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EUEE

ANSWER KEY(PDF)

EUEE PHYSICS 2011/2019

ANSWER WITH EXPLANATION(PDF)

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"Do all the good you can,
By all the means you can,
In all the ways you can,
In all the places you can,
At all the times you can,
To all the people you can,
As long as ever you can."

1. Two forces $\vec{F}_1 = 3\hat{i}$ N and $\vec{F}_2 = 4\hat{j}$ N are acting on a particle of mass m . What is the magnitude and direction of a force that balances the two?
- (A) $\vec{F}_{eq} = 5$ N at 143° counterclockwise from $\vec{F}_2$
 (B) $\vec{F}_{eq} = 7$ N at 127° counterclockwise from $\vec{F}_1$
 (C) $\vec{F}_{eq} = 7$ N at 127° counterclockwise from $\vec{F}_2$
 (D) $\vec{F}_{eq} = 5$ N at 143° counterclockwise from $\vec{F}_1$

SOLUTION: $F_N = \sqrt{3^2 + 4^2} = 5$ N, at an angle of $\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53^\circ$

Since, the force that cancel this force is 5N at 143° from $\vec{F}_2$

ANSWER: A

2. In playing room a turn table of radius 2m has moment of inertia 250Kg m^2 and is rotating about a frictionless vertical axel. When a boy of mass 50Kg stands near the rim, the system rotates with angular speed 3rad/s. The boy walks towards the center and stands at 1m from the axel. What is the final angular speed of the system?
- (A) 3rad/s (B) 2.5rad/s (C) 4.5rad/s (D) 5.4rad/s

SOLUTION: from the conservation of angular momentum;

$$I_i \omega_i = I_f \omega_f$$

$$[250 + 50(2)^2](3) = [250 + 50(1)^2](\omega_f)$$

$$\omega_f = 4.5\text{rad/s}$$

ANSWER: C

3. A thin circular ring of mass M and radius r and moment of inertia Mr^2 is rotating about its axis with a constant angular velocity ω . Two objects each of mass m , are attached gently to the opposite ends a diameter of the ring. What would be the angular velocity of the wheel?

(A) $\frac{\omega M}{(M+m)}$

(C) $\frac{\omega(M+2m)}{M}$

(B) $\frac{\omega(M+2m)}{(M+2m)}$

(D) $\frac{\omega M}{(M+2m)}$

SOLUTION: from the conservation of angular momentum;

$$I_i \omega_i = I_f \omega_f$$

$$Mr^2 \omega = (M + 2m)r^2 \omega_f$$

$$\omega_f = \frac{\omega M}{(M+2m)}$$

ANSWER: D

4. Five beads of equal mass are fixed on a rigid light rod that is free to rotate about a frictionless vertical bearing. The arrangement is such that, four of them are placed at 0.25m and the fifth one is at 0.5m from the axis of rotation. The rotational kinetic energy is 144J when the beads were rotating with angular speed of 48rad/s. What is the mass of each bead?

(A) 0.5Kg

(B) 0.25Kg

(C) 0.75Kg

(D) 1Kg

SOLUTION: $KE = \frac{1}{2}I^2\omega$ but $I = mr^2$

$$KE = \frac{1}{2}mr^2\omega = \frac{1}{2}[(4)(m)(0.25)^2 + m(0.5)^2](48^2)$$

$$144 = \frac{1}{2}[0.25m + 0.25m](2304)$$

$$144 = \frac{1}{2}[0.5m](2304)$$

$$144 = (0.25)(2304)m$$

$$\Rightarrow m = 0.25\text{Kg}$$

ANSWER: B

5. In which of the following case is no work done by dissipative force?
- (A) When a parachute jump from a plane
 - (B) On a racing car that in a desert
 - (C) For freely falling object
 - (D) When someone slides a box on a horizontal rough surface

ANSWER: C

6. Which of the following is equal to the amount of work required to stop a moving object?
- (A) The kinetic energy of the object
 - (B) The mass of the object times its acceleration
 - (C) The square of the velocity of the object
 - (D) The mass of the object times its velocity

EXPLANATION: a moving object has kinetic energy, thus the same amount of kinetic energy is Required to stop the object.

