1},$$

where A_1, A_2 are amplitudes of given two sound wave.

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q100. The work done in turning a magnet of magnetic moment M by an angle of 90° from the meridian, is n times the corresponding work done to turn it through an angle of 60° . The value of n is given by

- (a) 2 (b) 1
 (c) 0.5 (d) 0.25

Ans: (a)

Solution: Magnetic moment = M ; Initial angle through which magnet is turned $(\theta_1) = 90^\circ$ and final angle through which magnet is turned $(\theta_2) = 60^\circ$. Work done in turning the magnet through $90^\circ (W_1) = MB (\cos 0^\circ - \cos 90^\circ)$

$$= MB (1 - 0) = MB.$$

Similarly, $W_2 = MB (\cos 0^\circ - \cos 60^\circ)$

$$= M \left(1 - \frac{1}{2}\right) = \frac{MB}{2}$$

$$\therefore W_1 = 2W_2 \text{ or } n = 2.$$

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

PART 5. PHYSICS QUESTION BANK

Q1. Who indirectly determined the mass of the electron by measuring the charge of the electron?

- (a) Millikan
 (b) Rutherford
 (c) Einstein
 (d) Thomson

Ans: (d)

Solution: Chapter: Atoms

[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q2. The angle between the two vectors

$\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ will be [2001, 1994]

- (a) zero (b) 45°
 (c) 90° (d) 180°

Ans: (c)

Solution: $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$, $\vec{B} = 3\hat{i} + 4\hat{j} - 5\hat{k}$

$$\vec{A} \cdot \vec{B} = (3\hat{i} + 4\hat{j} + 5\hat{k})(3\hat{i} + 4\hat{j} - 5\hat{k})$$

$$|\vec{A}| |\vec{B}| \cos \theta = 9 + 16 - 25 = 0$$

$$|\vec{A}| \neq 0, |\vec{B}| \neq 0, \text{ hence, } \cos \theta = 0, \theta = 90^\circ$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q3. For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

- (a) $\frac{1}{2}$

(b) $\frac{1}{\sqrt{2}}$

(c) 2

(d) $\sqrt{2}$

Ans: (a)**Solution:** K.E. of satellite moving in an orbit around the earth is

$$K = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\sqrt{\frac{GM}{r}}\right)^2 = \frac{GMm}{2r}$$

P.E. of satellite and earth system is

$$U = \frac{GMm}{r} \Rightarrow \frac{K}{U} = \frac{\frac{GMm}{2r}}{\frac{GMm}{r}} = \frac{1}{2}$$

Chapter: Gravitation**[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]****Q4.** Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_H = 1.67 \times 10^{-27}$ kg]

(a) 10^{-23} C

(b) 10^{-37} C

(c) 10^{-47} C

(d) 10^{-20} C

Ans: (b)**Solution:** According to question, the net electrostatic force (F_E) = gravitational force (F_G)

$F_E = F_G$

$$\text{or } \frac{1}{4\pi\epsilon_0} \frac{\Delta e^2}{d^2} = \frac{Gm^2}{d^2}$$

$$\Rightarrow \Delta e = m \sqrt{\frac{G}{K}} \left(\frac{1}{4\pi\epsilon_0} = k = 9 \times 10^9 \right)$$

$$= 1.67 \times 10^{-27} \sqrt{\frac{6.67 \times 10^{-11}}{9 \times 10^9}}$$

$$\Delta e \approx 1.436 \times 10^{-37} \text{ C}$$

Chapter: Electrostatic Potential and capacitance**[Topic: Electric Field, Electric Field Lines & Dipole]****Q5.** A conducting circular loop is placed in a uniform magnetic field, $B = 0.025$ T with its plane perpendicular to the loop.The radius of the loop is made to shrink at a constant rate of 1 mm s^{-1} . The induced e.m.f. when the radius is 2 cm, is

(a) $2\pi\mu\text{V}$

(b) $n\mu\text{V}$

(c) $\frac{\pi}{2}\mu\text{V}$

(d) $2\mu\text{V}$

Ans: (b)**Solution:** Magnetic flux linked with the loop is $\phi = B\pi r^2$

$$|e| = \frac{d\phi}{dt} = B\pi \cdot 2r \frac{dr}{dt}$$

$$\text{When } r = 2 \text{ cm, } \frac{dr}{dt} = 1 \text{ mm s}^{-1}$$

$$e = 0.025 \times \pi \times 2 \times 2 \times 10^{-2} \times 10^{-3}$$

$$= 0.100 \times \pi \times 10^{-5} = \pi \times 10^{-6} \text{ V} = \pi\mu\text{V}$$

Chapter: Electromagnetic**[Topic: Magnetic Flux, Faraday's & Lenz's Law]****Q6.** An electron changes its position from orbit $n = 2$ to the orbit $n = 4$ of an atom. The wavelength of the emitted radiations is (R = Rydberg's constant)

(a) $\frac{16}{R}$

(b) $\frac{16}{3R}$

(c) $\frac{16}{5R}$

(d) $\frac{16}{7R}$

Ans: (b)**Solution:** $\bar{\nu} = R \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$, where $n_1 = 2$, $n_2 = 4$

$$\bar{\nu} = R \left(\frac{1}{4} - \frac{1}{16} \right)$$

$$\frac{1}{\lambda} = R \left(\frac{12}{4 \times 16} \right) \Rightarrow \lambda = \frac{16}{3R}$$

Chapter: Atoms**[Topic: Bohr Model & The Spectra of the Hydrogen Atom]****Q7.** For angles of projection of a projectile ($45^\circ - \theta$) and ($45^\circ + \theta$), the horizontal ranges described by the projectile are in the ratio of

(a) 1 : 3

(b) 1 : 2

(c) 2 : 1

(d) 1 : 1

Ans: (d)**Solution:** ($45^\circ - \theta$) & ($45^\circ + \theta$) are complementary angles as $45^\circ - \theta + 45^\circ + \theta = 90^\circ$. We know that if angle of projection of two projectiles make complementary angles, their ranges are equal. In this case also, the range will be same. So the ratio is 1 : 1.**Chapter: Kinematics Motion in a Plane****[Topic: Projectile Motion]****Q8.** A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2 . Assuming that the pressure inside the house is atmosphere pressure, the force exerted by the wind on the roof and the direction of the force will be ($\rho_{\text{air}} = 1.2 \text{ kg/m}^3$)

(a) 4.8×10^5 N, upwards

(b) 2.4×10^5 N, upwards

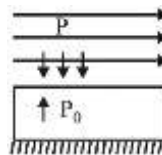
(c) 2.4×10^5 N, downwards

(d) 4.8×10^5 N, downwards

Ans: (b)**Solution:** According to Bernoulli's theorem,

$$P + \frac{1}{2}\rho v^2 = P_0 + 0$$

$$\text{So, } \Delta P = \frac{1}{2}\rho v^2$$



$$F = \Delta P A = \frac{1}{2}\rho v^2 A$$

$$= \frac{1}{2} \times 1.2 \times 40 \times 40 \times 250$$

$$= 2.4 \times 10^5 \text{ N (upwards)}$$

Chapter: Mechanical Properties of Fluids**[Topic: Fluid Flow, Reynold's Number & Bernoulli's Principle]**

Q9. There is an electric field E in x -direction. If the work done on moving a charge of 0.2 C through a distance of 2 m along a line making an angle 60° with x -axis is 4 J , then what is the value of E ?

- (a) 3 N/C (b) 4 N/C
(c) 5 N/C (d) 20 N/C

Ans: (d)

Solution: Charge (q) = 0.2 C ; Distance (d) = 2 m ; Angle $\theta = 60^\circ$ and work done (W) = 4 J .

Work done in moving the charge (W)

$$= F \cdot d \cos \theta = qEd \cos \theta$$

$$\text{or, } E = \frac{W}{qd \cos \theta} = \frac{4}{0.2 \times 2 \times \cos 60^\circ} = \frac{4}{0.4 \times 0.5}$$

$$= 20\text{ N/C.}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q10. A small signal voltage $V(t) = V_0 \sin \omega t$ is applied across an ideal capacitor C :

- (a) Current $I(t)$, lags voltage $V(t)$ by 90° .
(b) Over a full cycle the capacitor C does not consume any energy from the voltage source.
(c) Current $I(t)$ is in phase with voltage $V(t)$.
(d) Current $I(t)$ leads voltage $V(t)$ by 180° .

Ans: (b)

Solution: As we know, power $P = V_{\text{rms}} \cdot I_{\text{rms}} \cos \phi$

as $\cos \phi = 0$ ($\because \phi = 90^\circ$)

$\therefore$ Power consumed = 0

(in one complete cycle)

Chapter: Alternating Current

[Topic: Alternating Current, Voltage & Power]

Q11. Atomic weight of Boron is 10.81 and it has two isotopes ${}^5_1\text{B}^{10}$ and ${}^5_1\text{B}^{11}$. Then the ratio ${}^5_1\text{B}^{10} : {}^5_1\text{B}^{11}$ in nature would be

- (a) $19 : 81$ (b) $10 : 11$
(c) $15 : 16$ (d) $81 : 19$

Ans: (a)

Solution: Suppose that,

The number of ${}^{10}\text{B}$ type atoms = x

and the number of ${}^{11}\text{B}$ type atoms = y

Weight of ${}^{10}\text{B}$ type atoms = $10x$

Weight of ${}^{11}\text{B}$ type atoms = $11y$

Total number of atoms = $x + y$

$$\therefore \text{Atomic weight} = \frac{10x + 11y}{x + y} = 10.81$$

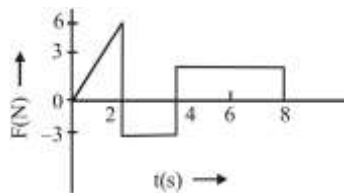
$$\Rightarrow 10x + 11y = 10.81x + 10.81y$$

$$\Rightarrow 0.81x = 0.19y = \frac{x}{y} = \frac{19}{81}$$

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q12. The force ' F ' acting on a particle of mass ' m ' is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from zero to 8 s is:



- (a) 24 Ns (b) 20 Ns
(c) 12 Ns (d) 6 Ns

Ans: (c)

Solution: Change in momentum,

$$\Delta p = \int F dt$$

= Area of F - t graph

$$= \frac{1}{2} \times 2 \times 6 - 3 \times 2 + 4 \times 3 = 12\text{ N-s}$$

Chapter: Dynamics Laws of Motion

[Topic: 1st, 2nd & 3rd Laws of Motion]

Q13. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q ?

[2012]

- (a) $Q/4\pi R^2 \sigma$
(b) $(Q/4\pi R^2 \sigma)^{-1/2}$
(c) $(4\pi R^2 Q/\sigma)^{1/4}$ (d) $(Q/4\pi R^2 \sigma)^{1/4}$

(σ stands for Stefan's constant)

Ans: (d)

Solution: Stefan's law for black body radiation

$$Q = \sigma e AT^4$$

$$T = \left[\frac{Q}{\sigma(4\pi R^2)} \right]^{\frac{1}{4}}$$

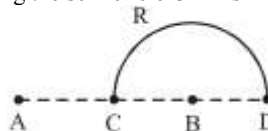
Here $e = 1$

$$A = 4\pi R^2$$

Chapter: Thermal Properties

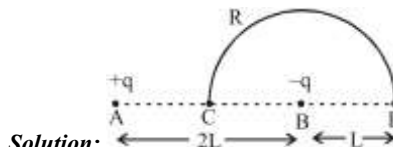
[Topic: Calorimetry & Heat Transfer]

Q14. Charges $+q$ and $-q$ are placed at points A and B respectively which are a distance $2L$ apart, C is the midpoint between A and B . The work done in moving a charge $+Q$ along the semicircle CRD is



- (a) $\frac{qQ}{2\pi\epsilon_0 L}$
(b) $\frac{qQ}{6\pi\epsilon_0 L}$
(c) $-\frac{qQ}{6\pi\epsilon_0 L}$
(d) $\frac{qQ}{4\pi\epsilon_0 L}$

Ans: (c)



Solution:

Potential at $C = V_C = 0$

Potential at $D = V_D$
 $= k \left(\frac{-q}{L} \right) + \frac{kq}{3L} = -\frac{2kq}{3L}$
 Potential difference
 $V_D - V_C = \frac{-2kq}{3L} = \frac{1}{4\pi\epsilon_0} \left(-\frac{2}{3} \cdot \frac{q}{L} \right)$
 $\Rightarrow \text{Work done} = Q(V_D - V_C)$
 $= -\frac{2}{3} \times \frac{1}{4\pi\epsilon_0} \frac{qQ}{L} = \frac{-qQ}{6\pi\epsilon_0 L}$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q15. A capacitor has capacity C and reactance X . If capacitance and frequency become double, then reactance will be

- (a) $4X$ (b) $X/2$
 (c) $X/4$ (d) $2X$

Ans: (c)

Solution: Capacitive reactance, $X = \frac{1}{\omega C} = \frac{1}{2\pi fC}$
 $\Rightarrow X \propto \frac{1}{fC}$
 $\frac{X'}{X} = \frac{f}{f'} \times \frac{C}{C'} = \frac{f}{2f} \times \frac{C}{2C} = \frac{1}{4}$
 $= X' = \frac{X}{4}$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q16. Fission of nuclei is possible because the binding energy per nucleon in them

- (a) increases with mass number at low mass numbers.
 (b) decreases with mass number at low mass numbers.
 (c) increases with mass number at high mass numbers.
 (d) decreases with mass number at high mass numbers.

Ans: (d)

Solution: B.E. per nucleon is smaller for lighter as well as heavier nucleus. But fusion reaction occurs for small mass number nuclei and fission reaction occurs for larger mass number nuclei to attain reaction binding energy per nucleon.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q17. The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is:

- (a) 4 ms^{-2} upwards (b) 4 ms^{-2} downwards
 (c) 14 ms^{-2} upwards (d) 30 ms^{-2} downwards

Ans: (a)

Solution: Net force, $F = T - mg$
 $ma = T - mg$
 $2000a = 28000 - 20000 = 8000$
 $a = \frac{8000}{2000} = 4 \text{ ms}^{-2}$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q18. 10 gm of ice cubes at 0°C are released in a tumbler (water equivalent 55 g) at 40°C . Assuming that negligible

heat is taken from the surroundings, the temperature of water in the tumbler becomes nearly ($L = 80 \text{ cal/g}$)

- (a) 31°C (b) 22°C
 (c) 19°C (d) 15°C

Ans: (b)

Solution: Let the final temperature be T
 Heat gained by ice $= mL + m \times s \times (T - 0)$
 $= 10 \times 80 + 10 \times 1 \times T$
 Heat lost by water $= 55 \times 1 \times (40 - T)$
 By using law of calorimetry,
 $800 + 10T = 55 \times (40 - T)$
 $\Rightarrow T = 21.54^\circ\text{C} \approx 22^\circ\text{C}$

Chapter: Thermal Properties
[Topic: Newton's Law of Cooling]

Q19. A parallel plate condenser with oil between the plates (dielectric constant of oil $K = 2$) has a capacitance C . If the oil is removed, then capacitance of the capacitor becomes

- (a) $\sqrt{2}C$ (b) $2C$
 (c) $\frac{C}{\sqrt{2}}$
 (d) $\frac{C}{2}$

Ans: (d)

Solution: When oil is placed between space of plates

$$C = \frac{2A\epsilon_0}{d} \dots (1) \left[C = \frac{KA\epsilon_0}{d}, \text{ if } K = 2 \right]$$

When oil is removed $C' = \frac{A\epsilon_0}{d} \dots (2)$

On comparing both equations, we get $C' = C/2$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q20. The velocity of electromagnetic radiation in a medium of permittivity ϵ_0 and permeability μ_0 is given by

- (a) $\sqrt{\frac{\epsilon_0}{\mu_0}}$
 (b) $\sqrt{\mu_0 \epsilon_0}$
 (c) $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$
 (d) $\sqrt{\mu_0 \epsilon_0}$

Ans: (c)

Solution: The velocity of electromagnetic radiation in a medium of permittivity ϵ_0 and permeability μ_0 is equal to $\frac{1}{\sqrt{\mu_0 \epsilon_0}}$.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q21. A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20 s and 10 s respectively. Initially the mixture has 40 g of A_1 and 160 g of A_2 . The amount of the two in the mixture will become equal after

- (a) 60 s (b) 80 s
 (c) 20 s (d) 40 s

Ans: (d)

Solution: Let, the amount of the two in the mixture will become equal after t years.

The amount of A_1 , which remains after t years

$$N_1 = \frac{N_{01}}{(2)^{\frac{t}{20}}}$$

The amount of A_2 , which remains, after t years

$$N_2 = \frac{N_{02}}{(2)^{\frac{t}{10}}}$$

According to the problem

$$N_1 = N_2$$

$$\frac{40}{(2)^{\frac{t}{20}}} = \frac{160}{(2)^{\frac{t}{10}}}$$

$$2^{\frac{t}{20}} = 2^{\left(\frac{t}{10} - 2\right)}$$

$$\frac{t}{20} = \frac{t}{10} - 2$$

$$\frac{t}{20} - \frac{t}{10} = -2$$

$$\frac{t}{20} = 2$$

$$t = 40 \text{ s}$$

Chapter: Nuclei

[Topic: Radioactivity]

Q22. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m/s. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is

- (a) 0°
 (b) $\frac{\pi}{3}$
 (c) $\frac{\pi}{6}$
 (d) $\frac{\pi}{4}$

Ans: (d)

Solution: Given; speed = 10 m/s; radius $r = 10$ m

Angle made by the wire with the vertical

$$\tan \theta = \frac{v^2}{rg} = \frac{10^2}{10 \times 10} = 1$$

$$\Rightarrow \theta = 45^\circ = \frac{\pi}{4}$$

Chapter: Dynamics Laws of Motion

[Topic: Circular Motion, Banking of Road]

Q23. If Q , E and W denote respectively the heat added, change in internal energy and the work done in a closed cyclic process, then:

- (a) $W = 0$
 (b) $Q = W = 0$
 (c) $E = 0$
 (d) $Q = 0$

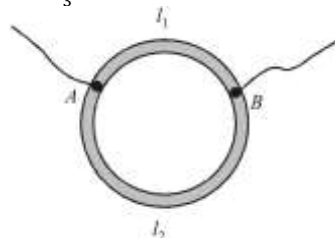
Ans: (c)

Solution: In a cyclic process, the initial state coincides with the final state. Hence, the change in internal energy is zero, as it depends only on the initial and final states. But Q & W are non-zero during a cycle process.

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

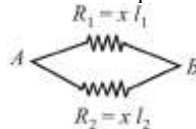
Q24. A ring is made of a wire having a resistance $R_0 = 12 \Omega$. Find the points A and B as shown in the figure, at which a current carrying conductor should be connected so that the resistance R of the sub-circuit between these points is equal to $\frac{8}{3} \Omega$.



- (a) $\frac{l_1}{l_2} = \frac{5}{8}$
 (b) $\frac{l_1}{l_2} = \frac{1}{3}$
 (c) $\frac{l_1}{l_2} = \frac{3}{8}$
 (d) $\frac{l_1}{l_2} = \frac{1}{2}$

Ans: (d)

Solution: Let x is the resistance per unit length then



equivalent resistance $R = \frac{R_1 R_2}{R_1 + R_2}$

$$\frac{(x_1 l_1)(x_2 l_2)}{x l_1 + x l_2}$$

$$\Rightarrow \frac{8}{3} = x \frac{l_1 l_2}{l_1 + l_2}$$

$$\frac{8}{3} = x \frac{l_1}{\frac{l_1}{l_2} + 1} \dots (i)$$

$$\text{also } R_0 = x l_1 + x l_2$$

$$12 = x(l_1 + l_2)$$

$$12 = x l_2 \left(\frac{l_1}{l_2} + 1 \right) \dots (ii)$$

$$\frac{(i)}{(ii)} \Rightarrow \frac{\frac{8}{3}}{\frac{12}{1}} = \frac{\frac{x l_1}{\left(\frac{l_1}{l_2} + 1\right)}}{x l_2 \left(\frac{l_1}{l_2} + 1\right)} = \frac{l_1}{l_2 \left(\frac{l_1}{l_2} + 1\right)^2}$$

$$\left(\frac{l_1}{l_2} + 1 \right)^2 \times \frac{8}{36} = \frac{l_1}{l_2}$$

$$(y^2 + 1 + 2y) \times \frac{8}{36} = y \text{ (where } y = \frac{l_1}{l_2})$$

$$8y^2 + 8 + 16y = 36y$$

$$\Rightarrow 8y^2 - 20y + 8 = 0$$

$$\Rightarrow 2y^2 - 5y + 2 = 0$$

$$\Rightarrow 2y^2 - 4y - y + 2 = 0$$

$$\Rightarrow 2y(y - 2) - 1(y - 2) = 0$$

$$\Rightarrow (2y - 1)(y - 2) = 0$$

$$\Rightarrow y = \frac{l_1}{l_2} = \frac{1}{2} \text{ or } 2$$

Chapter: Current Electricity

[Topic: Combination of Resistances]

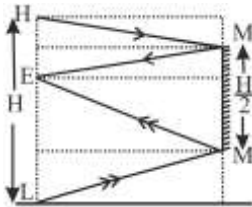
Q25. A person is six feet tall. How tall must a vertical mirror be if he is able to see his entire length?

[2000]

- (a) 3 ft (b) 4.5 ft
(c) 7.5 ft (d) 6 ft

Ans: (a)

Solution: To see his full image in a plane mirror a person requires a mirror of at least half of his height.



Chapter - Ray Optics and Optical

[Topic: Plane, Spherical Mirror & Reflection of Light]

Q26. The most penetrating radiation of the following is

- (a) gamma-rays
(b) alpha particles
(c) beta-rays
(d) X-rays

Ans: (a)

Solution: The penetrating power of radiation is directly proportional to the energy of its photon.

$$\text{Energy of a photon} = \frac{hc}{\lambda} \propto \frac{1}{\lambda}$$

$$\therefore \text{Penetrating power} \propto \frac{1}{\lambda}$$

λ is minimum for γ -rays, so penetrating power is maximum of γ -rays.

Chapter: Nuclei

[Topic: Radioactivity]

Q27. An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water?

- (a) mv^2 (b) $\frac{1}{2}mv^2$
(c) $\frac{1}{2}m^2v^2$
(d) $\frac{1}{2}mv^3$

Ans: (d)

Solution: m : mass per unit length

$\therefore$ rate of mass leaving the the hose per sec

$$= \frac{mx}{t} = mv$$

$$\text{Rate of K.E.} = \frac{1}{2} (mv) v^2 = \frac{1}{2} mv^3$$

Chapter: Work, Energy and Power

[Topic: Energy]

Q28. An ideal carnot engine, whose efficiency is 40% receives heat at 500 K. If its efficiency is 50%, then the intake temperature for the same exhaust temperature is

- (a) 600 K (b) 700 K
(c) 800 K (d) 900 K

Ans: (a)

Solution: Efficiency of carnot engine (η_1) = 40% = 0.4;
Initial intake temperature (T_1) = 500K and new efficiency (η_2) = 50% = 0.5.

$$\text{Efficiency } (\eta) = 1 - \frac{T_2}{T_1} \text{ or } \frac{T_2}{T_1} = 1 - \eta$$

$$\text{Therefore in first case, } \frac{T_2}{500} = 1 - 0.4 = 0.6$$

$$\Rightarrow T_2 = 0.6 \times 500 = 300\text{K}$$

$$\text{And in second case, } \frac{300}{T_1} = 1 - 0.5 = 0.5$$

$$\Rightarrow T_1 = \frac{300}{0.5} = 600\text{K}$$

Chapter: Heat & Thermodynamics

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q29. A student measures the terminal potential difference (V) of a cell (of emf E and internal resistance r) as a function of the current (I) flowing through it. The slope and intercept, of the graph between V and I , then, respectively, equal:

- (a) $-r$ and E
(b) r and $-E$
(c) $-E$ and r
(d) E and $-r$

47.A cell can be balanced against 110 cm and 100 cm of potentiometer wire, respectively with and without being short circuited through a resistance of 10Ω . Its internal resistance is

[2008]

Ans: (a)

Solution: The terminal potential difference of a cell is given by $V + Ir = E$

$$V = V_A - V_B$$

$$\text{or } V = E - Ir$$

$$\Rightarrow \frac{dV}{dI} = -r, \text{ Also for, } i = 0 \text{ then } V = E$$

$$\therefore \text{slope} = -r, \text{ intercept} = E$$

Chapter: Current Electricity

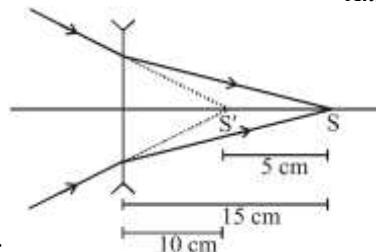
[Topic: Kirchhoff's Laws, Cells, Thermo emf &

Electrolysis]

Q30. A converging beam of rays is incident on a diverging lens. Having passed through the lens the rays intersect at a point 15 cm from the lens on the opposite side. If the lens is removed the point where the rays meet will move 5 cm closer to the lens. The focal length of the lens is

- (a) -10 cm (b) 20 cm
(c) -30 cm (d) 5 cm

Ans: (c)



Solution:

By lens formula,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$u = 10 \text{ cm}$$

$$v = 15 \text{ cm}$$

$$f = ?$$

Putting the values, we get

$$\frac{1}{15} - \frac{1}{10} = \frac{1}{f}$$

$$\frac{10-15}{150} = \frac{1}{f} \Rightarrow f = -\frac{150}{3} = -30 \text{ cm}$$

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q31. Pure Si at 500K has equal number of electron (n_e) and hole (n_h) concentrations of $1.5 \times 10^{16} \text{ m}^{-3}$. Doping by indium increases n_h to $4.5 \times 10^{22} \text{ m}^{-3}$. The doped semiconductor is of

- (a) n-type with electron concentration $n_e = 5 \times 10^{22} \text{ m}^{-3}$
- (b) p-type with electron concentration $n_e = 2.5 \times 10^{10} \text{ m}^{-3}$
- (c) n-type with electron concentration $n_e = 2.5 \times 10^{23} \text{ m}^{-3}$
- (d) p-type having electron concentration $n_e = 5 \times 10^9 \text{ m}^{-3}$

Ans: (d)

Solution: $n_e^2 = n_e n_h$
 $(1.5 \times 10^{16})^2 = n_e (4.5 \times 10^{22})$

$$\Rightarrow n_e = 0.5 \times 10^{10}$$

$$\text{or } n_e = 5 \times 10^9$$

$$\text{Given } n_h = 4.5 \times 10^{22}$$

$$\Rightarrow n_h \gg n_e$$

$\therefore$ Semiconductor is p-type and

$$n_e = 5 \times 10^9 \text{ m}^{-3}$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q32. Two particles A and B, move with constant velocities $\vec{v}_1$ and $\vec{v}_2$. At the initial moment their position vectors are $\vec{r}_1$ and $\vec{r}_2$ respectively. The condition for particles A and B for their collision is:

- (a) $\vec{r}_1 \cdot \vec{v}_1 = \vec{r}_2 \cdot \vec{v}_2$
- (b) $\vec{r}_1 \times \vec{v}_1 = \vec{r}_2 \times \vec{v}_2$
- (c) $\vec{r}_1 - \vec{r}_2 = \vec{v}_1 - \vec{v}_2$
- (d) $\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|} = \frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|}$

Ans: (d)

Solution: For collision $\vec{V}_B$ should be along

$$\vec{B} \rightarrow \vec{A} (\vec{r}_A - \vec{r}_B)$$

$$\text{So, } \frac{\vec{v}_2 - \vec{v}_1}{|\vec{v}_2 - \vec{v}_1|} = \frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|}$$



Chapter: Work, Energy and Power

[Topic: Collisions]

Q33. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v ,

respectively. If $\gamma = \frac{C_p}{C_v}$ and R is the universal gas constant, then C_v is equal to

- [2013]
- (a) $\frac{R}{(\gamma-1)}$
- (b) $\frac{(\gamma-1)}{R}$
- (c) γR
- (d) $\frac{1+\gamma}{1-\gamma}$

Ans: (a)

Solution: $C_p - C_v = R \Rightarrow C_p = C_v + R$

$$\therefore \gamma = \frac{C_p}{C_v} = \frac{C_v + R}{C_v} = \frac{C_v}{C_v} + \frac{R}{C_v}$$

$$\Rightarrow \gamma = 1 + \frac{R}{C_v} \Rightarrow \frac{R}{C_v} = \gamma - 1$$

$$\Rightarrow C_v = \frac{R}{\gamma-1}$$

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q34. When three identical bulbs of 60 watt, 200 volt rating are connected in series to a 200 volt supply, the power drawn by them will be

- (a) 20 watt
- (b) 60 watt
- (c) 180 watt
- (d) 10 watt

Ans: (a)

Solution: $\frac{1}{P_{eq}} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3}$ or $\frac{1}{P_{eq}} = \frac{3}{60}$

$$\Rightarrow P_{eq} = 20 \text{ watt.}$$

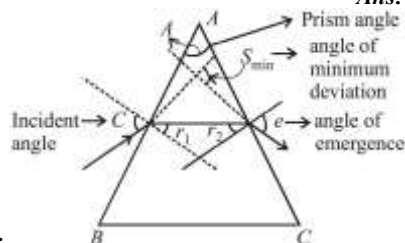
Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q35. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index

- (a) lies between $\sqrt{2}$ and 1
- (b) lies between 2 and $\sqrt{2}$
- (c) is less than 1
- (d) is greater than 2

Ans: (b)



Solution:

The angle of minimum deviation is given as

$$\delta_{min} = i + e - A$$

for minimum deviation

$$\delta_{min} = A \text{ then}$$

$$2A = i + e$$

$$\text{in case of } \delta_{min} \quad i = e$$

$$2A = 2i \quad r_1 = r_2 = \frac{A}{2}$$

$$i = A = 90^\circ$$

from Snell's law

$$1 \sin i = n \sin r_1$$

$$i = A = 0 \quad n_{\max} = 2$$

42

current from 100 μA to 300 μA produces a change in the collector current from 10mA to 20 mA. The current gain is

- (a) 50 (b) 75
(c) 100 (d) 25

Ans: (a)

Solution: The current gain

$$\beta = \frac{\Delta I_c}{\Delta I_B} = \frac{10\text{mA}}{200\mu\text{A}} = \frac{10 \times 10^3}{200} = 50$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q42. If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the unit of b is

- (a) km/s (b) kms
(c) km/s^2 (d) kms^2

Ans: (c)

Solution: $[x] = [bt^2]$. Hence $[b] = [x/t^2] = \text{km/s}^2$.

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q43. A circular platform is mounted on a frictionless vertical axle. Its radius $R = 2$ m and its moment of inertia about the axle is 200 kgm^2 . It is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of 1 ms^{-1} relative to the ground. Time taken by the man to complete one revolution is

- (a) πs
(b) $\frac{3\pi}{2}\text{s}$
(c) $2\pi\text{s}$
(d) $\frac{\pi}{2}\text{s}$

Ans: (c)

Solution: Using conservation

$$L_i = 0 \text{ (Initial moment)}$$

$$L_f = mvR - I\omega \text{ (Final moment)}$$

According to the conservation of momentum

$$L_i = L_f$$

$$\Rightarrow mvR - I\omega = 0$$

$$mvR = I\omega$$

$$\omega = \left(\frac{1}{2}\right)$$

$$(v + \omega R)t = 2\pi R$$

$$t\left(1 + \frac{1}{2} \times 2\right) = 2\pi \times 2$$

$$t = 2\pi \text{ sec.}$$

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q44. A particle executes simple harmonic oscillation with an amplitude a . The period of oscillation is T . The minimum time taken by the particle to travel half of the amplitude from the equilibrium position is

- (a) $T/8$ (b) $T/12$
(c) $T/2$ (d) $T/4$

Ans: (b)

Solution: Displacement from the mean position

$$y = a \sin\left(\frac{2\pi}{T}\right)t$$

According to problem $y = a/2$

$$\frac{a}{2} = a \sin\left(\frac{2\pi}{T}\right)t$$

$$= \frac{\pi}{6} = \left(\frac{2\pi}{T}\right)t = t = \frac{T}{12}$$

This is the minimum time taken by the particle to travel half of the amplitude from the equilibrium position.

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum &

Spring Pendulum]

Q45. A charged particle of charge q and mass m enters perpendicularly in a magnetic field $\vec{B}$. Kinetic energy of the particle is E ; then frequency of rotation is

- (a) $\frac{qB}{m\pi}$
(b) $\frac{qB}{2\pi m}$
(c) $\frac{qBE}{2\pi m}$
(d) $\frac{qB}{2\pi E}$

Ans: (b)

Solution: For circular path in magnetic field,

$$mr\omega^2 = qvB$$

$$\Rightarrow \omega^2 = \frac{qvB}{mr} \text{ As } v = r\omega$$

$$\omega^2 = \frac{q(r\omega)B}{mr} \Rightarrow \omega = \frac{qB}{m}$$

$\therefore$ If v is frequency of rotation, then

$$v = \frac{\omega}{2\pi} \Rightarrow v = \frac{qB}{2\pi m}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field

& Moment]

Q46. The de-Broglie wavelength of neutron in thermal equilibrium at temperature T is

- (a) $\frac{30.8}{\sqrt{T}} \text{ \AA}$
(b) $\frac{3.08}{\sqrt{T}} \text{ \AA}$
(c) $\frac{0.308}{\sqrt{T}} \text{ \AA}$
(d) $\frac{0.0308}{\sqrt{T}} \text{ \AA}$

Ans: (a)

Solution: From formula

$$\lambda = \frac{h}{\sqrt{2mKT}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.67 \times 10^{-27} \times 1.38 \times 10^{-23} T}} \text{ m}$$

[By placing value of h , m and k]

$$= \frac{30.8}{\sqrt{T}} \text{ \AA}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

Q47. According to Newton, the viscous force acting between liquid layers of area A and velocity gradient $\Delta V/\Delta Z$ is given by $F = -\eta A \frac{\Delta V}{\Delta Z}$ where η is constant called coefficient of viscosity. The dimensional formula of η is

- (a) $\text{ML}^{-2}\text{T}^{-2}$
(c) ML^2T^{-2}

- (b) $\text{M}^0\text{L}^0\text{T}^0$
(d) $\text{ML}^{-1}\text{T}^{-1}$

Ans: (d)

Solution: Substitute the dimensional formula of F , A , ΔV and ΔZ on both sides and find that for η .

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q48. The ratio of radii of gyration of a circular ring and a circular disc, of the same mass and radius, about an axis passing through their centres and perpendicular to their planes are

[NEET Kar. 2013, 2008]

- (a) $\sqrt{2}:1$ (b) $1:\sqrt{2}$
(c) $3:2$ (d) $2:1$

Ans: (a)

Solution: $\because I = MK^2 \therefore K = \sqrt{\frac{I}{M}}$

$$I_{\text{ring}} = MR^2 \text{ and } I_{\text{disc}} = \frac{1}{2}MR^2$$

$$\frac{K_1}{K_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{MR^2}{\left(\frac{MR^2}{2}\right)}} = \sqrt{2}:1$$

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q49. A wave in a string has an amplitude of 2 cm. The wave travels in the +ve direction of x axis with a speed of 128 m/sec and it is noted that 5 complete waves fit in 4 m length of the string. The equation describing the wave is

- (a) $y = (0.02) \text{ m} \sin (15.7x - 2010t)$
(b) $y = (0.02) \text{ m} \sin (15.7x + 2010t)$
(c) $y = (0.02) \text{ m} \sin (7.85x - 1005t)$
(d) $y = (0.02) \text{ m} \sin (7.85x + 1005t)$

Ans: (c)

Solution: $A = 2\text{cm}$, $\frac{\omega}{k} = 128 \text{ ms}^{-1}$, $5\lambda = 4$, $\lambda = \frac{4}{5} \text{ m}$

$$y = A \sin (kx - \omega t),$$

$$k = \frac{2\pi}{\lambda} = \frac{2\pi \times 5}{4} = \frac{314}{4} = 7.85$$

$$y = 0.02 \text{ m} \sin (7.85x - 1005t)$$

$$\omega = 128 \times 7.85 = 1005$$

Chapter: Waves

[Topic: Basic of Waves]

Q50. If a long hollow copper pipe carries a current, then magnetic field is produced

- (a) inside the pipe only
(b) outside the pipe only
(c) both inside and outside the pipe
(b) no where

Ans: (b)

Solution: Inside a hollow pipe carrying current, the magnetic field is zero, since according to Ampere's law, $B_r \cdot 2\pi r = \mu_0 \times 0 \Rightarrow B_r = 0$.

But for external points, the current behaves as if it was concentrated at the axis only; so, outside, $B_0 = \frac{\mu_0 I}{2\pi r}$.

Thus, the magnetic field is produced outside the pipe only.

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

PART 6. PHYSICS QUESTION BANK

Q51. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively illuminate a metallic surface whose work function is 0.5 eV successively. Ratio of maximum speeds of emitted electrons will be

- (a) 1 : 4 (b) 1 : 2
(c) 1 : 1 (d) 1 : 5

Ans: (b)

Solution: The maximum kinetic energy of emitted electrons is given by

$$K.E = \phi - \phi_0$$

$$K.E_1 = 1 \text{ eV} - 0.5 \text{ eV} = 0.5 \text{ eV}$$

$$K.E_2 = 2.5 \text{ eV} - 0.5 \text{ eV} = 2 \text{ eV}$$

$$\frac{KE_1}{KE_2} = \frac{0.5\text{eV}}{2\text{eV}} = \frac{1}{4}$$

$$= \frac{v_1}{v_2} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q52. The motion of a particle along a straight line is described by equation :

$$x = 8 + 12t - t^3$$

where x is in metre and t in second. The retardation of the particle when its velocity becomes zero, is :

- (a) 24 ms^{-2} (b) zero
(c) 6 ms^{-2} (d) 12 ms^{-2}

Ans: (d)

Solution: $x = 8 + 12t - t^3$

The final velocity of the particle will be zero, because it retarded.

$$V = 0 + 12 - 3t^2 = 0$$

$$3t^2 = 12$$

$$t = 2 \text{ sec}$$

Now the retardation

$$a = \frac{dv}{dt} = 0 - 6t$$

$$a [t = 2] = -12 \text{ m/s}^2$$

$$\text{retardation} = 12 \text{ m/s}^2$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q53. A spherical ball rolls on a table without slipping. Then the fraction of its total energy associated with rotation is

- (a) $2/5$ (b) $2/7$

(c) 3/5

(d) 3/7

Ans: (b)

$$\text{Solution: } \frac{K_r}{E} = \frac{\frac{1}{2}MK^2\omega^2}{\frac{1}{2}M\omega^2[K^2+R^2]} = \frac{K^2}{K^2+R^2}$$

$$= \frac{\frac{2}{5}}{1+\frac{2}{5}} = \frac{2}{7}$$

$$\text{Here, } K^2 = \frac{2}{5}R^2$$

Chapter: System of Particles and Rotational Motion
[Topic: Rolling Motion]

Q54. With the propagation of a longitudinal wave through a material medium, the quantities transmitted in the propagation direction are

- (a) Energy, momentum and mass
- (b) Energy
- (c) Energy and mass
- (d) Energy and linear momentum

Ans: (b)

Solution: With the propagation of a longitudinal wave, energy alone is propagated.

Chapter: Waves
[Topic: Basic of Waves]

Q55. A coil carrying electric current is placed in uniform magnetic field, then

- (a) torque is formed
- (b) e.m.f is induced
- (c) both (a) and (b) are correct
- (d) none of the above

Ans: (a)

Solution: A current carrying coil has magnetic dipole moment. Hence, a torque $\vec{p}_m \times \vec{B}$ acts on it in magnetic field.

Chapter: Moving Charges and Magnetic Field
[Topic: Force & Torque on a Current Carrying Conductor]

Q56. Which of the following statement is correct?