ANSWER: A

7. A 1Kg roller coaster is acted on by a 4N force over a displacement of 2m in the direction of force and then set free. The roller is moving on a smooth and horizontal surface towards a free a spring of constant K, whose other end is fixed on the wall. If the spring is compressed by 20cm to rest, then what is the value of the spring constant?
- (A) 100N/m
 - (B) 200N/m
 - (C) 800N/m
 - (D) 400N/m

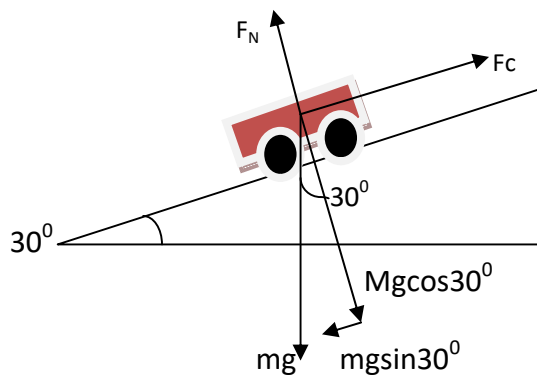
SOLUTION: Given $F = 4\text{N}$, $S = 2\text{m}$, $\Delta X = 20\text{cm} = 0.2\text{m}$, $K = ?$

$$FS = \frac{1}{2}k(\Delta X)^2 \Rightarrow K = \frac{2FS}{(\Delta X)^2} = \frac{2 \times 4 \times 2}{(0.2)^2} = \frac{16}{0.04} = 400\text{N/m}$$

ANSWER: D

8. A trolley is set to move on a smooth track that is banked at an angle of 30° . For a trolley moving with a speed 5m/s to round the curve, what is the radius of the banked surface?
- (A) 2.5m
 - (B) 5.0m
 - (C) 10m
 - (D) 3.5m

SOLUTION: given $v = 5\text{m/s}$, $\theta = 30^\circ$



$$\Rightarrow F_c - mg \sin 30^\circ = 0$$

$$\Rightarrow \frac{mv^2}{r} = mg \sin 30^\circ \Rightarrow r = \frac{v^2}{g \sin 30^\circ} = \frac{5^2}{10 \times \sin 30^\circ} = 5\text{m}$$

ANSWER: B

9. A grade 11 physics teacher ordered four of his students to measure the length of a class room. He provided them the following length measuring instruments. The instruments are meter rule with centimeter division, vernier calipers, micrometer screw gauge and meter tape with centimeter scale, but its zero reading is not visible. Which one of these instruments is appropriate for the task?

(A) Meter rule (C) Vernier calipers
(B) Micrometer screw gauge (D) Meter tape

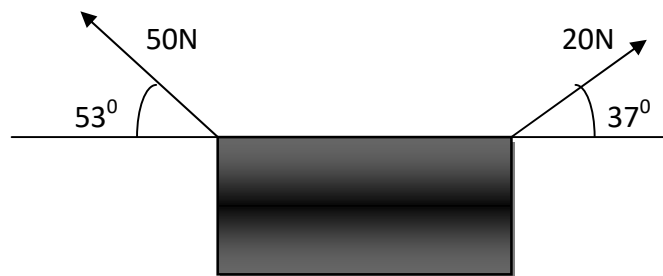
ANSWER: A

10. Which part of a scientific method report discusses the accuracy of measurements taken?
- (A) Aim (B) Methods (C) Theory (D) Results