- (a) Photocurrent increases with intensity of light
- (b) Photocurrent is proportional to the applied voltage
- (c) Current in photocell increases with increasing frequency
- (d) Stopping potential increases with increase of incident light

Ans: (a)

Solution: According to photoelectric effect, speed of electron (kinetic energy) emitted depends upon frequency of incident light while number of photoelectrons emitted depends upon intensity of incident light. Hence, as the intensity of light increases, the photocurrent increases. In a photo-cell, the photocurrent has no relation with the applied voltage.

Stopping potential is the (negative) potential at which the current is just reduced to zero. It is independent of intensity of light but depends on the frequency of light similar to K.E.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q57. A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v . The two balls meet at $t = 18$ s. What is the value of v ?

(take $g = 10 \text{ m/s}^2$)

- (a) 75 m/s
- (b) 55 m/s
- (c) 40 m/s
- (d) 60 m/s

Ans: (a)

Solution: Clearly distance moved by 1st ball in 18s = distance moved by 2nd ball in 12s.

Now, distance moved in 18 s by 1st ball = $\frac{1}{2} \times 10 \times 18^2 = 90 \times 18 = 1620 \text{ m}$

Distance moved in 12 s by 2nd ball

$$= ut + \frac{1}{2}gt^2$$

$$1620 = 12v + 5 \times 144$$

$$= v = 135 - 60 = 75 \text{ ms}^{-1}$$

Chapter: Kinematics Motion in a Straight Line
[Topic: Motion Under Gravity]

Q58. In a rocket a seconds pendulum is mounted. Its period of oscillation decreases when the rocket [1991]

- (a) comes down with uniform acceleration
- (b) moves round the earth in a geostationary orbit
- (c) moves up with a uniform velocity
- (d) moves up with uniform acceleration

Ans: (d)

Solution: $T = 2\pi\sqrt{\frac{l}{g}}$. When the rocket accelerates upwards g increases to $(g + a)$.

Chapter: Gravitation
[Topic: Gravitational Field, Potential and Energy]

Q59. Two identical piano wires kept under the same tension T have a fundamental frequency of 600 Hz. The fractional increase in the tension of one of the wires which will lead to occurrence of 6 beats/s when both the wires oscillate together would be

- (a) 0.02
- (b) 0.03
- (c) 0.04
- (d) 0.01

Ans: (a)

Solution: For fundamental mode,

$$f = \frac{1}{2\ell} \sqrt{\frac{T}{\mu}}$$

Taking logarithm on both sides, we get

$$\log f = \log \left(\frac{1}{2\ell} \right) + \log \left(\sqrt{\frac{T}{\mu}} \right)$$

$$= \log \left(\frac{1}{2\ell} \right) + \frac{1}{2} \log \left(\frac{T}{\mu} \right)$$

$$\text{or } \log f = \log \left(\frac{1}{2\ell} \right) + \frac{1}{2} [\log T - \log \mu]$$

Differentiating both sides, we get

$$\frac{df}{f} = \frac{1}{2} \frac{dT}{T} \quad (\text{as } \ell \text{ and } \mu \text{ are constants})$$

$$\Rightarrow \frac{dT}{T} = 2 \times \frac{df}{f}$$

$$\text{Here } df = 6$$

$$f = 600 \text{ Hz}$$

$$\frac{dT}{T} = \frac{2 \times 6}{600} = 0.02$$

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q60. If θ_1 and θ_2 be the apparent angles of dip observed in two vertical planes at right angles to each other, then the true angle of dip θ is given by :-

- (a) $\tan^2 \theta = \tan^2 \theta_1 + \tan^2 \theta_2$ (b) $\cot^2 \theta = \cot^2 \theta_1 - \cot^2 \theta_2$
(c) $\tan^2 \theta = \tan^2 \theta_1 - \tan^2 \theta_2$ (d) $\cot^2 \theta = \cot^2 \theta_1 + \cot^2 \theta_2$

Ans: (d)

Solution: If θ_1 and θ_2 are apparent angles of dip Let α be the angle which one of the plane make with the magnetic meridian.

$$\tan \theta_1 = \frac{H \cos \alpha}{V} \quad \text{i.e., } \cos \alpha = \frac{H \tan \theta_1}{V} \dots (i)$$

$$\tan \theta_2 = \frac{H \sin \alpha}{V} \quad \text{i.e., } \sin \alpha = \frac{H \tan \theta_2}{V} \dots (ii)$$

Squaring and adding (i) and (ii), we get

$$\cos^2 \alpha + \sin^2 \alpha = \left(\frac{V}{H}\right)^2 \left(\frac{1}{\tan^2 \theta_1} + \frac{1}{\tan^2 \theta_2}\right)$$

$$\text{i.e., } 1 = \frac{V^2}{H^2} [\cot^2 \theta_1 + \cot^2 \theta_2]$$

$$\text{or } \frac{H^2}{V^2} = \cot^2 \theta_1 + \cot^2 \theta_2$$

$$\text{i.e., } \cot^2 \theta = \cot^2 \theta_1 + \cot^2 \theta_2$$

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q61. In Rutherford scattering experiment, what will be the correct angle for α -scattering for an impact parameter, $b = 0$?

- (a) 90° (b) 270°
(c) 0° (d) 180°

Ans: (d)

Solution: Impact parameter for Rutherford scattering experiment,

$$b = \frac{Ze^2 \cot\left(\frac{\theta}{2}\right)}{4\pi \epsilon_0 k_1} = 0 \Rightarrow \cot\left(\frac{\theta}{2}\right) = 0$$

$$= \frac{\theta}{2} = 90^\circ \text{ or } \theta = 180^\circ$$

Chapter: Atoms

[Topic: Atomic Structure, Rutherford's Nuclear Model of Atom]

Q62. A particle moves with a velocity $\vec{v} = 6\hat{i} - 4\hat{j} + 3\hat{k}$ m/s under the influence of a constant force $\vec{F} = 20\hat{i} + 15\hat{j} - 5\hat{k}$ N. The instantaneous power applied to the particle is [2000]

- (a) 45 J/s (b) 35 J/s
(c) 25 J/s (d) 195 J/s

Ans: (a)

$$\text{Solution: } P = \vec{F} \cdot \vec{v} = (6\hat{i} - 4\hat{j} + 3\hat{k}) \cdot (20\hat{i} + 15\hat{j} - 5\hat{k})$$

$$= 6 \times 20 - 4 \times 15 - 3 \times 5 = 45 \text{ J/s}$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q63. The escape velocity on the surface of earth is 11.2 km/s. What would be the escape velocity on the surface of another planet of the same mass but $1/4$ times the radius of the earth?

- (a) 22.4 km/s (b) 44.8 km/s
(c) 5.6 km/s (d) 11.2 km/s

Ans: (a)

$$\text{Solution: } v_{\text{earth}} = \sqrt{\frac{2GM_e}{R_e}}$$

$$v_{\text{planet}} = \sqrt{\frac{2GM_p}{R_p}} = \sqrt{\frac{2GM_e}{\frac{R_e}{4}}} = \sqrt{\frac{8GM_e}{R_e}}$$

$$\frac{v_{\text{planet}}}{v_{\text{earth}}} = \sqrt{\frac{8GM_e}{R_e}} \times \sqrt{\frac{R_e}{2GM_e}} = 2$$

$$\therefore v_{\text{planet}} = 2 \times v_{\text{earth}} = 2 \times 11.2 = 22.4 \text{ km/s}$$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q64. Two identical charged spheres suspended from a common point by two massless strings of lengths l , are initially at a distance d ($d \ll l$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v . Then v varies as a function of the distance x between the spheres, as :

- (a) $v \propto x^{\frac{1}{2}}$
(b) $v \propto x$
(c) $v \propto x^{-\frac{1}{2}}$
(d) $v \propto x^{-1}$

Ans: (c)

Solution: From figure $\tan \theta =$

$$\frac{\frac{F_e}{mg}}{\frac{kq^2}{x^2 mg}} = \frac{x}{2l}$$

$$\text{or } x^3 \propto q^2 \dots (1)$$

$$\text{or } x^{3/2} \propto q \dots (2)$$

Differentiating eq. (1) w.r.t. time

$$3x^{\frac{1}{2}} \frac{dx}{dt} \propto 2q \frac{dq}{dt} \text{ but } \frac{dq}{dt} \text{ is constant}$$

so $x^{\frac{1}{2}}(v) \propto q$ Replace q from eq. (2)

$$x^{\frac{1}{2}}(v) \propto x^{3/2} \text{ or } v \propto x^{-1/2}$$

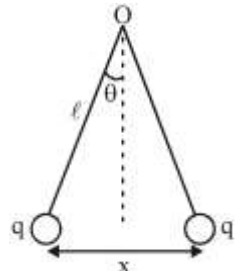
Chapter: Electrostatic Potential

and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q65. A rectangular, a square, a circular and an elliptical loop, all in the $(x-y)$ plane, are moving out of a uniform magnetic field with a constant velocity, $\vec{V} = v\hat{i}$. The magnetic field is directed along the negative z axis direction. The induced emf, during the passage of these loops, out of the field region, will not remain constant for [2009]

- (a) the circular and the elliptical loops.
(b) only the elliptical loop.



- (c) any of the four loops.
(d) the rectangular, circular and elliptical loops.

Ans: (a)

Solution: The induced emf will remain constant only in the case of rectangular and square loops. In case of the circular and the elliptical loops, the rate of change of area of the loops during their passage out of the field is not constant, hence induced emf will not remain constant for them.

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q66. The energy of hydrogen atom in n th orbit is E_n , then the energy in n th orbit of single ionised helium atom will be

- (a) $4E_n$
(b) $E_n/4$
(c) $2E_n$
(d) $E_n/2$

Ans: (a)

Solution: We have $E_n = \frac{-2\pi^2 m K^2 Z^2 e^4}{n^2 h^2}$. For helium $Z = 2$. Hence requisite answer is $4E_n$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q67. Two projectiles are fired from the same point with the same speed at angles of projection 60° and 30° respectively. Which one of the following is true?

- (a) Their maximum height will be same
(b) Their range will be same
(c) Their landing velocity will be same
(d) Their time of flight will be same

Ans: (b)

Solution: Given, $u_1 = u_2 = u$, $\theta_1 = 60^\circ$, $\theta_2 = 30^\circ$

In 1st case, we know that range

$$R_1 = \frac{u^2 \sin 2(60^\circ)}{g} = \frac{u^2 \sin 120^\circ}{g}$$

$$= \frac{u^2 \sin(90^\circ + 30^\circ)}{g}$$

$$\frac{u^2 (\cos 30^\circ)}{g} = \frac{\sqrt{3}u^2}{2g}$$

In 2nd case, when $\theta_2 = 30^\circ$, then

$$R_2 = \frac{u^2 \sin 60^\circ}{g} = \frac{u^2 \sqrt{3}}{2g} = R_1 = R_2$$

[we get same value of ranges].

Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q68. The cylindrical tube of a spray pump has radius, R , one end of which has n fine holes, each of radius r . If the speed of the liquid in the tube is V , the speed of the ejection of the liquid through the holes is :

- (a) $\frac{VR^2}{nr^2}$
(b) $\frac{VR^2}{n^3 r^2}$
(c) $\frac{V^2 R}{nr}$

(d) $\frac{VR^2}{n^2 r^2}$

Ans: (a)

Solution: Inflow rate of volume of the liquid = Outflow rate of volume of the liquid

$$\pi R^2 V = n \pi r^2 (v) \Rightarrow v = \frac{\pi R^2 V}{n \pi r^2} = \frac{VR^2}{nr^2}$$

Chapter: Mechanical Properties of Fluids

[Topic: Fluid Flow, Reynold's Number & Bernoulli's

Principle]

Q69. The electric field in a certain region is acting radially outward and is given by $E = Aa$. A charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by

- (a) $A \epsilon_0 a^2$
(b) $4 \pi \epsilon_0 Aa^3$
(c) $\epsilon_0 Aa^3$
(d) $4 \pi \epsilon_0 Aa^2$

Ans: (b)

Solution: Net flux emitted from a spherical surface of radius a according to Gauss's theorem

$$\phi_{\text{net}} = \frac{q_{\text{in}}}{\epsilon_0}$$

$$\text{or, } (Aa) (4\pi a^2) = \frac{q_{\text{in}}}{\epsilon_0}$$

$$\text{So, } q_{\text{in}} = 4\pi \epsilon_0 A a^3$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q70. The stable nucleus that has a radius half that of Fe^{56} is

- (a) Li^7
(b) Na^{21}
(c) S^{16}
(d) Ca^{40}

Ans: (a)

Solution: The nuclear radius $R = R_0 A^{1/3}$

$$\text{or } R \propto A^{1/3}$$

$$\text{or, } R^3 \propto A = A \propto R^3$$

$$\therefore \frac{A_2}{A_1} = \left(\frac{R_2}{R_1}\right)^3 \left(\frac{R_1}{R_2}\right)^3 = \frac{1}{8}$$

$$A_2 = \frac{A_1}{8} = \frac{56}{8} = 7$$

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q71. A stone is dropped from a height h . It hits the ground with a certain momentum P . If the same stone is dropped from a height 100% more than the previous height, the momentum when it hits the ground will change by :

- (a) 68%
(b) 41%
(c) 200%
(d) 100%

Ans: (b)

Solution: Momentum $P = mv = m\sqrt{2gh}$

$$(\because v^2 = u^2 + 2gh; \text{ Here } u = 0)$$

When stone hits the ground momentum

$$P = m\sqrt{2gh}$$

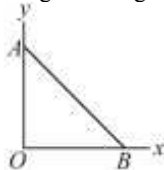
when same stone dropped from $2h$ (100% of initial) then momentum

$$P' = m\sqrt{2g(2h)} = \sqrt{2}P$$

Which is changed by 41% of initial.

Chapter: Dynamics Laws of Motion
[Topic: 1st, 2nd & 3rd Laws of Motion]

Q72. As per the diagram, a point charge $+q$ is placed at the origin O . Work done in taking another point charge $-Q$ from the point A [coordinates $(0, a)$] to another point B [coordinates $(a, 0)$] along the straight path AB is:



- (a) zero
 (b) $\left(\frac{-qQ}{4\pi\epsilon_0 a^2}\right) \sqrt{2}a$
 (c) $\left(\frac{qQ}{4\pi\epsilon_0 a^2}\right) \cdot \frac{a}{\sqrt{2}}$
 (d) $\left(\frac{qQ}{4\pi\epsilon_0 a^2}\right) \cdot \sqrt{2}a$

Ans: (a)

Solution: We know that potential energy of two charge system is given by

$$U = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$$

According to question,

$$U_A = \frac{1}{4\pi\epsilon_0} \frac{(+q)(-Q)}{a} = -\frac{1}{4\pi\epsilon_0} \frac{Qq}{a}$$

$$\text{and } U_B = \frac{1}{4\pi\epsilon_0} \frac{(+q)(-Q)}{a} = -\frac{1}{4\pi\epsilon_0} \frac{Qq}{a}$$

$$\Delta U = U_B - U_A = 0$$

We know that for conservative force,

$$W = -\Delta U = 0$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q73. An inductance L having a resistance R is connected to an alternating source of angular frequency ω . The quality factor Q of the inductance is

- (a) $\frac{R}{\omega L}$
 (b) $\left(\frac{\omega L}{R}\right)^2$
 (c) $\left(\frac{R}{\omega L}\right)^{\frac{1}{2}}$
 (d) $\frac{\omega L}{R}$

Ans: (d)

Solution: Quality factor

$$= \frac{\text{Potential drop across capacitor or inductor}}{\text{Potential drop across } R}$$

$$= \frac{I\omega L}{IR} = \frac{\omega L}{R}$$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q74. If in nuclear fusion process the masses of the fusing nuclei be m_1 and m_2 and the mass of the resultant nucleus be m_3 , then

- (a) $m_3 > (m_1 + m_2)$
 (b) $m_3 = m_1 + m_2$

- (c) $m_3 = |m_1 - m_2|$
 (d) $m_3 < (m_1 + m_2)$

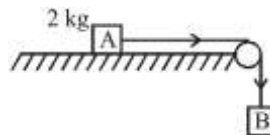
Ans: (d)

Solution: $m_3 < (m_1 + m_2)$ ($\because m_1 + m_2 = m_3 + E$)
 as $E = [m_1 + m_2 - m_3] C^2$

Chapter: Nuclei

[Topic: Mass-Energy & Nuclear Reactions]

Q75. The coefficient of static friction, μ_s , between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. ($g = 10 \text{ m/s}^2$)



- (a) 0.4 kg
 (b) 2.0 kg
 (c) 4.0 kg
 (d) 0.2 kg

Ans: (a)

Solution: $m_B g = \mu_s m_A g$
 $\therefore m_A g = \mu_s m_A g$
 $\Rightarrow m_B = \mu_s m_A$
 or, $m_B = 0.2 \times 2 = 0.4 \text{ kg}$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q76. Certain quantity of water cools from 70°C to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is:

- (a) 45°C
 (b) 20°C
 (c) 42°C
 (d) 10°C

Ans: (a)

Solution: Let the temperature of surroundings be θ_0

By Newton's law of cooling

$$\frac{\theta_1 - \theta_2}{t} = k \left[\frac{\theta_1 + \theta_2}{2} - \theta_0 \right]$$

$$\Rightarrow \frac{70-60}{5} = k \left[\frac{70+60}{2} - \theta_0 \right]$$

$$\Rightarrow 2 = k [65 - \theta_0] \dots (i)$$

$$\text{Similarly, } \frac{60-54}{5} = k \left[\frac{60+54}{2} - \theta_0 \right]$$

$$\Rightarrow \frac{6}{5} = k [57 - \theta_0] \dots (ii)$$

By dividing (i) by (ii) we have

$$\frac{10}{6} = \frac{65-\theta_0}{57-\theta_0} \Rightarrow \theta_0 = 45^\circ$$

Chapter: Thermal Properties
[Topic: Newton's Law of Cooling]

Q77. The electric and magnetic field of an electromagnetic wave are

- (a) in opposite phase and perpendicular to each other
 (b) in opposite phase and parallel to each other
 (c) in phase and perpendicular to each other
 (d) in phase and parallel to each other.

Ans: (c)

Solution: Variation in magnetic field causes electric field and vice-versa.

In electromagnetic waves, $\vec{E} \perp \vec{B}$. Both $\vec{E}$ and $\vec{B}$ are in the same phase.

In electromagnetic waves

$$E = E_0 \sin(\omega t - kx)$$

$$B = B_0 \sin(\omega t - kx)$$

The electromagnetic waves travel in the direction of $(\vec{E} \times \vec{B})$

Chapter - Electromagnetic Waves

[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q78. The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed is :

- (a) 30 days (b) 50 days
(c) 60 days (d) 15 days

Ans: (b)

$$\text{Solution: } N_1 = N_0 e^{-\lambda t_1} \quad N_2 = \frac{1}{3} N_0$$

$$\frac{N_0}{3} = N_0 e^{-\lambda t_2}$$

$$= \frac{1}{3} = e^{-\lambda t_2} \dots (i)$$

$$N_2 = \frac{2}{3} N_0$$

$$\frac{2}{3} N_0 = N_0 e^{-\lambda t_1}$$

$$= \frac{2}{3} = e^{-\lambda t_1} \dots (ii)$$

Dividing equation (i) by equation (ii)

$$\frac{1}{2} = e^{-\lambda(t_2 - t_1)}$$

$$\lambda(t_2 - t_1) = \ln 2$$

$$t_2 - t_1 = \frac{\ln 2}{\lambda} = T_{1/2} = 50 \text{ days}$$

Chapter: Nuclei

[Topic: Radioactivity]

Q79. A car of mass 1000 kg negotiates a banked curve of radius 90 m on a frictionless road. If the banking angle is 45° , the speed of the car is :

- (a) 20 ms^{-1} (b) 30 ms^{-1}
(c) 5 ms^{-1} (d) 10 ms^{-1}

Ans: (c)

$$\text{Solution: For banking } \tan \theta = \frac{v^2}{Rg}$$

$$\tan 45 = \frac{v^2}{90 \times 10} = 1$$

$$v = 30 \text{ m/s}$$

Chapter: Dynamics Laws of Motion

[Topic: Circular Motion, Banking of Road]

Q80. One mole of an ideal gas at an initial temperature of T K does $6R$ joules of work adiabatically. If the ratio of specific heats of this gas at constant pressure and at constant volume is $5/3$, the final temperature of gas will be

- (a) $(T - 4) \text{ K}$
(b) $(T + 2.4) \text{ K}$
(c) $(T - 2.4) \text{ K}$
(d) $(T + 4) \text{ K}$

Ans: (a)

$$\text{Solution: } T_1 = T, W = 6R \text{ joules, } \gamma = \frac{5}{3}$$

$$W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{nRT_1 - nRT_2}{\gamma - 1}$$

$$= \frac{nR(T_1 - T_2)}{\gamma - 1}$$

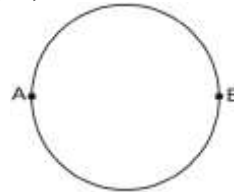
$$n = 1, T_1 = T = \frac{R(T - T_2)}{\frac{5}{3} - 1} = 6R$$

$$\Rightarrow T_2 = (T - 4) \text{ K}$$

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q81. A wire of resistance $12 \text{ ohms per meter}$ is bent to form a complete circle of radius 10 cm . The resistance between its two diametrically opposite points, A and B as shown in the figure, is



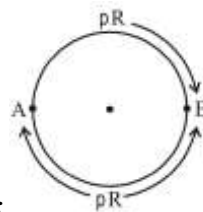
(a) 3Ω

(b) $6\pi\Omega$

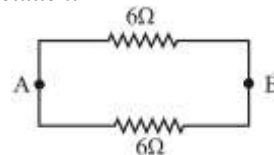
(c) 6Ω

(d) $0.6\pi\Omega$

Ans: (a)



Solution:



The resistance of length $2\pi R$ is 12Ω . Hence the resistance of length πR is 6Ω . Thus two resistances of 6Ω can be represented as shown in fig. 2.

$$\therefore \text{Equivalent resistance } R = \frac{6 \times 6}{12} = 3\Omega$$

Chapter: Current Electricity

[Topic: Combination of Resistances]

Q82. If two mirrors are kept inclined at 60° to each other and a body is placed at the middle, then total number of images formed is

- (a) six
(b) five
(c) four
(d) three

Ans: (b)

Solution: Angle between two mirrors (θ) = 60° . Number of images formed by the inclined mirror (n) = $\frac{360^\circ}{\theta} - 1 = \frac{360^\circ}{60^\circ} - 1 = 6 - 1 = 5$

Chapter - Ray Optics and Optical

[Topic: Plane, Spherical Mirror & Reflection of Light]

Q83. What is the respective number of α and β -particles emitted in the following radioactive decay $^{200}_{90}\text{X}_{90} \rightarrow ^{168}_{80}\text{Y}_{80}$?

- (a) 6 and 8 (b) 6 and 6
(c) 8 and 8 (d) 8 and 6

Ans: (d)

Solution: $^{200}_{90}\text{X}_{90} \rightarrow ^{168}_{80}\text{Y}_{80}$. We know that $^{200}_{90}\text{X}_{90} \rightarrow n_2\text{He}^4 + m_{-1}\beta^0 + ^{168}_{80}\text{Y}_{80}$.

Therefore, in this process,

$$200 = 4n + 168 \text{ or } n = \frac{200-168}{4} = 8.$$

$$\text{Also, } 90 = 2n - m + 80$$

$$\text{or, } m = 2n + 80 - 90 = (2 \times 8 + 80 - 90) = 6.$$

Thus, respective number of α and β -particles will be 8 and 6.

Chapter: Nuclei

[Topic: Radioactivity]

Q84. A body of mass 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction? ($g = 10 \text{ m/s}^2$)

- (a) 30 J (b) 40 J
(c) 10 J (d) 20 J

Ans: (d)

Solution: When the body is thrown upwards, its K.E is converted into P.E. The loss of energy due to air friction is the difference of K.E and P.E.

$$\frac{1}{2}mv^2 - mgh = \frac{1}{2} \times 1 \times 400 - 1 \times 18 \times 10 \\ = 200 - 180 = 20 \text{ J}$$

Chapter: Work, Energy and Power

[Topic: Energy]

Q85. Two vessels separately contain two ideal gases A and B at the same temperature. The pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is :

- (a) $\frac{3}{4}$ (b) 2
(c) $\frac{1}{2}$
(d) $\frac{2}{3}$

Solution: From $PV = nRT$

$$P_A = \frac{\rho_A M_A}{RT} \text{ and } P_B = \frac{\rho_B M_B}{RT}$$

From question,

$$\frac{P_A}{P_B} = \frac{\rho_A M_A}{\rho_B M_B} = 2 \frac{M_A}{M_B} = \frac{3}{2}$$

$$\text{So, } \frac{M_A}{M_B} = \frac{3}{4}$$

Ans: (a)

Chapter: Kinetic Theory

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q86.

- (a) 1.0 ohm (b) 0.5 ohm
(c) 2.0 ohm (d) zero

Ans: (a)

Solution: Here $E > \frac{ER}{R+r}$, hence the lengths 110 cm and 100 cm are interchanged.

Without being short-circuited through R, only the battery E is balanced.

$$E = \frac{V}{L} \times l_1 = \frac{V}{L} \times 110 \dots (i)$$

$$\text{When R is connected across E, } R_i = \frac{V}{L} \times l_2$$

$$\text{or, } R \left(\frac{E}{R+r} \right) = \frac{V}{L} \times 100 \dots (ii)$$

Dividing (i) by (ii), we get

$$\frac{R+r}{R} = \frac{110}{100}$$

$$\text{or, } 100R + 100r = 110R$$

$$\text{or, } 10R = 100r$$

$$\therefore r = \frac{10R}{100} = \frac{10 \times 10}{100 (\because R=10\Omega)}$$

$$\Rightarrow r = 1\Omega.$$

Chapter: Current Electricity

[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q87. A lens having focal length f and aperture of diameter d forms an image of intensity I . Aperture of diameter $\frac{d}{2}$ in central region of lens is covered by a black paper. Focal length of lens and intensity of image now will be respectively:

- (a) f and $\frac{1}{4}$
(b) $\frac{3f}{4}$ and $\frac{1}{2}$
(c) f and $\frac{3I}{4}$
(d) $\frac{f}{2}$ and $\frac{1}{2}$

Ans: (c)

Solution: By covering aperture, focal length does not change. But intensity is reduced by $\frac{1}{4}$ times, as aperture diameter $\frac{d}{2}$ is covered.

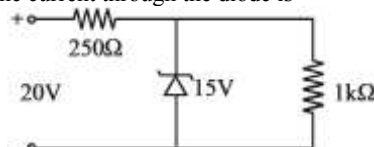
$$\therefore I' = I - \frac{1}{4} = \frac{3I}{4}$$

$$\therefore \text{New focal length} = f \text{ and intensity} = \frac{3I}{4}.$$

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q88. A zener diode, having breakdown voltage equal to 15V, is used in a voltage regulator circuit shown in figure. The current through the diode is

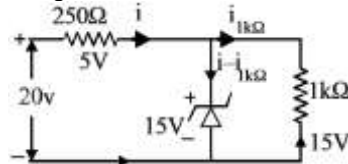


(a) 10 mA

(b) 15 mA

(c) 20 mA

(d) 5 mA

Ans: (d)**Solution:** Voltage across zener diode is constant.

Current in 1kΩ resistor,

$$(i)_{1k\Omega} = \frac{15\text{volt}}{1k\Omega} = 15 \text{ mA}$$

Current in 250Ω resistor,

$$(i)_{250\Omega} = \frac{(20-15)V}{250\Omega} = \frac{5V}{250\Omega}$$

$$= \frac{20}{1000} \text{ A} = 20 \text{ mA}$$

$$(i)_{\text{zener diode}} = (20 - 15) = 5 \text{ mA.}$$

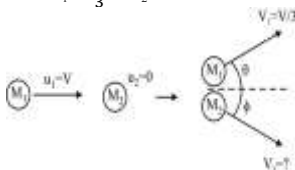
Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q89. On a frictionless surface a block of mass M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed $\frac{v}{3}$. The second block's speed after the collision is :

- (a) $\frac{3}{4}v$
 (b) $\frac{3}{\sqrt{2}}v$
 (c) $\frac{\sqrt{3}}{2}v$
 (d) $\frac{2\sqrt{2}}{3}v$

Solution: Here, $M_1 = M_2$ and $u_2 = 0$

$$u_1 = V, V_1 = \frac{v}{3}; V_2 = ?$$



From figure, along x-axis,

$$M_1 u_1 + M_2 u_2 = M_1 V_1 \cos \theta + M_2 V_2 \cos \phi \dots (i)$$

Along y-axis

$$0 = M_1 V_1 \sin \theta - M_2 V_2 \sin \phi \dots (ii)$$

By law of conservation of kinetic energy

$$\frac{1}{2} M_1 u_1^2 + \frac{1}{2} M_2 u_2^2 = \frac{1}{2} M_1 V_1^2 + \frac{1}{2} M_2 V_2^2 \dots (iii)$$

Putting $M_1 = M_2$ and $u_2 = 0$ in equation (i), (ii) and (iii) we get

$$\theta + \phi = \frac{\pi}{2} = 90^\circ$$

$$\text{and } u_1^2 = V_1^2 + V_2^2$$

$$V^2 = \left(\frac{V}{3}\right)^2 + V_2^2 \left[u_1 = V \text{ and } V_1 = \frac{V}{3}\right]$$

$$\text{or, } V^2 - \left(\frac{V}{3}\right)^2 = V_2^2$$

$$V^2 - \frac{V^2}{9} = V_2^2$$

$$\text{or } V_2^2 = \frac{8}{9} V^2 \Rightarrow V_2 = \frac{2\sqrt{2}}{3} V$$

Chapter: Work, Energy and Power
[Topic: Collisions]

Q90. The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The ratio of specific heat at constant pressure to that at constant volume is

- (a) 8/7 (b) 5/7
 (c) 9/7 (d) 7/5

Ans: (d)

$$\text{Solution: } C_P = \frac{7}{2}R; C_V = C_P - R = \frac{7}{2}R - R = \frac{5}{2}R$$

$$\frac{C_P}{C_V} = \frac{\frac{7}{2}R}{\frac{5}{2}R} = \frac{7}{5}$$

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q91. In India electricity is supplied for domestic use at 220 V. It is supplied at 110 V in USA. If the resistance of a 60 W bulb for use in India is R , the resistance of a 60 W bulb for use in USA will be

- (a) $R/2$ (b) R
 (c) $2R$ (d) $R/4$

Ans: (d)

$$\text{Solution: } P = \frac{V^2}{R} = R = \frac{V^2}{P} = \frac{(220)^2}{60} = \frac{4(110)^2}{60}$$

$$R' = \frac{(110)^2}{60} = \frac{R}{4}$$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q92. A thin prism of angle 15° made of glass of refractive index $\mu_1 = 1.5$ is combined with another prism of glass of refractive index $\mu_2 = 1.75$. The combination of the prism produces dispersion without deviation. The angle of the second prism should be

- (a) 7° (b) 10°
 (c) 12° (d) 5°

Ans: (b)**Solution:** Deviation = zero

$$\text{So, } \delta = \delta_1 + \delta_2 = 0$$

$$\Rightarrow (\mu_1 - 1)A_1 + (\mu_2 - 1)A_2 = 0$$

$$\Rightarrow A_2 (1.75 - 1) = - (1.5 - 1) 15^\circ$$

$$\Rightarrow A_2 = - \frac{0.5}{0.75} \times 15^\circ$$

$$\text{or } A_2 = -10^\circ.$$

Negative sign shows that the second prism is inverted with respect to the first.

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q93. In a junction diode, the holes are due to

- (a) protons
 (b) extra electrons
 (c) neutrons
 (d) missing electrons

Ans: (d)

Solution: Holes are produced due to missing of electrons.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q94. Two particles which are initially at rest, move towards each other under the action of their internal attraction. If their speeds are v and $2v$ at any instant, then the speed of centre of mass of the system will be:

- (a) $2v$
- (b) zero
- (c) 1.5
- (d) v

Ans: (b)

Solution: If no external force act on a system of particles, the centre of mass remains at rest. So, speed of centre of mass is zero.

Chapter: System of Particles and Rotational Motion

[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q95. A particle starts simple harmonic motion from the mean position. Its amplitude is A and time period is T . What is its displacement when its speed is half of its maximum speed

- (a) $\frac{\sqrt{2}}{3}A$
- (b) $\frac{\sqrt{3}}{2}A$
- (c) $\frac{2}{\sqrt{3}}A$
- (d) $\frac{A}{\sqrt{2}}$

Ans: (b)

Solution: $v_{\max} = A\omega$ when $v = \frac{v_{\max}}{2} = \frac{A\omega}{2}$

$$v = \omega\sqrt{A^2 - y^2}$$

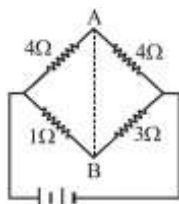
$$= \frac{A\omega}{2} = \omega\sqrt{A^2 - y^2} = y = \pm \frac{\sqrt{3}}{2}A$$

[Alt : The displacement at which the speed is n times the maximum speed is given by $y = a\sqrt{1 - n^2}$]

Chapter: Oscillation

[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q96. In the circuit shown, if a conducting wire is connected between points A and B, the current in this wire will



- (a) flow in the direction which will be decided by the value of V
- (b) be zero
- (c) flow from B to A
- (d) flow from A to B

Ans: (c)

Solution: Current will flow from B to A

Potential drop over the resistance CA will be more due to higher value of resistance. So potential at A will be less as compared with at B . Hence, current will flow from B to A .

Chapter: Current Electricity

[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q97. In Young's double slit experiment the distance between the slits and the screen is doubled. The separation between the slits is reduced to half. As a result the fringe width

- (a) is doubled
- (b) is halved
- (c) becomes four times
- (d) remains unchanged

Ans: (c)

Solution: Fringe width $\beta = \frac{\lambda D}{d}$

From question $D' = 2D$ and $d' = \frac{d}{2}$

$$\therefore \beta' = \frac{\lambda D^1}{d^1} = 4\beta$$

Chapter - Wave Optics

[Topic: Young's Double Slit Experiment]

Q98. A common emitter amplifier has a voltage gain of 50, an input impedance of 100Ω and an output impedance of 200Ω . The power gain of the amplifier is

- (a) 500
- (b) 1000
- (c) 1250
- (d) 50

Ans: (c)

Solution: Power gain = voltage gain $\times$ current gain

$$= V_G I_G = \frac{V_o}{V_i} \cdot \frac{I_o}{I_i}$$

$$= \frac{V_o^2}{V_i^2} \cdot \frac{R_i}{R_o} = 50 \times 50 \times \frac{100}{200}$$

$$= \frac{2500}{2} = 1250$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q99. A physical quantity of the dimensions of length that can be formed out of c , G and $\frac{e^2}{4\pi\epsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge]

- (a) $c^2 \left[G \frac{e^2}{4\pi\epsilon_0} \right]^{\frac{1}{2}}$
- (b) $\frac{1}{c^2} \left[G \frac{e^2}{4\pi\epsilon_0} \right]^{\frac{1}{2}}$
- (c) $\frac{1}{c} G \frac{e^2}{4\pi\epsilon_0}$
- (d) $\frac{1}{c^2} \left[G \frac{e^2}{4\pi\epsilon_0} \right]^{\frac{1}{2}}$

Ans: (d)

Solution: Let dimensions of length is related as,

$$L = [c]^x [G]^y \left[\frac{e^2}{4\pi\epsilon_0} \right]^z$$

$$\frac{e^2}{4\pi\epsilon_0} = ML^3T^{-2}$$

$$L = [LT^{-1}]^x [M^{-1}L^3T^{-2}]^y [ML^3T^{-2}]^z$$

$$[L] = [L^{x+3y+3z} M^{-y+z} T^{-x-2y-2z}]$$

Comparing both sides

$$-y + z = 0 \Rightarrow y = z \dots (i)$$

$$x + 3y + 3z = 1 \dots (ii)$$

$$-x - 4z = 0 (\because y = z) \dots (iii)$$

From (i), (ii) & (iii)

$$z = y = \frac{1}{2}, x = -2$$

$$\text{Hence, } L = c^{-2} \left[G \cdot \frac{e^2}{4\pi\epsilon_0} \right]^{\frac{1}{2}}$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q100. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

(a) $t = 1s$

(b) $t = 0.5s$

(c) $t = 0.25s$

(d) $t = 2s$

Ans: (a)

Solution: When angular acceleration (α) is zero then torque on the wheel becomes zero.

$$\theta(t) = 2t^3 - 6t^2$$

$$= \frac{d\theta}{dt} = 6t^2 - 12t = \alpha = \frac{d^2\theta}{dt^2} = 12t - 12 = 0$$

$$\therefore t = 1 \text{ sec.}$$

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

PART 7. PHYSICS QUESTION BANK

Q1. Two springs of spring constants k_1 and k_2 are joined in series. The effective spring constant of the combination is given by

(a) $k_1 k_2 / (k_1 + k_2)$

(b) $k_1 k_2$

(c) $(k_1 + k_2) / 2$

(d) $k_1 + k_2$

Ans: (a)

$$\text{Solution: } \frac{1}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2} \Rightarrow \frac{1}{k_{eq}} = \frac{k_1 + k_2}{k_1 k_2}$$

$$\Rightarrow k_{eq} = \frac{k_1 k_2}{k_1 + k_2}$$

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q2. A proton moving with a velocity 3×10^5 m/s enters a magnetic field of 0.3 tesla at an angle of 30° with the field. The radius of curvature of its path will be (e/m for proton = 10^8 C/kg)

(a) 2 cm

(b) 0.5 cm

(c) 0.02 cm

(d) 1.25 cm

Ans: (b)

$$\text{Solution: } r = \frac{mv \sin \theta}{Be} = \frac{3 \times 10^5 \sin 30^\circ}{0.3 \times 10^8}$$

$$\frac{3 \times 10^5 \times \frac{1}{2}}{3 \times 10^7} = 0.5 \times 10^{-2} \text{ m} = 0.5 \text{ cm.}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q3. If the momentum of electron is changed by P , then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be :

(a) $200P$

(b) $400P$

(c) $\frac{P}{200}$

(d) $100P$

Ans: (a)

Solution: The de-Broglie's wavelength associated with the moving electron $\lambda = \frac{h}{p}$

Now, according to problem

$$\frac{d\lambda}{\lambda} = -\frac{dp}{p}$$

$$\frac{0.5}{100} = \frac{P'}{P}$$

$$P' = 200P$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

Q4. The device that can act as a complete electronic circuit is

(a) junction diode

(b) integrated circuit

(c) junction transistor

(d) zener diode

Ans: (b)

Solution: Integrated circuit can act as a complete electronic circuit.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Digital Electronics and Logic Gates]

Q5. The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation of the type $f = c m^x k^y$, where c is a dimensionless constant. The values of x and y are

(a) $x = \frac{1}{2}, y = \frac{1}{2}$

(b) $x = -\frac{1}{2}, y = -\frac{1}{2}$

(c) $x = \frac{1}{2}, y = -\frac{1}{2}$

(d) $x = -\frac{1}{2}, y = \frac{1}{2}$

Ans: (d)

Solution: $f = c m^x k^y$;

Spring constant $k = \text{force/length}$.

$$[M^0 L^0 T^{-1}] = [M^x (MT^{-2})^y] = [M^{x+y} T^{-2y}]$$

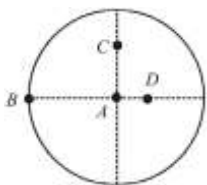
$$\Rightarrow x + y = 0, -2y = -1 \text{ or } y = \frac{1}{2}$$

$$\text{Therefore, } x = -\frac{1}{2}$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q6. The moment of inertia of a uniform circular disc is maximum about an axis perpendicular to the disc and passing through :



- (a) B
(b) C
(c) D
(d) A

Ans: (a)

Solution: According to parallel axis theorem of the moment of Inertia

$$I = I_{cm} + md^2$$

I is maximum for point B so I_{max} about B.

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q7. The wave described by $y = 0.25 \sin(10\pi x - 2\pi t)$, where x and y are in meters and t in seconds, is a wave travelling along the:

- (a) -ve x direction with frequency 1 Hz.
(b) +ve x direction with frequency π Hz and wavelength $\lambda = 0.2$ m.
(c) +ve x direction with frequency 1 Hz and wavelength $\lambda = 0.2$ m
(d) -ve x direction with amplitude 0.25 m and wavelength $\lambda = 0.2$ m

Ans: (c)

Solution: $y = 0.25 \sin(10\pi x - 2\pi t)$

Comparing this equation with the standard wave equation $y = a \sin(kx - \omega t)$

We get, $k = 10\pi$

$$\Rightarrow \frac{2\pi}{\lambda} = 10\pi \Rightarrow \lambda = 0.2 \text{ m}$$

And $\omega = 2\pi$ or, $2\pi v = 2\pi \Rightarrow v = 1 \text{ Hz}$.

The sign inside the bracket is negative, hence the wave travels in +ve x - direction.

Chapter: Waves

[Topic: Basic of Waves]

Q8. A coil of one turn is made of a wire of certain length and then from the same length a coil of two turns is made. If the same current is passed in both the cases, then the ratio of the magnetic inductions at their centres will be

- (a) 2 : 1
(b) 1 : 4
(c) 4 : 1
(d) 1 : 2

Ans: (b)

Solution: Let

ℓ be length of wire.

1st case :

$$\ell = 2\pi r \Rightarrow r = \frac{\ell}{2\pi}$$

$$B = \frac{\mu_0 I n}{2r} = \frac{\mu_0 I \times 2\pi}{2\ell} = \frac{\mu_0 \pi I}{\ell} \quad [\because n = 1] \dots (1)$$

$$2\text{nd Case : } \ell = 2(2\pi r') \Rightarrow r' = \frac{\ell}{4\pi}$$

$$B' = \frac{\mu_0 I n}{2r'} = \frac{2\mu_0 I \pi}{\frac{\ell}{2}} = 4 \left(\frac{\mu_0 \pi I}{\ell} \right) = 4B,$$

using (1) (where $n = 2$)

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q9. In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is

- (a) 1.8 V
(b) 1.2 V
(c) 0.5 V
(d) 2.3 V

Ans: (c)

Solution: The stopping potential is equal to maximum kinetic energy.

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q10. A body is moving with velocity 30 m/s towards east. After 10 seconds its velocity becomes 40 m/s towards north. The average acceleration of the body is

- (a) 1 m/s²
(b) 7 m/s²
(c) 7 m/s²
(d) 5 m/s²

Ans: (d)

Solution: Average acceleration

$$< a > = \frac{\text{Change in velocity}}{\text{Total Time}}$$

$$< a > = \frac{|40\hat{j} - 30\hat{i}|}{10 - 0}$$

$$< a > = \sqrt{4^2 + (-3)^2}$$

$$< a > = 5 \text{ m/sec}^2$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q11. A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclination plane will be

- (a) $\frac{g}{2}$
(b) $\frac{g}{3}$
(c) $\frac{g}{4}$
(d) $\frac{2g}{3}$

Ans: (c)

$$\text{Solution: } a = \frac{g \sin \theta}{1 + \frac{K^2}{R^2}} = \frac{g \sin 30^\circ}{1 + 1} = \frac{g}{4}$$

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q12. The frequency of sinusoidal wave $n = 0.40 \cos[2000t + 0.80]$ would be

- (a) 1000π Hz
(b) 2000 Hz
(c) 20 Hz
(d) $\frac{1000}{\pi}$ Hz

Ans: (d)

Solution: Comparing with the equation

$$\xi = A \cos(2\pi vt + \phi)$$

$$\text{We get } 2\pi v = 2000 \Rightarrow v = \frac{2000}{2\pi} = \frac{1000}{\pi} \text{ Hz}$$

Chapter: Waves
[Topic: Basic of Waves]

Q13. A straight wire of length 0.5 metre and carrying a current of 1.2 ampere is placed in uniform magnetic field of induction 2 tesla. The magnetic field is perpendicular to the length of the wire. The force on the wire is

- (a) 2.4 N (b) 1.2 N
(c) 3.0 N (d) 2.0 N

Ans: (b)

Solution: $F = Bi$

$$= 2 \times 1.2 \times 0.5 = 1.2 \text{ N}$$

Chapter: Moving Charges and Magnetic Field
[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q14. The X-rays cannot be diffracted by means of an ordinary grating because of

- (a) high speed
(b) short wavelength
(c) large wavelength
(d) none of these

Ans: (b)

Solution: We know that the X-rays are of short wavelength as compared to grating constant of optical grating. As a result of this, it makes difficult to observe X-rays diffraction with ordinary grating.

Chapter - Dual Nature of Radiation and Matter
[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q15. A man of 50 kg mass is standing in a gravity free space at a height of 10 m above the floor. He throws a stone of 0.5 kg mass downwards with a speed 2 m/s. When the stone reaches the floor, the distance of the man above the floor will be:

- (a) 9.9 m (b) 10.1 m
(c) 10 m (d) 20 m

Ans: (b)

Solution: No external force is acting, therefore, momentum is conserved.

By momentum conservation,

$$50u + 0.5 \times 2 = 0$$

where u is the velocity of man.

$$u = -\frac{1}{50} \text{ ms}^{-1}$$

Negative sign of u shows that man moves upward.

Time taken by the stone to reach the ground

$$= \frac{10}{2} = 5 \text{ s}$$

$$\text{Distance moved by the man} = 5 \times \frac{1}{50} = 0.1 \text{ m}$$

$\therefore$ when the stone reaches the floor, the distance of the man above floor = 10.1 m

Chapter: Kinematics Motion in a Straight Line
[Topic: Motion Under Gravity]

Q16. At what height from the surface of earth the gravitational potential and the value of g are $-5.4 \times 10^7 \text{ J kg}^{-1}$ and 6.0 ms^{-2} respectively?

Take the radius of earth as 6400 km :

- (a) 2600 km (b) 1600 km

(c) 1400 km

(d) 2000 km

Ans: (a)

Solution: As we know, gravitational potential (v) and acceleration due to gravity (g) with height

$$V = \frac{-GM}{R+h} = -5.4 \times 10^7 \dots (1)$$

$$\text{and } g = \frac{GM}{(R+h)^2} = 6 \dots (2)$$

Dividing (1) by (2)

$$\frac{\frac{-GM}{R+h}}{\frac{GM}{(R+h)^2}} = \frac{-5.4 \times 10^7}{6}$$

$$\frac{(R+h)^2}{(R+h)} = \frac{5.4 \times 10^7}{6}$$

$$\Rightarrow R+h = 9000 \text{ km so, } h = 2600 \text{ km}$$

Chapter: Gravitation

[Topic: Gravitational Field, Potential and Energy]

Q17. A tuning fork of frequency 512 Hz makes 4 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per sec when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was

- (a) 510 Hz (b) 514 Hz
(c) 516 Hz (d) 508 Hz

Ans: (d)

Solution: The frequency of the piano string = $512 + 4 = 516$ or 508 . When the tension is increased, beat frequency decreases to 2, it means that frequency of the string is 508 as frequency of string increases with tension.

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q18. The magnetic susceptibility is negative for :

- (a) diamagnetic material only
(b) paramagnetic material only
(c) ferromagnetic material only
(d) paramagnetic and ferromagnetic materials

Ans: (a)

Solution: Magnetic susceptibility χ for dia-magnetic materials only is negative and low $|\chi| = -1$; for paramagnetic substances low but positive $|\chi| = 1$ and for ferromagnetic substances positive and high $|\chi| = 10^2$.

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q19. What is the radius of iodine atom (At. no. 53, mass no. 126)

- (a) $2.5 \times 10^{-11} \text{ m}$ (b) $2.5 \times 10^{-9} \text{ m}$
(c) $7 \times 10^{-9} \text{ m}$ (d) $7 \times 10^{-6} \text{ m}$

Ans: (a)

Solution: 53 electrons in iodine atom are distributed as 2, 8, 18, 18, 7

$$\therefore n = 5$$

$$r_n = \frac{(0.53 \times 10^{-10})n^2}{Z}$$

$$= \frac{0.53 \times 10 \times 5^2}{53} = 2.5 \times 10^{-11} \text{ m}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q20. What is the linear velocity if angular velocity vector $\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$ and position vector $\vec{r} = 5\hat{i} - 6\hat{j} + 6\hat{k}$

- (a) $6\hat{i} + 2\hat{j} - 3\hat{k}$
 (b) $-18\hat{i} - 13\hat{j} + 2\hat{k}$
 (c) $18\hat{i} + 13\hat{j} - 2\hat{k}$ (d) $6\hat{i} - 2\hat{j} + 8\hat{k}$

Ans: (b)

Solution: As we know that

$$\vec{v} = \vec{\omega} \times \vec{r} = (3\hat{i} - 4\hat{j} + \hat{k}) \times (5\hat{i} - 6\hat{j} + 6\hat{k})$$

$$= -18\hat{i} - 13\hat{j} + 2\hat{k}$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q21. The escape velocity of a sphere of mass m is given by (G = Universal gravitational constant; M = Mass of the earth and R_e = Radius of the earth)

- (a) $\sqrt{\frac{GM}{R_e}}$
 (b) $\sqrt{\frac{2GM}{R_e}}$
 (c) $\sqrt{\frac{2GMm}{R_e}}$
 (d) $\sqrt{\frac{2GM+R_e}{R_e}}$

Ans: (b)

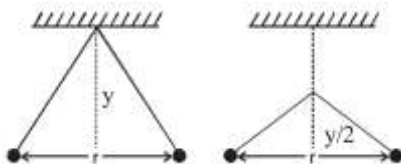
Solution: Escape velocity is the minimum velocity with which a body is projected to escape from earth's gravitational field

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R_e} \Rightarrow v_e = \sqrt{\frac{2GM}{R_e}}$$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q22. Two pith balls carrying equal charges are suspended from a common point by strings of equal length. The equilibrium separation between them is r . Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become



- (a) $\left(\frac{r}{\sqrt{2}}\right)$
 (b) $\left(\frac{2r}{\sqrt{3}}\right)$
 (c) $\left(\frac{2r}{3}\right)$
 (d) $\left(\frac{r}{\sqrt{2}}\right)^2$

Ans: (a)

Solution: From figure, $\tan \theta = \frac{F_e}{mg} \Rightarrow \frac{r}{y} = \frac{\frac{kq^2}{r^2}}{mg}$

$[\because F = \frac{kq^2}{r^2} \text{ from coulomb's law}]$

$$\Rightarrow r^3 \propto y \Rightarrow r'^3 \propto \frac{y}{2} \Rightarrow \frac{r'}{r} = \frac{1}{2^{1/3}}$$

$$\Rightarrow r' = \frac{r}{\sqrt[3]{2}}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q23. A conducting circular loop is placed in a uniform magnetic field of 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced emf in the loop when the radius is 2 cm is

- (a) $4.8 \pi \mu V$ (b) $0.8 \pi \mu V$
 (c) $1.6 \pi \mu V$ (d) $3.2 \pi \mu V$

Ans: (d)

Solution: Induced emf in the loop is given by $e = -B \cdot \frac{dA}{dt}$ where A is the area of the loop.

$$e = -B \cdot \frac{d}{dt}(\pi r^2) = -B \pi 2r \frac{dr}{dt}$$

$$r = 2 \text{ cm} = 2 \times 10^{-2} \text{ m}$$

$$dr = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$$

$$dt = 1 \text{ s}$$

$$e = -0.04 \times 3.14 \times 2 \times 2 \times 10^{-2} \times \frac{2 \times 10^{-3}}{1} \text{ V}$$

$$= 0.32 \pi \times 10^{-5} \text{ V}$$

$$= 3.2 \pi \times 10^{-6} \text{ V}$$

$$= 3.2 \pi \mu V$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q24. When an electron jumps from the fourth orbit to the second orbit, one gets the

- (a) second line of Lyman series
 (b) second line of Paschen series
 (c) second line of Balmer series
 (d) first line of Pfund series

Ans: (c)

Solution: When the electron drops from any orbit to second orbit, then wavelength of line obtained belongs to Balmer series.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q25. If a body A of mass M is thrown with velocity v at an angle of 30° to the horizontal and another body B of the same mass is thrown with the same speed at an angle of 60° to the horizontal, the ratio of horizontal range of A to B will be

- (a) 1 : 3 (b) 1 : 1
 (c) $1 : \sqrt{3}$ (d) $\sqrt{3} : 1$

Ans: (b)

Solution: Horizontal range is same when angle of projection with the horizontal is θ and $(90^\circ - \theta)$.

Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q26. A fluid is in streamline flow across a horizontal pipe of variable area of cross section. For this which of the following statements is correct?

[NEET Kar. 2013]

- (a) The velocity is minimum at the narrowest part of the pipe and the pressure is minimum at the widest part of the pipe
 (b) The velocity is maximum at the narrowest part of the pipe and pressure is maximum at the widest part of the pipe
 (c) Velocity and pressure both are maximum at the narrowest part of the pipe
 (d) Velocity and pressure both are maximum at the widest part of the pipe

Ans: (b)

Solution: According to Bernoulli's theorem,

$$P + \frac{1}{2}\rho v^2 = \text{constant and } Av = \text{constant}$$

If A is minimum, v is maximum, P is minimum.

Chapter: Mechanical Properties of Fluids

[Topic: Viscosity & Terminal Velocity]

Q27. What is the flux through a cube of side 'a' if a point charge of q is at one of its corner :

- (a) $\frac{2q}{e_0}$
 (b) $\frac{q}{8e_0}$
 (c) $\frac{q}{e_0}$
 (d) $\frac{q}{2e_0}$

Ans: (b)

Solution: Eight identical cubes are required to arrange so that this charge is at centre of the cube formed so flux.

$$\Phi = \frac{q}{8\epsilon_0}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q28. The instantaneous values of alternating current and voltages in a circuit are given as

$$i = \frac{1}{\sqrt{2}} \sin(100\pi t) \text{ amper}$$

$$e = \frac{1}{\sqrt{2}} \sin\left(100\pi t + \frac{\pi}{3}\right) \text{ Volt}$$

The average power in Watts consumed in the circuit is :

- (a) $\frac{1}{4}$
 (b) $\frac{\sqrt{3}}{4}$
 (c) $\frac{1}{2}$
 (d) $\frac{1}{8}$

Ans: (d)

Solution: The average power in the circuit where $\cos \phi =$ power factor

$$<P> = V_{\text{rms}} \times I_{\text{rms}} \cos \phi$$

$$\phi = \pi/3 = \text{phase difference} = \frac{180}{3} = 60$$

$$V_{\text{rms}} = \frac{1}{\sqrt{2}} = \frac{1}{2} \text{ volt}$$

$$I_{\text{rms}} = \frac{1}{\sqrt{2}} = \left(\frac{1}{2}\right) A$$

$$\cos \phi = \cos \frac{\pi}{3} = \frac{1}{2}$$

$$<P> = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8} W$$

Chapter: Alternating Current

[Topic: Alternating Current, Voltage & Power]

Q29. A nucleus ruptures into two nuclear parts, which have their velocity ratio equal to 2:1. What will be the ratio of their nuclear size (nuclear radius)?

[1996]

- (a) $2^{1/3} : 1$ (b) $1 : 2^{1/3}$
 (c) $3^{1/2} : 1$ (d) $1 : 3^{1/2}$

Ans: (b)

Solution: Applying law of conservation of momentum,

$$m_1 v_1 = m_2 v_2$$

$$\frac{v_1}{v_2} = \frac{m_2}{m_1}$$

$$\frac{v_1}{v_2} = \frac{m_1}{m_2}$$

$$\text{As } m = \frac{4}{3}\pi r^3 \rho \Rightarrow m \propto r^3$$

$$\text{Hence, } \frac{m_2}{m_1} = \frac{r_2^3}{r_1^3}$$

$$\frac{v_1}{v_2} = \frac{r_2^3}{r_1^3} \Rightarrow \frac{r_2}{r_1} = \left(\frac{1}{2}\right)^{\frac{1}{3}}$$

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q30. A body of mass M hits normally a rigid wall with velocity V and bounces back with the same velocity. The impulse experienced by the body is

- (a) MV (b) 1.5 MV
 (c) 2 MV (d) zero

Ans: (c)

Solution: Impulse experienced by the body

= change in momentum

$$= MV - (-MV)$$

$$= 2MV.$$

Chapter: Dynamics Laws of Motion

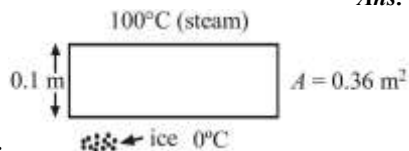
[Topic: Ist, IInd & IIIrd Laws of Motion]

Q31. A slab of stone of area 0.36 m^2 and thickness 0.1 m is exposed on the lower surface to steam at 100°C . A block of ice at 0°C rests on the upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is :

(Given latent heat of fusion of ice = $3.36 \times 10^5 \text{ J kg}^{-1}$) :

- (a) $1.24 \text{ J/m/s/}^\circ\text{C}$ (b) $1.29 \text{ J/m/s/}^\circ\text{C}$
 (c) $2.05 \text{ J/m/s/}^\circ\text{C}$ (d) $1.02 \text{ J/m/s/}^\circ\text{C}$

Ans: (a)



Solution:

Rate of heat given by steam = Rate of heat taken by ice

where K = Thermal conductivity of the slab

m = Mass of the ice

L = Latent heat of melting/fusion

A = Area of the slab

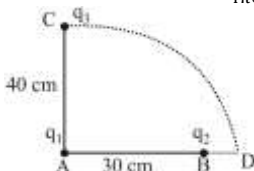
$$\frac{dQ}{dt} = \frac{KA(100 - 0)}{1} = m \frac{dL}{dt},$$

$$\frac{K \times 100 \times 0.36}{0.1} = \frac{4.8 \times 3.36 \times 10^5}{60 \times 60}$$

$$K = 1.24 \text{ J/m/s/}^\circ\text{C}$$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q32. Two charges q_1 and q_2 are placed 30 cm apart, as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of the system is $\frac{q_3}{4\pi\epsilon_0}k$, where k is



- (a) $8q_1$
 (c) $8q_2$
- (b) $6q_1$
 (d) $6q_2$

Ans: (c)

Solution: We know that potential energy of discrete system of charges is given by

$$U = \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_2}{r_{12}} + \frac{q_2 q_3}{r_{23}} + \frac{q_3 q_1}{r_{31}} \right)$$

According to question,

$$U_{\text{initial}} = \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_2}{0.3} + \frac{q_2 q_3}{0.5} + \frac{q_3 q_1}{0.4} \right)$$

$$U_{\text{final}} = \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_2}{0.3} + \frac{q_2 q_3}{0.1} + \frac{q_3 q_1}{0.4} \right)$$

$$U_{\text{final}} - U_{\text{initial}} = \frac{1}{4\pi\epsilon_0} \left(\frac{q_1 q_2}{0.1} - \frac{q_2 q_3}{0.5} \right) = \frac{q_3}{4\epsilon_0} (8q_2)$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Potential Energy & Work Done in Carrying a Charge]

Q33. In an experiment, 200 V A.C. is applied at the ends of an LCR circuit. The circuit consists of an inductive reactance (X_L) = 50 Ω , capacitive reactance (X_C) = 50 Ω and ohmic resistance (R) = 10 Ω . The impedance of the circuit is [1996]

- (a) 10 Ω
 (c) 30 Ω
- (b) 20 Ω
 (d) 40 Ω

Ans: (a)

Solution: Given : Supply voltage (V_{ac}) = 200 V

Inductive reactance (X_L) = 50 Ω

Capacitive reactance (X_C) = 50 Ω

Ohmic resistance (R) = 10 Ω .

We know that impedance of the LCR circuit (Z)

$$= \sqrt{(X_L - X_C)^2 + R^2}$$

$$= \sqrt{\{(50 - 50)^2 + (10)^2\}} = 10\Omega$$

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q34. M_p denotes the mass of a proton and M_n that of a neutron. A given nucleus, of binding energy B , contains Z protons and N neutrons. The mass $M(N, Z)$ of the nucleus is given by (c is the velocity of light)

- (a) $M(N, Z) = NM_n + ZM_p + B/c^2$
 (b) $M(N, Z) = NM_n + ZM_p - Bc^2$
 (c) $M(N, Z) = NM_n + ZM_p + Bc^2$
 (d) $M(N, Z) = NM_n + ZM_p - B/c^2$

Ans: (d)

Solution: Mass defect = $\frac{BE}{c^2}$

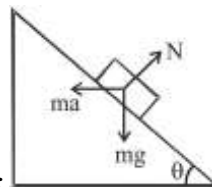
Mass of nucleus = Mass of proton + mass of neutron – mass defect

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q35. A block of mass m is placed on a smooth wedge of inclination θ . The whole system is accelerated horizontally so that the block does not slip on the wedge. The force exerted by the wedge on the block (g is acceleration due to gravity) will be

- (a) $mg/\cos \theta$
 (b) $mg \cos \theta$
 (c) $mg \sin \theta$
 (d) mg

Ans: (a)



Solution:

$$N = m a \sin \theta + mg \cos \theta \dots (1)$$

$$\text{Also, } m g \sin \theta = m a \cos \theta \dots (2)$$

$$\text{From (1) \& (2), } a = g \tan \theta$$

$$N = mg \frac{\sin^2 \theta}{\cos \theta} + mg \cos \theta$$

$$= \frac{mg}{\cos \theta} (\sin^2 \theta + \cos^2 \theta) = \frac{mg}{\cos \theta}$$

$$\text{or, } N = \frac{mg}{\cos \theta}$$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q36. A beaker full of hot water is kept in a room. If it cools from 80 $^\circ\text{C}$ to 75 $^\circ\text{C}$ in t_1 minutes, from 75 $^\circ\text{C}$ to 70 $^\circ\text{C}$ in t_2 minutes and from 70 $^\circ\text{C}$ to 65 $^\circ\text{C}$ in t_3 minutes, then

- (a) $t_1 = t_2 = t_3$
 (b) $t_1 < t_2 = t_3$
 (c) $t_1 < t_2 < t_3$
 (d) $t_1 > t_2 > t_3$

Ans: (c)

Solution: Let θ_0 be the temperature of the surrounding.

Then

$$\frac{80 - 75}{t_1} = k \left(\frac{80 + 75}{2} - \theta_0 \right)$$

$$\text{or, } \frac{5}{t_1} = k(77.5 - \theta_0)$$

$$\text{or, } t_1 = \frac{5}{k(77.5 - \theta_0)} \dots (1)$$

$$\text{Similarly, } t_2 = \frac{5}{k(72.5 - \theta_0)} \dots (2)$$

$$\text{and } t_3 = \frac{5}{k(67.5 - \theta_0)} \dots (3)$$

From (1), (2) & (3), it is obvious that

$$t_1 < t_2 < t_3$$

Chapter: Thermal Properties
[Topic: Newton's Law of Cooling]

Q37. If the potential of a capacitor having capacity $6 \mu\text{F}$ is increased from 10 V to 20 V , then increase in its energy will be

- (a) $4 \times 10^{-4} \text{ J}$ (b) $4 \times 10^{-4} \text{ J}$
(c) $9 \times 10^{-4} \text{ J}$ (d) 12×10^{-6}

Ans: (c)

Solution: Capacitance of capacitor (C) = $6 \mu\text{F} = 6 \times 10^{-6} \text{ F}$; Initial potential (V_1) = 10 V and final potential (V_2) = 20 V .

The increase in energy (ΔU)

$$\begin{aligned} &= \frac{1}{2} C (V_2^2 - V_1^2) \\ &= \frac{1}{2} \times (6 \times 10^{-6}) \times [(20)^2 - (10)^2] \\ &= (3 \times 10^{-6}) \times 300 = 9 \times 10^{-4} \text{ J} \end{aligned}$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q38. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic waves, then the direction of propagation of the waves will be along

- (a) $\vec{B} \times \vec{E}$
(b) $\vec{E}$
(c) $\vec{B}$
(d) $\vec{E} \times \vec{B}$

Ans: (d)

Solution: Direction of propagation of electro-magnetic waves is perpendicular to Electric field and Magnetic field. Hence, direction is given by vector $\vec{S} = \vec{E} \times \vec{H} = \frac{\vec{E} \times \vec{B}}{\mu_0}$.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q39. The half life of a radioactive isotope 'X' is 50 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' were found to be in the ratio of 1 : 15 in a sample of a given rock. The age of the rock was estimated to be

- (a) 150 years (b) 200 years
(c) 250 years (d) 100 years

Ans: (b)

Solution: Let number of atoms in X = N_x

Number of atoms in Y = N_y

By question

$$\frac{N_x}{N_y} = \frac{1}{15}$$

$$\therefore \text{Part of } N_x = \frac{1}{16} (N_x + N_y)$$

$$= \frac{1}{24} (N_x + N_y)$$

So, total 4 half lives are passed, so, age of rock is $4 \times 50 = 200$ years

Chapter: Nuclei
[Topic: Radioactivity]

Q40. A car of mass m is moving on a level circular track of radius R . If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by :

- (a) $\sqrt{\mu_s m R g}$
(b) $\sqrt{\frac{R g}{\mu_s}}$
(c) $\sqrt{\frac{m R g}{\mu_s}}$
(d) $\sqrt{\mu_s R g}$

Ans: (d)

Solution: For smooth driving maximum speed of car v then

$$\begin{aligned} \frac{mv^2}{R} &= \mu_s mg \\ v &= \sqrt{\mu_s R g} \end{aligned}$$

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

Q41. An ideal gas at 27°C is compressed adiabatically to $\frac{8}{27}$ of its original volume. The rise in temperature is

- (a) 475°C (b) 402°C
(c) 275°C (d) 175°C

Ans: (b)

Solution: $T = 27^\circ\text{C} = 300 \text{ K}$

$$\gamma = \frac{5}{3}; V_2 = \frac{8}{27} V_1; \frac{V_1}{V_2} = \frac{27}{8}$$

From adiabatic process we know that

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = \left(\frac{27}{8}\right)^{\frac{5}{3}-1}$$

$$\frac{T_2}{T_1} = \frac{9}{4} = T_2 = \frac{9}{4} \times T_1 = \frac{9}{4} \times 300 = 675 \text{ K}$$

$$T_2 = 675 - 273^\circ\text{C} = 402^\circ\text{C}$$

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q42. When a wire of uniform cross-section a , length l and resistance R is bent into a complete circle, resistance between any two of diametrically opposite points will be

- (a) $\frac{R}{4}$ (b) $4R$
(c) $\frac{R}{8}$ (d) $\frac{R}{2}$

Ans: (a)

$$\text{Solution: } R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{\left(\frac{R}{2}\right)\left(\frac{R}{2}\right)}{\frac{R}{2} + \frac{R}{2}} \therefore R_{eq} = \frac{R}{4}$$

Chapter: Current Electricity
[Topic: Combination of Resistances]

Q43. Ray optics is valid, when characteristic dimensions are

- (a) of the same order as the wavelength of light
- (b) much smaller than the wavelength of light
- (c) of the order of one millimetre
- (d) much larger than the wavelength of light

Ans: (d)

Solution: Characteristic dimensions must be much larger than the wavelength of light.

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q44. The count rate of a Geiger Muller counter for the radiation of a radioactive material of half-life 30 minutes decreases to 5 sec^{-1} after 2 hours. The initial count rate was

- (a) 20 sec^{-1}
- (b) 25 sec^{-1}
- (c) 80 sec^{-1}
- (d) 625 sec^{-1}

Ans: (c)

Solution: Half-life = 30 minutes; Rate of decrease (N) = 5 per second and total time = 2 hours = 120 minutes. Relation for initial and final count rate

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{\text{time}}{\text{half-life}}} = \left(\frac{1}{2}\right)^{\frac{120}{30}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}. \text{ Therefore, } N_0 = 16 \times N = 16 \times 5 = 80 \text{ s}^{-1}.$$

Chapter: Nuclei
[Topic: Radioactivity]

Q45. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2 . Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$, then

- (a) $E_1 = E_2$
- (b) $E_1 < E_2$
- (c) $\frac{E_1}{E_2} = \frac{m_1}{m_2}$
- (d) $E_1 > E_2$

Ans: (b)

Solution: $E = \frac{p^2}{2m}$

or, $E_1 = \frac{p_1^2}{2m_1}, E_2 = \frac{p_2^2}{2m_2}$

or, $m_1 = \frac{p_1^2}{2E_1}, m_2 = \frac{p_2^2}{2E_2}$

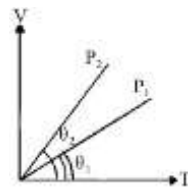
$m_1 > m_2 \Rightarrow \frac{m_1}{m_2} > 1$

$\frac{p_1^2 E_2}{E_1 p_2^2} > 1 = \frac{E_2}{E_1} > 1 [p_1 = p_2]$

or, $E_2 > E_1$

Chapter: Work, Energy and Power
[Topic: Energy]

Q46. In the given (V – T) diagram, what is the relation between pressure P_1 and P_2 ?



- (a) $P_2 > P_1$
- (b) $P_2 < P_1$
- (c) Cannot be predicted
- (d) $P_2 = P_1$

Ans: (b)

Solution: $P_1 > P_2$

As $V = \text{constant} \Rightarrow P \propto T$

Hence from V–T graph $P_1 > P_2$

Chapter: Kinetic Theory

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q47. A steady current of 1.5 amp flows through a copper voltmeter for 10 minutes. If the electrochemical equivalent of copper is $30 \times 10^{-5} \text{ g coulomb}^{-1}$, the mass of copper deposited on the electrode will be

- (a) 0.50 g
- (b) 0.67 g
- (c) 0.27 g
- (d) 0.40 g.

Ans: (c)

Solution: We have, $m = ZIt$

where, Z is the electrochemical equivalent of copper.

$= m = 30 \times 10^{-5} \times 1.5 \times 10 \times 60$

$= 0.27 \text{ gm.}$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q48. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The power of the combination is:

- (a) $\sqrt{\frac{f_1}{f_2}}$
- (b) $\sqrt{\frac{f_2}{f_1}}$
- (c) $\frac{f_1 + f_2}{2}$
- (d) $\frac{f_1 + f_2}{f_1 f_2}$

Ans: (d)

Solution: The focal length of the combination

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\therefore$ Power of the combinations,

$P = \frac{f_1 + f_2}{f_1 f_2} \left(\because P = \frac{1}{f} \right)$

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q49. Which one of the following statement is FALSE ?

- (a) Pure Si doped with trivalent impurities gives a p-type semiconductor
- (b) Majority carriers in a n-type semiconductor are holes
- (c) Minority carriers in a p-type semiconductor are electrons

(d) The resistance of intrinsic semiconductor decreases with increase of temperature

Ans: (b)

Solution: Majority carriers in an n-type semiconductor are electrons.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

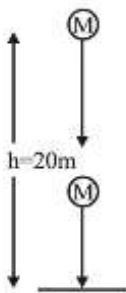
Q50. A ball is thrown vertically downwards from a height of 20 m with an initial velocity v_0 . It collides with the ground loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity v_0 is :
 (Take $g = 10 \text{ ms}^{-2}$)

- (a) 20 ms^{-1} (b) 28 ms^{-1}
 (c) 10 ms^{-1} (d) 14 ms^{-1}

Ans: (a)

Solution: When ball collides with the ground it loses its 50% of energy

$$\therefore \frac{KE_f}{KE_i} = \frac{1}{2} \Rightarrow \frac{\frac{1}{2}mv_f^2}{\frac{1}{2}mv_i^2} = \frac{1}{2}$$



$$\text{or } \frac{v_f}{v_i} = \frac{1}{\sqrt{2}}$$

$$\text{or, } \frac{\sqrt{v_0^2 + 2gh}}{\sqrt{2gh}} = \frac{1}{\sqrt{2}}$$

$$\text{or, } 4gh = v_0^2 + 2gh$$

$$\therefore v_0 = 20 \text{ ms}^{-1}$$

Chapter: Work, Energy and Power
[Topic: Collisions]

PART 8. PHYSICS QUESTION BANK

Q51. If γ be the ratio of specific heats of a perfect gas, the number of degrees of freedom of a molecule of the gas is

- (a) $\frac{25}{2(\gamma-1)}$
 (b) $\frac{3\gamma-1}{2\gamma-1}$
 (c) $\frac{2}{\gamma-1}$
 (d) $\frac{9}{2(\gamma-1)}$

Ans: (c)

Solution: We know that ratio of specific heats,

$$\gamma = 1 + \frac{2}{n} \text{ or } n = \frac{2}{\gamma-1}$$

[where n = Degree of freedom]

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q52. An electric kettle has two heating coils. When one of the coils is connected to an a.c. source, the water in the kettle boils in 10 minutes. When the other coil is used, the water boils in 40 minutes. If both the coils are connected in parallel, the time taken by the same quantity of water to boil will be

- (a) 15 min (b) 8 min
 (c) 4 min (d) 25 min

Ans: (b)

$$\text{Solution: Time} = \frac{10 \times 40}{10 + 40} = \frac{400}{50} = 8 \text{ min}$$

Chapter: Current Electricity
[Topic: Heating Effects of Current]

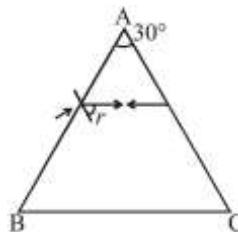
Q53. The refractive index of the material of a prism is $\sqrt{2}$ and its refracting angle is 30° . One of the refracting surfaces of the prism is made a mirror inwards. A beam of monochromatic light enters the prism from the mirror surface if its angle of incidence of the prism is

- (a) 30° (b) 45°
 (c) 60° (d) 0°

Ans: (b)

Solution: $\angle r = 30^\circ$ (using law of triangle)

$$\Rightarrow \mu = \frac{\sin i}{\sin r}$$



$$= \sqrt{2} \times \sin 30^\circ = \sin i$$

$$= \sin i = \frac{1}{\sqrt{2}} \Rightarrow i = 45^\circ$$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q54. A semi-conducting device is connected in a series circuit with a battery and a resistance. A current is found to pass through the circuit. If the polarity of the battery is reversed, the current drops to almost zero. The device may be

- (a) a p - n junction
 (b) an intrinsic semi-conductor
 (c) a p -type semi-conductor
 (d) an n -type semi-conductor

Ans: (a)

Solution: In reverse bias, the current through a p - n junction is almost zero.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q55. Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i} + 2\hat{j} + \hat{k}$ and $-3\hat{i} - 2\hat{j} + \hat{k}$ respectively. The centre of mass of this system has a position vector:

- (a) $-2\hat{i} - \hat{j} + \hat{k}$ (b) $2\hat{i} - \hat{j} - 2\hat{k}$
 (c) $\hat{i} + \hat{j} + \hat{k}$ (d) $-2\hat{i} + 2\hat{k}$

Ans: (a)

Solution: The position vector of the centre of mass of two particle system is given by

$$\vec{R} = \frac{m_1\vec{R}_1 + m_2\vec{R}_2}{(m_1 + m_2)}$$

$$= \frac{1}{4}[-8\hat{i} - 4 + 4\hat{k}] = -2\hat{i} - \hat{j} + \hat{k}$$

Chapter: System of Particles and Rotational Motion
[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q56. Which one of the following is a simple harmonic motion?

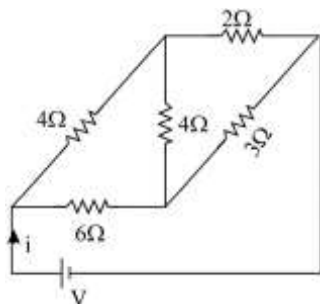
- (a) Ball bouncing between two rigid vertical walls
 (b) Particle moving in a circle with uniform speed
 (c) Wave moving through a string fixed at both ends
 (d) Earth spinning about its own axis.

Ans: (c)

Solution: A wave moving through a string fixed at both ends, is a transverse wave formed as a result of simple harmonic motion of particles of the string.

Chapter: Oscillation
[Topic: Energy in Simple Harmonic Motion]

Q57. For the network shown in the Fig. the value of the current i is



- (a) $\frac{9V}{35}$
 (b) $\frac{18V}{5}$
 (c) $\frac{5V}{9}$
 (d) $\frac{5V}{18}$

Ans: (d)

Solution: It is a balanced Wheatstone bridge. Hence resistance 4Ω can be eliminated.

$$\therefore R_{eq} = \frac{6 \times 9}{6+9} = \frac{18}{5}$$

$$\therefore i = \frac{V}{R_{eq}} = \frac{5V}{18}$$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q58. In Young's double slit experiment carried out with light of wavelength (λ) = $5000\text{\AA}$, the distance between the slits is 0.2 mm and the screen is at 200 cm from the slits. The central maximum is at $x = 0$. The third maximum (taking the central maximum as zeroth maximum) will be at x equal to

- (a) 1.67 cm (b) 1.5 cm
 (c) 0.5 cm (d) 5.0 cm

Ans: (b)

$$\text{Solution: } x = (n)\lambda \frac{D}{d} = 3 \times 5000 \times 10^{-10} \times \frac{2}{0.2 \times 10^{-3}}$$

$$= 1.5 \times 10^{-2}\text{ m} = 1.5\text{ cm}$$

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q59. For transistor action :

- (1) Base, emitter and collector regions should have similar size and doping concentrations.
 (2) The base region must be very thin and lightly doped.
 (3) The emitter-base junction is forward biased and base-collector junction is reverse biased.
 (4) Both the emitter-base junction as well as the base-collector junction are forward biased.
 (a) (3) , (4)
 (b) (4) , (1)
 (c) (1) , (2)
 (d) (2) , (3)

Ans: (d)

Solution: For transistor action, the base region must be very thin and lightly doped. Also, the emitter-base junction is forward biased and base-collector junction is reverse biased.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q60. If energy (E) , velocity (V) and time (T) are chosen as the fundamental quantities, the dimensional formula of surface tension will be :

- (a) $[E V^{-1} T^{-2}]$
 (b) $[E V^{-2} T^{-2}]$
 (c) $[E^{-2} V^{-1} T^{-3}]$
 (d) $[E V^{-2} T^{-1}]$

Ans: (b)

Solution: Let surface tension
 $s = E^a V^b T^c$

$$\frac{MLT^{-2}}{L} = (ML^2T^{-2})^a \left(\frac{L}{T}\right)^b (T)^c$$

Equating the dimension of LHS and RHS

$$ML^0T^{-2} = M^a L^{2a+b} T^{-2a-b+c}$$

$$\Rightarrow a = 1, 2a + b = 0, -2a - b + c = -2$$

$$\Rightarrow a = 1, b = -2, c = -2$$

Hence, the dimensions of surface tension are $[E V^{-2} T^{-2}]$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q61. A circular disk of moment of inertia I_1 is rotating in a horizontal plane, its symmetry axis, with a constant

angular speed ω_i . Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f . The energy lost by the initially rotating disk to friction is:

- (a) $\frac{1}{2} \frac{I_b^2}{(I_t + I_b)} \omega_i^2$
 (b) $\frac{I_t^2}{(I_t + I_b)} \omega_i^2$
 (c) $\frac{I_b - I_t}{(I_t + I_b)} \omega_i^2$
 (d) $\frac{1}{2} \frac{I_b I_t}{(I_t + I_b)} \omega_i^2$

Ans: (d)

Solution: By conservation of angular momentum,

$$I_t \omega_i = (I_t + I_b) \omega_f$$

where ω_f is the final angular velocity of disks

$$\omega_f = \left(\frac{I_t}{I_t + I_b} \right) \omega_i$$

Loss in K.E., $\Delta K = \text{Initial K.E.} - \text{Final K.E.}$

$$= \frac{1}{2} I_t \omega_i^2 - \frac{1}{2} (I_t + I_b) \omega_f^2$$

$$= \Delta K =$$

$$\frac{1}{2} I_t \omega_i^2 - \frac{1}{2} (I_t + I_b) \left(\frac{I_t}{I_t + I_b} \right)^2 \omega_i^2$$

$$= \frac{1}{2} \omega_i^2 \frac{I_t}{(I_t + I_b)} (I_t + I_b - I_t) = \frac{1}{2} \omega_i^2 \frac{I_t I_b}{I_t + I_b}$$

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q62. The time period of a mass suspended from a spring is T . If the spring is cut into four equal parts and the same mass is suspended from one of the parts, then the new time period will be

- (a) $2T$
 (b) $\frac{T}{4}$
 (c) T
 (d) $\frac{T}{2}$

Ans: (d)

$$\text{Solution: } T = 2\pi \sqrt{\frac{m}{k}}$$

When a spring is cut into n parts

Spring constant for each part = nk

Here, $n = 4$

$$T_1 = 2\pi \sqrt{\frac{m}{4k}} = \frac{T}{2}$$

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q63. When a proton is accelerated through 1 V , then its kinetic energy will be

- (a) 1840 eV
 (b) 13.6 eV
 (c) 1 eV
 (d) 0.54 eV

Ans: (c)

Solution: Potential difference (V) = 1 V ,

K.E. acquired = qV

$$= 1.6 \times 10^{-19} \times 1$$

$$= 1.6 \times 10^{-19} \text{ joules} = 1\text{ eV}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q64. Electrons used in an electron microscope are accelerated by a voltage of 25 kV . If the voltage is increased to 100 kV then the de-Broglie wavelength associated with the electrons would

- (a) increase by 2 times
 (b) decrease by 2 times
 (c) decrease by 4 times
 (d) increase by 4 times

Ans: (b)

$$\text{Solution: } \lambda \propto \frac{1}{\sqrt{V}}$$

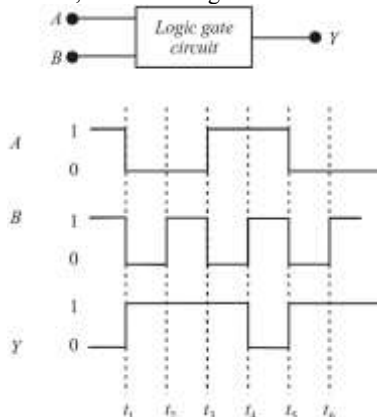
$$= \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \sqrt{\frac{100\text{ keV}}{25\text{ keV}}} = 2$$

$$\Rightarrow \lambda_2 = \frac{\lambda_1}{2}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

Q65. The following Figure shows a logic gate circuit with two inputs A and B and the output Y . The voltage waveforms of A , B and Y are given :



The logic gate is :

- (a) NAND gate
 (b) NOR gate
 (c) OR gate
 (d) AND gate

Ans: (a)

Solution: From the given waveforms, the truth table is as follows.