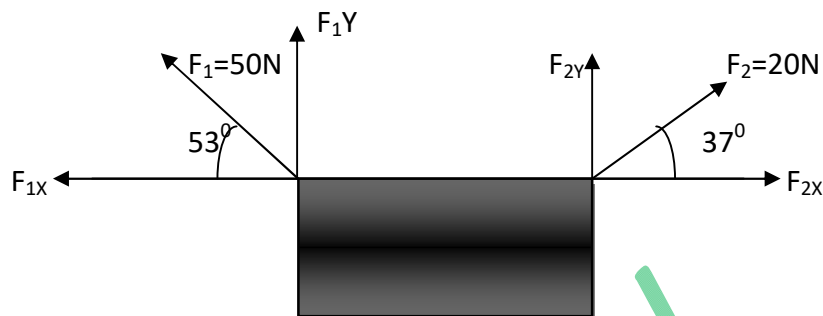
ANSWER: B

11. Two forces exerted on a block as shown in the figure below. What is horizontal component of the force?

(A) 14N, West
(B) 30N, West
(C) 70N, East
(D) 28N, West



SOLUTION:

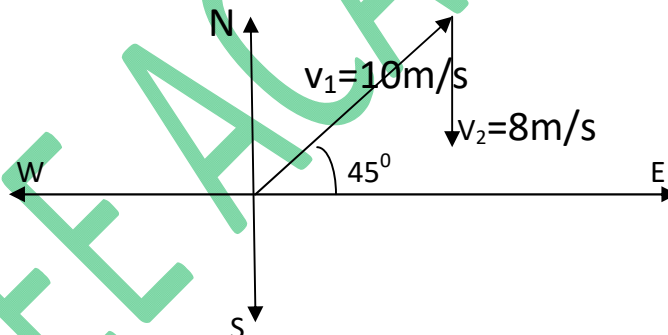


- Let assume east is positive and west is negative
 $F_{1x} = -F_1 \cos 53^\circ = -50 \text{ N} \times \cos 53^\circ = -30 \text{ N}$, $F_{2x} = F_2 \cos 37^\circ = 20 \text{ N} \times \cos 37^\circ = 16 \text{ N}$
 $F_{\text{net}x} = F_{1x} + F_{2x} = -30 \text{ N} + 16 \text{ N} = -14 \text{ N}$ (or 14N West)

ANSWER: A

12. What is the magnitude of the resultant velocity for a bird flying first at a speed of 10m/s North East and then flying to South at a speed of 8m/s?
- (A) 12.8m/s (C) 7.13m/s
 (B) 16.6m/s (D) 7.07m/s

SOLUTION:



$$V_{1y} = 10 \sin 45^\circ = 7.07 \text{ m/s} , \quad v_{1x} = 10 \cos 45^\circ = 7.07 \text{ m/s}$$

$$V_{\text{NET},y} = 7.07 \text{ m/s} - 8 \text{ m/s} = -0.93 \text{ m/s} (0.93 \text{ South})$$

$$V_{\text{NET},x} = V_{1x} = 7.07 \text{ m/s}$$

$$V_{\text{NET}} = \sqrt{(V_{\text{NET},x})^2 + (V_{\text{NET},y})^2} = \sqrt{7.07^2 + (-0.93)^2} = 7.13 \text{ m/s}$$

ANSWER: C

13. Let $\mathbf{C} = \mathbf{A} \times \mathbf{B}$ and $\theta \neq 90^\circ$, where θ is the smaller angle between $\mathbf{A}$ and $\mathbf{B}$ when they are drawn with their tails at same point. Which of the following is **NOT** true?
- (A) $\mathbf{A} \cdot \mathbf{C} = 0$ (C) $|\mathbf{C}| = |\mathbf{A}| |\mathbf{B}| \sin \theta$
 (B) $\mathbf{A} \cdot \mathbf{B} = 0$ (D) $-\mathbf{C} = \mathbf{B} \times \mathbf{A}$

EXPLANATION: since $\mathbf{C} = \mathbf{A} \times \mathbf{B}$, $\mathbf{C}$ is perpendicular to both $\mathbf{A}$ and $\mathbf{B}$.

Thus, $\mathbf{A} \cdot \mathbf{C} = 0$.

$\mathbf{A} \cdot \mathbf{B} \neq 0$ Since, $\theta \neq 90^\circ$

ANSWER: B

14. A driver of an automobile travelling at a constant speed of 20m/s suddenly applies a brake and the automobile comes to rest in 2.0 seconds after skidding for a certain distance. What is the length of the skid distance?