A	B	Y
1	1	0
0	0	1
0	1	1
1	0	1

The above truth table is for NAND gate.

Therefore, the logic gate is NAND gate.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Digital Electronics and Logic Gates]

Q66. The dimensional formula of pressure is

- (a) $[MLT^{-2}]$
 (b) $[ML^{-1}T^{-2}]$
 (c) $[ML^{-1}T^{-3}]$
 (d) $[MLT^{-3}]$

Ans: (c)

Solution: $[\text{Pressure}] = [\text{Force}] / [\text{Area}]$
 $= \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q67. The moment of inertia of a thin uniform rod of mass M and length L about an axis passing through its midpoint and perpendicular to its length is I_0 . Its moment of inertia about an axis passing through one of its ends and perpendicular to its length is

- (a) $I_0 + ML^2/2$ (b) $I_0 + ML^2/4$
 (c) $I_0 + 2ML^2$ (d) $I_0 + ML^2$

Ans: (b)

Solution: By theorem of parallel axes,
 $I = I_{cm} + Md^2$
 $I = I_0 + M(L/2)^2 = I_0 + ML^2/4$

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q68. Which one of the following statements is true ?

- (a) The sound waves in air are longitudinal while the light waves are transverse
 (b) Both light and sound waves in air are longitudinal
 (c) Both light and sound waves can travel in vacuum
 (d) Both light and sound waves in air are transverse

Ans: (a)

Solution: Sound waves in air are longitudinal and the light waves are transverse.

Chapter: Waves

[Topic: Basic of Waves]

Q69. The magnetic field ($d\vec{B}$) due to a small element ($d\vec{\ell}$) at a distance ($\vec{r}$) and element carrying current i is

- (a) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{\ell} \times \vec{r}}{r} \right)$
 (b) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{\ell} \times \vec{r}}{r^2} \right)$
 (c) $d\vec{B} = \frac{\mu_0}{4\pi} i^2 \left(\frac{d\vec{\ell} \times \vec{r}}{r} \right)$
 (d) $d\vec{B} = \frac{\mu_0}{4\pi} i \left(\frac{d\vec{\ell} \times \vec{r}}{r^3} \right)$

Ans: (d)

Solution: According to Biot Savart law,

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{(d\vec{\ell} \times \vec{r})}{r^3}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q70. The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on this metal, the cut-off voltage for the photoelectric emission is nearly
 [2011M]

- (a) 2 V
 (c) 5 V

- (b) 3 V
 (d) 1 V

Ans: (a)

Solution: K.E. = $h\nu - h\nu_0 = eV_0$ (V_0 = cut off voltage)

$$= V_0 = \frac{h}{e} (8.2 \times 10^{14} - 3.3 \times 10^{14})$$

$$= \frac{6.6 \times 10^{-34} \times 4.9 \times 10^{14}}{1.6 \times 10^{-19}} \approx 2V.$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q71. A particle has initial velocity $(3\hat{i} + 4\hat{j})$ and has acceleration $(0.4\hat{i} + 0.3\hat{j})$. Its speed after 10 s is:

- (a) 7 units (b) $7\sqrt{2}$ units
 (c) 8.5 units (d) 10 units

Ans: (b)

Solution: $\vec{u} = 3\hat{i} + 4\hat{j}$, $\vec{a} = 0.4\hat{i} + 0.3\hat{j}$

$\Rightarrow u_x = 3 \text{ units}, u_y = 4 \text{ units}$

$a_x = 0.4 \text{ units}, a_y = 0.3 \text{ units}$

$\therefore v_x = u_x + a_x \times 10 = 3 + 4 = 7 \text{ ms}^{-1}$

and $v_y = 4 + 0.3 \times 10 = 4 + 3 = 7 \text{ ms}^{-1}$

$$\therefore v = \sqrt{v_x^2 + v_y^2} = 7\sqrt{2} \text{ ms}^{-1}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q72. A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on the inclined plane, then

- (a) solid sphere reaches the bottom first
 (b) solid sphere reaches the bottom last
 (c) disc will reach the bottom first
 (d) all reach the bottom at the same time

Ans: (a)

Solution: For solid sphere, $\frac{K^2}{R^2} = \frac{2}{5}$

For disc and solid cylinder, $\frac{K^2}{R^2} = \frac{1}{2}$

As $\frac{K^2}{R^2}$ for solid sphere is smallest, it takes minimum time to reach the bottom of the incline

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q73. Velocity of sound waves in air is 330 m/s. For a particular sound wave in air, a path difference of 40 cm is equivalent to phase difference of 1.6π . The frequency of this wave is

- (a) 165 Hz (b) 150 Hz
 (c) 660 Hz (d) 330 Hz

Ans: (c)

Solution: From $\Delta x = \frac{\lambda}{2\pi} \Delta\phi$,

$$\lambda = 2\pi \frac{\Delta x}{\Delta\phi} = \frac{2\pi(0.4)}{1.6} = 0.5\text{m}$$

$$f = \frac{v}{\lambda} = \frac{330}{0.5} = 660\text{Hz}$$

Chapter: Waves

[Topic: Basic of Waves]

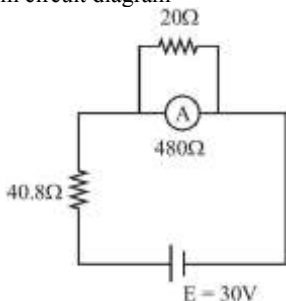
Q74. A circuit contains an ammeter, a battery of 30V and a resistance 40.8Ω all connected in series. If the ammeter has a coil of resistance 480Ω and a shunt of 20Ω , the reading in the ammeter will be:

[2015 RS]

- (a) 0.25 A (b) 2A
(c) 1 A (d) 0.5 A

Ans: (d)

Solution: From circuit diagram



$$\text{Resistance of ammeter} = \frac{480 \times 20}{480 + 20} = 19.2\Omega.$$

$$\text{Total resistance } R = 40.8 + 19.2 = 60\Omega$$

$$\text{Reading in the ammeter } i = \frac{V}{R}$$

$$= \frac{30}{40.8 + 19.2} = 0.5A$$

Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q75. An electron of mass m and charge e is accelerated from rest through a potential difference of V volt in vacuum. Its final speed will be

- (a) $\frac{eV}{2m}$
(b) $\frac{e}{m}$
(c) $\sqrt{\frac{2eV}{m}}$
(d) $\sqrt{\frac{eV}{2m}}$

Ans: (c)

Solution: Kinetic energy of electron accelerated through a potential $V = eV$

$$\Rightarrow \frac{1}{2}mv^2 = eV$$

$$= v^2 = \frac{2eV}{m} \Rightarrow v = \sqrt{\frac{2eV}{m}}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q76. Two bodies, A (of mass 1 kg) and B (of mass 3 kg), are dropped from heights of 16m and 25m, respectively. The ratio of the time taken by them to reach the ground is

- (a) 12/5 (b) 5/12
(c) 4/5 (d) 5/4

Ans: (c)

Solution: Let t_1 & t_2 be the time taken by A and B respectively to reach the ground then from the formula,

$$h = \frac{1}{2}gt^2,$$

$$\text{For first body, } 16 = \frac{1}{2}gt_1^2$$

$$\text{For second body, } 25 = \frac{1}{2}gt_2^2$$

$$\therefore \frac{16}{25} = \frac{t_1^2}{t_2^2} \Rightarrow \frac{t_1}{t_2} = \frac{4}{5}.$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q77. Two sound waves with wavelengths 5.0 m and 5.5m respectively, each propagate in a gas with velocity 330 m/s. We expect the following number of beats per second

- (a) 0 (b) 1
(c) 6 (d) 12

Ans: (c)

Solution: Frequencies of sound waves are $\frac{330}{5}$ & $\frac{330}{5.5}$

i.e., 66 Hz and 60 Hz

Frequencies of beat = 66 – 60 = 6 per second

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q78. There are four light-weight-rod samples A,B,C,D separately suspended by threads. A bar magnet is slowly brought near each sample and the following observations are noted

- (i) A is feebly repelled
(ii) B is feebly attracted
(iii) C is strongly attracted
(iv) D remains unaffected
Which one of the following is true ?
(a) B is of a paramagnetic material
(b) C is of a diamagnetic material
(c) D is of a ferromagnetic material
(d) A is of a non-magnetic material

Ans: (a)

Solution: A $\rightarrow$ diamagnetic

B $\rightarrow$ paramagnetic

C $\rightarrow$ Ferromagnetic

D $\rightarrow$ Non magnetic

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q79. The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is :-

- (a) 1 (b) 4
(c) 0.5 (d) 2

Ans: (b)

Solution: For last line of Balmer series : $n_1 = 2$ and $n_2 = \infty$

$$\frac{1}{\lambda_B} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = R_1^2 \left[\frac{1}{2^2} - \frac{1}{\infty^2} \right]$$

$$\lambda_B = \frac{4}{R} \dots (i)$$

For last line of Lyman series : $n_1 = 1$ and $n_2 = \infty$

$$\frac{1}{\lambda_L} = RZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = RZ^2 \left[\frac{1}{1^2} - \frac{1}{\infty^2} \right]$$

$$\lambda_L = \frac{1}{R} \dots \text{(ii)}$$

Dividing equation (i) by (ii)

$$\frac{\lambda_B}{\lambda_L} = \frac{\frac{4}{R}}{\frac{1}{R}}$$

Ratio of wavelengths is $\frac{\lambda_B}{\lambda_T} = 4$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q80. The angle between two vectors of magnitude 12 and 18 units when their resultant is 24 units, is

- (a) $63^\circ 51'$ (b) $75^\circ 52'$
(c) $82^\circ 31'$ (d) $89^\circ 16'$

Ans: (b)

Solution: We know that, $R^2 = A^2 + B^2 + 2AB\cos\theta$

$$(24)^2 = (12)^2 + (18)^2 + 2(12)(18)\cos\theta$$

$$\cos\theta = \frac{108}{432} \Rightarrow \theta = 75^\circ 52'$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q81. The escape velocity of a body on the surface of the earth is 11.2 km/s. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become

- (a) 44.8 km/s (b) 22.4 km/s
(c) 11.2 km/s (remains unchanged)
(d) 5.6 km/s

Ans: (b)

Solution: Escape velocity

$$v_e = \sqrt{\frac{2GM_e}{R_e}}, v'_e = \sqrt{\frac{2GM'_e}{R'_e}}$$

$$\therefore \frac{v'_e}{v_e} = \sqrt{\frac{M'_e}{M_e} \times \frac{R_e}{R'_e}}$$

$$\text{Given } M'_e = 2M_e \text{ and } R'_e = \frac{R_e}{2}$$

$$\therefore \frac{v'_e}{v_e} = \sqrt{\frac{2M_e}{M_e} \times \frac{R_e}{\frac{R_e}{2}}} = \sqrt{4} = 2$$

$$v_e = 2v_e = 2 \times 11.2 = 22.4 \text{ km/s}$$

Chapter: Gravitation

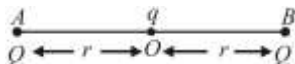
[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q82. A charge 'q' is placed at the centre of the line joining two equal charges 'Q'. The system of the three charges will be in equilibrium if 'q' is equal to

- (a) Q/2 (b) -Q/4
(c) Q/4 (d) -Q/2

Ans: (b)

Solution: The system of three charges will be in equilibrium.



For this, force between charge at A and B + force between charge at point O and either at A or B is zero.

$$\text{i.e., } \frac{kQ^2}{r^2} + \frac{kQq}{\left(\frac{r}{2}\right)^2} = 0$$

By solving we get,

$$q = -\frac{Q}{4}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q83. A circular disc of radius 0.2 meter is placed in a uniform magnetic field of induction $\frac{1}{\pi}$ (Wb/m²) in such a way that its axis makes an angle of 60° with $\vec{B}$. The magnetic flux linked with the disc is:

- (a) 0.02 Wb (b) 0.06 Wb
(c) 0.08 Wb (d) 0.01 Wb

Ans: (a)

Solution: Here, $B = \frac{1}{\pi}$ (Wb/m²)

$$\theta = 60^\circ$$

Area normal to the plane of the disc

$$= \pi r^2 \cos 60^\circ = \frac{\pi r^2}{2}$$

Flux = B × normal area

$$= \frac{0.2 \times 0.2}{2} = 0.02 \text{ Wb}$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q84. Which of the following transitions in a hydrogen atom emits the photon of highest frequency?

[2000]

- (a) $n = 2$ to $n = 1$ (b) $n = 2$ to $n = 6$
(c) $n = 6$ to $n = 2$ (d) $n = 1$ to $n = 2$

Ans: (a)

$$\text{Solution: } \bar{\nu} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \text{ or } \frac{1}{\lambda} = R \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

$$\text{Frequency, } \nu = Rc \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

Note : See the greatest energy difference and also see that the transition is from higher to lower energy level. Hence, it is highest in case of $n = 2$ to $n = 1$.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q85. The maximum range of a gun of horizontal terrain is 16 km. If $g = 10 \text{ ms}^{-2}$, then muzzle velocity of a shell must be

- (a) 160 ms^{-1} (b) $200\sqrt{2} \text{ ms}^{-1}$
(c) 400 ms^{-1} (d) 800 ms^{-1}

Ans: (c)

$$\text{Solution: } R_{\max} = \frac{v^2}{g} = 16000 [16 \text{ km} = 16000 \text{ m}]$$

$$\text{or } v = (16000g)^{\frac{1}{2}} = (16000 \times 10)^{\frac{1}{2}} = 400 \text{ ms}^{-1}$$

Chapter: Kinematics Motion in a Plane

[Topic: Projectile Motion]

Q86. The terminal velocity v_t of a small steel ball of radius r falling under gravity through a column of a viscous liquid of coefficient of viscosity η depends on

mass of the ball m , acceleration due to gravity g , coefficient of viscosity η and radius r . Which of the following relations is dimensionally correct?

- (a) $v_r \propto \frac{mgr}{\eta}$
 (b) $v_r \propto mgr\eta$
 (c) $v_r \propto \frac{mg}{r\eta}$
 (d) $v_r \propto \frac{\eta mg}{r}$

Ans: (c)

Solution: Note that according to Stoke's law

$$6\pi\eta r v_r = mg$$

Hence, the valid relation is $v_r \propto \frac{mg}{r\eta}$

Chapter: Mechanical Properties of Fluids

[Topic: Surface Tension, Surface Energy & Capillarity]

Q87. A charge Q is enclosed by a Gaussian spherical surface of radius R . If the radius is doubled, then the outward electric flux will

- (a) increase four times
 (b) be reduced to half
 (c) remain the same
 (d) be doubled

Ans: (c)

Solution: By Gauss's theorem,

$$\phi = Q_{in} \epsilon_0$$

Thus, the net flux depends only on the charge enclosed by the surface. Hence, there will be no effect on the net flux if the radius of the surface is doubled.

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q88. In an ac circuit an alternating voltage $e = 200\sqrt{2} \sin 100t$ volts is connected to a capacitor of capacity $1 \mu\text{F}$. The r.m.s. value of the current in the circuit is

- (a) 10 mA
 (b) 100 mA
 (c) 200 mA
 (d) 20 mA

Ans: (d)

$$\text{Solution: } V_{\text{rms}} = \frac{200\sqrt{2}}{\sqrt{2}} = 200\text{V}$$

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{X_C} = \frac{\frac{200}{1}}{100 \times 10^{-6}} = 2 \times 10^{-2} = 20\text{mA}$$

Chapter: Alternating Current

[Topic: Alternating Current, Voltage & Power]

Q89. The mass number of a nucleus is equal to the number of

- (a) protons it contains
 (b) nucleons it contains
 (c) neutrons it contains
 (d) electron it contains

Ans: (b)

Solution: Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q90. A body under the action of a force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$, acquires an acceleration of 1 m/s^2 . The mass of this body must be

- (a) 10 kg
 (b) 20 kg

(c) $10\sqrt{2} \text{ kg}$

(d) $2\sqrt{10} \text{ kg}$

Ans: (c)

$$\text{Solution: } \vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k},$$

$$|\vec{F}| = \sqrt{36 + 64 + 100} = 10\sqrt{2}\text{N}$$

$$(\because F = \sqrt{F_x^2 + F_y^2 + F_z^2}),$$

$$a = 1 \text{ ms}^{-2}$$

$$\therefore F = ma$$

$$\therefore m = \frac{10\sqrt{2}}{1} = 10\sqrt{2} \text{ kg}$$

Chapter: Dynamics Laws of Motion

[Topic: Ist, IInd & IIIrd Laws of Motion]

Q91. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t . The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t ?

- (a) $\frac{Q}{4}$
 (b) $\frac{Q}{16}$
 (c) $2Q$
 (d) $\frac{Q}{2}$

Ans: (b)

Solution: The rate of heat flow is given by

$$\frac{Q}{t} = K \cdot A \cdot \frac{\Delta T}{\ell}$$

$$\text{Area of Original rod } A = \pi R^2;$$

$$\text{Areal of new rod } A' = \frac{\pi R^2}{4}.$$

Volume of original rod will be equal to the volume of new rod.

$$\therefore \pi R^2 \ell = \pi \left(\frac{R}{2}\right)^2 \ell'$$

$$\Rightarrow \frac{\ell'}{\ell} = \frac{R^2}{\left(\frac{R^2}{4}\right)} = 4$$

$$\frac{Q'}{Q} = \frac{A'}{A} \cdot \frac{\ell}{\ell'} = \frac{1}{4} \cdot \frac{1}{4} = \frac{1}{16}$$

$$Q' = \frac{Q}{16}$$

Chapter: Thermal Properties

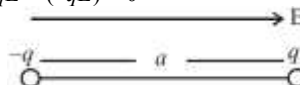
[Topic: Calorimetry & Heat Transfer]

Q92. An electric dipole has the magnitude of its charge as q and its dipole moment is p . It is placed in uniform electric field E . If its dipole moment is along the direction of the field, the force on it and its potential energy are respectively

- (a) $q \cdot E$ and max.
 (b) $2q \cdot E$ and min.
 (c) $q \cdot E$ and $p \cdot E$
 (d) zero and min.

Ans: (d)

Solution: When the dipole is in the direction of field then net force is $qE + (-qE) = 0$



and its potential energy is minimum

$$= -P \cdot E = -qaE$$

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q93. An LCR series circuit is connected to a source of alternating current. At resonance, the applied voltage and the current flowing through the circuit will have a phase difference of

- (a) π (b) $\frac{\pi}{2}$
 (c) $\frac{\pi}{4}$ (d) 0

Ans: (d)

Solution: At resonance, $\omega L = \frac{1}{\omega C}$. The circuit behaves as if it contains R only. So, phase difference = 0

At resonance, impedance is minimum $Z_{\min} = R$ and current is maximum, given by

$$I_{\max} = \frac{E}{Z_{\min}} = \frac{E}{R}$$

It is interesting to note that before resonance the current leads the applied emf, at resonance it is in phase, and after resonance it lags behind the emf. LCR series circuit is also called as acceptor circuit and parallel LCR circuit is called rejector circuit.

Chapter: Alternating Current
[Topic: A.C. Circuit, LCR Circuit, Quality & Power Factor]

Q94. Solar energy is mainly caused due to

- (a) gravitational contraction
 (b) burning of hydrogen in the oxygen
 (c) fission of uranium present in the Sun
 (d) fusion of protons during synthesis of heavier elements

Ans: (d)

Solution: As a result of fusion, enormous amount of heat is liberated which is the main cause of source of solar energy.

Chapter: Nuclei
[Topic: Mass-Energy & Nuclear Reactions]

Q95. A man weighing 80 kg, stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of 5 m/s^2 . What would be the reading on the scale ? ($g = 10\text{ m/s}^2$)

- (a) 1200 N (b) zero
 (c) 400 N (d) 800 N

Ans: (a)

Solution: Reading of the scale
 = Apparent wt. of the man = $m(g + a)$
 = $80(10 + 5) = 1200\text{ N}$

Chapter: Dynamics Laws of Motion
[Topic: Motion of Connected Bodies, Pulleys]

Q96. A body cools from 50.0°C to 48°C in 5s. How long will it take to cool from 40.0°C to 39°C ? Assume the temperature of surroundings to be 30.0°C and Newton's law of cooling to be valid.

- (a) 2.5 s (b) 10 s
 (c) 20 s (d) 5 s

Ans: (b)

Solution: Rate of cooling $\propto$ temperature difference

between system and surrounding.

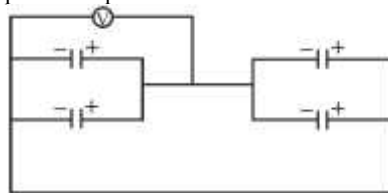
As the temperature difference is halved, so the rate of cooling will also be halved.

So time taken will be doubled

$$t = 2 \times 5\text{ sec.} = 10\text{ sec.}$$

Chapter: Thermal Properties
[Topic: First Law of Thermodynamics]

Q97. The four capacitors, each of $25\mu\text{ F}$ are connected as shown in fig. The dc voltmeter reads 200 V. The charge on each plate of capacitor is



- (a) $\pm 2 \times 10^{-3}\text{ C}$
 (b) $\pm 5 \times 10^{-3}\text{ C}$
 (c) $\pm 2 \times 10^{-2}\text{ C}$
 (d) $\pm 5 \times 10^{-2}\text{ C}$

Ans: (b)

Solution: Charge on each plate of each capacitor

$$Q = \pm CV = \pm 25 \times 10^{-6} \times 200$$

$$= \pm 5 \times 10^{-3}\text{ C}$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q98. The electromagnetic radiations are caused by

- (a) a stationary charge
 (b) uniformly moving charges
 (c) accelerated charges
 (d) all of above

Ans: (c)

Solution: A stationary charge produces electric field only; an uniformly moving charge produces localised electromagnetic field; an accelerated charge produces electromagnetic radiations.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q99. A nucleus ${}^m_n\text{X}$ emits one α -particle and two β -particles. The resulting nucleus is

- (a) ${}^{[m-6]}_{[n-4]}\text{Z}$
 (b) ${}^{m-6}_n\text{Z}$
 (c) ${}^{m-4}_n\text{X}$
 (d) ${}^{[m-4]}_{[n-2]}\text{Y}$

Ans: (c)

Solution: When ${}^m_n\text{X}$ emits one α -particle then its atomic mass decreases by 4 units and atomic number by 2. Therefore, the new nucleus becomes ${}^{[m-4]}_{[n-2]}\text{Y}$. But as it emits two β^- particles, its atomic number increases by 2. Thus the resulting nucleus is ${}^{m-4}_n\text{X}$

Chapter: Nuclei
[Topic: Radioactivity]

- Q100.** A 500 kg car takes a round turn of radius 50 m with a velocity of 36 km/h. The centripetal force is
 (a) 250 N (b) 750 N
 (c) 1000 N (d) 1200 N

Ans: (c)

Solution: Centripetal force = $\frac{mv^2}{r} = \frac{500 \times (10)^2}{50}$
 = 1000 N

$\Rightarrow 36 \text{ km/hr} = 10 \text{ m/s}$

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

PART 9. PHYSICS QUESTION BANK

- Q1.** If the ratio of specific heat of a gas at constant pressure to that at constant volume is γ , the change in internal energy of a mass of gas, when the volume changes from V to $2V$ at constant pressure P , is

- (a) $\frac{R}{(\gamma-1)}$
 (b) PV
 (c) $\frac{PV}{(\gamma-1)}$
 (d) $\frac{\gamma PV}{(\gamma-1)}$

Ans: (c)

Solution: Change in internal energy is equal to work done in adiabatic system

$$\Delta W = -\Delta U \text{ (Expansion in the system)}$$

$$= -\frac{1}{(\gamma-1)}(P_1 V_1 - P_2 V_2)$$

$$\Delta U = \frac{1}{(1-\gamma)}(P_2 V_2 - P_1 V_1)$$

$$\text{Here, } V_1 = V, V_2 = 2V$$

$$\Delta U = \frac{1}{1-\gamma}[P \times 2V - PV] = \frac{PV}{1-\gamma}$$

$$= \Delta U = -\frac{PV}{\gamma-1}$$

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

- Q2.** Resistances n , each of r ohm, when connected in parallel give an equivalent resistance of R ohm. If these resistances were connected in series, the combination would have a resistance in ohms, equal to

- (a) nR
 (b) $n^2 R$
 (c) R/n^2 (d) R/n

Ans: (b)

$$\text{Solution: } R = \frac{r}{n} \Rightarrow r = nR$$

$$\text{When connected in series, } R_{eq} = nr$$

$$= n(nR) = n^2 R$$

Chapter: Current Electricity
[Topic: Combination of Resistances]

- Q3.** Which of the following is not due to total internal reflection?

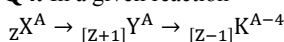
- (a) Working of optical fibre
 (b) Difference between apparent and real depth of pond
 (c) Mirage on hot summer days
 (d) Brilliance of diamond

Ans: (b)

Solution: Difference between apparent and real depth of a pond is due to the refraction of light, not due to the total internal reflection. Other three phenomena are due to the total internal reflection.

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

- Q4.** In a given reaction



Radioactive radiations are emitted in the sequence of

- (a) α, β, γ
 (b) γ, α, β
 (c) β, α, γ
 (d) γ, β, α

Ans: (c)

Solution: Increase of charge number by 1 indicates β emission. Decrease of mass number by 4 and charge number by 2 indicates α emission. No change of mass number and charge number indicates γ -emission.

Chapter: Nuclei
[Topic: Radioactivity]

- Q5.** A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 feet tall building. After a fall of 30 feet each towards earth, their respective kinetic energies will be in the ratio of

- (a) $1 : \sqrt{2}$ (b) $\sqrt{2} : 1$
 (c) $1 : 4$ (d) $1 : 2$

Ans: (d)

Solution: Since height is same for both balls, their velocities on reaching the ground will be same

$$\frac{K.E_1}{K.E_2} = \frac{\frac{1}{2} m_1 v_0^2}{\frac{1}{2} m_2 v_0^2} = \frac{m_1}{m_2} = \frac{2}{4} = \frac{1}{2}$$

Chapter: Work, Energy and Power
[Topic: Energy]

- Q6.** At 10°C the value of the density of a fixed mass of an ideal gas divided by its pressure is x . At 110°C this ratio is:

- (a) x
 (b) $\frac{383}{283} x$
 (c) $\frac{10}{110} x$
 (d) $\frac{283}{383} x$

Ans: (d)

Solution: Let the mass of the gas be m .

At a fixed temperature and pressure, volume is fixed.

$$\text{Density of the gas, } \rho = \frac{m}{v}$$

$$\text{Now } \frac{\rho}{P} = \frac{m}{PV} = \frac{m}{nRT}$$

$$\Rightarrow \frac{m}{nRT} = x \text{ (By question)}$$

$$\Rightarrow xT = \text{constant} \Rightarrow x_1 T_1 = x_2 T_2$$

$$\Rightarrow x_2 \Rightarrow \frac{x_1 T_1}{T_2} = \frac{283}{383} \times \begin{cases} T_1 = 283\text{K} \\ T_2 = 383\text{K} \end{cases}$$

Chapter: Kinetic Theory

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q7. In producing chlorine through electrolysis, 100 watt power at 125 V is being consumed. How much chlorine per minute is liberated? E.C.E. of chlorine is 0.367×10^{-6} kg/coulomb.

- (a) 21.3 mg (b) 24.3 mg
(c) 13.6 mg (d) 17.6 mg

Ans: (d)

Solution: Power = $V \times I$

$$I = \frac{\text{Power}}{V} = \frac{100}{125}$$

E.C.E. of chlorine is 0.367×10^{-6} kg/coulomb

Charge passing in one minute = $\frac{100}{125} \times 60$

= 48 coulomb

Chlorine precipitated = $0.367 \times 10^{-6} \times 48$

= 17.6×10^{-6} kg

= 17.6 mg

Chapter: Current Electricity

[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q8. A boy is trying to start a fire by focusing sunlight on a piece of paper using an equiconvex lens of focal length 10 cm. The diameter of the Sun is 1.39×10^9 m and its mean distance from the earth is 1.5×10^{11} m. What is the diameter of the Sun's image on the paper?

- (a) 9.2×10^{-4} m (b) 6.5×10^{-4} m
(c) 6.5×10^{-5} m (d) 12.4×10^{-4} m

Ans: (a)

Solution: We have, $\left| \frac{v}{u} \right| = \frac{\text{Size of image}}{\text{Size of object}}$

or, Size of image = $\left| \frac{v}{u} \right| \times \text{Size of object}$

$$= \left(\frac{10^{-1}}{1.5 \times 10^{11}} \right) \times (1.39 \times 10^9)$$

$$= 0.92 \times 10^{-3} \text{ m} = 9.2 \times 10^{-4} \text{ m}$$

$\therefore$ Diameter of the sun's image = 9.2×10^{-4} m.

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q9. Which one of the following bonds produces a solid that reflects light in the visible region and whose electrical conductivity decreases with temperature and has high melting point?

- (a) metallic bonding
(b) van der Waal's bonding
(c) ionic bonding
(d) covalent bonding

Ans: (a)

Solution: For a metal, conductivity decreases with increase in temperature.

Also, metal has high melting point.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q10. A body of mass (4m) is lying in x-y plane at rest. It suddenly explodes into three pieces. Two pieces, each of mass (m) move perpendicular to each other with equal speeds (v). The total kinetic energy generated due to explosion is :

- (a) mv^2 (b) $\frac{3}{2}mv^2$
(c) $2mv^2$ (d) $4mv^2$

Ans: (b)

Solution: By conservation of linear momentum

$$2mv_i = \sqrt{2}mv \Rightarrow v_i = \frac{v}{\sqrt{2}}$$

As two masses of each of mass m move perpendicular to each other.

Total KE generated

$$= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}(2m)v_i^2$$

$$= mv^2 + \frac{mv^2}{2} = \frac{3}{2}mv^2$$

Chapter: Work, Energy and Power

[Topic: Collisions]

Q11. The degree of freedom of a molecule of a triatomic gas is

- (a) 2 (b) 4
(c) 6 (d) 8

Ans: (c)

Solution: No. of degree of freedom = $3K - N$

where K is no. of atom and N is the number of relations between atoms. For triatomic gas,

$$K = 3, N = {}^3C_2 = 3$$

$$\text{No. of degree of freedom} = 3(3) - 3 = 6$$

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q12. Two 220 volt, 100 watt bulbs are connected first in series and then in parallel. Each time the combination is connected to a 220 volt a.c. supply line. The power drawn by the combination in each case respectively will be [2003]

- (a) 50 watt, 200 watt (b) 50 watt, 100 watt
(c) 100 watt, 50 watt (d) 200 watt, 150 watt

Ans: (a)

Solution: Power $\propto \frac{1}{\text{Resistance}}$

In series combination, resistance doubles.

Hence, power will be halved.

In parallel combination, resistance halves.

Hence, power will be doubled.

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q13. The refractive index of the material of the prism is $\sqrt{3}$; then the angle of minimum deviation of the prism is

- (a) 30° (b) 45°
(c) 60° (d) 75°

Ans: (c)

Solution: Angle of minimum deviation

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \sqrt{3} = \frac{\sin\left(\frac{60^\circ + \delta_m}{2}\right)}{\sin\left(\frac{60^\circ}{2}\right)}$$

$$= \sin\left(30^\circ + \frac{\delta_m}{2}\right) = \frac{\sqrt{3}}{2} \Rightarrow 30^\circ + \frac{\delta_m}{2} = 60^\circ$$

$$\Rightarrow \delta_m = 60^\circ.$$

Chapter - Ray Optics and Optical
[Topic: Prism & Dispersion of Light]

Q14. The cause of the potential barrier in a p - n diode is
 (a) depletion of positive charges near the junction
 (b) concentration of positive charges near the junction
 (c) depletion of negative charges near the junction
 (d) concentration of positive and negative charges near the junction

Ans: (d)

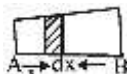
Solution: During the formation of a junction diode, holes from p -region diffuse into n -region and electrons from n -region diffuse into p -region. In both cases, when an electron meets a hole, they cancel the effect of each other and as a result, a thin layer at the junction becomes free from any of charge carriers. This is called depletion layer. There is a potential gradient in the depletion layer, negative on the p -side and positive on the n -side. The potential difference thus developed across the junction is called potential barrier.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q15. If the linear density (mass per unit length) of a rod of length 3m is proportional to x , where x is the distance from one end of the rod, the distance of the centre of gravity of the rod from this end is
 (a) 2.5 m (b) 1 m
 (c) 1.5 m (d) 2 m

Ans: (d)

Solution: Consider an element of length dx at a distance x from end A.
 Here, mass per unit length λ of rod
 $\lambda \propto x = \lambda = kx$
 $\therefore dm = \lambda dx = kx dx$



Position of centre of gravity of rod from end A.

$$x_{CG} = \frac{\int_0^L x dm}{\int_0^L dm}$$

$$\therefore x_{CG} = \frac{\int_0^3 x (kx dx)}{\int_0^3 kx dx} = \frac{\left[\frac{x^3}{3}\right]_0^3}{\left[\frac{x^2}{2}\right]_0^3} = \frac{\frac{(3)^3}{3}}{\frac{(3)^2}{2}} = 2m$$

Chapter: System of Particles and Rotational Motion
[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q16. A particle is subjected to two mutually perpendicular simple harmonic motions such that its x and y coordinates are given by

$$x = 2 \sin \omega t; y = 2 \sin \left(\omega t + \frac{\pi}{4} \right)$$

The path of the particle will be

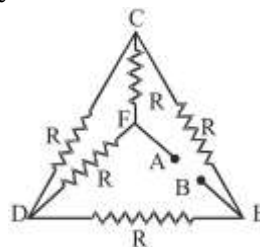
- (a) a straight line
- (b) a circle
- (c) an ellipse
- (d) a parabola

Ans: (c)

Solution: As phase difference $= \frac{\pi}{4}$, the resultant path of particle is an ellipse.

Chapter: Oscillation
[Topic: Energy in Simple Harmonic Motion]

Q17. Five equal resistances each of resistance R are connected as shown in the figure. A battery of V volts is connected between A and B . The current flowing in $AFCEB$ will be



- (a) $\frac{2V}{R}$
- (b) $\frac{3V}{R}$
- (c) $\frac{V}{R}$
- (d) $\frac{V}{2R}$

Ans: (d)

Solution: A balanced Wheatstone's bridge exists between A & B .

$$\therefore R_{eq} = R$$

$$\text{Current through circuit} = V/R$$

$$\text{Current through AFCEB} = V/2R$$

Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q18. If yellow light emitted by sodium lamp in Young's double slit experiment is replaced by a monochromatic blue light of the same intensity [1992]

- (a) fringe width will decrease
- (b) fringe width will increase
- (c) fringe width will remain unchanged
- (d) fringes will become less intense

Ans: (a)

Solution: As $\beta = \frac{\lambda D}{d}$ and $\lambda_b < \lambda_y$,

$\therefore$ Fringe width β will decrease

Chapter - Wave Optics
[Topic: Young's Double Slit Experiment]

Q19. A transistor is operated in common-emitter configuration at $V_c = 2$ V such that a change in the base current from 100 μ A to 200 μ A produces a change in the collector current from 5 mA to 10 mA. The current gain is

- (a) 100 (b) 150
(c) 50 (d) 75

Ans: (c)

Solution: $\Delta I_E = \Delta I_B + \Delta I_C$

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

$$\Delta I_C = (10 - 5)10^3$$

$$= 5 \times 10^3 \text{ A}$$

$$\Delta I_B = (200 - 100)10^{-6}$$

$$= 100 \times 10^{-6} \text{ A}$$

$$\beta = \frac{5 \times 10^3}{100 \times 10^{-6}} = \frac{5}{100} \times 1000 = 50$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q20. If dimensions of critical velocity v_c of a liquid flowing through a tube are expressed as $[\eta^x \rho^y r^z]$, where η , ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x , y and z are given by :

- (a) -1, -1, 1 (b) -1, -1, -1
(c) 1, 1, 1 (d) 1, -1, -1

Ans: (d)

Solution: Applying dimensional method :

$$v_c = \eta^x \rho^y r^z$$

$$[M^0 L T^{-1}] = [ML^{-1} T^{-1}]^x [ML^{-3} T^{-1}]^y [M^0 L T^{-1}]^z$$

Equating powers both sides

$$x + y = 0; -x = -1 \therefore x = 1$$

$$1 + y = 0 \therefore y = -1$$

$$-x - 3y + z = 1$$

$$-1 - 3(-1) + z = 1$$

$$-1 + 3 + z = 1$$

$$\therefore z = -1$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q21. A thin circular ring of mass M and radius R is rotating in a horizontal plane about an axis vertical to its plane with a constant angular velocity ω . If two objects each of mass m be attached gently to the opposite ends of a diameter of the ring, the ring will then rotate with an angular velocity:

- (a) $\frac{\omega M}{M+2m}$
(b) $\frac{\omega(M+2m)}{M}$
(c) $\frac{\omega M}{M+m}$
(d) $\frac{\omega(M-2m)}{M+2m}$

Ans: (a)

Solution: In absence of external torque, $L = I\omega = \text{constant}$

$$I_1 \omega_1 = I_2 \omega_2, I_1 = MR^2, I_2 = MR^2 + 2mR^2$$

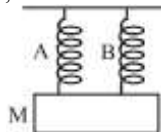
(Moment of inertia of a thin circular ring about an axis vertical to its plane $= MR^2$)

$$\therefore \omega_2 = \frac{I_1}{I_2} \omega = \frac{M}{M+2m} \omega.$$

Chapter: System of Particles and Rotational Motion

[Topic: Torque, Couple and Angular Momentum]

Q22. A body of mass M , executes vertical SHM with periods t_1 and t_2 , when separately attached to spring A and spring B respectively. The period of SHM, when the body executes SHM, as shown in the figure is t_0 . Then



(a) $t_0^{-1} = t_1^{-1} + t_2^{-1}$

(c) $t_0^2 = t_1^2 + t_2^2$

(b) $t_0 = t_1 + t_2$

(d) $t_0^{-2} = t_1^{-2} + t_2^{-2}$

Ans: (d)

Solution: $t = 2\pi \sqrt{\frac{m}{k}}$

$$\Rightarrow k = \text{Const.} t^{-2}$$

Here the springs are joined in parallel. So

$$k_0 = k_1 + k_2$$

where k_0 is resultant force constant

$$\therefore \text{Const.} t_0^{-2} = \text{Const.} t_1^{-2} + \text{Const.} t_2^{-2}$$

$$\text{or, } t_0^{-2} = t_1^{-2} + t_2^{-2}$$

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q23. A positively charged particle moving due east enters a region of uniform magnetic field directed vertically upwards. The particle will

- (a) continue to move due east
(b) move in a circular orbit with its speed unchanged
(c) move in a circular orbit with its speed increased
(d) gets deflected vertically upwards.

Ans: (b)

Solution: In a perpendicular magnetic field, the path of a charged particle is a circle, and the magnetic field does not cause any change in energy.

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q24. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by

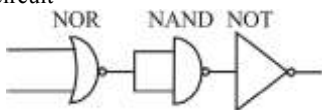
- (a) increasing the potential difference between the anode and filament
(b) increasing the filament current
(c) decreasing the filament current
(d) decreasing the potential difference between the anode and filament

Ans: (a)

Solution: In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by increasing the potential difference between the anode and filament.

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q25. The circuit

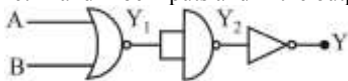


is equivalent to

- (a) AND gate
- (b) NAND gate
- (c) NOR gate
- (d) OR gate

Ans: (c)

Solution: Let A and B be inputs and Y the output.



$$\text{Then } Y_1 = \overline{(A + B)} = \bar{A} \cdot \bar{B}$$

(By De-Morgan's theorem)

$$Y_2 = \overline{Y_1} = \overline{(\bar{A} \cdot \bar{B})} = \bar{\bar{A}} + \bar{\bar{B}} = A + B$$

$$\therefore Y = \overline{Y_2} = \overline{(A + B)}$$

Hence, the given circuit is equivalent to a NOR gate.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q26. The dimensional formula of torque is

- (a) $[ML^2T^{-2}]$
- (b) $[MLT^{-2}]$
- (c) $[ML^{-1}T^{-2}]$
- (d) $[ML^{-2}T^{-2}]$

Ans: (a)

$$\text{Solution: } \tau = [\text{Force} \times \text{distance}]$$

$$= [MLT^{-2}] [L] = ML^2T^{-2}$$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q27. A small mass attached to a string rotates on frictionless table top as shown. If the tension in the string is increased by pulling the string causing the radius of the circular motion to decrease by a factor of 2, the kinetic energy of the mass will



- (a) remain constant
- (b) increase by a factor of 2
- (c) increase by a factor of 4
- (d) decrease by a factor of 2

Ans: (c)

$$\text{Solution: } K.E. = \frac{L^2}{2I}$$

The angular momentum L remains conserved about the centre.

That is, L = constant.

$$I = mr^2$$

$$\therefore K.E. = \frac{L^2}{2mr^2}$$

$$\text{In 2nd case, } K.E. = \frac{L^2}{2(mr'^2)}$$

$$\text{But } r' = \frac{r}{2}$$

$$K.E. = \frac{L^2}{2m\left(\frac{r}{2}\right)^2} = \frac{4L^2}{2mr^2} \Rightarrow K.E.' = 4 K.E.$$

$\therefore$ K.E. is increased by a factor of 4.

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q28. A transverse wave propagating along x-axis is represented by $y(x, t) = 80 \sin\left(0.5\pi x - 4\pi t - \frac{\pi}{4}\right)$ where x is in metres and t is in seconds. The speed of the wave is

- (a) 0.5π m/s
- (b) $\frac{\pi}{4}$ m/s
- (c) 8 m/s
- (d) 4π m/s

Ans: (c)

Solution: Speed of a wave represented by the equation

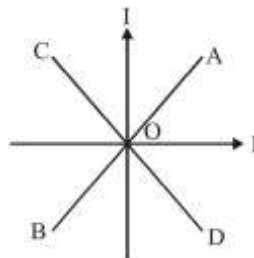
$$y(x, t) = A \sin(kx - \omega t + \phi) \text{ is } v = \frac{\omega}{k}$$

By comparison, $\omega = 4\pi$; $k = 0.5\pi$

$$v = \frac{\omega}{k} = \frac{4\pi}{0.5\pi} = 8 \text{ m/sec}$$

Chapter: Waves
[Topic: Basic of Waves]

Q29. Two equal electric currents are flowing perpendicular to each other as shown in the figure. AB and CD are perpendicular to each other and symmetrically placed with respect to the current flow. Where do we expect the resultant magnetic field to be zero?



- (a) on AB
- (b) on CD
- (c) on both AB and CD
- (d) on both OD and BO

Ans: (a)

Solution: Net magnetic field on AB is zero because magnetic field due to both current carrying wires is equal in magnitude but opposite in direction.

Chapter: Moving Charges and Magnetic Field
[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q30. A source S_1 is producing, 10^{15} photons per second of wavelength $5000 \text{ \AA}$. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength $5100 \text{ \AA}$. Then, (power of S_2) (power of S_1) is equal to :

- (a) 1.00
- (b) 1.02
- (c) 1.04
- (d) 0.98

Ans: (a)

Solution: Energy emitted/sec by $S_1, P_1 = n_1 \frac{hc}{\lambda_1}$

Energy emitted/sec by $S_2, P_2 = n_2 \frac{hc}{\lambda_2}$

$$\therefore \frac{P_2}{P_1} = \frac{n_2}{n_1} \cdot \frac{\lambda_1}{\lambda_2}$$

$$= \frac{1.02 \times 10^{15}}{10^{15}} \cdot \frac{5000}{5100} = 1.0$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q31. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to:

- (a) (velocity) $^{3/2}$ (b) (distance) 2
(c) (distance) $^{-2}$ (d) (velocity) $^{2/3}$

Ans: (a)

Solution: $x = \frac{1}{t+5}$

$$\therefore v = \frac{dx}{dt} = \frac{-1}{(t+5)^2}$$

$$\therefore a = \frac{dv}{dt} = \frac{2}{(t+5)^3} = 2x^3$$

$$\text{Now } \frac{1}{(t+5)} \propto v^{\frac{1}{2}}$$

$$\therefore \frac{1}{(t+5)^3} \propto v^{\frac{3}{2}} \propto a$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q32. The speed of a homogenous solid sphere after rolling down an inclined plane of vertical height h from rest without sliding is

- (a) $\sqrt{\frac{10}{7}gh}$
(b) $\sqrt{gh}$
(c) $\sqrt{\frac{6}{5}gh}$
(d) $\sqrt{\frac{4}{3}gh}$ **Solution:** (a) P.E. = total K.E.

$$mgh = \frac{7}{10}mv^2, \text{ (see sol. of Q.9)}$$

$$v = \sqrt{\frac{10gh}{7}}$$

Chapter: System of Particles and Rotational Motion

[Topic: Rolling Motion]

Q33. The transverse wave represented by the equation $y = 4 \sin\left(\frac{\pi}{6}\right) \sin(3x - 15t)$ has

- (a) amplitude = 4 (b) wavelength = $4\frac{\pi}{3}$
(c) speed of propagation = 5 (d) period = $\frac{\pi}{15}$

Ans: (c)

Solution: Compare the given equation with standard form

$$y = r \sin\left[\frac{2\pi x}{\lambda} - \frac{2\pi t}{T}\right]$$

$$\frac{2\pi}{\lambda} = 3, \lambda = \frac{2\pi}{3} \text{ and } \frac{2\pi}{T} = 15$$

$$T = \frac{2\pi}{15}$$

Speed of propagation,

$$v = \frac{\lambda}{T} = \frac{\frac{2\pi}{3}}{\frac{2\pi}{15}} = 5$$

Chapter: Waves

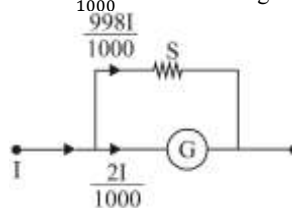
[Topic: Vibration of String & Organ Pipe]

Q34. In an ammeter 0.2% of main current passes through the galvanometer. If resistance of galvanometer is G , the resistance of ammeter will be :

- (a) $\frac{1}{499}G$
(b) $\frac{499}{500}G$
(c) $\frac{1}{500}G$
(d) $\frac{500}{499}G$

Ans: (c)

Solution: As 0.2% of main current passes through the galvanometer hence $\frac{998}{1000}I$ current through the shunt.



$$\left(\frac{2I}{1000}\right)G = \left(\frac{998I}{1000}\right)S \Rightarrow S = \frac{G}{499}$$

Total resistance of Ammeter

$$R = \frac{SG}{S+G} = \frac{\left(\frac{G}{499}\right)G}{\left(\frac{G}{499}\right)+G} = \frac{G}{500}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q35. The nature of ions knocked out from hot surfaces is

- (a) Protons
(b) Neutrons
(c) Electrons
(d) Nuclei

Ans: (c)

Solution: Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q36. A ball is thrown vertically upward. It has a speed of 10 m/sec when it has reached one half of its maximum height. How high does the ball rise?

Take $g = 10 \text{ m/s}^2$.

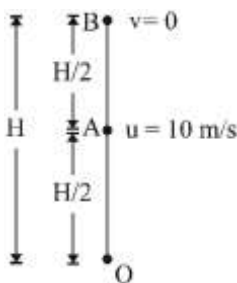
- (a) 10 m (b) 5 m
(c) 15 m (d) 20 m

Ans: (a)

Solution: For part AB

From 3rd equation of motion

$$v^2 = u^2 - 2gH$$



$$0 = u^2 - 2g(H/2) = u^2 - gH$$

$$H = \frac{u^2}{g} = \frac{10^2}{10} = 10\text{m}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q37. A body of mass 'm' is taken from the earth's surface to the height equal to twice the radius (R) of the earth. The change in potential energy of body will be

- (a) $\frac{2}{3} mgR$ (b) $3 mgR$
(c) $\frac{1}{3} mgR$ (d) $mg2R$

Ans: (a)

Solution: Initial P. E., $U_i = \frac{-GMm}{R}$,

Final P.E., $U_f = \frac{-GMm}{3R}$ [$\because R' = R + 2R = 3R$]

$\therefore$ Change in potential energy,

$$\Delta U = \frac{-GMm}{3R} + \frac{GMm}{R} = \frac{GMm}{R} \left(1 - \frac{1}{3}\right) = \frac{2}{3} \frac{GMm}{R} = \frac{2}{3} mgR \left(\frac{GMm}{R} = mgR\right)$$

$$\text{Alternate : } \Delta U = \frac{mgh}{1 + \frac{h}{R}}$$

By placing the value of $h = 2R$ we get

$$\Delta U = \frac{2}{3} mgR.$$

Chapter: Gravitation

[Topic: Gravitational Field, Potential and Energy]

Q38. Two vibrating tuning forks produce progressive waves given by $y_1 = 4 \sin 500 \pi t$ and $y_2 = 2 \sin 506 \pi t$. Number of beats produced per minute is

- (a) 360 (b) 180
(c) 60 (d) 3

Ans: (b)

Solution: Equation of progressive wave is given by

$$y = A \sin 2\pi f t$$

Given $y_1 = 4 \sin 500 \pi t$ and $y_2 = 2 \sin 506 \pi t$.

Comparing the given equations with equation of progressive wave, we get

$$2f_1 = 500 \Rightarrow f_1 = 250$$

$$2f_2 = 506 \Rightarrow f_2 = 253$$

$$\text{Beats} = f_2 - f_1 = 253 - 250 = 3 \text{ beats/sec}$$

$$= 3 \times 60 = 180 \text{ beats/minute.}$$

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q39. Electromagnets are made of soft iron because soft iron has

- (a) low retentivity and high coercive force
(b) high retentivity and high coercive force

- (c) low retentivity and low coercive force
(d) high retentivity and low coercive force

Ans: (d)

Solution: Soft iron has high retentivity and low coercive force.

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q40. Given the value of Rydberg constant is 10^7m^{-1} , the wave number of the last line of the Balmer series in hydrogen spectrum will be :

- (a) $0.025 \times 10^4 \text{m}^{-1}$ (b) $0.5 \times 10^7 \text{m}^{-1}$
(c) $0.25 \times 10^7 \text{m}^{-1}$ (d) $2.5 \times 10^7 \text{m}^{-1}$

Ans: (c)

Solution: According to Bohr's theory, the wave number of the last line of the Balmer series in hydrogen spectrum, For hydrogen atom $z = 1$

$$\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$$

$$= 10^7 \times 1^2 \left(\frac{1}{2^2} - \frac{1}{\infty^2} \right)$$

$$\Rightarrow \text{wave number } \frac{1}{\lambda} = 0.25 \times 10^7 \text{m}^{-1}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q41. If a unit vector is represented by $0.5\hat{i} + 0.8\hat{j} + c\hat{k}$, the value of c is

- (a) 1 (b) $\sqrt{0.11}$
(c) $\sqrt{0.01}$ (d) 0.39

Ans: (b)

Solution: $\hat{r} = 0.5\hat{i} + 0.8\hat{j} + c\hat{k}$

$$|\hat{r}| = 1 = \sqrt{(0.5)^2 + (0.8)^2 + c^2}$$

$$(0.5)^2 + (0.8)^2 + c^2 = 1$$

$$c^2 = 0.11 \Rightarrow c = \sqrt{0.11}$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q42. A ball is dropped from a satellite revolving around the earth at a height of 120 km. The ball will [1996]

- (a) continue to move with same speed along a straight line tangentially to the satellite at that time
(b) continue to move with the same speed along the original orbit of satellite
(c) fall down to earth gradually
(d) go far away in space

Ans: (b)

Solution: The orbital speed of satellite is independent of mass of satellite, so the ball will behave as a satellite and will continue to move with the same speed in the original orbit.

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q43. Two metallic spheres of radii 1 cm and 3 cm are given charges of $-1 \times 10^{-2} \text{C}$ and $5 \times 10^{-2} \text{C}$, respectively. If

these are connected by a conducting wire, the final charge on the bigger sphere is :

- (a) $2 \times 10^{-2} \text{ C}$ (b) $3 \times 10^{-2} \text{ C}$
(c) $4 \times 10^{-2} \text{ C}$ (d) $1 \times 10^{-2} \text{ C}$

Ans: (b)

Solution: At equilibrium potential of both sphere becomes same if charge of sphere one x and other sphere $Q - x$ then

where $Q = 4 \times 10^{-2} \text{ C}$

$$V_1 = V_2$$

$$\frac{kx}{1\text{cm}} = \frac{k(Q-x)}{3\text{cm}}$$

$$3x = Q - x \Rightarrow 4x = Q$$

$$x = \frac{Q}{4} = \frac{4 \times 10^{-2}}{4} \text{ C} = 1 \times 10^{-2}$$

$$Q' = Q - x = 3 \times 10^{-2} \text{ C}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q44. As a result of change in the magnetic flux linked to the closed loop shown in the Fig,



an e.m.f. V volt is induced in the loop. The work done (joules) in taking a charge Q coulomb once along the loop is

- (a) QV (b) $2QV$
(c) $QV/2$ (d) Zero

Ans: (a)

$$\text{Solution: } \xi = \frac{W}{Q} = V = \frac{W}{Q} \Rightarrow W = QV$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q45. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass, e is the charge on the electron and ϵ_0 is the vacuum permittivity, the speed of the electron is

- (a) 0 (b) $\frac{e}{\sqrt{\epsilon_0 a_0 m}}$
(c) $\frac{e}{\sqrt{4\pi\epsilon_0 a_0 m}}$ (d) $\frac{\sqrt{4\pi\epsilon_0 a_0 m}}{e}$

Ans: (c)

Solution: Centripetal force = Coulombian force

$$\frac{mv^2}{a_0} = \frac{1}{4\pi\epsilon_0} \frac{e \times e}{a_0^2}$$

$$xv^2 - \frac{e^2}{4\pi\epsilon_0 \cdot a_0 \cdot m} \Rightarrow v = \frac{e}{\sqrt{4\pi\epsilon_0 \cdot a_0 \cdot m}}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q46. Two bodies of same mass are projected with the same velocity at an angle 30° and 60° respectively. The ratio of their horizontal ranges will be

- (a) 1 : 1 (b) 1 : 2
(c) 1 : 3 (d) $2:\sqrt{2}$

Ans: (a)

Solution: Horizontal range is same when angle of projection is θ or $(90^\circ - \theta)$.

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q47. Water rises to a height 'h' in a capillary tube. If the length of capillary tube above the surface of water is made less than 'h' then :

- (a) water rises upto the top of capillary tube and stays there without overflowing
(b) water rises upto a point a little below the top and stays there
(c) water does not rise at all.
(d) Water rises upto the tip of capillary tube and then starts overflowing like fountain.

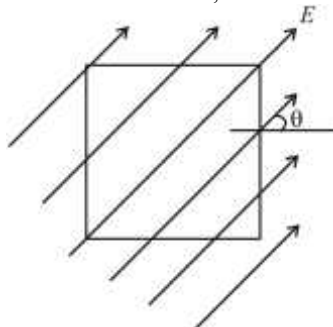
Ans: (a)

Solution: Water rises upto the top of capillary tube and stays there without overflowing.

Chapter: Mechanical Properties of Fluids

[Topic: Surface Tension, Surface Energy & Capillarity]

Q48. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in Figure. The electric flux linked to the surface, in units of volt. m , is



- (a) EL^2 (b) $EL^2 \cos\theta$
(c) $EL^2 \sin\theta$ (d) zero

Ans: (d)

Solution: Electric flux, $\phi = EA \cos \theta$, where θ = angle between E and normal to the surface.

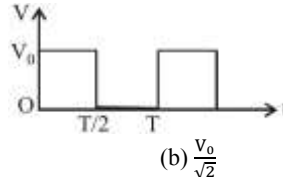
$$\text{Here } \theta = \frac{\pi}{2}$$

$$\Rightarrow \phi = 0$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q49. The r.m.s. value of potential difference V shown in the figure is



- (a) V_0 (b) $\frac{V_0}{\sqrt{2}}$

(c) $V_0/2$

(d) $\frac{V_0}{\sqrt{3}}$

Ans: (b)

$$\text{Solution: } V_{\text{rms}} = \sqrt{\frac{\left(\frac{T}{2}\right)V_0^2 + 0}{T}} = \frac{V_0}{\sqrt{2}}$$

Chapter: Alternating Current**[Topic: Alternating Current, Voltage & Power]**

Q50. The mass number of He is 4 and that for sulphur is 32. The radius of sulphur nuclei is larger than that of helium by

(a) $\sqrt{8}$

(b) 4

(c) 2

(d) 8

Ans: (c)

$$\text{Solution: } \frac{R_s}{R_{\text{He}}} = \left(\frac{A_s}{A_{\text{He}}}\right)^{\frac{1}{3}} \left(\frac{32}{4}\right)^{\frac{1}{3}} = 2$$

Chapter: Nuclei**[Topic: Composition and Size of the Nucleus]**

PART 10. PHYSICS QUESTION BANK

Q51. Sand is being dropped on a conveyor belt at the rate of M kg/s. The force necessary to keep the belt moving with a constant velocity of v m/s will be:

(a) Mv newton

(b) $2Mv$ newton

(c) $\frac{Mv}{2}$ newton

(d) zero

Ans: (a)

$$\text{Solution: } F = \frac{d(Mv)}{dt} = M \frac{dv}{dt} + v \frac{dM}{dt}$$

 $\therefore v$ is constant,

$$\therefore F = v \frac{dM}{dt} \text{ But } \frac{dM}{dt} = M \text{ kg/s}$$

$$\therefore F = vM \text{ newton.}$$

Chapter: Dynamics Laws of Motion**[Topic: Ist, IInd & IIIrd Laws of Motion]**

Q52. The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r , whose outer surface radiates as a black body at a temperature T K is given by:

(a) $\frac{\sigma r^2 T^4}{R^2}$

(b) $\frac{\sigma r^2 T^4}{4\pi R^2}$

(c) $\frac{\sigma r^4 T^4}{R^4}$

(d) $\frac{4\pi\sigma r^2 T^4}{R^2}$

(where σ is Stefan's constant)**Ans: (a)**

$$\text{Solution: } E = \frac{s}{s_0} \sigma T^4 = \frac{4\pi r^2}{4\pi R^2} \sigma T^4$$

$$= \sigma \frac{r^2}{R^2} T^4$$

Chapter: Thermal Properties**[Topic: Calorimetry & Heat Transfer]**

Q53. A bullet of mass 2 g is having a charge of $2\mu\text{C}$. Through what potential difference must it be accelerated, starting from rest, to acquire a speed of 10 m/s?

(a) 50 V

(b) 5 kV

(c) 50 kV

(d) 5 V

Ans: (c)

$$\text{Solution: } qV = \frac{1}{2}mv^2$$

$$\Rightarrow 2 \times 10^{-6} \times V = \frac{1}{2} \times \frac{2}{1000} \times 10 \times 10$$

$$\therefore V = 50 \text{ kV}$$

Chapter: Electrostatic Potential and capacitance**[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]**

Q54. The time constant of C–R circuit is

(a) $1/CR$

(b) C/R

(c) CR

(d) R/C

Ans: (c)

Solution: The time constant for resonance circuit, $= CR$

Growth of charge in a circuit containing capacitance and resistance is given by the formula, $q = q_0 \left(1 - e^{-\frac{t}{CR}}\right)$
CR is known as time constant in this formula.

Chapter: Alternating Current**[Topic: Transformers & LC Oscillations]**

Q55. The mass of proton is $1.0073 u$ and that of neutron is $1.0087 u$ (u = atomic mass unit). The binding energy of ${}^4_2\text{He}$ is

(a) 0.061 u

(b) 0.0305 j

(c) 0.0305 erg

(d) 28.4 MeV

Ans: (d)

$$\text{Solution: } \Delta m = (2 \times 1.0074 + 2 \times 1.0087 - 4.0015) = 0.0307$$

$$E = (\Delta m) \times 931 \text{ MeV} = 0.0307 \times 931 = 28.5 \text{ MeV}$$

Chapter: Nuclei**[Topic: Mass-Energy & Nuclear Reactions]**

Q56. A monkey of mass 20 kg is holding a vertical rope. The rope will not break when a mass of 25 kg is suspended from it but will break if the mass exceeds 25 kg. What is the maximum acceleration with which the monkey can climb up along the rope? ($g = 10 \text{ m/s}^2$)

(a) 2.5 m/s^2

(b) 5 m/s^2

(c) 10 m/s^2

(d) 25 m/s^2

Ans: (a)

Solution: T = Tension caused in string by monkey
 $= m(g + a)$

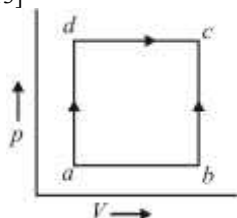
$$T \leq 25 \times 10 = 20(10 + a) \leq 250$$

$$\text{or, } 10 + a \leq 12.5 \Rightarrow a \leq 2.5$$

Chapter: Dynamics Laws of Motion**[Topic: Motion of Connected Bodies, Pulleys]**

Q57. A system is taken from state a to state c by two paths adc and abc as shown in the figure. The internal energy at a is $U_a = 10 \text{ J}$. Along the path adc the amount of heat absorbed $\delta Q_1 = 50 \text{ J}$ and the work done $\delta W_1 = 20 \text{ J}$

whereas along the path abc the heat absorbed $\delta Q_2 = 36 \text{ J}$. The amount of work done along the path abc is [NEET Kar. 2013]



- (a) 6 J
(b) 10 J
(c) 12 J
(d) 36 J

Ans: (a)

Solution: From first law of thermodynamics

$$\begin{aligned} Q_{\text{adc}} &= \Delta U_{\text{adc}} + W_{\text{adc}} \\ 50 \text{ J} &= \Delta U_{\text{adc}} + 20 \text{ J} \\ \Delta U_{\text{adc}} &= 30 \text{ J} \\ \text{Again, } Q_{\text{abc}} &= \Delta U_{\text{abc}} + W_{\text{abc}} \\ W_{\text{abc}} &= Q_{\text{abc}} - \Delta U_{\text{abc}} \\ &= Q_{\text{abc}} - \Delta U_{\text{adc}} \\ &= 36 \text{ J} - 30 \text{ J} \\ &= 6 \text{ J} \end{aligned}$$

Chapter: Thermal Properties
[Topic: First Law of Thermodynamics]

Q58. A $4 \mu\text{F}$ conductor is charged to 400 volts and then its plates are joined through a resistance of $1 \text{ k}\Omega$. The heat produced in the resistance is

- (a) 0.16 J
(b) 1.28 J
(c) 0.64 J
(d) 0.32 J

Ans: (d)

Solution: The energy stored in the capacitor $= \frac{1}{2} CV^2$

$$\begin{aligned} &= \frac{1}{2} \times 4 \times 10^{-6} \times (400)^2 \\ &= 0.325 \end{aligned}$$

This energy will be converted into heat in the resistor

Chapter: Electrostatic Potential and capacitance
[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q59. If ϵ_0 and μ_0 are the electric permittivity and magnetic permeability in vacuum, ϵ and μ are corresponding quantities in medium, then refractive index of the medium is

- (a) $\sqrt{\frac{\epsilon}{\epsilon_0}}$
(b) $\sqrt{\frac{\epsilon_0 \mu}{\epsilon \mu_0}}$
(c) $\sqrt{\frac{\epsilon_0 \mu_0}{\epsilon \mu}}$
(d) $\sqrt{\frac{\epsilon}{\epsilon_0 \mu_0}}$

Ans: (d)

Solution: We know that velocity of electromagnetic wave in vacuum $(v_0) = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$ and velocity of electromagnetic wave in medium is $(v) = \frac{1}{\sqrt{\mu \epsilon}}$.

Therefore refractive index of the medium $(\mu) = \frac{\text{Vel. of EM. wave in vacuum } (v_0)}{\text{Vel. of EM. wave in medium } (v)}$

$$\begin{aligned} &= \frac{\frac{1}{\sqrt{\mu_0 \epsilon_0}}}{\frac{1}{\sqrt{\mu \epsilon}}} = \sqrt{\frac{\mu \epsilon}{\mu_0 \epsilon_0}} \end{aligned}$$

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q60. Two radioactive nuclei P and Q, in a given sample decay into a stable nucleolus R. At time $t = 0$, number of P species are $4 N_0$ and that of Q are N_0 . Half-life of P (for conversion to R) is 1 minute where as that of Q is 2 minutes. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be

- (a) $3 N_0$
(b) $\frac{9 N_0}{2}$
(c) $\frac{5 N_0}{2}$
(d) $2 N_0$

Ans: (b)

Solution: Initially $P \rightarrow 4 N_0$

$$Q \rightarrow N_0$$

Half life $T_P = 1 \text{ min.}$

$T_Q = 2 \text{ min.}$

Let after time t number of nuclei of P and Q are equal, that is

$$\begin{aligned} \frac{4 N_0}{2^{\frac{t}{1}}} &= \frac{N_0}{2^{\frac{t}{2}}} \\ \Rightarrow \frac{4 N}{2^{\frac{t}{1}}} &= \frac{1}{2^{\frac{t}{2}}} \\ \Rightarrow 2^{\frac{t}{1}} &= 4 \cdot 2^{\frac{t}{2}} \\ 2^{\frac{t}{1}} &= 2^{(2 + \frac{t}{2})} \\ \frac{t}{1} &= 2 + \frac{t}{2} \Rightarrow \frac{t}{2} = 2 \\ \Rightarrow t &= 4 \text{ min} \end{aligned}$$

$$N_P = \frac{(4 N_0)}{2^{\frac{4}{1}}} = \frac{N_0}{4}$$

at $t = 4 \text{ min.}$

$$N_Q = \frac{N_0}{4} = \frac{N_0}{4}$$

or population of R

$$\begin{aligned} &\left(4 N_0 - \frac{N_0}{4} \right) + \left(N_0 - \frac{N_0}{4} \right) \\ &= \frac{9 N_0}{2} \end{aligned}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q61. A body of mass 0.4 kg is whirled in a vertical circle making 2 rev/sec. If the radius of the circle is 1.2 m, then tension in the string when the body is at the top of the circle, is

- (a) 41.56 N
(b) 89.86 N
(c) 109.86 N
(d) 115.86 N

Ans: (a)

Solution: Given : Mass (m) = 0.4 kg
Its frequency (n) = 2 rev/sec

Radius (r) = 1.2 m. We know that linear velocity of the body (v) = $\omega r = (2\pi n)r$
 $= 2 \times 3.14 \times 1.2 \times 2 = 15.08 \text{ m/s}$.

Therefore, tension in the string when the body is at the top of the circle (T)

$$= \frac{mv^2}{r} - mg = \frac{0.4 \times (15.08)^2}{2} - (0.4 \times 9.8)$$

$$= 45.78 - 3.92 = 41.56 \text{ N}$$

Chapter: Dynamics Laws of Motion
[Topic: Circular Motion, Banking of Road]

Q62. A sample of gas expands from volume V_1 to V_2 . The amount of work done by the gas is greatest, when the expansion is

- (a) adiabatic
- (b) isobaric
- (c) isothermal
- (d) equal in all cases

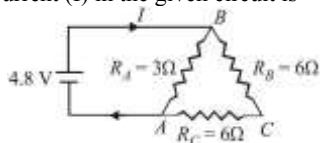
Ans: (b)

Solution: In thermodynamics for same change in volume, the work done is maximum in isobaric process because in $P - V$ graph, area enclosed by curve and volume axis is maximum in isobaric process.

So, the choice (b) is correct.

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q63. The current (I) in the given circuit is



- (a) 1.6 A
- (c) 0.32 A
- (b) 2.0 A
- (d) 3.2 A

Ans: (b)

Solution: In circuit, R_B and R_C are in series, so, $R_s = 6 + 6 = 12 \Omega$. This 12Ω resistance is in parallel with $R_A = 3 \Omega$. So, equivalent resistance of circuit

$$R = \frac{3 \times 12}{3 + 12} = \frac{36}{15} = \frac{12}{5} \Omega$$

$$\therefore \text{Current in circuit, } I = \frac{V}{R}$$

$$= \frac{4.8}{\left(\frac{12}{5}\right)} = \frac{4.8 \times 5}{12} = 2 \text{ A}$$

Chapter: Current Electricity
[Topic: Combination of Resistances]

Q64. A ray of light travelling in a transparent medium of refractive index μ , falls on a surface separating the medium from air at an angle of incidence of 45° . For which of the following value of μ the ray can undergo total internal reflection?

[2010]

- (a) $\mu = 1.33$
- (b) $\mu = 1.40$
- (c) $\mu = 1.50$
- (d) $\mu = 1.25$

Ans: (c)

Solution: For total internal reflection,

$$\mu \geq \frac{1}{\sin C} \geq \sqrt{2} \quad 1.414$$

$$\Rightarrow \mu = 1.50$$

Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q65. The mass of α -particle is

- (a) less than the sum of masses of two protons and two neutrons
- (b) equal to mass of four protons
- (c) equal to mass of four neutrons
- (d) equal to sum of masses of two protons and two neutron

Ans: (a)

Solution: α -particle = ${}_2\text{He}^4$ It contains 2 p and 2 n. As some mass is converted into B.E., therefore, mass of α particle is slightly less than the sum of the masses of 2 p and 2 n.

Chapter: Nuclei
[Topic: Radioactivity]

Q66. When a long spring is stretched by 2 cm, its potential energy is U. If the spring is stretched by 10 cm, the potential energy stored in it will be

- (a) 25 U
- (b) U/5
- (c) 5 U
- (d) 10 U

Ans: (a)

Solution: If k be the spring constant, then

$$U = \frac{1}{2} \times k \times (2)^2 = 2k$$

$$U_{\text{final}} = \frac{1}{2} \times k \times (10)^2 = 50k$$

$$\Rightarrow \frac{U}{U_{\text{final}}} = \frac{2k}{50k} = \frac{1}{25}$$

$$\Rightarrow U_{\text{final}} = 25U$$

Chapter: Work, Energy and Power
[Topic: Energy]

Q67. When volume of system is increased twice and temperature is decreased half of its initial temperature, then pressure becomes

- (a) 2 times
- (b) 4 times
- (c) $\frac{1}{2}$ times
- (d) $\frac{1}{4}$ times

Ans: (d)

Solution: Chapter: Kinetic Theory
[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q68. Kirchhoff's first and second laws for electrical circuits are consequences of

- (a) conservation of electric charge and energy respectively
- (b) conservation of electric charge
- (c) conservation of energy and electric charge respectively
- (d) conservation of energy

Ans: (a)

Solution: Kirchhoff's first law deals with conservation of electrical charge & the second law deals with conservation of electrical energy.

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q69. A convex lens and a concave lens, each having same focal length of 25 cm, are put in contact to form a combination of lenses. The power in diopters of the combination is

- (a) 50 (b) infinite
 (c) zero (d) 25

Ans: (c)

Solution: From the formula,

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{25} - \frac{1}{25} = 0$$

$$\text{Power of combination} = \frac{1}{f} = 0$$

Chapter - Ray Optics and Optical
[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q70. A *p-n* photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. It can detect a signal of wavelength

- (a) 4000 nm (b) 6000 nm
 (c) 4000 Å (d) 6000 Å

Ans: (c)

Solution: $\lambda_{\max} = \frac{hc}{E}$

$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2.5 \times 1.6 \times 10^{-19}} \approx 5000 \text{ Å}$$

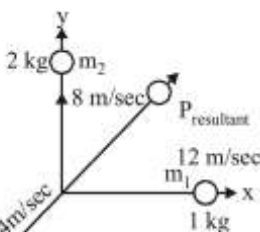
The wavelength detected by photodiode should be less than $\lambda_{\max}$. Hence it can detect a signal of wavelength 4000 Å.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q71. An explosion breaks a rock into three parts in a horizontal plane. Two of them go off at right angles to each other. The first part of mass 1 kg moves with a speed of 12 ms⁻¹ and the second part of mass 2 kg moves with speed 8 ms⁻¹. If the third part flies off with speed 4 ms⁻¹ then its mass is

- (a) 5 kg (b) 7 kg
 (c) 17 kg (d) 3 kg

Ans: (a)



Solution:

$$P_{\text{resultant}} = \sqrt{12^2 + 16^2}$$

$$= \sqrt{144 + 256} = 20$$

$$m_3 v_3 = 20 \text{ (momentum of third part)}$$

$$\text{or, } m_3 = \frac{20}{4} = 5 \text{ kg}$$

Chapter: Work, Energy and Power
[Topic: Collisions]

Q72. The number of translational degrees of freedom for a diatomic gas is

- (a) 2 (b) 3
 (c) 5 (d) 6

Ans: (b)

Solution: Number of translational degrees of freedom are same for all types of gases.

Chapter: Kinetic Theory
[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q73. Fuse wire is a wire of

- (a) low resistance and high melting point
 (b) high resistance and high melting point
 (c) high resistance and low melting point
 (d) low resistance and low melting point

Ans: (c)

Solution: Fuse wire : It is used in a circuit to control the maximum current flowing in circuit. It is a thin wire having **high resistance** and is made up of a material with **low melting point**.

Chapter: Current Electricity
[Topic: Heating Effects of Current]

Q74. Angle of deviation (δ) by a prism (refractive index = μ and supposing the angle of prism A to be small) can be given by

- (a) $\delta = (\mu - 1)A$
 (b) $\delta = (\mu + 1)A$
 (c) $\delta = \frac{\sin \frac{A+\delta}{2}}{\sin \frac{A}{2}}$
 (d) $\delta = \frac{\mu-1}{\mu+1}A$

Ans: (a)

Solution: When the angle of prism is small, $\delta = (\mu - 1)A$

Chapter - Ray Optics and Optical
[Topic: Optical Instruments]

Q75. To obtain a *p*-type germanium semiconductor, it must be doped with

- (a) arsenic
 (b) antimony
 (c) indium
 (d) phosphorus

Ans: (c)

Solution: *p*-type germanium semiconductor is formed when it is doped with a trivalent impurity atom.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Solids, Semiconductors and P-N Junction Diode]

Q76. A solid sphere of radius *R* is placed on a smooth horizontal surface. A horizontal force *F* is applied at height *h* from the lowest point. For the maximum acceleration of the centre of mass,

- (a) $h = R$
 (b) $h = 2R$
 (c) $h = 0$
 (d) The acceleration will be same whatever h may be

Ans: (d)

Solution: As friction is absent at the point of contact,

$$\text{Acceleration} = \frac{\text{Force}}{\text{Mass}}$$

It is independent of h

Chapter: System of Particles and Rotational Motion
[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q77. The composition of two simple harmonic motions of equal periods at right angle to each other and with a phase difference of π results in the displacement of the particle along

- (a) circle
 (b) figures of eight
 (c) straight line
 (d) ellipse

Ans: (c)

Solution: $x = a \sin \omega t$

and $y = b \sin (\omega t + \pi) = -b \sin \omega t$

$$\text{or, } \frac{x}{a} = \frac{4y}{b} \text{ or } y = -\frac{b}{a}x$$

It is an equation of a straight line.

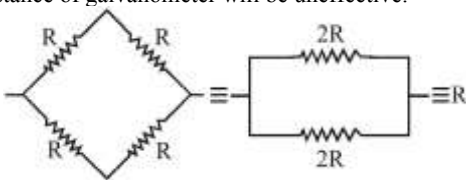
Chapter: Oscillation
[Topic: Energy in Simple Harmonic Motion]

Q78. In a Wheatstone's bridge all the four arms have equal resistance R . If the resistance of the galvanometer arm is also R , the equivalent resistance of the combination as seen by the battery is

- (a) $2R$
 (b) $\frac{R}{4}$
 (c) $\frac{R}{2}$
 (d) R

Ans: (d)

Solution: Since, Wheatstone's bridge is balanced, then resistance of galvanometer will be ineffective.