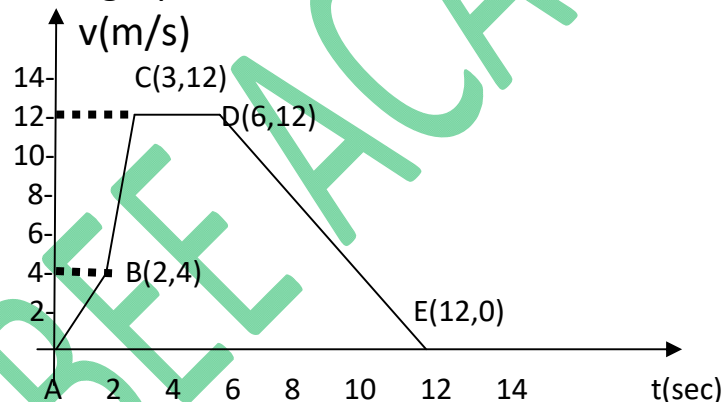
(A) 20m (B) 10m (C) 40m (D) 400m

EXPLANATION: Given $u = 20\text{m/s}$, $v = 0\text{m/s}$, $t = 2\text{s}$

$$S = \left(\frac{u+v}{2} \right) t = \left(\frac{20+0}{2} \right) (2) = 20\text{m}$$

ANSWER: A

15. Which of the following is correct about the motion shown in the velocity – time graph below?



- (A) Between C and D, the motion is with constant acceleration.
 (B) Between B and C, the acceleration is 4m/s^2 .
 (C) Total displacement is 84m.
 (D) Between D and E, the motion is with constant positive acceleration.

EXPLANATION:

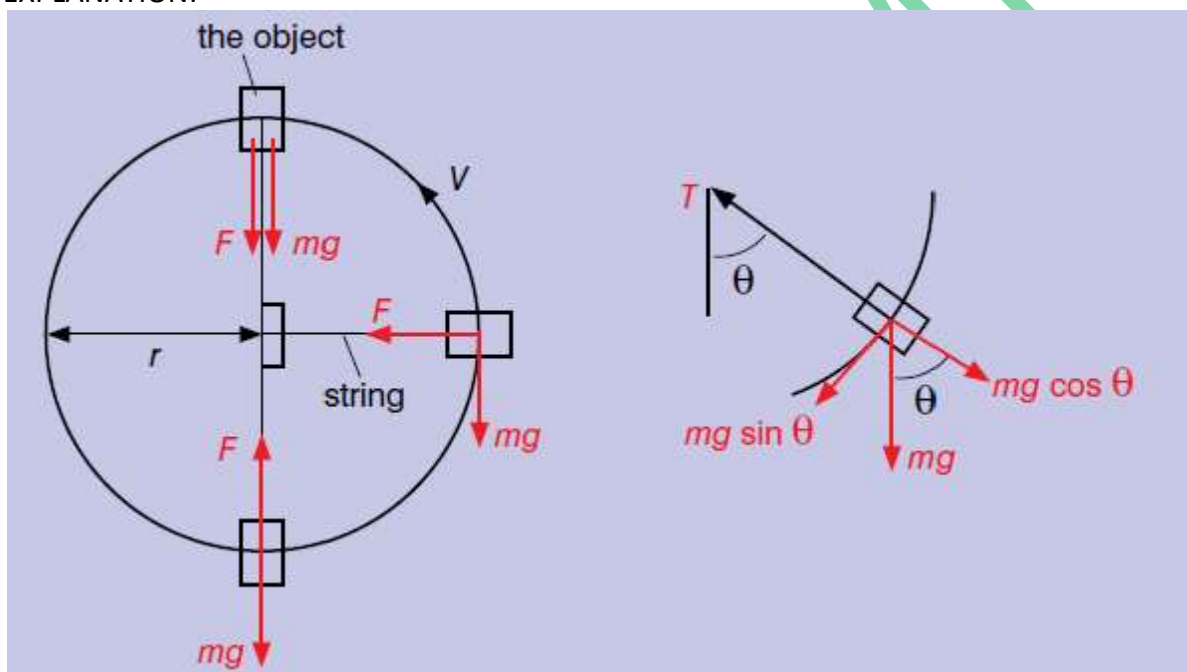
- Between C and D, the motion is with constant velocity, thus acceleration is zero.
- Between B and C, $a = \frac{\Delta v}{\Delta t} = \frac{12-4}{3-2} = 8\text{m/s}^2$
- Total displacement is total Area under the graph
 Thus $A = \frac{1}{2}(2 \times 4) + \frac{1}{2}(1 \times 8) + 1 \times 4 + 3 \times 12 + \frac{1}{2}(6 \times 12) = 84\text{m}$