Chapter: Current Electricity
[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q79. In Young's experiment, two coherent sources are placed 0.90 mm apart and fringe are observed one metre away. If it produces second dark fringe at a distance of 1 mm from central fringe, the wavelength of monochromatic light used would be

- (a) $60 \times 10^{-4} \text{ cm}$
 (b) $10 \times 10^{-4} \text{ cm}$
 (c) $10 \times 10^{-5} \text{ cm}$
 (d) $6 \times 10^{-5} \text{ cm}$

Ans: (d)

Solution: For dark fringe

$$x = (2n - 1) \frac{\lambda D}{2d}$$

$$\lambda = \frac{2xd}{(2n - 1)D} = \frac{2 \times 10^{-3} \times 0.9 \times 10^{-3}}{(2 \times 2 - 1) \times 1}$$

$$\lambda = 0.6 \times 10^{-6} \text{ m} = 6 \times 10^{-5} \text{ cm}$$

Chapter - Wave Optics

[Topic: Young's Double Slit Experiment]

Q80. The voltage gain of an amplifier with 9% negative feedback is 10. The voltage gain without feedback will be

- (a) 90
 (b) 10
 (c) 1.25
 (d) 100

Ans: (d)

Solution: Negative feedback is applied to reduce the output voltage of an amplifier. If there is no negative feedback, the value of output voltage could be very high. In the options given, the maximum value of voltage gain is 100. Hence it is the correct option.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Junction Transistor]

Q81. If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are :

- (a) $[F V T^{-1}]$
 (b) $[F V T^{-2}]$
 (c) $[F V^{-1} T^{-1}]$
 (d) $[F V^{-1} T]$

Ans: (d)

Solution: Force = mass $\times$ acceleration

$$\Rightarrow [\text{Mass}]$$

$$= \left[\frac{\text{force}}{\text{acceleration}} \right]$$

$$= \left[\frac{\text{force} \times \text{velocity}}{\text{time}} \right] = [F V^{-1} T]$$

Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q82. If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then:

- (a) $\vec{r} \cdot \vec{\tau} > 0$ and $\vec{F} \cdot \vec{\tau} < 0$
 (b) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} = 0$
 (c) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} \neq 0$
 (d) $\vec{r} \cdot \vec{\tau} \neq 0$ and $\vec{F} \cdot \vec{\tau} = 0$

Ans: (b)

Solution: $\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow \vec{r} \cdot \vec{\tau} = 0$ $\vec{F} \cdot \vec{\tau} = 0$

Since, $\vec{\tau}$ is perpendicular to the plane of $\vec{r}$ and $\vec{F}$, hence the dot product of $\vec{\tau}$ with $\vec{r}$ and $\vec{F}$ is zero.

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q83. The amplitude of a pendulum executing simple harmonic motion falls to $1/3$ the original value after 100 oscillations. The amplitude falls to S times the original value after 200 oscillations, where S is

- (a) $1/9$
 (b) $1/2$
 (c) $2/3$
 (d) $1/6$

Ans: (a)

Solution: In harmonic oscillator, amplitude falls exponentially.

After 100 oscillations amplitude falls to $\frac{1}{3}$ times.

$\therefore$ After next 100 oscillations i.e., after 200 oscillations amplitude falls to $\left(\frac{1}{3}\right)^2 = \frac{1}{9}$ times.

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q84. A 10 eV electron is circulating in a plane at right angles to a uniform field at magnetic induction 10^{-4} Wb/m² (= 1.0 gauss). The orbital radius of the electron is

- (a) 12 cm (b) 16 cm
(c) 11 cm (d) 18 cm

Ans: (c)

Solution: K.E. of electron = 10 eV

$$\Rightarrow \frac{1}{2}mv^2 = 10\text{eV}$$

$$\Rightarrow \frac{1}{2}(9.1 \times 10^{-31})v^2 = 10 \times 1.6 \times 10^{-19}$$

$$\Rightarrow v^2 = \frac{2 \times 10 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$$

$$\Rightarrow v^2 = 3.52 \times 10^{12} \Rightarrow v = 1.88 \times 10^6 \text{ m/s}$$

Also, we know that for circular motion

$$\frac{mv^2}{r} = Bev \Rightarrow r = \frac{mv}{Be} = 11\text{cm}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q85. In the phenomenon of electric discharge through gases at low pressure, the coloured glow in the tube appears as a result of:

- (a) excitation of electrons in the atoms
(b) collision between the atoms of the gas
(c) collisions between the charged particles emitted from the cathode and the atoms of the gas
(d) collision between different electrons of the atoms of the gas

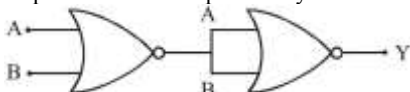
Ans: (a)

Solution: The coloured glow in the tube appears as a result of excitations of electrons in the atoms.

Chapter - Dual Nature of Radiation and Matter

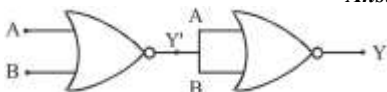
[Topic: Matter Waves, Cathode & Positive Rays]

Q86. In the following circuit, the output Y for all possible inputs A and B is expressed by the truth table



- (a) ABY011011101110 (b) ABY001010100110
(c) ABY000011101111 (d) ABY000010100111

Ans: (c)



Solution:

$$Y' = A + B$$

$$Y = \overline{Y'} \cdot B = \overline{A + B} \cdot B = A + B$$

Therefore truth table :

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Digital Electronics and Logic Gates]

Q87. Dimensional formula of self inductance is

- (a) $[MLT^{-2}A^{-2}]$
(b) $[ML^2T^{-1}A^{-2}]$
(c) $[ML^2T^{-2}A^{-2}]$
(d) $[ML^2T^{-2}A^{-1}]$

Ans: (c)

$$\text{Solution: } L = \epsilon \left(\frac{d\phi}{dI} \right) = \frac{W}{q} \left(\frac{T}{I} \right)$$

$$\text{or, } [L] = \frac{[ML^2T^{-2}][T]}{[AT][A]} = ML^2T^{-2}A^{-2}$$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q88. Four identical thin rods each of mass M and length l, form a square frame. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is:

- (a) $\frac{2}{3}Ml^2$
(b) $\frac{13}{3}Ml^2$
(c) $\frac{1}{3}Ml^2$
(d) $\frac{4}{3}Ml^2$

Ans: (d)

Solution: Moment of inertia of a thin rod of length l about an axis passing through centre and perpendicular to the rod = $\frac{1}{12}Ml^2$

Thus moment of inertia of the frame.

$$\frac{m_1^2}{12} + \frac{m_1^2}{4} = \frac{4m_1^2}{12} = \frac{m_1^2}{3}$$

$$\text{Total M.I.} = 4 \times \frac{m_1^2}{3}$$

Chapter: System of Particles and Rotational Motion

[Topic: Moment of Inertia, Rotational K.E. and Power]

Q89. The time of reverberation of a room A is one second. What will be the time (in seconds) of reverberation of a room, having all the dimensions double of those of room A ?

- (a) 4 (b) $\frac{1}{2}$
(c) 1 (d) 2

Ans: (d)

Solution: Reverberation time is defined as the time during which the intensity of sound in the auditorium becomes one millionth of the initial intensity.

Sabine has shown that standard reverberation time for an auditorium is given by the formula

$$T_R = K \frac{V}{\alpha S}$$

Here, V is volume of the auditorium, S is the surface area. So, $T_R = \frac{KV}{\alpha S} = 1(\text{given})$

$$T_R = \frac{K.l^3}{6\alpha l^2}$$

(Assuming auditorium to be cubic in shape)

$$= \frac{K}{6\alpha} l$$

$$\text{So, } T_R \propto l$$

If dimension is doubled, reverberation time t will be doubled. So,

New $T_R = 2$ sec.

Chapter: Waves

[Topic: Basic of Waves]

Q90. A straight wire of diameter 0.5 mm carrying a current of 1 A is replaced by another wire of 1 mm diameter carrying same current. The strength of magnetic field far away is

- (a) twice the earlier value
- (b) same as the earlier value
- (c) one-half of the earlier value
- (d) one-quarter of the earlier value

Ans: (b)

Solution: $B = \frac{\mu_0 i}{2\pi r}$ and so it is independent of thickness.

The current is same in both the wires, hence magnetic field induced will be same.

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q91. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be:

- (a) 2.4 V
- (b) -1.2 V
- (c) -2.4 V
- (d) 1.2 V

Ans: (d)

Solution: $K_{\max} = \frac{hc}{\lambda} - W = \frac{hc}{\lambda} - 5.01$

$$= \frac{12375}{\lambda(\text{in Å})} - 5.01$$

$$= \frac{12375}{2000} - 5.01 = 6.1875 - 5.01 = 1.1775$$

$$= 1.2 \text{ V}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q92. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2 , then:

[2009]

- (a) $S_2 = 3S_1$
- (b) $S_2 = 4S_1$
- (c) $S_2 = S_1$
- (d) $S_2 = 2S_1$

Ans: (b)

Solution: $u = 0$, $t_1 = 10\text{s}$, $t_2 = 20\text{s}$

Using the relation, $S = ut + \frac{1}{2}at^2$

Acceleration being the same in two cases,

$$S_1 = \frac{1}{2}a \times t_1^2, S_2 = \frac{1}{2}a \times t_2^2$$

$$\therefore \frac{S_1}{S_2} = \left(\frac{t_1}{t_2}\right)^2 = \left(\frac{10}{20}\right)^2 = \frac{1}{4}$$

$$S_2 = 4S_1$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q93. If a sphere is rolling, the ratio of the translational energy to total kinetic energy is given by

- (a) 7 : 10
- (b) 2 : 5
- (c) 10 : 7
- (d) 5 : 7

Ans: (d)

Solution: $E = E_t + E_r = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$$= \frac{1}{2}mv^2 + \frac{1}{2} \times \left(\frac{2}{5}mr^2\right) \omega^2$$

$$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$$

$$\frac{E_t}{E} = \frac{\frac{1}{2}mv^2}{\frac{7}{10}mv^2} = \frac{5}{7}$$

Chapter: System of Particles and Rotational Motion

[Topic: Kepler's Laws of Planetary Motion]

Q94. When sound waves travel from air to water, which of the following remains constant?

- (a) Velocity
- (b) Wavelength
- (c) Frequency
- (d) All of the above

Ans: (c)

Solution: Chapter: Waves

[Topic: Vibration of String & Organ Pipe]

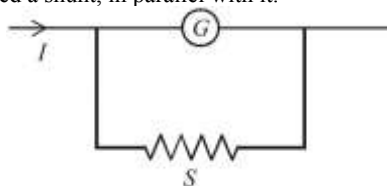
Q95. A milli voltmeter of 25 milli volt range is to be converted into an ammeter of 25 ampere range. The value (in ohm) of necessary shunt will be :

[2012]

- (a) 0.001
- (b) 0.01
- (c) 1
- (d) 0.05

Ans: (a)

Solution: Galvanometer is converted into ammeter, by connected a shunt, in parallel with it.



$$\frac{GS}{G+S} = \frac{V_G}{I} = \frac{25 \times 10^{-3}}{25}$$

$$\frac{GS}{G+S} = 0.001\Omega$$

Here $S \ll G$ so

$$S = 0.001 \Omega$$

Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q96. If the threshold wavelength for a certain metal is 2000 Å, then the work-function of the metal is

- (a) 6.2 J (b) 6.2 eV
(c) 6.2 MeV (d) 6.2 keV

Ans: (b)

Solution: Threshold wavelength (λ) = 2000 Å
= 2000×10^{-10} m. Work function

$$(W) = \frac{hc}{\lambda} = \frac{(6.6 \times 10^{-34}) \times (3 \times 10^8)}{2000 \times 10^{-10}} \\ = 9.9 \times 10^{-19} \text{ J} = \frac{9.9 \times 10^{-19}}{1.6 \times 10^{-19}} = 6.2 \text{ eV}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q97. If a ball is thrown vertically upwards with speed u , the distance covered during the last t seconds of its ascent is

- (a) $(u + gt)t$
(b) ut
(c) $\frac{1}{2}gt^2$
(d) $ut - \frac{1}{2}gt^2$

Ans: (c)

Solution: Let body takes T sec to reach maximum height.

Then $v = u - gT$

$v = 0$, at highest point.

$$T = \frac{u}{g} \dots (1)$$



Velocity attained by body
in $(T - t)$ sec $v = u - g(T - t)$
 $= u - gT + gt = u - g\frac{u}{g} + gt$

or $v = gt \dots (2)$

$\therefore$ Distance travelled in last t sec of its ascent

$$s = (gt)t - \frac{1}{2}gt^2 = \frac{1}{2}gt^2$$

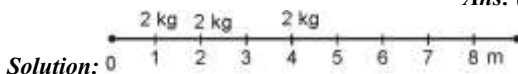
Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q98. Infinite number of bodies, each of mass 2 kg are situated on x-axis at distances 1m, 2m, 4m, 8m, respectively, from the origin. The resulting gravitational potential due to this system at the origin will be

- (a) $-\frac{8}{3}G$
(b) $-\frac{4}{3}G$
(c) $-4G$ (d) $-G$

Ans: (c)



Solution:

$$\text{Gravitational potential } V = \frac{-Gm}{r} \\ V_0 = -\frac{G \times 2}{1} - \frac{G \times 2}{2} - \frac{G \times 2}{4} - \frac{G \times 2}{8} \\ - 2G \left[1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \dots \infty \right] \\ = -2G \times \frac{1}{1 - \frac{1}{2}} = -2G \times \frac{1}{\frac{1}{2}} = -4G$$

Chapter: Gravitation

[Topic: Gravitational Field, Potential and Energy]

Q99. Two sound sources emitting sound each of wavelength λ are fixed at a given distance apart. A listener moves with a velocity u along the line joining the two sources. The number of beats heard by him per second is

- (a) $\frac{u}{2\lambda}$
(b) $\frac{2u}{\lambda}$
(c) $\frac{u}{\lambda}$
(d) $\frac{u}{3\lambda}$

Ans: (b)

Solution: Frequency received by listener from the rear source,

$$n' = \frac{v-u}{v} \times n = \frac{v-u}{v} \times \frac{v}{\lambda} = \frac{v-u}{\lambda}$$

Frequency received by listener from the front source,

$$n'' = \frac{v+u}{v} \times \frac{v}{\lambda} = \frac{v+u}{\lambda}$$

$$\text{No. of beats} = n'' - n' \\ = \frac{v+u}{\lambda} - \frac{v-u}{\lambda} = \frac{v+u-v+u}{\lambda} = \frac{2u}{\lambda}$$

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q100. The magnetic moment of a diamagnetic atom is

- (a) equal to zero (b) much greater than one
(c) 1 (d) between zero and one

Ans: (a)

Solution: The magnetic moment of a diamagnetic atom is equal to zero.

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

PART 11. PHYSICS QUESTION BANK

Q1. Consider 3rd orbit of He⁺ (Helium), using non-relativistic approach, the speed of electron in this orbit will be [given $K = 9 \times 10^9$ constant, $Z = 2$ and h (Planck's Constant) = 6.6×10^{-34} J s]

[2015]

- (a) 1.46×10^6 m/s (b) 0.73×10^6 m/s
(c) 3.0×10^8 m/s (d) 2.92×10^6 m/s

Ans: (a)

Solution: Speed of electron in n th orbit

$$V_n = \frac{2\pi KZe^2}{nh}$$

$$V = (2.19 \times 10^6 \text{ m/s}) \frac{Z}{n}$$

$$V = (2.19 \times 10^6) \frac{2}{3} \quad (Z = 2 \text{ \& n} = 3)$$

$$V = 1.46 \times 10^6 \text{ m/s}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q2. Find the torque of a force $\vec{F} = -3\hat{i} + \hat{j} + 5\hat{k}$ acting at the point $\vec{r} = 7\hat{i} + 3\hat{j} + \hat{k}$.

- (a) $-21\hat{i} + 3\hat{j} + 5\hat{k}$ (b) $-14\hat{i} + 3\hat{j} + 16\hat{k}$
(c) $4\hat{i} + 4\hat{j} + 6\hat{k}$ (d) $14\hat{i} - 38\hat{j} + 16\hat{k}$

Ans: (d)

Solution: $\vec{\tau} = -3\hat{i} + \hat{j} + 5\hat{k}$; $\vec{r} = 7\hat{i} + 3\hat{j} + \hat{k}$

Torque ($\vec{\tau}$) = $\vec{r} \times \vec{F}$

$$= (7\hat{i} + 3\hat{j} + \hat{k}) \times (-3\hat{i} + \hat{j} + 5\hat{k})$$

$$= 7\hat{k} + 35(-\hat{j}) - 9(-\hat{k}) + 15\hat{i} - 3\hat{j} + (-\hat{i})$$

$$= 14\hat{i} - 38\hat{j} + 16\hat{k}$$

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q3. The escape velocity from the surface of the earth is v_e . The escape velocity from the surface of a planet whose mass and radius are three times those of the earth, will be

- (a) v_e (b) $3v_e$
(c) $9v_e$ (d) $1/3v_e$

Ans: (a)

Solution: Escape velocity on surface of earth (v_e) =

$$\sqrt{\frac{2GM_e}{R_e}} \propto \sqrt{\frac{M_e}{R_e}}$$

$$\frac{v_e}{v_p} = \sqrt{\frac{M_e}{R_e}} \times \sqrt{\frac{R_p}{M_p}}$$

$$= \sqrt{\frac{M_e}{R_e}} \times \sqrt{\frac{3R_e}{3M_e}} = \frac{1}{1} = 1$$

or, $v_p = v_e$.

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q4. Two positive ions, each carrying a charge q , are separated by a distance d . If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)

- (a) $\frac{4\pi\epsilon_0 Fd^2}{e^2}$
(b) $\sqrt{\frac{4\pi\epsilon_0 Fe^2}{d^2}}$
(c) $\sqrt{\frac{4\pi\epsilon_0 Fd^2}{e^2}}$
(d) $\frac{4\pi\epsilon_0 Fd^2}{q^2}$

Ans: (c)

Solution: Let n be the number of electrons missing.

$$F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q^2}{d^2}$$

$$= q = \sqrt{4\pi\epsilon_0 d^2 F} = ne$$

$$\therefore n = \sqrt{\frac{4\pi\epsilon_0 Fd^2}{e^2}}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q5. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in a time Δt . Then the total quantity of electric charge Q that passes any point in the circuit during the time Δt is represented by

- (a) $Q = R \cdot \frac{\phi}{\Delta t}$
(b) $Q = \frac{1}{R} \cdot \frac{\Delta\phi}{\Delta t}$
(c) $Q = \frac{\Delta\phi}{R}$
(d) $Q = \frac{\Delta\phi}{\Delta t}$

Ans: (c)

Solution: $\frac{\Delta\phi}{\Delta t} = \epsilon = iR \Rightarrow \Delta\phi = (i\Delta t)R = QR$

$$= Q = \frac{\Delta\phi}{R}$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q6. When hydrogen atom is in its first excited level, its radius is

- (a) four times its ground state radius
(b) twice
(c) same
(d) half

Ans: (a)

$$\text{Solution: } R = \frac{R_0 n^2}{Z}$$

$$\text{Radius in ground state} = \frac{R_0}{Z}$$

$$\text{Radius in first excited state} = \frac{R_0 \times 4}{Z} \quad (\because n = 2)$$

Hence, radius of first excited state is four times the radius in ground state.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q7. A particle moves so that its position vector is given by $\vec{r} = \cos \omega t \hat{x} + \sin \omega t \hat{y}$. Where ω is a constant. Which of the following is true?

- (a) Velocity and acceleration both are perpendicular to $\vec{r}$
(b) Velocity and acceleration both are parallel to $\vec{r}$
(c) Velocity is perpendicular to $\vec{r}$ and acceleration is directed towards the origin
(d) Velocity is perpendicular to $\vec{r}$ and acceleration is directed away from the origin

Ans: (c)

Solution: Given: Position vector

$$\vec{r} = \cos \omega t \hat{x} + \sin \omega t \hat{y}$$

$$\therefore \text{Velocity, } \vec{v} = -\omega \sin \omega t \hat{x} + \omega \cos \omega t \hat{y}$$

and acceleration,

$$\vec{a} = -\omega^2 \cos \omega t \hat{x} - \omega^2 \sin \omega t \hat{y} = -\omega^2 \vec{r}$$

$$\vec{r} \cdot \vec{v} = 0 \text{ hence } \vec{r} \perp \vec{v} \text{ and}$$

$\vec{a}$ is directed towards the origin.

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q8. A certain number of spherical drops of a liquid of radius 'r' coalesce to form a single drop of radius 'R' and volume 'V'. If 'T' is the surface tension of the liquid, then :

- (a) energy = $4VT \left(\frac{1}{r} - \frac{1}{R} \right)$ is released
 (b) energy = $3VT \left(\frac{1}{r} + \frac{1}{R} \right)$ is absorbed
 (c) energy = $3VT \left(\frac{1}{r} - \frac{1}{R} \right)$ is released
 (d) energy is neither released nor absorbed

Ans: (c)

Solution: As surface area decreases so energy is released.

$$\text{Energy released} = 4\pi R^2 T [n^{1/3} - 1]$$

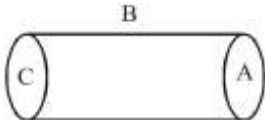
$$\text{where } R = n^{1/3} r$$

$$= 4\pi R^3 T \left[\frac{1}{r} - \frac{1}{R} \right] = 3VT \left[\frac{1}{r} - \frac{1}{R} \right]$$

Chapter: Mechanical Properties of Fluids

[Topic: Surface Tension, Surface Energy & Capillarity]

Q9. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of voltmeter associated with the curved surface B , the flux linked with the plane surface A in units of voltmeter will be



- (a) $\frac{q}{2\epsilon_0}$
 (b) $\frac{\phi}{3}$
 (c) $\frac{q}{\epsilon_0} - \phi$
 (d) $\frac{1}{2} \left(\frac{q}{\epsilon_0} - \phi \right)$

Ans: (d)

Solution: Since $\phi_{\text{total}} = \phi_A + \phi_B + \phi_C = \frac{q}{\epsilon_0}$,

where q is the total charge.

As shown in the figure, flux associated with the curved surface B is $\phi = \phi_B$

Let us assume flux linked with the plane surfaces A and C be

$$\phi_A = \phi_C = \phi'$$

Therefore,

$$\frac{q}{\epsilon_0} = 2\phi' + \phi_B = 2\phi' + \phi$$

$$\Rightarrow \phi' = \frac{1}{2} \left(\frac{q}{\epsilon_0} - \phi \right)$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q10. In an a.c circuit the e.m.f. (e) and the current (i) at any instant are given respectively by

$$e = E_0 \sin \omega t$$

$$i = I_0 \sin (\omega t - \phi)$$

The average power in the circuit over one cycle of a.c. is

- (a) $\frac{E_0 I_0}{2}$
 (b) $\frac{E_0 I_0}{2} \sin \phi$

- (c) $\frac{E_0 I_0}{2} \cos \phi$
 (d) $E_0 I_0$

Ans: (c)

Solution: The average power in the circuit over one cycle of a.c. is given by

$$P_{\text{av}} = e_{\text{rms}} \times i_{\text{rms}} \times \cos \phi$$

$$= \frac{E_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}} \cos \phi = \frac{E_0 I_0}{2} \cos \phi$$

Chapter: Alternating Current

[Topic: Alternating Current, Voltage & Power]

Q11. The nucleus which has radius one-third of the radius of Cs^{189} is

- (a) ${}^7_3\text{He}$
 (b) ${}^7_3\text{Li}$
 (c) ${}^{141}_{56}\text{Ba}$
 (d) ${}^{235}_{92}\text{U}$

Ans: (b)

Solution: Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q12. The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperatures T_1 and T_2 ($T_1 > T_2$). The rate of heat transfer, $\frac{dQ}{dt}$ through the rod in a steady state is given by:

- (a) $\frac{dQ}{dt} = \frac{k(T_1 - T_2)}{LA}$
 (b) $\frac{dQ}{dt} = kLA(T_1 - T_2)$
 (c) $\frac{dQ}{dt} = \frac{kA(T_1 - T_2)}{L}$
 (d) $\frac{dQ}{dt} = \frac{kL(T_1 - T_2)}{A}$

Ans: (c)

Solution: $\frac{dQ}{dt} = \frac{kA(T_1 - T_2)}{L}$

[$(T_1 - T_2)$ is the temperature difference]

Chapter: Thermal Properties

[Topic: Calorimetry & Heat Transfer]

Q13. Each corner of a cube of side l has a negative charge, $-q$. The electrostatic potential energy of a charge q at the centre of the cube is

- (a) $-\frac{4q^2}{\sqrt{2}\pi\epsilon_0 l}$
 (b) $\frac{\sqrt{3}q^2}{4\pi\epsilon_0 l}$
 (c) $\frac{4q^2}{\sqrt{2}\pi\epsilon_0 l}$
 (d) $-\frac{4q^2}{\sqrt{3}\pi\epsilon_0 l}$

Ans: (d)

Solution: Length of body diagonal = $\sqrt{3}l$

$\therefore$ Distance of centre of cube from each corner

$$r = \frac{\sqrt{3}}{2} l$$

P.E. at centre

$$= 8 \times \text{Potential Energy due to } A$$

$$= 8 \times Kq \times (-q)$$

$$= 8 \times \frac{1}{4\pi\sqrt{3}l} \times 2 \times q \times (-q) = \frac{-4q^2}{\sqrt{3}\pi\epsilon_0 l}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q14. A transformer having efficiency of 90% is working on 200V and 3kW power supply. If the current in the secondary coil is 6A, the voltage across the secondary coil and the current in the primary coil respectively are :

- (a) 300 V, 15A (b) 450 V, 15A
(c) 450V, 13.5A (d) 600V, 15A

Ans: (b)

Solution: Efficiency $\eta = \frac{V_s I_s}{V_p I_p} = 0.9 = \frac{V_s(6)}{3 \times 10^3}$

$$\Rightarrow V_s = 450 \text{ V}$$

As $V_s I_s = 3000$ so

$$I_p = \frac{3000}{V_p} = \frac{3000}{200} \text{ A} = 15 \text{ A}$$

Chapter: Alternating Current

[Topic: Transformers & LC Oscillations]

Q15. For a nuclear fusion process, the suitable nuclei are

- (a) any nuclei
(b) heavy nuclei
(c) light nuclei
(d) nuclei lying in the middle of the periodic table

Ans: (c)

Solution: For nuclear fusion process the nuclei with low mass are suitable.

Chapter: Nuclei

[Topic: Mass-Energy & Nuclear Reactions]

Q16. A lift weighing 1000 kg is moving upwards with an acceleration of 1 m/s^2 . The tension in the supporting cable is

- (a) 980 N (b) 10800 N
(c) 9800 N (d) 8800 N

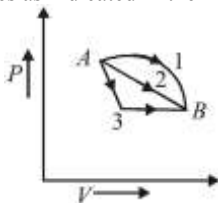
Ans: (b)

Solution: $T - (1000 \times 9.8) = 1000 \times 1$
 $= T = 10800 \text{ N}$

Chapter: Dynamics Laws of Motion

[Topic: Motion of Connected Bodies, Pulleys]

Q17. An ideal gas goes from state A to state B via three different processes as indicated in the P-V diagram :



If Q_1, Q_2, Q_3 indicate the heat absorbed by the gas along the three processes and $\Delta U_1, \Delta U_2, \Delta U_3$ indicate the change in internal energy along the three processes respectively, then

- (a) $Q_1 > Q_2 > Q_3$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(b) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 = \Delta U_2 = \Delta U_3$
(c) $Q_1 = Q_2 = Q_3$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$
(d) $Q_3 > Q_2 > Q_1$ and $\Delta U_1 > \Delta U_2 > \Delta U_3$

Ans: (a)

Solution: Initial and final condition is same for all process

$$\Delta U_1 = \Delta U_2 = \Delta U_3$$

from first law of thermodynamics

$$\Delta Q = \Delta U + \Delta W$$

Work done

$$\Delta W_1 > \Delta W_2 > \Delta W_3 \text{ (Area of P.V. graph)}$$

$$\text{So } \Delta Q_1 > \Delta Q_2 > \Delta Q_3$$

Chapter: Heat & Thermodynamics

[Topic: First Law of Thermodynamics]

Q18. The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be :-

- (a) $\frac{R}{n}$
(b) $n^2 R$
(c) $\frac{R}{n^2}$
(d) nR

Ans: (b)

Solution: We know that, $R = \frac{\rho l}{A}$

$$\text{or } R = \frac{\rho l^2}{\text{Volume}} \times R \propto l^2$$

According to question $l_2 = n l_1$

$$\frac{R_2}{R_1} = \frac{n^2 l_1^2}{l_1^2}$$

$$\text{or, } \frac{R_2}{R_1} = n^2$$

$$\Rightarrow R_2 = n^2 R_1$$

Chapter: Current Electricity

[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q19. The oscillating electric and magnetic field vectors of electromagnetic wave are oriented along

- (a) the same direction and in phase
(b) the same direction but have a phase difference of 90°
(c) mutually perpendicular directions and are in phase
(d) mutually perpendicular directions but has a phase difference of 90°

Ans: (c)

Solution: The direction of oscillations of E and B fields are perpendicular to each other as well as to the direction of propagation. So, electro-magnetic waves are transverse in nature.

The electric and magnetic fields oscillate in same phase.

Chapter - Electromagnetic Waves

[Topic: Electromagnetic Waves, Conduction & Displacement Current]

Q20. The activity of a radioactive sample is measured as N_0 counts per minute at $t = 0$ and N_0/e counts per minute at $t = 5$ minutes. The time (in minutes) at which the activity reduces to half its value is

- (a) $\log_e \frac{2}{5}$ (b) $\frac{5}{\log_e 2}$
(c) $5 \log_{10} 2$ (d) $5 \log_e 2$

Ans: (d)

Solution: $N = N_0 e^{-\lambda t}$

Here, $t = 5$ minutes

$$\frac{N_0}{e} = N_0 \cdot e^{-5\lambda}$$

$$= 5\lambda = 1,$$

$$\lambda = \frac{1}{5},$$

$$\text{Now, } T_{1/2} = \frac{\ln 2}{\lambda} = 5 \text{ } \ell\text{n}2$$

Chapter: Nuclei

[Topic: Radioactivity]

- Q21.** What will be the maximum speed of a car on a road turn of radius 30 m if the coefficient of friction between the tyres and the road is 0.4 (Take $g = 9.8 \text{ m/s}^2$)
- (a) 10.84 m/s (b) 9.84 m/s
(c) 8.84 m/s (d) 6.84 m/s

Ans: (a)

Solution: $r = 30 \text{ m}$ and $\mu = 0.4$.

$$v_{\max} = \sqrt{\mu rg} = \sqrt{0.4 \times 30 \times 9.8} = 10.84 \text{ m/s}$$

Chapter: Dynamics Laws of Motion

[Topic: Circular Motion, Banking of Road]

- Q22.** An ideal gas undergoing adiabatic change has the following pressure-temperature relationship
- (a) $P^\gamma T^{1-\gamma} = \text{constant}$ [1996]
(b) $P^\gamma T^{\gamma-1} = \text{constant}$
(c) $P^\gamma T^{1-\gamma} = \text{constant}$
(d) $P^{1-\gamma} T^\gamma = \text{constant}$

Ans: (d)

Solution: We know that in adiabatic process,

$$PV^\gamma = \text{constant} \dots (1)$$

From ideal gas equation, we know that

$$PV = nRT$$

$$V = \frac{nRT}{P} \dots (2)$$

Putting the value from equation (2) in equation (1),

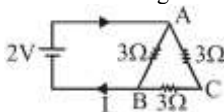
$$P \left(\frac{nRT}{P} \right)^\gamma = \text{constant}$$

$$P^{(1-\gamma)} T^\gamma = \text{constant}$$

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

- Q23.** The current in the following circuit is



- (a) 1A
(b) $\frac{2}{3}$ A
(c) $\frac{2}{9}$ A
(d) $\frac{1}{8}$ A

Ans: (a)

Solution: Resistance of ACB, $R' = 3\Omega + 3\Omega = 6\Omega$.

For net resistance between A and B; $R' = 6\Omega$ and 3Ω are in parallel.

$$R_{AB} = \frac{3 \times 6}{3 + 6} = \frac{18}{9} = 2\Omega$$

$$\text{Current in circuit (I)} = \frac{E}{R_{AB}} = \frac{2}{2} = 1A$$

Chapter: Current Electricity

[Topic: Combination of Resistances]

- Q24.** The frequency of a light wave in a material is $2 \times 10^{14} \text{ Hz}$ and wavelength is 5000 Å. The refractive index of material will be

- (a) 1.50 (b) 3.00
(c) 1.33 (d) 1.40

Ans: (b)

Solution: By using $v = n\lambda$

$$\text{Here, } n = 2 \times 10^{14} \text{ Hz}$$

$$\lambda = 5000 \text{ Å} = 5000 \times 10^{-10} \text{ m}$$

$$v = 2 \times 10^{14} \times 5000 \times 10^{-10} = 10^8 \text{ m/s}$$

Refractive index of the material,

$$\mu = \frac{c}{v} = \frac{3 \times 10^8}{10^8} = 3$$

Chapter - Ray Optics and Optical

[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

- Q25.** The half life of radium is 1600 years. The fraction of a sample of radium that would remain after 6400 years
- (a) 1/4 (b) 1/2
(c) 1/8 (d) 1/16

Ans: (d)

$$\text{Solution: } \frac{N}{N_0} = \left(\frac{1}{2} \right)^{\frac{6400}{1600}} = \left(\frac{1}{2} \right)^4 = \frac{1}{16}$$

Chapter: Nuclei

[Topic: Radioactivity]

- Q26.** If the kinetic energy of a particle is increased by 300%, the momentum of the particle will increase by
- (a) 20% (b) 200%
(c) 100% (d) 50%

Ans: (c)

Solution: New K.E., $E' = 4E$

$$p = \sqrt{2mE} \text{ and } p' = \sqrt{2mE'}$$

$$\frac{p'}{p} = \sqrt{\frac{2m \times 4E}{2mE}} = 2$$

$$\frac{p'}{p} - 1 = 2 - 1 \text{ [on subtracting 1 in both sides.]}$$

$$\frac{p' - p}{p} \times 100 = (2 - 1) \times 100 = 100\%$$

Chapter: Work, Energy and Power

[Topic: Energy]

- Q27.** The equation of state for 5 g of oxygen at a pressure P and temperature T, when occupying a volume V, will be

- (a) $PV = (5/16) RT$
(b) $PV = (5/32) RT$
(c) $PV = 5 RT$
(d) $PV = (5/2) RT$

where R is the gas constant.

Ans: (b)

$$\text{Solution: } n = \frac{5}{32} \text{ PV} = \frac{5}{32} RT \text{ [} \because PV = nRT \text{]}$$

Chapter: Kinetic Theory

[Topic: Kinetic Theory of an Ideal Gas & Gas Laws]

Q28. Two cells, having the same e.m.f., are connected in series through an external resistance R . Cells have internal resistances r_1 and r_2 ($r_1 > r_2$) respectively. When the circuit is closed, the potential difference across the first cell is zero. The value of R is

- (a) $\frac{r_1+r_2}{2}$
 (b) $\frac{r_1-r_2}{2}$
 (c) $r_1 + r_2$
 (d) $r_1 - r_2$

Solution: Current in the circuit

$$= \frac{E + E}{r_1 + r_2 + R} = \frac{2E}{r_1 + r_2 + R}$$

P.D. across first cell = $E - ir_1$

$$= E - \frac{2E \times r_1}{(r_1 + r_2) + R}$$

Now, $E = \frac{2Er_1}{(r_1 + r_2) + R} = 0$

$$\Rightarrow E = \frac{2Er_1}{r_1 + r_2 + R} \Rightarrow 2r_1 = r_1 + r_2 + R$$

$R = r_1 - r_2$

Ans: (d)

Chapter: Current Electricity

[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q29. Sodium has body centred packing. Distance between two nearest atoms is $3.7 \text{ \AA}$. The lattice parameter is

- (a) $4.3 \text{ \AA}$ (b) $3.0 \text{ \AA}$
 (c) $8.6 \text{ \AA}$ (d) $6.8 \text{ \AA}$

Solution: $d = \frac{\sqrt{3}}{2} a$

$$3.7 = \frac{\sqrt{3}}{2} a$$

$$a = \frac{2 \times 3.7}{\sqrt{3}} = 4.3 \text{ \AA}$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q30. A solid cylinder of mass 3 kg is rolling on a horizontal surface with velocity 4 ms^{-1} . It collides with a horizontal spring of force constant 200 Nm^{-1} . The maximum compression produced in the spring will be :

- (a) 0.5 m (b) 0.6 m
 (c) 0.7 m (d) 0.2 m

Ans: (b)

Solution: At maximum compression the solid cylinder will stop so loss in K.E. of cylinder = gain in P.E. of spring

$$\Rightarrow \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}kx^2$$

$$\Rightarrow \frac{1}{2}mv^2 + \frac{1}{2} \frac{mR^2}{2} \left(\frac{v}{R}\right)^2 = \frac{1}{2}kx^2$$

$$\Rightarrow \frac{3}{4}mv^2 = \frac{1}{2}kx^2$$

$$\Rightarrow \frac{3}{4} \times 3 \times (4)^2 = \frac{1}{2} \times 200x^2$$

$$\Rightarrow \frac{36}{100} = x^2 \Rightarrow x = 0.6 \text{ m}$$

Chapter: Work, Energy and Power

[Topic: Collisions]

Q31. If for a gas, $\frac{R}{C_v} = 0.67$, the gas is made up of molecules which are

- (a) diatomic
 (b) mixture of diatomic and polyatomic molecules
 (c) monoatomic
 (d) polyatomic

Ans: (c)

Solution: Since $\frac{R}{C_v} = 0.67 \Rightarrow C_v = \frac{3}{2}R$, hence gas is monoatomic.

Chapter: Kinetic Theory

[Topic: Degree of Freedom, Specific Heat Capacity & Mean Free Path]

Q32. If 25 W , 220 V and 100 W , 220 V bulbs are connected in series across a 440 V line, then [2001]

- (a) only 25 W bulb will fuse
 (b) only 100 W bulb will fuse
 (c) both bulbs will fuse
 (d) none of these

Ans: (a)

Solution: As for an electric appliance $R = \left(\frac{V^2}{W}\right)$, so for same specified voltage V_s

$$\frac{R_{25}}{R_{100}} = \frac{100}{25} = 4$$

$$\text{i.e., } R_{25} = 4R_{100}$$

Now in series potential divides in proportion to resistance.

$$\text{So, } V_1 = \frac{R_1}{(R_1 + R_2)} V$$

$$\text{i.e., } V_{25} = \frac{4}{5} \times 440 = 352 \text{ V}$$

$$\text{and } V_2 = \frac{R_2}{(R_1 + R_2)} V$$

$$\text{i.e., } V_{100} = \frac{1}{5} \times 440 = 88 \text{ V}$$

From this, it is clear that voltage across 100 W bulb ($= 88 \text{ V}$) is lesser than specified (220 V) while across 25 W bulb ($= 352 \text{ V}$) is greater than specified (220 V), so, 25 W bulb will fuse.

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q33. A astronomical telescope has objective and eyepiece of focal lengths 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, the lenses must be separated by a distance :

- (a) 37.3 cm (b) 46.0 cm
 (c) 50.0 cm (d) 54.0 cm

Ans: (d)

Solution: Given: Focal length of objective, $f_o = 40 \text{ cm}$

Focal length of eye - piece $f_e = 4 \text{ cm}$

image distance, $v_o = 200 \text{ cm}$

Using lens formula for objective lens

$$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o} \Rightarrow \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o}$$

$$\Rightarrow \frac{1}{v_o} = \frac{1}{40} + \frac{1}{-200} = \frac{+5-1}{200}$$

$$\Rightarrow v_0 = 50 \text{ cm}$$

$$\text{Tube length } \ell = |v_0| + f_e = 50 + 4 = 54 \text{ cm.}$$

Chapter - Ray Optics and Optical

[Topic: Optical Instruments]

Q34. When arsenic is added as an impurity to silicon, the resulting material is

- (a) *n*-type semiconductor
- (b) *p*-type semiconductor
- (c) *n*-type conductor
- (d) insulator

Ans: (a)

Solution: Arsenic contains 5 electrons in its outermost shell. When Arsenic is mixed with silicon there is one electron extra in silicon crystal. Hence, such type of semiconductor is *n*-type semiconductor.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q35. The centre of mass of a system of particles does not depend upon

- (a) masses of the particles
- (b) forces acting on the particles
- (c) position of the particles
- (d) relative distances between the particles

Ans: (b)

Solution: Centre of mass of system depends upon position and masses of particle. Also, it depends upon relative distance between particles.

Chapter: System of Particles and Rotational Motion

[Topic: Centre of Mass, Centre of Gravity & Principle of Moments]

Q36. A particle moving along the X-axis, executes simple harmonic motion then the force acting on it is given by

- (a) $-A \cos(kx)$
- (b) $A \cos(kx)$
- (c) $A \exp(-kx)$
- (d) Akx

where, *A* and *k* are positive constants.

Ans: (a)

Solution: For simple harmonic motion, $F = -Kx$.
Here, $K = Ak$.

Chapter: Oscillation

[Topic: Energy in Simple Harmonic Motion]

Q37. If specific resistance of a potentiometer wire is $10^{-7} \Omega \text{m}$, the current flow through it is 0.1 A and the cross-sectional area of wire is 10^{-6}m^2 then potential gradient will be

- (a) 10^{-2} volt/m
- (b) 10^{-4} volt/m
- (c) 10^{-6} volt/m
- (d) 10^{-8} volt/m

Ans: (a)

Solution: Potential gradient = Potential fall per unit length. In this case resistance of unit length.

$$R = \frac{\rho l}{A} = \frac{10^{-7} \times 1}{10^{-6}} = 10^{-1} \Omega$$

Potential fall across *R* is

$$V = I.R = 0.1 \times 10^{-1} = 0.01 \text{ volt/m}$$

$$= 10^{-2} \text{ volt/m}$$

Chapter: Current Electricity

[Topic: Wheatstone Bridge & Different Measuring Instruments]

Q38. The Young's double slit experiment is performed with blue and with green light of wavelengths 4360 Å and 5460 Å respectively. If *x* is the distance of 4th maxima from the central one, then

- (a) $x(\text{blue}) = x(\text{green})$
- (b) $x(\text{blue}) > x(\text{green})$
- (c) $x(\text{blue}) < x(\text{green})$
- (d) $\frac{x(\text{blue})}{x(\text{green})} = \frac{5460}{4360}$

Ans: (c)

Solution: Distance of *n*th maxima, $x = n\lambda \frac{D}{d} \propto \lambda$

$$\text{As } \lambda_b < \lambda_g$$

$$x_{\text{blue}} < x_{\text{green}}$$

Chapter - Wave Optics

[Topic: Young's Double Slit Experiment]

Q39. A transistor is operated in common emitter configuration at constant collector voltage $V_c = 1.5 \text{ V}$ such that a change in the base current from 100 μA to 150 μA produces a change in the collector current from 5 mA to 10 mA. The current gain (β) is

- (a) 75
- (b) 100
- (c) 50
- (d) 67

Ans: (b)

Solution: $\Delta I_b = +50 \mu\text{A}$, $\Delta I_c = 5 \times 10^{-3} \text{ A}$

$$\beta = \frac{\Delta I_c}{\Delta I_b} = \frac{5 \times 10^{-3}}{50 \times 10^{-6}} = \frac{5 \times 1000}{50} = 100$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q40. The pair of quantities having same dimensions is

- (a) Young's modulus and energy
- (b) impulse and surface tension
- (c) angular momentum and work
- (d) work and torque

Ans: (d)

Solution: Work = Force × displacement

Torque = Force × force arm

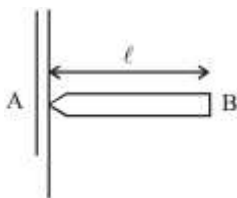
= mass × acceleration × length

$$= [M] \times [LT^{-2}] \times [L] = [ML^2T^{-2}]$$

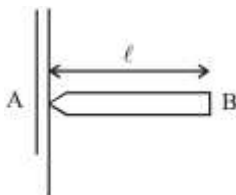
Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

Q41. A uniform rod AB of length *l*, and mass *m* is free to rotate about point A. The rod is released from rest in the horizontal position. Given that the moment of inertia of the rod about A is $\frac{ml^2}{3}$, the initial angular acceleration of the rod will be [2007]



- (a) $\frac{mgl}{2}$
 (b) $\frac{3}{2}g\ell$
 (c) $\frac{3g}{2\ell}$
 (d) $\frac{2g}{3\ell}$



Solution:

Weight of the rod will produce torque,

$$\tau = mg \times \frac{\ell}{2}$$

Also, $\tau = I\alpha$

where, I is the moment of inertia $= \frac{ml^2}{3}$

and α is the angular acceleration

$$\frac{ml^2}{3}\alpha = mg \times \frac{\ell}{2} \Rightarrow \alpha = \frac{3g}{2\ell}$$

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q42. A simple pendulum has a metal bob, which is negatively charged. If it is allowed to oscillate above a positively charged metallic plate, then its time period will

- (a) increase
 (b) decrease
 (c) become zero
 (d) remain the same

Ans: (b)

Solution: We know that the time period (T)

$$= 2\pi \sqrt{\frac{l}{g}} \propto \frac{1}{\sqrt{g}} \quad g' = \text{geffective}$$

Since the negatively charged bob is attracted by the positively charged plate, therefore acceleration due to gravity will increase and time period will decrease.

Chapter: Oscillation

[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q43. A beam of electrons is moving with constant velocity in a region having simultaneous perpendicular electric and magnetic fields of strength 20 Vm^{-1} and 0.5 T respectively at right angles to the direction of motion of the electrons. Then the velocity of electrons must be

- (a) 8 m/s
 (b) 20 m/s
 (c) 40 m/s
 (d) $\frac{1}{40} \text{ m/s}$

Ans: (c)

Solution: The electron moves with constant velocity without deflection. Hence, force due to magnetic field is equal and opposite to force due to electric field.

$$qvB = qE \Rightarrow v = \frac{E}{B} = \frac{20}{0.5} = 40 \text{ m/s}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q44. A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of $3 \times 10^6 \text{ ms}^{-1}$. The velocity of the particle is:

- (a) $2.7 \times 10^{-18} \text{ ms}^{-1}$
 (b) $9 \times 10^{-2} \text{ ms}^{-1}$
 (c) $3 \times 10^{-31} \text{ ms}^{-1}$
 (d) $2.7 \times 10^{-21} \text{ ms}^{-1}$

(mass of electron $= 9.1 \times 10^{-31} \text{ kg}$)

Ans: (d)

Solution: Wavelength of particle (λ_1) $= \frac{h}{mv} = \frac{h}{(1 \times 10^{-3}) \times v}$

where v is the velocity of the particle.

Wave length of electron

$$(\lambda_2) = \frac{h}{(9.1 \times 10^{-31}) \times (3 \times 10^6)}$$

But $\lambda_1 = \lambda_2$

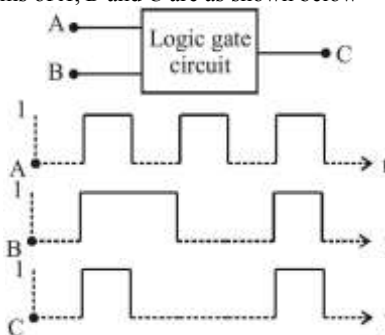
$$\frac{h}{(1 \times 10^{-3}) \times v} = \frac{h}{(9.1 \times 10^{-31}) \times (3 \times 10^6)}$$

$$\Rightarrow v = \frac{9.1 \times 10^{-31} \times 3 \times 10^6}{10^{-3}} = 2.73 \times 10^{-21} \text{ ms}^{-1}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Matter Waves, Cathode & Positive Rays]

Q45. The following figure shows a logic gate circuit with two inputs A and B and the output C . The voltage waveforms of A , B and C are as shown below



The logic circuit gate is

- (a) NAND gate
 (b) NOR gate
 (c) OR gate
 (d) AND gate

Ans: (d)

Solution: On the basis of given graph, following table is possible.

A	B	C
0	0	0
1	1	1
0	1	0
1	0	0

It is the truth table of AND gate.

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q46. Of the following quantities, which one has dimension different from the remaining three?

- (a) Energy per unit volume
- (b) Force per unit area
- (c) Product of voltage and charge per unit volume
- (d) Angular momentum.

Ans: (d)

Solution: For angular momentum, the dimensional formula is ML^2T^{-1} . For other three, it is $ML^{-1}T^{-2}$.

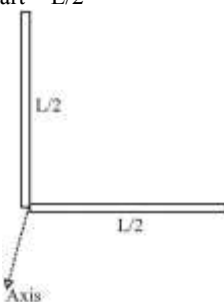
Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q47. A thin rod of length L and mass M is bent at its midpoint into two halves so that the angle between them is 90° . The moment of inertia of the bent rod about an axis passing through the bending point and perpendicular to the plane defined by the two halves of the rod is:

- (a) $\frac{ML^2}{24}$
- (b) $\frac{ML^2}{12}$
- (c) $\frac{ML^2}{6}$
- (d) $\frac{\sqrt{2}ML^2}{24}$

Ans: (b)

Solution: Mass of each part = $M/2$
Length of each part = $L/2$



Total M.I. = Sum of M.I.s of both parts

$$= \left(\frac{M}{2}\right) \left(\frac{L}{2}\right)^2 \times \frac{1}{3} + \left(\frac{M}{2}\right) \left(\frac{L}{2}\right)^2 \times \frac{1}{3}$$

$$= 2 \times \frac{M}{2} \times \frac{L^2}{4} \times \frac{1}{3} = \frac{ML^2}{12}$$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q48. A point source emits sound equally in all directions in a non-absorbing medium. Two points P and Q are at distances of 2 m and 3 m respectively from the source. The ratio of the intensities of the waves at P and Q is

- (a) 3 : 2
- (b) 2 : 3
- (c) 9 : 4
- (d) 4 : 9

Ans: (c)

Solution: Intensity = Energy/sec/unit area

$$\text{Area} \propto r^2 \Rightarrow I \propto 1/r^2$$

$$\Rightarrow \frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} = \frac{3^2}{2^2} = \frac{9}{4}$$

Chapter: Waves

[Topic: Basic of Waves]

Q49. At what distance from a long straight wire carrying a current of 12 A will the magnetic field be equal to $3 \times 10^{-5} \text{ Wb/m}^2$?

- (a) $8 \times 10^{-2} \text{ m}$
- (b) $12 \times 10^{-2} \text{ m}$
- (c) $18 \times 10^{-2} \text{ m}$
- (d) $24 \times 10^{-2} \text{ m}$

Ans: (a)

Solution: Current (I) = 12 A and magnetic field (B) = $3 \times 10^{-5} \text{ Wb/m}^2$. Consider magnetic field $\vec{B}$ at distance r .

$$\text{Magnetic field } B = \frac{\mu_0 I}{2\pi r}$$

$$\Rightarrow r = \frac{\mu_0 I}{2\pi B} = \frac{(4\pi \times 10^{-7}) \times 12}{2 \times \pi (3 \times 10^{-5})} = 8 \times 10^{-2} \text{ m}$$

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q50. The number of photo electrons emitted for light of a frequency ν (higher than the threshold frequency ν_0) is proportional to:

- (a) Threshold frequency (ν_0)
- (b) Intensity of light
- (c) Frequency of light (ν)
- (d) $\nu - \nu_0$

Ans: (b)

Solution: The number of photoelectrons emitted is proportional to the intensity of incident light. Saturation current $\propto$ intensity.

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

PART 12. PHYSICS QUESTION BANK

Q51. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3} \text{ ms}^{-2}$, in the third second is:

- (a) 6 m
- (b) 4 m
- (c) $\frac{10}{3} \text{ m}$
- (d) $\frac{19}{3} \text{ m}$

Ans: (c)

Solution: Distance travelled in the n th second is given by

$$t_n = u + \frac{a}{2}(2n - 1)$$

$$\text{put } u = 0, a = \frac{4}{3} \text{ ms}^{-2}, n = 3$$

$$\therefore d = 0 + \frac{4}{3 \times 2} (2 \times 3 - 1) = \frac{4}{6} \times 5 = \frac{10}{3} \text{ m}$$

Chapter: Kinematics Motion in a Straight Line
[Topic: Non-uniform motion]

Q52. Kepler's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet i.e. $T^2 = Kr^3$ here K is constant. If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is $F = \frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as
(a) $GMK = 4\pi^2$ (b) $K = G$
(c) $K = \frac{1}{G}$ (d) $GK = 4\pi^2$

Ans: (a)

Solution: As we know, orbital speed, $V_{\text{orb}} = \sqrt{\frac{GM}{r}}$

$$\text{Time period } T = \frac{2\pi r}{V_{\text{orb}}} = \frac{2\pi r}{\sqrt{GM}} \sqrt{r}$$

Squarring both sides,

$$T^2 = \left(\frac{2\pi r \sqrt{r}}{\sqrt{GM}} \right)^2 = \frac{4\pi^2}{GM} \cdot r^3$$

$$\Rightarrow \frac{T^2}{r^3} = \frac{4\pi^2}{GM} = K$$

$$\Rightarrow GMK = 4\pi^2$$

Chapter: Gravitation

[Topic: Kepler's Laws of Planetary Motion]

Q53. Equation of a progressive wave is given by

$$y = 4 \sin \left[\pi \left(\frac{t}{5} - \frac{x}{9} \right) \right] + \frac{\pi}{6}$$

Then which of the following is correct?

- (a) $v = 5 \text{ cm}$
(b) $\lambda = 18 \text{ cm}$
(c) $a = 0.04 \text{ cm}$
(d) $f = 50 \text{ Hz}$

Ans: (b)

Solution: The standard equation of a progressive wave is

$$y = a \sin \left[2\pi \left(\frac{t}{T} - \frac{x}{\lambda} \right) + \phi \right]$$

The given equation can be written as

$$y = 4 \sin \left[2\pi \left(\frac{t}{10} - \frac{x}{18} \right) + \frac{\pi}{16} \right]$$

$$\therefore a = 4 \text{ cm}, T = 10 \text{ s}, \lambda = 18 \text{ cm and } \phi = \pi/16$$

Hence, (b) is correct.

Chapter: Waves

[Topic: Vibration of String & Organ Pipe]

Q54. A galvanometer of resistance, G is shunted by a resistance S ohm. To keep the main current in the circuit unchanged, the resistance to be put in series with the galvanometer is

- (a) $\frac{S^2}{(S+G)}$
(b) $\frac{SG}{(S+G)}$
(c) $\frac{G^2}{S+G}$
(d) $\frac{G}{(S+G)}$

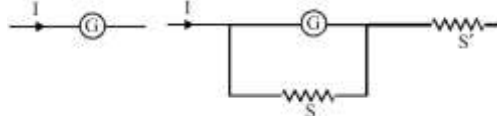
Ans: (c)

Solution: To keep the main current in the circuit unchanged, the resistance of the galvanometer should be equal to the net resistance.

$$G = \left(\frac{GS}{G+S} \right) + S'$$

$$= G - \frac{GS}{G+S} = S'$$

$$S' = \frac{G^2}{G+S}$$



Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q55. Kinetic energy of an electron, which is accelerated in a potential difference of 100 V is

- (a) $1.6 \times 10^{-17} \text{ J}$ (b) $1.6 \times 10^{-19} \text{ J}$
(c) $1.6 \times 10^{-21} \text{ J}$ (d) $1.6 \times 10^{-25} \text{ J}$

Ans: (a)

Solution: Potential difference (V) = 100 V. The kinetic energy of an electron = $1 \text{ eV} = 1 \times (1.6 \times 10^{-19}) = 1.6 \times 10^{-19} \text{ J}$. Therefore kinetic energy in 100 volts = $(1.6 \times 10^{-19}) \times 100 = 1.6 \times 10^{-17} \text{ J}$.

$$[\text{Alt : K.E.} = qV]$$

$$= 1.6 \times 10^{-19} \times 100 \text{ J} = 1.6 \times 10^{-17} \text{ J}$$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q56. A man throws balls with the same speed vertically upwards one after the other at an interval of 2 seconds. What should be the speed of the throw so that more than two balls are in the sky at any time? [Given $g = 9.8 \text{ m/s}^2$]

- (a) Only with speed 19.6 m/s
(b) More than 19.6 m/s
(c) At least 9.8 m/s
(d) Any speed less than 19.6 m/s

Ans: (b)

Solution: Let the required speed of throw be $u \text{ ms}^{-1}$. Then time taken to reach maximum height,

$$t = \frac{u}{g}$$

For two balls to remain in air at any time, t must be greater than 2.

$$\therefore \frac{u}{g} > 2 = u > 196 \text{ m/s}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

Q57. Two waves of lengths 50 cm and 51 cm produce 12 beats per sec. The velocity of sound is

- (a) 306 m/s (b) 331 m/s
(c) 340 m/s (d) 360 m/s

Ans: (a)

Solution: Given : Wavelength of first wave (λ_1) = 50 cm = 0.5 m

Wavelength of second wave (λ_2)

$$= 51 \text{ cm} = 0.51 \text{ m}$$

frequency of beats per sec (n) = 12.

We know that the frequency of beats,

$$n = 12 = \frac{v}{\lambda_1} - \frac{v}{\lambda_2}$$

$$[11] \Rightarrow 12 = v \left[\frac{1}{0.5} - \frac{1}{0.51} \right]$$

$$= [2 - 1.9608] = v \times 0.0392$$

$$\text{or, } v = \frac{12}{0.0392} = 306 \text{ m/s}$$

[where, v = velocity of sound]

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q58. If a diamagnetic substance is brought near the north or the south pole of a bar magnet, it is:

- repelled by the north pole and attracted by the south pole
- attracted by the north pole and repelled by the south pole
- attracted by both the poles
- repelled by both the poles

Ans: (d)

Solution: Diamagnetic substances do not have any unpaired electron. And they are magnetised in direction opposite to that of magnetic field. Hence, when they are brought to north or south pole of a bar magnet, they are repelled by poles.

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q59. Two particles of masses m_1 , m_2 move with initial velocities u_1 and u_2 . On collision, one of the particles get excited to higher level, after absorbing energy ε . If final velocities of particles be v_1 and v_2 then we must have

- $\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 - \varepsilon$
- $\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 - \varepsilon = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$
- $\frac{1}{2} m_1^2 u_1^2 + \frac{1}{2} m_2^2 u_2^2 + \varepsilon = \frac{1}{2} m_1^2 v_1^2 + \frac{1}{2} m_2^2 v_2^2$
- $m_1^2 u_1 + m_2^2 u_2 - \varepsilon = m_1^2 v_1 + m_2^2 v_2$

Ans: (b)

Solution: By law of conservation of energy,

$$K.E_i = K.E_f - \text{excitation energy } (\varepsilon)$$

$$\text{or } \frac{1}{2} m v_1^2 + \frac{1}{2} m v_2^2 = \frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 - \varepsilon$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q60. Which of the following is not a vector quantity? [1996]

- displacement
- electric field
- work
- acceleration

Ans: (c)

Solution: Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q61. A satellite in force free space sweeps stationary interplanetary dust at a rate $dM/dt = \alpha v$ where M is the mass and v is the velocity of the satellite and α is a constant. What is the deceleration of the satellite?

- $-\alpha v^2$
- $-\frac{\alpha v^2}{2M}$
- $-\frac{\alpha v^2}{M}$
- $-\frac{2\alpha v^2}{M}$

Ans: (c)

$$\text{Solution: } F = \left(\frac{dM}{dt} \right) v = \alpha v^2 \left(\frac{dM}{dt} = \alpha v \right)$$

$$\therefore \text{Retardation} = \frac{-F}{M} = -\frac{\alpha v^2}{M}$$

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q62. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r . The Coulomb force $\vec{F}$ between the two is

- $K \frac{e^2}{r^3} \vec{r}$
- $K \frac{e^2}{r^2} \hat{r}$
- $-K \frac{e^2}{r^3} \hat{r}$
- $-K \frac{e^2}{r^3} \vec{r}$ (where $K = \frac{1}{4\pi\epsilon_0}$)

Ans: (d)

Solution: Charges $(-e)$ on electron and (e) on proton exert a force of attraction given by

$$\text{Force} = \frac{(K)((-e)(e))}{r^2} \hat{r} = \frac{-Ke^2}{r^3} \vec{r} \left(\hat{r} = \frac{\vec{r}}{r} \right)$$

Note : Magnitude of Coulomb force is given by $\frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$

but in vector form $\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^3} \vec{r}$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q63. A magnetic field of 2×10^{-2} T acts at right angles to a coil of area 100 cm^2 , with 50 turns. The average e.m.f. induced in the coil is 0.1 V , when it is removed from the field in t sec. The value of t is

- 10 s
- 0.1 s
- 0.01 s
- 1 s

Ans: (b)

$$\text{Solution: } e = \frac{-(\Phi_2 - \Phi_1)}{t} = \frac{-(-NBA)}{t} = \frac{NBA}{t}$$

$$t = \frac{NBA}{e} = \frac{50 \times 2 \times 10^{-2} \times 10^{-2}}{0.1} = 0.1 \text{ s}$$

Chapter: Electromagnetic

[Topic: Magnetic Flux, Faraday's & Lenz's Law]

Q64. The spectrum obtained from a sodium vapour lamp is an example of

- band spectrum
- continuous spectrum
- emission spectrum
- absorption spectrum

Ans: (c)

Solution: A spectrum is observed, when light coming directly from a source is examined with a spectroscope. Therefore spectrum obtained from a sodium vapour lamp is emission spectrum.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q65. A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1} . The time after which the distance between them becomes shortest, is :

- (a) 5 h (b) $5\sqrt{2} \text{ h}$
(c) $10\sqrt{2} \text{ h}$ (d) 0 h

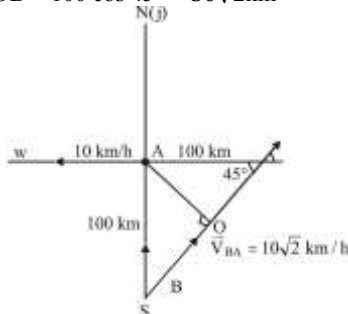
Ans: (a)

Solution: $\vec{V}_A = 10(-\hat{i})$

$\vec{V}_B = 10(\hat{j})$

$\vec{V}_{BA} = 10\hat{j} + 10\hat{i} = 10\sqrt{2} \text{ km/h}$

Distance $OB = 100 \cos 45^\circ = 50\sqrt{2} \text{ km}$



Time taken to reach the shortest distance between

$$A \text{ and } B = \frac{OB}{V_{BA}} = \frac{50\sqrt{2}}{10\sqrt{2}} = 5 \text{ h}$$

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q66. The wettability of a surface by a liquid depends primarily on

- (a) surface tension
(b) density
(c) angle of contact between the surface and the liquid
(d) viscosity

Ans: (c)

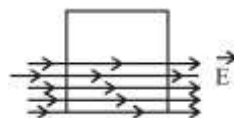
Solution: Wettability of a surface by a liquid primarily depends on angle of contact between the surface and liquid.

If angle of contact is acute liquids wet the solid and vice-versa.

Chapter: Mechanical Properties of Fluids

[Topic: Surface Tension, Surface Energy & Capillarity]

Q67. A square surface of side L metres is in the plane of the paper. A uniform electric field $\vec{E}$ (volt/m), also in the plane of the paper, is limited only to the lower half of the square surface (see figure). The electric flux in SI units associated with the surface is



(a) $EL^2/2$

(c) EL^2

(b) zero

(d) $EL^2/(2\epsilon_0)$

Ans: (b)

Solution: Flux = $\vec{E} \cdot \vec{A}$.

$\vec{E}$ is electric field vector & $\vec{A}$ is area vector.

Here, angle between $\vec{E}$ & $\vec{A}$ is 90° .

So, $\vec{E} \cdot \vec{A} = 0$; Flux = 0

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Flux & Gauss's Law]

Q68. In an A.C. circuit with voltage V and current I the power dissipated is

- (a) dependent on the phase between V and I
(b) $\frac{1}{\sqrt{2}} VI$
(c) $\frac{1}{\sqrt{2}} VI$
(d) VI

Ans: (a)

Solution: Power dissipated = $E_{\text{rms}} \cdot I_{\text{rms}} = (E_{\text{rms}})(I_{\text{rms}}) \cos \theta$
Hence, power dissipated depends upon phase difference.

Chapter: Alternating Current

[Topic: Alternating Current, Voltage & Power]

Q69. The mass density of a nucleus varies with mass number A as

- (a) A^2 (b) A
(c) constant (d) $1/A$

Ans: (c)

Solution: The nuclear radius r varies with mass number A according to the relation

$$r \propto A^{1/3} \text{ or } A \propto r^3$$

$$\text{Now, density} = \frac{\text{mass}}{\text{volume}}$$

Further, mass $\propto A$ and volume $\propto r^3$

$$\frac{\text{mass}}{\text{volume}} = \text{constant}$$

Chapter: Nuclei

[Topic: Composition and Size of the Nucleus]

Q70. If a cricketer catches a ball of mass 150 gm moving with a velocity of 20 m/s , then he experiences a force of (Time taken to complete the catch is 0.1 sec.)

- (a) 300 N (b) 30 N
(c) 3 N (d) 0.3 N

Ans: (b)

Solution: Net force experienced = $\frac{\text{Total Impulse}}{\text{Time taken}}$

$$= \frac{m\Delta v}{t} = 0.15 \times \frac{20}{0.1} = 30 \text{ N}$$

Chapter: Dynamics Laws of Motion

[Topic: 1st, 2nd & 3rd Laws of Motion]

Q71. A black body at 227°C radiates heat at the rate of $7 \text{ cal/cm}^2\text{s}$. At a temperature of 727°C , the rate of heat radiated in the same units will be:

[2009]

(a) 50

(b) 112

(c) 80

(d) 60

Ans: (b)**Solution:** According to Stefan's law $E = \sigma T^4$,

$$T_1 = 500 \text{ K}$$

$$T_2 = 1000 \text{ K}$$

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{1000}{500}\right)^4 = 16$$

$$\therefore E_2 = 16 \times 7 = 112 \text{ cal / cm}^2\text{s}$$

Chapter: Thermal Properties**[Topic: Calorimetry & Heat Transfer]****Q72.** A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

(a) qEy^2

(b) qE^2y

(c) qEy

(d) q^2Ey

Ans: (c)**Solution:** K.E. = Force $\times$ distance = $qE.y$ **Chapter: Electrostatic Potential and capacitance****[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]****Q73.** The primary of a transformer when connected to a dc battery of 10 volt draws a current of 1 mA. The number of turns of the primary and secondary windings are 50 and 100 respectively. The voltage in the secondary and the current drawn by the circuit in the secondary are respectively

(a) 20 V and 0.5 mA

(b) 20 V and 2.0 mA

(c) 10 V and 0.5 mA

(d) Zero and therefore no current

Ans: (d)**Solution:** A transformer is essentially an AC device. DC source so no mutual induction between coils

$$\Rightarrow E_2 = 0 \text{ and } I_2 = 0$$

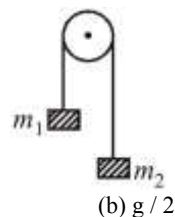
Chapter: Alternating Current**[Topic: Transformers & LC Oscillations]****Q74.** It is possible to understand nuclear fission on the basis of the

(a) liquid drop model of the nucleus

(b) meson theory of the nuclear forces

(c) proton-proton cycle

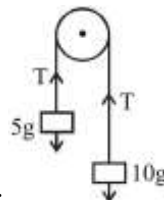
(d) independent particle model of the nucleus

Ans: (a)**Solution:** According to liquid drop model of nucleus, an excited nucleus breaks into lighter nuclei just like an excited drop breaks into tiny drops.**Chapter: Nuclei****[Topic: Mass-Energy & Nuclear Reactions]****Q75.** Two blocks $m_1 = 5 \text{ gm}$ and $m_2 = 10 \text{ gm}$ are hung vertically over a light frictionless pulley as shown here. What is the acceleration of the masses when they are left free?

(a) $g/3$

(c) g

(d) $g/5$

(where g is acceleration due to gravity)**Ans: (a)****Solution:**Let T be the tension in the string.

$$\therefore 10g - T = 10a \dots (i)$$

$$T - 5g = 5a \dots (ii)$$

Adding (i) and (ii),

$$5g = 15a = a = \frac{g}{3} \text{ mps}^2$$

Chapter: Dynamics Laws of Motion**[Topic: Motion of Connected Bodies, Pulleys]****Q76.** The internal energy change in a system that has absorbed 2 kcal of heat and done 500 J of work is:

(a) 6400 J

(b) 5400 J

(c) 7900 J

(d) 8900 J

Ans: (c)**Solution:** According to first law of thermodynamics

$$Q = \Delta U + W$$

$$\Delta U = Q - W$$

$$= 2 \times 4.2 \times 1000 - 500 = 8400 - 500$$

$$= 7900 \text{ J}$$

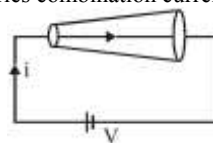
Chapter: Heat & Thermodynamics**[Topic: First Law of Thermodynamics]****Q77.** Across a metallic conductor of non-uniform cross section a constant potential difference is applied. The quantity which remains constant along the conductor is :

(a) current

(b) drift velocity

(c) electric field

(d) current density

Ans: (a)**Solution:** Here, metallic conductor can be considered as the combination of various conductors connected in series. And in series combination current remains same.**Chapter: Current Electricity**

[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q78. The frequency of electromagnetic wave, which is best suited to observe a particle of radius 3×10^{-4} cm is of the order of

- (a) 10^{15} (b) 10^{14}
(c) 10^{13} (d) 10^{12}

Ans: (b)

Solution: Size of particle = $\lambda = \frac{c}{\nu}$

$$3 \times 10^{-6} = \frac{3 \times 10^8}{\nu}$$

$$\nu = 10^{14} \text{ Hz}$$

However, when frequency is higher than this, wavelength is still smaller. Resolution becomes better.

Chapter - Electromagnetic Waves
[Topic: Electromagnetic Spectrum]

Q79. The decay constant of a radio isotope is λ . If A_1 and A_2 are its activities at times t_1 and t_2 respectively, the number of nuclei which have decayed during the time $(t_1 - t_2)$:

- (a) $\lambda(A_1 - A_2)$
(b) $A_1 t_1 - A_2 t_2$
(c) $A_1 - A_2$
(d) $\frac{A_1 - A_2}{\lambda}$

Ans: (d)

Solution: Activity is given by

$$A = \frac{dN}{dt} = -\lambda N$$

Activity at time t_1 is

$$A_1 = -\lambda N_1$$

and activity at time t_2 is $A_2 = -\lambda N_2$

As $t_1 > t_2$, therefore, number of atoms remained after time t_1 is less than that remained after time t_2 . That is, $N_1 < N_2$.

$\therefore$ number of nuclei decayed in $(t_1 - t_2)$

$$= N_2 - N_1 = \frac{(A_1 - A_2)}{\lambda}$$

Chapter: Nuclei

[Topic: Radioactivity]

Q80. A particle of mass M is moving in a horizontal circle of radius R with uniform speed V . When it moves from one point to a diametrically opposite point, its

- (a) kinetic energy changes by $MV^2/4$
(b) momentum does not change
(c) momentum changes by $2MV$
(d) kinetic energy changes by MV^2

Ans: (c)

Solution: On the diametrically opposite points, the velocities have same magnitude but opposite directions. Therefore, change in momentum is $MV - (-MV) = 2MV$

Chapter: Dynamics Laws of Motion

[Topic: Circular Motion, Banking of Road]

Q81. A diatomic gas initially at 18°C is compressed adiabatically to one eighth of its original volume. The temperature after compression will be

- (a) 18°C (b) 668.4°C
(c) 395.4°C (d) 144°C

Ans: (b)

Solution: Initial temperature (T_1) = $18^\circ\text{C} = 291 \text{ K}$

Let Initial volume (V_1) = V

Final volume (V_2) = $\frac{V}{8}$

According to adiabatic process,

$TV^{\gamma-1} = \text{constant}$

According to question, $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$$\Rightarrow T_2 = 293 \left(\frac{V_1}{V_2} \right)^{\gamma-1}$$

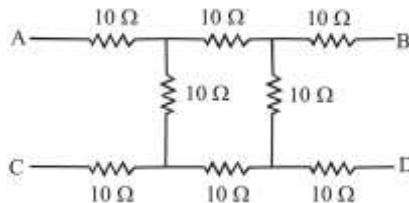
$$= T_2 = 293(8)^{\frac{7}{5}-1} = 293 \times 2.297 = 668.4 \text{ K}$$

[For diatomic gas $\gamma = \frac{C_p}{C_v} = \frac{7}{5}$]

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q82. What will be the equivalent resistance of circuit shown in figure between two points A and D [1996]

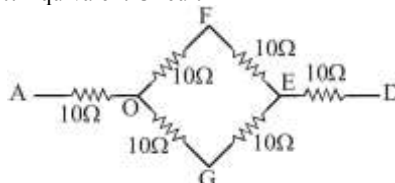


- (a) 10Ω
(c) 30Ω

- (b) 20Ω
(d) 40Ω

Ans: (c)

Solution: Equivalent Circuit



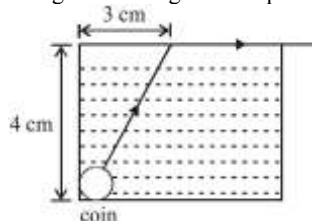
Equivalent Resistance of circuit

$$= 10\Omega + \frac{20 \times 20}{20+20} + 10 = 10 + 10 + 10 = 30\Omega$$

Chapter: Current Electricity

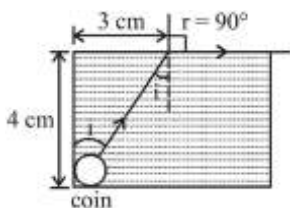
[Topic: Combination of Resistances]

Q83. A small coin is resting on the bottom of a beaker filled with liquid. A ray of light from the coin travels upto the surface of the liquid and moves along its surface. How fast is the light travelling in the liquid?



- (a) $2.4 \times 10^8 \text{ m/s}$
(c) $1.2 \times 10^8 \text{ m/s}$

- (b) $3.0 \times 10^8 \text{ m/s}$
(d) $1.8 \times 10^8 \text{ m/s}$



Ans: (d)

Solution:

Hypotenuse comes out to be 5 cm.

$$\text{Since, } \frac{1}{\mu} = \frac{\sin i}{\sin 90^\circ}$$

$$\mu = \frac{1}{\sin i} = \frac{5}{3}$$

$$\text{Speed, } v = \frac{c}{\mu} = \frac{3 \times 10^8}{\frac{5}{3}} = 1.8 \times 10^8 \text{ m/s}$$

Chapter - Ray Optics and Optical

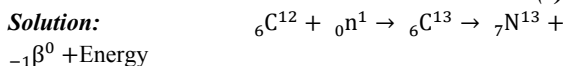
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q84. The nucleus ${}_6\text{C}^{12}$ absorbs an energetic neutron and emits a beta particle (β^-). The resulting nucleus is

- (a) ${}_7\text{N}^{14}$ (b) ${}_7\text{N}^{13}$
(c) ${}_5\text{B}^{13}$ (d) ${}_6\text{C}^{13}$

Ans: (b)

Solution:



Chapter: Nuclei

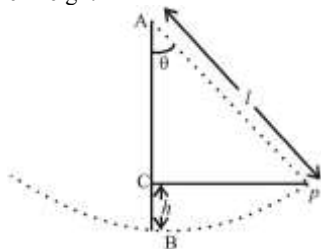
[Topic: Radioactivity]

Q85. In a simple pendulum of length l the bob is pulled aside from its equilibrium position through an angle θ and then released. The bob passes through the equilibrium position with speed

- (a) $\sqrt{2gl(1 + \cos\theta)}$
(b) $\sqrt{2gl\sin\theta}$
(c) $\sqrt{2gl\ell}$
(d) $\sqrt{2gl(1 - \cos\theta)}$

Ans: (d)

Solution: If l is length of pendulum and θ be angular amplitude then height



$$h = AB - AC = l - l \cos \theta = l(1 - \cos \theta)$$

At extreme position, potential energy is maximum and kinetic energy is zero; At mean (equilibrium) position potential energy is zero and kinetic energy is maximum, so from principle of conservation of energy.

$$(KE + PE)_{\text{at P}} = (KE + PE)_{\text{at B}}$$

$$0 + mgh = \frac{1}{2}mv^2 + 0$$

$$\Rightarrow v = \sqrt{2gh} = \sqrt{2gl(1 - \cos\theta)}$$

Chapter: Work, Energy and Power

[Topic: Energy]

Q86. A gas at 27°C temperature and 30 atmospheric pressure is allowed to expand to the atmospheric pressure. If the volume becomes 10 times its initial volume, then the final temperature becomes

- (a) 100°C (b) 173°C
(c) 273°C (d) -173°C

Ans: (d)

Solution: Given : Initial temperature of gas

$$(T_1) = 27^\circ\text{C} = 300 \text{ K}$$

$$\text{Initial pressure } (P_1) = 30 \text{ atm}$$

$$\text{Initial volume } (V_1) = V$$

$$\text{Final pressure } (P_2) = 1 \text{ atm}$$

$$\text{Final volume } (V_2) = 10V.$$

We know from the general gas equation that $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

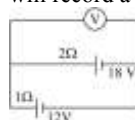
$$\text{or, } \frac{30 \times V}{300} = \frac{1 \times 10V}{T_2}$$

$$\text{or, } T_2 = 100 \text{ K} = -173^\circ\text{C}.$$

Chapter: Kinetic Theory

[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q87. Two batteries, one of emf 18 volt and internal resistance 2Ω and the other of emf 12 volt and internal resistance 1Ω , are connected as shown. The voltmeter V will record a reading of



- (a) 30 volt (b) 18 volt
(c) 15 volt (d) 14 volt

Ans: (d)

$$\text{Solution: } V = \frac{\frac{E_1 + E_2}{\frac{1}{r_1} + \frac{1}{r_2}}}{\frac{1}{r_1} + \frac{1}{r_2}} = \frac{\frac{18 + 12}{\frac{1}{2} + \frac{1}{1}}}{\frac{1}{2} + \frac{1}{1}} = 14V$$

(Since the cells are in parallel).

Chapter: Current Electricity

[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q88. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will

- (a) remain unchanged
(b) become zero
(c) become infinite
(d) become small, but non-zero

Ans: (c)

$$\text{Solution: } \frac{1}{f} = (\mu_g - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

where, $\mu_g = 1$ is given.

$$\Rightarrow \frac{1}{f} = (1 - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right) = 0 \Rightarrow f = \infty$$

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q89. A p-n photodiode is made of a material with a band gap of 2.0 eV. The minimum frequency of the radiation that can be absorbed by the material is nearly

- (a) 10×10^{14} Hz (b) 5×10^{14} Hz
(c) 1×10^{14} Hz (d) 20×10^{14} Hz

Ans: (b)

Solution: $E_g = 2.0 \text{ eV} = 2 \times 1.6 \times 10^{-19} \text{ J}$

$$E_g = h\nu$$

$$\therefore \nu = \frac{E_g}{h} = \frac{2 \times 1.6 \times 10^{-19} \text{ J}}{6.62 \times 10^{-34} \text{ J s}}$$

$$= 0.4833 \times 10^{15} \text{ s}^{-1} = 4.833 \times 10^{14} \text{ Hz} = 5 \times 10^{14} \text{ Hz}$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q90. Two spheres A and B of masses m_1 and m_2 respectively collide. A is at rest initially and B is moving with velocity v along x-axis. After collision B has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass A moves after collision in the direction.

- (a) Same as that of B
(b) Opposite to that of B
(c) $\theta = \tan^{-1}(1/2)$ to the x-axis
(d) $\theta = \tan^{-1}(1/2)$ to the x-axis

Ans: (c)

Solution: $m_2 m_1$



$$u = 0$$

conservation of linear momentum along x-direction

$$m_2 v = m_1 v_x \Rightarrow \frac{m_2 v}{m_1} = v_x$$

along y-direction

$$m_2 \times \frac{v}{2} = m_1 v_y \Rightarrow v_y = \frac{m_2 v}{2m_1}$$

Note: Let A moves in the direction, which makes an angle θ with initial direction i.e.

$$\tan \theta = \frac{v_y}{v_x} = \frac{\frac{m_2 v}{2m_1}}{\frac{m_2 v}{m_1}}$$

$$\tan \theta = \frac{1}{2}$$

$$\Rightarrow \theta = \tan^{-1}\left(\frac{1}{2}\right) \text{ to the x-axis.}$$

Chapter: Work, Energy and Power

[Topic: Collisions]

Q91. For hydrogen gas, $C_p - C_v = a$ and for oxygen gas, $C_p - C_v = b$, so the relation between a and b is given by

- (a) $a = 16b$ (b) $16b = a$
(c) $a = 4b$ (d) $a = b$

Ans: (d)

Solution: Both are diatomic gases and $C_p - C_v = R$ for all gases.

Chapter: Kinetic Theory

[Topic: Displacement, Phase, Velocity & Acceleration of SHM]

Q92. A battery of 10 V and internal resistance 0.5Ω is connected across a variable resistance R. The value of R for which the power delivered is maximum is equal to

- (a) 0.25Ω (b) 0.5Ω
(c) 1.0Ω (d) 2.0Ω

Ans: (b)

Solution: Power is maximum when $r = R$, $R = r = 0.5\Omega$.

Chapter: Current Electricity

[Topic: Heating Effects of Current]

Q93. In an astronomical telescope in normal adjustment a straight black line of length L is drawn on inside part of objective lens. The eye-piece forms a real image of this line. The length of this image is l. The magnification of the telescope is :

- (a) $\frac{L}{l} - 1$ (b) $\frac{L+1}{L-1}$
(c) $\frac{L}{l}$ (d) $\frac{L}{l} + 1$

Ans: (c)

Solution: Magnification by eye piece

$$m = \frac{f}{f+u}$$

$$-\frac{1}{L} = \frac{f_e}{f_e + [-(f_o + f_e)]} = -\frac{f_e}{f_o} \text{ or, } \frac{1}{L} = \frac{f_e}{f_o}$$

$$\text{Magnification, } M = \frac{f_o}{f_e} = \frac{L}{l}$$

Chapter - Ray Optics and Optical

[Topic: Optical Instruments]

Q94. Which of the following, when added as an impurity, into the silicon, produces n-type semiconductor?

- (a) Phosphorous
(b) Aluminium
(c) Magnesium
(d) Both b and c

Ans: (a)

Solution: Phosphorous (P) is pentavalent and silicon is tetravalent. Therefore, when silicon is doped with pentavalent impurity, it forms a n-type semiconductor.

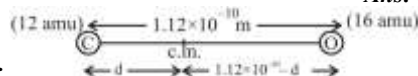
Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]

Q95. In carbon monoxide molecule, the carbon and the oxygen atoms are separated by a distance $1.12 \times 10^{-10} \text{ m}$. The distance of the centre of mass, from the carbon atom is

- (a) $0.64 \times 10^{-10} \text{ m}$ (b) $0.56 \times 10^{-10} \text{ m}$
(c) $0.51 \times 10^{-10} \text{ m}$ (d) $0.48 \times 10^{-10} \text{ m}$

Ans: (a)



Solution:

From definition of centre of mass.

$$d = \frac{16 \times 1.12 \times 10^{-10} + 12 \times 0}{16 + 12}$$

$$\frac{16 \times 1.12 \times 10^{-10}}{28} = 0.64 \times 10^{-10} \text{ m.}$$

Chapter: System of Particles and Rotational Motion

[Topic: Angular Displacement, Velocity and Acceleration]

Q96. The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively

- (a) $K_0/2$ and K_0 (b) K_0 and $2K_0$
(c) K_0 and K_0 (d) 0 and $2K_0$.

Ans: (c)

Solution: We have, $U + K = E$

where, U = potential energy, K = Kinetic energy, E = Total energy.

Also, we know that, in S.H.M., when potential energy is maximum, K.E. is zero and vice-versa.

$$U_{\max} + 0 = E \Rightarrow U_{\max} = E$$

Further,

$$KE^2 = \frac{1}{2} m \omega a^2 \cos^2 \omega t$$

But by question, $KE = K_0 \cos^2 \omega t$

$$K_0 = \frac{1}{2} m \omega^2 a^2$$

Hence, total energy, $E = \frac{1}{2} m \omega^2 a^2 = K_0$

$$U_{\max} = K_0 \text{ \& } E = K_0.$$

Chapter: Oscillation

[Topic: Energy in Simple Harmonic Motion]

Q97. Potentiometer measures potential more accurately because

- (a) it measures potential in the open circuit
(b) it uses sensitive galvanometer for null deflection
(c) it uses high resistance potentiometer wire
(d) it measures potential in the closed circuit

Ans: (a)

Solution: Potentiometer measures potential current more accurately because it measure potential in open circuit and hence error in potential due to internal resistance is removed.

Chapter: Current Electricity

[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q98. In Young's double slit experiment, the fringe width is found to be 0.4 mm. If the whole apparatus is immersed in water of refractive index $\frac{4}{3}$, without disturbing the geometrical arrangement, the new fringe width will be

- (a) 0.30 mm (b) 0.40 mm
(c) 0.53 mm (d) 450 microns

Ans: (a)

$$\text{Solution: } \beta' = \frac{\beta}{\mu} = \frac{0.4}{\frac{4}{3}} = 0.3 \text{ mm}$$

Chapter - Wave Optics

[Topic: Diffraction, Polarization of Light & Resolving Power]

Q99. An n-p-n transistor conducts when

- (a) both collector and emitter are negative with respect to the base
(b) both collector and emitter are positive with respect to the base

(c) collector is positive and emitter is negative with respect to the base

(d) collector is positive and emitter is at same potential as the base

Ans: (c)

Solution: When the collector is positive and emitter is negative w.r.t. base, it causes the forward biasing for each junction, which causes conduction of current.

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Junction Transistor]

Q100. The dimensions of $(\mu_0 \epsilon_0)^{\frac{1}{2}}$ are

- (a) $[L^{1/2} T^{-1/2}]$
(b) $[L^{-1} T]$
(c) $[L T^{-1}]$
(d) $[L^{-1/2} T^{1/2}]$

Ans: (c)

$$\text{Solution: } (\mu_0 \epsilon_0)^{-1/2} = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = c : \text{ speed of light}$$

where ϵ_0 = permittivity of free space

μ_0 = permeability of free space

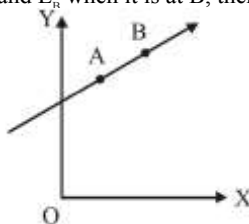
So dimensions are $[LT^{-1}]$

Chapter: Units and Measurement

[Topic: Dimensions of Physical Quantities]

PART 13. PHYSICS QUESTION BANK

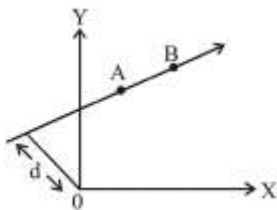
Q1. A particle of mass m moves in the XY plane with a velocity v along the straight line AB. If the angular momentum of the particle with respect to origin O is L_A when it is at A and L_B when it is at B, then



- (a) $L_A = L_B$
(b) the relationship between L_A and L_B depends upon the slope of the line AB
(c) $L_A < L_B$
(d) $L_A > L_B$

Ans: (a)

Solution: Angular momentum = Linear momentum $\times$ distance of line of action of linear momentum about the origin.



$$L_A = p_A \times d, L_B = p_B \times d$$

As linear momenta are p_A and p_B equal, therefore, $L_A = L_B$.

Chapter: System of Particles and Rotational Motion
[Topic: Torque, Couple and Angular Momentum]

Q2. Masses M_A and M_B hanging from the ends of strings of lengths L_A and L_B are executing simple harmonic motions. If their frequencies are $f_A = 2f_B$, then

- (a) $L_A = 2L_B$ and $M_A = M_B/2$
- (b) $L_A = 4L_B$ regardless of masses
- (c) $L_A = L_B/4$ regardless of masses
- (d) $L_A = 2L_B$ and $M_A = 2M_B$

Ans: (c)

$$\text{Solution: } f_A = \frac{1}{2\pi} \sqrt{\frac{g}{L_A}}$$

$$\text{and } f_B = \frac{f_A}{2} = \frac{1}{2\pi} \sqrt{\frac{g}{L_B}}$$

$$\therefore \frac{f_A}{f_B} = \frac{1}{2\pi} \sqrt{\frac{g}{L_A}} \times 2\pi \sqrt{\frac{L_B}{g}}$$

$$\Rightarrow 2 = \sqrt{\frac{L_B}{L_A}} = 4 = \frac{L_B}{L_A},$$

regardless of mass.

Chapter: Oscillation
[Topic: Time Period, Frequency, Simple Pendulum & Spring Pendulum]

Q3. An electron enters a region where magnetic field (B) and electric field (E) are mutually perpendicular, then

- (a) it will always move in the direction of B
- (b) it will always move in the direction of E
- (c) it always possesses circular motion
- (d) it can go undeflected also

Ans: (d)

Solution: When the deflection produced by electric field is equal to the deflection produced by magnetic field, then the electron can go undeflected.

Chapter: Moving Charges and Magnetic Field
[Topic: Motion of Charged Particle in Magnetic Field & Moment]

Q4. In a discharge tube ionization of enclosed gas is produced due to collisions between

- (a) negative electrons and neutral atoms/molecules
- (b) photons and neutral atoms/molecules
- (c) neutral gas atoms/molecules
- (d) positive ions and neutral atoms/molecules

Ans: (a)

Solution: When electrons emitted from cathode collide with gas molecules or atoms, they knock out outer

electrons and produce positively charged ions. They become part of positive rays.

Chapter - Dual Nature of Radiation and Matter
[Topic: Matter Waves, Cathode & Positive Rays]

Q5. The output of OR gate is 1

- (a) if either input is zero
- (b) if both inputs are zero
- (c) if either or both inputs are
- (d) only if both inputs are 1

Ans: (c)

Solution: Output will be one if A or B or both are one. $Y = A + B$

Chapter: Semiconductor Electronics Materials, Devices
[Topic: Digital Electronics and Logic Gates]

Q6. The dimensional formula for angular momentum is

- (a) $[M^0 L^2 T^{-2}]$
- (b) $[ML^2 T^{-1}]$
- (c) $[MLT^{-1}]$
- (d) $[ML^2 T^{-2}]$

Ans: (b)

Solution: [Angular momentum]
 = [Momentum of inertia] $\times$ [Angular velocity]
 = $ML^2 \times T^{-1}$
 = $ML^2 T^{-1}$

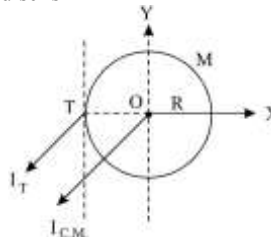
Chapter: Units and Measurement
[Topic: Dimensions of Physical Quantities]

Q7. The moment of inertia of a uniform circular disc of radius R and mass M about an axis touching the disc at its diameter and normal to the disc is

- (a) $\frac{2}{5}MR^2$
- (b) $\frac{3}{2}MR^2$
- (c) $\frac{1}{2}MR^2$
- (d) MR^2

Ans: (c)

Solution: M.I. of a uniform circular disc of radius 'R' and mass 'M' about an axis passing through C.M. and normal to the disc is



$$I_{CM} = \frac{1}{2} MR^2$$

From parallel axis theorem,

$$I_T = I_{C.M.} + MR^2 = \frac{1}{2} R^2 + MR^2 = \frac{3}{2} MR^2$$

Chapter: System of Particles and Rotational Motion
[Topic: Moment of Inertia, Rotational K.E. and Power]

Q8. The phase difference between two waves, represented by

$$y_1 = 10^{-6} \sin\{100t + (x/50) + 0.5\} \text{ m}$$

$$y_2 = 10^{-6} \cos\{100t + (x/50)\} \text{ m}$$

where x is expressed in metres and t is expressed in seconds, is approximately

- (a) 1.5 radians (b) 1.07 radians
(c) 2.07 radians (d) 0.5 radians

Ans: (b)

Solution: $y_1 = 10^{-6} \sin(100t + x/50 + 0.5)\text{m}$
 $= 10^{-6} \cos(100t + x/50 - \pi/2 + 0.5)\text{m}$
 $y_2 = 10^{-6} \cos(100t + x/50)\text{m}$
 $\therefore \phi = \pi/2 - 0.5 = 1.07 \text{ rad}$

Chapter: Waves

[Topic: Basic of Waves]

Q9. The magnetic field at a distance r from a long wire carrying current i is 0.4 tesla. The magnetic field at a distance $2r$ is

- (a) 0.2 tesla (b) 0.8 tesla
(c) 0.1 tesla (d) 1.6 tesla

Ans: (a)

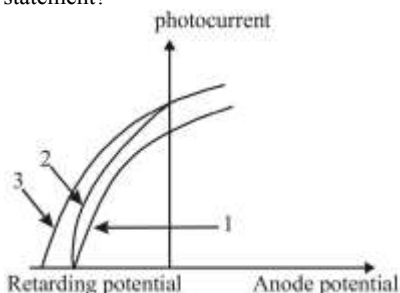
Solution: $B = \frac{\mu_0 i}{2\pi r}$ or $B \propto \frac{1}{r}$

When r is doubled, the magnetic field becomes half, i.e., now the magnetic field will be 0.2 T.

Chapter: Moving Charges and Magnetic Field

[Topic: Magnetic Field, Biot-Savart's Law & Ampere's Circuital Law]

Q10. The figure shows a plot of photo current versus anode potential for a photo sensitive surface for three different radiations. Which one of the following is a correct statement?



- (a) Curves (1) and (2) represent incident radiations of same frequency but of different intensities.
 (b) Curves (2) and (3) represent incident radiations of different frequencies and different intensities.
 (c) Curves (2) and (3) represent incident radiations of same frequency having same intensity.
 (d) Curves (1) and (2) represent incident radiations of different frequencies and different intensities.

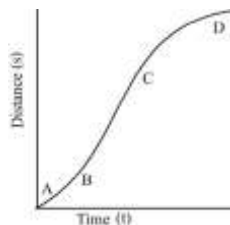
Ans: (a)

Solution: Retarding potential depends on the frequency of incident radiation but is independent of intensity.

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q11.



A particle shows distance - time curve as given in this figure. The maximum instantaneous velocity of the particle is around the point:

- (a) B
(b) C
(c) D
(d) A

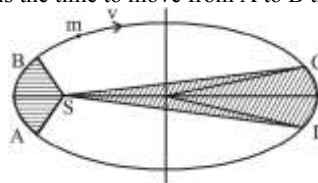
Ans: (b)

Solution: The slope of the graph $\frac{ds}{dt}$ is maximum at C and hence the instantaneous velocity is maximum at C.

Chapter: Kinematics Motion in a Straight Line

[Topic: Non-uniform motion]

Q12. The figure shows elliptical orbit of a planet m about the sun S . The shaded area SCD is twice the shaded area SAB . If t_1 is the time for the planet to move from C to D and t_2 is the time to move from A to B then :



- (a) $t_1 = 4t_2$ (b) $t_1 = 2t_2$
(c) $t_1 = t_2$ (d) $t_1 > t_2$

Ans: (b)

Solution: According to Kepler's law, the areal velocity of a planet around the sun always remains constant.

$SCD : A_1 - t_1$ (areal velocity constant)

$SAB : A_2 - t_2$

$$\frac{A_1}{t_1} = \frac{A_2}{t_2},$$

$$t_1 = t_2 \cdot \frac{A_1}{A_2} \text{ (given } A_1 = 2A_2)$$

$$= t_2 \cdot \frac{2A_2}{A_2}$$

$$\therefore t_1 = 2t_2$$

Chapter: Gravitation

[Topic: Kepler's Laws of Planetary Motion]

Q13. The velocity of sound in any gas depends upon

- (a) wavelength of sound only
(b) density and elasticity of gas
(c) intensity of sound waves only
(d) amplitude and frequency of sound

Ans: (b)

Solution: Velocity of sound in any gas depends upon density and elasticity of gas.

Chapter: Waves

[Topic: Vibration of String & Organ Pipe]

Q14. A galvanometer has a coil of resistance 100 ohm and gives a full-scale deflection for 30 mA current. It is to work as a voltmeter of 30 volt range, the resistance required to be added will be

- (a) 900Ω (b) 1800Ω
(c) 500Ω (d) 1000Ω

Ans: (a)

Solution: Let the resistance to be added be R , then

$$30 = I_g (r + R)$$

$$\therefore R = \frac{30}{I_g} - r = \frac{30}{30 \times 10^{-3}} - 100$$

$$= 1000 - 100 = 900\Omega$$

Chapter: Moving Charges and Magnetic Field

[Topic: Galvanometer and Its Conversion into Ammeter & Voltmeter]

Q15. In photoelectric effect the work function of a metal is 3.5 eV. The emitted electrons can be stopped by applying a potential of -1.2 V. Then [1994]

- (a) the energy of the incident photon is 4.7 eV
(b) the energy of the incident photon is 2.3 eV
(c) if higher frequency photon be used, the photoelectric current will rise
(d) when the energy of photon is 3.5 eV, the photoelectric current will be maximum

Ans: (a)

Solution: $h\nu = W_0 + E_k = 3.5 + 1.2 = 4.7 \text{ eV}$

Chapter - Dual Nature of Radiation and Matter

[Topic: Electron Emission, Photon Photoelectric Effect & X-ray]

Q16. If a ball is thrown vertically upwards with a velocity of 40 m/s, then velocity of the ball after two seconds will be ($g = 10 \text{ m/s}^2$)

- (a) 15 m/s (b) 20 m/s
(c) 25 m/s (d) 28 m/s

Ans: (b)

Solution: Initial velocity (u) = 40 m/s

$$\text{Acceleration } a = -g \text{ m/s}^2 = -10 \text{ m/s}^2$$

Time = 2 seconds

By 1st equation of motion,

$$v = u + at$$

$$v = 40 - 10(2) = 20 \text{ m/s}$$

Chapter: Kinematics Motion in a Straight Line

[Topic: Motion Under Gravity]

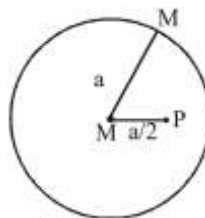
Q17. A particle of mass M is situated at the centre of spherical shell of mass M and radius a . The magnitude of the gravitational potential at a point situated at $a/2$ distance from the centre, will be

- (a) $\frac{2GM}{a}$
(b) $\frac{3GM}{a}$
(c) $\frac{4GM}{a}$
(d) $\frac{GM}{a}$

Ans: (b)

Solution: $V_P = V_{\text{spherical shell}} + V_{\text{particle}}$

$$= \frac{GM}{a} + \frac{GM}{\frac{a}{2}} = \frac{3GM}{a}$$



Chapter: Gravitation

[Topic: Gravitational Field, Potential and Energy]

Q18. Two waves of the same frequency and intensity superimpose each other in opposite phases. After the superposition, the intensity and frequency of waves will

- (a) increase
(b) decrease
(c) remain constant
(d) become zero

Ans: (c)

Solution: We know that interference is said to be constructive at point where resultant intensity is maximum (are in phase) and destructive at points where resultant intensity is minimum or 0 (are in opposite phase). Therefore, after the superposition, frequency and intensity of waves will remain constant.

Chapter: Waves

[Topic: Beats, Interference & Superposition of Waves]

Q19. Curie temperature is the temperature above which

- (a) ferromagnetic material becomes paramagnetic material
(b) paramagnetic material becomes diamagnetic material
(c) paramagnetic material becomes ferromagnetic material
(d) ferromagnetic material becomes diamagnetic material.

Ans: (a)

Solution: Curie temperature is the temperature above which ferromagnetic material becomes paramagnetic material.

Chapter: Magnetism and Matter

[Topic: The Earth's Magnetism, Magnetic Materials and their Properties]

Q20. In the spectrum of hydrogen, the ratio of the longest wavelength in the Lyman series to the longest wavelength in the Balmer series is [2015 RS, 2013]

- (a) $\frac{9}{4}$
(b) $\frac{27}{5}$
(c) $\frac{16}{27}$
(d) $\frac{4}{9}$

Ans: (d)

Solution: For Lyman series ($2 \rightarrow 1$)

$$\frac{1}{\lambda_L} = R \left[1 - \frac{1}{2^2} \right] = \frac{3R}{4}$$

For Balmer series ($3 \rightarrow 2$)

$$\frac{1}{\lambda_B} = R \left[\frac{1}{4} - \frac{1}{9} \right] = \frac{5R}{36}$$

$$\Rightarrow \frac{\lambda_L}{\lambda_B} = \frac{\frac{4}{36}}{\frac{5R}{36}} = \frac{4}{5} \left(\frac{5}{3} \right) = \frac{5}{27}$$

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q21. Which of the following is not a vector quantity?

- (a) speed
- (b) velocity
- (c) torque
- (d) displacement

Ans: (a)

Solution: A vector quantity has both magnitude and direction. In the given options, speed has only magnitude, therefore, it is non- vector or scalar quantity.

Chapter: Kinematics Motion in a Plane

[Topic: Vectors]

Q22. The escape velocity from earth is 11.2 km/s. If a body is to be projected in a direction making an angle 45° to the vertical, then the escape velocity is

- (a) 11.2×2 km/s
- (b) 11.2 km/s
- (c) $11.2 / \sqrt{2}$ km/s
- (d) $11.2\sqrt{2}$ km/s

Ans: (b)

Solution: Escape velocity does not depend on the angle of projection.

Chapter: Gravitation

[Topic: Motion of Satellites, Escape Speed and Orbital Velocity]

Q23. When air is replaced by a dielectric medium of force constant K, the maximum force of attraction between two charges, separated by a distance

- (a) decreases K-times
- (b) increases K-times
- (c) remains unchanged
- (d) becomes $\frac{1}{K^2}$ times

Ans: (a)

Solution: In air, $F_{\text{air}} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$

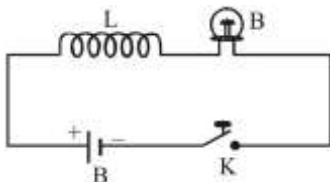
In medium, $F_m = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{Kr^2}$

$$\frac{F_m}{F_{\text{air}}} = \frac{1}{K} = F_m = \frac{F_{\text{air}}}{K} \text{ (decreases K-times)}$$

Chapter: Electrostatic Potential and capacitance

[Topic: Electric Field, Electric Field Lines & Dipole]

Q24. In the circuit of Fig, the bulb will become suddenly bright if



- (a) contact is made or broken
- (b) contact is made

- (c) contact is broken
- (d) won't become bright at all

Ans: (c)

Solution: When a circuit is broken, the induced e.m.f. is largest. So the answer is (c) .

Chapter: Electromagnetic

[Topic: Motional and Static EMI & Applications]

Q25. When a hydrogen atom is raised from the ground state to an excited state,

- (a) P.E decreases and K.E. increases
- (b) P.E. increases and K.E decreases
- (c) both K.E. and P.E. decrease
- (d) absorption spectrum

Ans: (b)

Solution: P. E. = $-\frac{KZe^2}{r}$ and KE = $\frac{KZe^2}{2r}$, where, r is the radius of orbit which increases as we move from ground to an excited state. Therefore, when a hydrogen atom is raised from the ground state, it increases the value of r. As a result of this, P.E. increases (decreases in negative) and K.E. decreases.

Chapter: Atoms

[Topic: Bohr Model & The Spectra of the Hydrogen Atom]

Q26. The position vector of a particle $\vec{R}$ as a function of time is given by:

$$\vec{R} = 4 \sin(2\pi t) \hat{i} + 4 \cos(2\pi t) \hat{j}$$

Where R is in meter, t in seconds and $\hat{i}$ and $\hat{j}$ denote unit vectors along x-and y-directions, respectively.

Which one of the following statements is wrong for the motion of particle?

- (a) Magnitude of acceleration vector is $\frac{v^2}{R}$, where v is the velocity of particle
- (b) Magnitude of the velocity of particle is 8 meter/second
- (c) path of the particle is a circle of radius 4 meter.
- (d) Acceleration vector is along $\vec{R}$

Ans: (b)

Solution: Here, $x = 4\sin(2\pi t)$...(i)

$y = 4\cos(2\pi t)$...(ii)

Squaring and adding equation (i) and (ii)

$$x^2 + y^2 = 4^2 \Rightarrow R = 4$$

Motion of the particle is circular motion,

acceleration vector is along $-\vec{R}$ and its magnitude = $\frac{v^2}{R}$

Velocity of particle, $V = \omega R = (2\pi) (4) = 8\pi$

Chapter: Kinematics Motion in a Plane

[Topic: Relative Velocity in 2D & Circular Motion]

Q27. The angle of contact between pure water and pure glass, is

- (a) 0°
- (b) 45°
- (c) 90°
- (d) 135°

Ans: (a)

Solution: We know that angle of contact is the angle between the tangent to liquid surface at the point of contact and solid surface inside the liquid. In case of pure water and pure glass, the angle of contact is zero.

Chapter: Mechanical Properties of Fluids
[Topic: Thermometry, Thermocouple & Thermal Expansion]

Q28. A charge q is located at the centre of a cube. The electric flux through any face is

- (a) $\frac{q}{6(4\pi\epsilon_0)}$
 (b) $\frac{2\pi q}{6(4\pi\epsilon_0)}$
 (c) $\frac{4\pi q}{6(4\pi\epsilon_0)}$
 (d) $\frac{\pi q}{6(4\pi\epsilon_0)}$

Ans: (c)

Solution: Cube has 6 faces. Flux through any face is given by

$$\phi = \frac{q}{6\epsilon_0} = \frac{q4\pi}{6(4\pi\epsilon_0)}$$

Chapter: Electrostatic Potential and capacitance
[Topic: Electrostatic Potential & Equipotential Surfaces]

Q29. In an a.c. circuit, the r.m.s. value of current, i_{rms} is related to the peak current, i_0 by the relation [1994]

- (a) $I_{\text{rms}} = \sqrt{2}I_0$
 (b) $I_{\text{rms}} = \pi I_0$
 (c) $I_{\text{rms}} = \frac{1}{\pi}I_0$
 (d) $I_{\text{rms}} = \frac{1}{\sqrt{2}}I_0$

Ans: (d)

Solution: $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$

Chapter: Alternating Current
[Topic: Alternating Current, Voltage & Power]

Q30. The constituents of atomic nuclei are believed to be

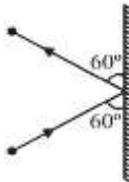
- (a) neutrons and protons
 (b) protons only
 (c) electrons and protons
 (d) electrons, protons and neutrons.

Ans: (a)

Solution: Nucleus contains only neutrons and protons.

Chapter: Nuclei
[Topic: Composition and Size of the Nucleus]

Q31. A 3 kg ball strikes a heavy rigid wall with a speed of 10 m/s at an angle of 60° . It gets reflected with the same speed and angle as shown here. If the ball is in contact with the wall for 0.20s, what is the average force exerted on the ball by the wall?



- (a) 150 N
 (b) zero
 (c) $150\sqrt{3}$ N
 (d) 300 N

Ans: (c)

Solution: Change in momentum along the wall
 $= mv \cos 60^\circ - mv \cos 60^\circ = 0$
 Change in momentum perpendicular to the wall
 $= mv \sin 60^\circ - (-mv \sin 60^\circ) = 2mv \sin 60^\circ$

$$\therefore \text{Applied force} = \frac{\text{Change in momentum}}{\text{Time}} \\ = \frac{2mv \sin 60^\circ}{0.20} \\ = \frac{2 \times 3 \times 10 \times \sqrt{3}}{2 \times 20} = 50 \times 3\sqrt{3} \\ = 150\sqrt{3} \text{ newton}$$

Chapter: Dynamics Laws of Motion
[Topic: 1st, 2nd & 3rd Laws of Motion]

Q32. An electric kettle takes 4A current at 220 V. How much time will it take to boil 1 kg of water from temperature 20°C ? The temperature of boiling water is 100°C .

- (a) 6.3 min
 (b) 8.4 min
 (c) 12.6 min
 (d) 4.2 min

Ans: (a)

Solution: Heat required to raise the temperature of 1kg water from 20°C to 100°C is given by $Q = ms\Delta\theta = (1 \times 4200 \times 80) \text{ J}$

Power of kettle (P) = $VI = (220 \times 4) \text{ W}$

$$\therefore \text{Time taken} = \frac{Q}{P} = \frac{1 \times 4200 \times 80}{220 \times 4} \\ = 381.81 \text{ sec} = 6.36 \text{ min}$$

Chapter: Thermal Properties
[Topic: Calorimetry & Heat Transfer]

Q33. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system :

- (a) decreases by a factor of 2 (b) remains the same
 (c) increases by a factor of 2 (d) increases by a factor of 4

Ans: (a)

Solution: When battery is replaced by another uncharged capacitor

As uncharged capacitor is connected parallel

So, $C' = 2C$

$$\text{and } V_c = \frac{q_1 + q_2}{C_1 + C_2}$$

$$V_c = \frac{q+0}{C+C} \\ \Rightarrow V_c = \frac{V}{2}$$

Initial Energy of system, $U_i = \frac{1}{2}CV^2 \dots (i)$

$$\text{Final energy of system, } U_f = \frac{1}{2}(2C) \left(\frac{V}{2}\right)^2 \\ = \frac{1}{2}CV^2 \left(\frac{1}{2}\right) \dots (ii)$$

From equation (i) and (ii)

$$U_f = \frac{1}{2}U_i$$

i.e., Total electrostatic energy of resulting system decreases by a factor of 2

Chapter: Electrostatic Potential and capacitance
[Topic: Capacitors, Capacitance, Grouping of Capacitors & Energy Stored in a Capacitor.]

Q34. A 220 volts input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is

- (a) 3.6 ampere (b) 2.8 ampere
(c) 2.5 ampere (d) 5.0 ampere

Ans: (d)

Solution: $\frac{V_2}{V_1} = 0.8 \frac{I_1}{I_2}$

$\Rightarrow \frac{V_2 I_2}{V_1 I_1} = 0.8$

$V_1 = 220 \text{ V}, I_2 = 2.0 \text{ A}, V_2 = 440 \text{ V}$

$I_1 = \frac{V_2 I_2}{V_1} \times \frac{10}{8} = \frac{440 \times 2 \times 10}{220 \times 8} = 5 \text{ A}$

Chapter: Alternating Current

[Topic: Transformers & LC Oscillations]

Q35. In nuclear reactions, we have the conservation of

- (a) mass only
(b) energy only
(c) momentum only
(d) mass, energy and momentum

Ans: (d)

Solution: Chapter: Nuclei

[Topic: Mass-Energy & Nuclear Reactions]

Q36. A mass of 1 kg is suspended by a thread. It is

- (i) lifted up with an acceleration 4.9 m/s^2 ,
(ii) lowered with an acceleration 4.9 m/s^2 .

The ratio of the tensions is

- (a) 3 : 1 (b) 1 : 2
(c) 1 : 3 (d) 2 : 1

Ans: (a)

Solution: In case (i) we have

$T_1 - (1 \times g) = 1 \times 4.9$

$= T_1 = 9.8 + 4.9 = 14.7 \text{ N}$

In case (ii), $1 \times g - T_2 = 1 \times 4.9$

$= T_2 = 9.8 - 4.9 = 4.9 \text{ N}$

$\therefore \frac{T_1}{T_2} = \frac{14.7}{4.9} = \frac{3}{1}$

Chapter: Dynamics Laws of Motion

[Topic: Motion of Connected Bodies, Pulleys]

Q37. 110 joules of heat is added to a gaseous system whose internal energy is 40 J. Then the amount of external work done is

- (a) 150 J (b) 70 J
(c) 110 J (d) 40 J

Ans: (b)

Solution: $\Delta Q = \Delta U + \Delta W$

$\Rightarrow \Delta W = \Delta Q - \Delta U = 110 - 40 = 70 \text{ J}$

Chapter: Heat & Thermodynamics

[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q38. A wire of resistance 4Ω is stretched to twice its original length. The resistance of stretched wire would be

- (a) 4Ω (b) 8Ω
(c) 16Ω (d) 2Ω

Ans: (c)

Solution: Resistance $R = \frac{\rho l}{A}$

$\therefore l' = 2l$

$\therefore A' = \frac{A}{2}$

$\therefore R' = \rho \frac{2l}{\frac{A}{2}} = 4R = 4 \times 4 \Omega = 16 \Omega$

Therefore the resistance of new wire becomes 16Ω

Chapter: Current Electricity

[Topic: Electric Current, Drift of Electrons, Ohm's Law, Resistance & Resistivity]

Q39. The energy of the em waves is of the order of 15 keV. To which part of the spectrum does it belong?

- (a) Infra-red rays
(b) Ultraviolet rays
(c) γ -rays
(d) X-rays

Ans: (d)

Solution: Energy of x-ray is (100 eV to 100 keV)

Hence energy of the order of 15 keV belongs to x-rays.

Chapter - Electromagnetic Waves

[Topic: Electromagnetic Spectrum]

Q40. The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an

- (a) isomer of parent
(b) isotone of parent
(c) isotope of parent
(d) isobar of parent

Ans: (c)

Solution: Isotopes of an element have the same atomic number but different mass number. A radioactive substance when emits one alpha particles (${}^4_2\text{He}$), its mass number reduces by 4 and charge no. reduces by 2 and after emission of two β -particles its charge no. increase by 2 thus the charge no. i.e. atomic number remains the same.

Chapter: Nuclei

[Topic: Radioactivity]

Q41. When milk is churned, cream gets separated due to

- (a) centripetal force
(b) centrifugal force
(c) frictional force
(d) gravitational force

Ans: (b)

Solution: Cream gets separated from a churned milk due to centrifugal force.

Chapter: Dynamics Laws of Motion

[Topic: Work]

Q42. An ideal gas A and a real gas B have their volumes increased from V to 2V under isothermal conditions. The increase in internal energy

- (a) will be same in both A and B
(b) will be zero in both the gases
(c) of B will be more than that of A
(d) of A will be more than that of B

Ans: (b)

Solution: Under isothermal conditions, there is no change in internal energy.

Chapter: Heat & Thermodynamics
[Topic: Specific Heat Capacity & Thermodynamic Processes]

Q43. Two wires of the same metal have same length, but their cross-sections are in the ratio 3:1. They are joined in series. The resistance of thicker wire is 10Ω . The total resistance of the combination will be

- (a) 10Ω (b) 20Ω
 (c) 40Ω (d) 100Ω

Ans: (c)

Solution: Length of each wire = l ; Area of thick wire (A_1) = $3A$; Area of thin wire (A_2) = A and resistance of thick wire (R_1) = 10Ω . Resistance (R) = $\rho \frac{l}{A} \propto \frac{1}{A}$ (if l is constant)

$$\frac{R_1}{R_2} = \frac{A_2}{A_1} = \frac{A}{3A} = \frac{1}{3}$$

$$\text{or, } R_2 = 3R_1 = 3 \times 10 = 30\Omega$$

The equivalent resistance of these two resistors in series = $R_1 + R_2 = 30 + 10 = 40\Omega$.

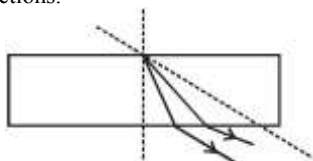
Chapter: Current Electricity
[Topic: Combination of Resistances]

Q44. A beam of light composed of red and green rays is incident obliquely at a point on the face of rectangular glass slab. When coming out on the opposite parallel face, the red and green rays emerge from

- (a) one point propagating in the same direction
 (b) two points propagating in two different non-parallel directions
 (c) two points propagating in two different parallel directions
 (d) one point propagating in two different directions

Ans: (c)

Solution: Since refractive index for both the light are different, so they emerge out moving in two different parallel directions.



Chapter - Ray Optics and Optical
[Topic: Refraction of Light at Plane Surface & Total Internal Reflection]

Q45. A radioactive element has half life period 800 years. After 6400 years what amount will remain? [1989]

- (a) $\frac{1}{2}$
 (b) $\frac{1}{16}$
 (c) $\frac{1}{8}$
 (d) $\frac{1}{256}$

Ans: (d)

Solution: No. of half lives, $n = \frac{t}{T} = \frac{6400}{800} = 8$

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^8 = \frac{1}{256}$$

Chapter: Nuclei
[Topic: Radioactivity]

Q46. Two bodies with kinetic energies in the ratio 4 : 1 are moving with equal linear momentum. The ratio of their masses is

- (a) 1 : 2 (b) 1 : 1
 (c) 4 : 1 (d) 1 : 4

Ans: (d)

$$\text{Solution: } \frac{(KE)_1}{(KE)_2} = \frac{\frac{1}{2}m_1v_1^2}{\frac{1}{2}m_2v_2^2} = \frac{4}{1} \Rightarrow \frac{m_1v_1^2}{m_2v_2^2} = \frac{4}{1}$$

$$\Rightarrow \frac{(m_1v_1)^2m_2}{(m_2v_2)^2m_1} = \frac{4}{1} \Rightarrow \frac{p_1^2}{p_2^2} \times \frac{m_2}{m_1} = \frac{4}{1}$$

$$\frac{m_2}{m_1} = \frac{4 \times p_2^2}{1 \times p_1^2} = \frac{4}{1} \times 1 \Rightarrow \frac{m_2}{m_1} = \frac{1}{4}$$

[Given: $p_1 = p_2$]

Chapter: Work, Energy and Power
[Topic: Energy]

Q47. The equation of state, corresponding to 8g of O_2 is

- (a) $PV = 8RT$
 (b) $PV = RT/4$
 (c) $PV = RT$
 (d) $PV = RT/2$

Ans: (b)

Solution: 8g of oxygen is equivalent to $(1/4)$ mole.

$$\text{So, } PV = \frac{1}{4}RT$$

Chapter: Kinetic Theory

[Topic: Speeds of Gas, Pressure & Kinetic Energy]

Q48. A battery is charged at a potential of 15V for 8 hours when the current flowing is 10A. The battery on discharge supplies a current of 5A for 15 hours. The mean terminal voltage during discharge is 14V. The “watt-hour” efficiency of the battery is

- (a) 87.5% (b) 82.5%
 (c) 80% (d) 90%

Ans: (a)

$$\text{Solution: Efficiency is given by } \eta = \frac{\text{output}}{\text{input}} = \frac{5 \times 15 \times 14}{10 \times 8 \times 15} = 0.875 \text{ or } 87.5\%$$

Chapter: Current Electricity
[Topic: Kirchhoff's Laws, Cells, Thermo emf & Electrolysis]

Q49. A body is located on a wall. Its image of equal size is to be obtained on a parallel wall with the help of a convex lens. The lens is placed at a distance 'd' ahead of second wall, then the required focal length will be

- (a) only $\frac{d}{4}$
 (b) only $\frac{d}{2}$
 (c) more than $\frac{d}{4}$ but less than $\frac{d}{2}$
 (d) less than $\frac{d}{4}$

Ans: (b)

Solution: Using the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Given $v = d$, for equal size image $|v| = |u| = d$

By sign convention $u = -d$

$$\frac{1}{f} = \frac{1}{d} + \frac{1}{d} \text{ or } f = \frac{d}{2}$$

Chapter - Ray Optics and Optical

[Topic: Refraction at Curved Surface, Lenses & Power of Lens]

Q50. For a cubic crystal structure which one of the following relations indicating the cell characteristics is correct?

(a) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$

(b) $a = b = c$ and $\alpha \neq \beta \neq \gamma = 90^\circ$

(c) $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$

(d) $a \neq b \neq c$ and $\alpha \neq \beta$ and $\gamma \neq 90^\circ$

Ans: (c)

Solution: For a cubic crystal,

$$a = b = c \text{ and } \alpha = \beta = \gamma = 90^\circ$$

Chapter: Semiconductor Electronics Materials, Devices

[Topic: Solids, Semiconductors and P-N Junction Diode]