- Between D and E, $a = \frac{\Delta v}{\Delta t} = \frac{0-12}{12-6} = -2\text{m/s}^2$

ANSWER: C

16. An object of mass M is set in a vertical circular motion. The tension T from the rope keeps the object in a circular path with speed v . Where does the rope experience a maximum tension?
- (A) At the top of the circle
 (B) When it is at 45° to the vertical line
 (C) When the object is at half of the circle
 (D) At the bottom of the circle

EXPLANATION:



The tension in the rope is given by:

$$T = \frac{mv^2}{r} + mg \cos \theta$$

At bottom of the circle $\theta = 0^\circ$

$$T = \frac{mv^2}{r} + mg \cos(0^\circ) = \frac{mv^2}{r} + mg$$

Since, the rope experience a maximum tension at the **BOTTOM** of the circle.

ANSWER: D

17. A shell is fired from a gun, whose barrel is inclined at an angle to the horizontal. During the flight, the shell explodes in air into fragments. The center of mass of different fragments will follow
- (A) a horizontal straight line
 (B) parabola

(C) a vertical straight line

(D) an unpredictable

EXPLANATION: since its inclined projection, center of mass of the fragment will follow parabola.

ANSWER: B

18. The rate of change of momentum of the raindrop can be given by $F = ma + u \frac{\Delta m}{\Delta t}$. In this expression what does u represent ?

(A) The rate of change of the velocity for combined system

(B) The velocity of the rain drop

(C) The velocity of the loss in mass of raindrop

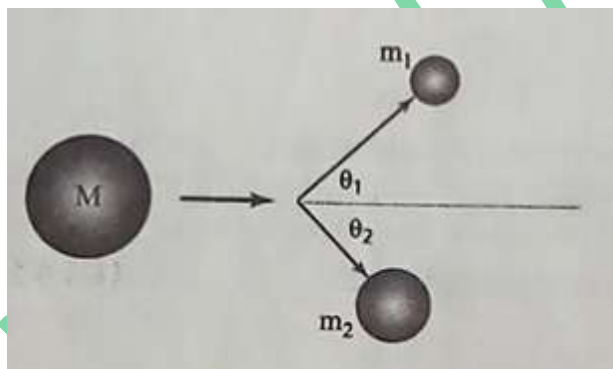
(D) The velocity of the extra mass added to the raindrop

EXPLANATION: The force acting on the raindrop at a certain time can be expressed as:

$F = \text{rate of change of momentum} = ma + u \frac{\Delta m}{\Delta t}$ where F is the force on the raindrop, m is the mass of the raindrop, u is the velocity of the extra mass that has been added to the raindrop.

ANSWER: D

19. A ball of mass M moves with speed V in the $+X$ direction. It explodes into two pieces that go off at angles of θ_1 and θ_2 , as shown below.



- (A) $P_1 = \frac{MV \cos \theta_2}{\sin(\theta_1 + \theta_2)}$, and $P_2 = \frac{MV \cos \theta_1}{\sin(\theta_1 + \theta_2)}$
 (B) $P_1 = MV \tan \theta_2$, and $p_2 = MV \tan \theta_1$
 (C) $P_1 = \frac{MV \sin \theta_2}{\sin(\theta_1 + \theta_2)}$, and $p_2 = \frac{MV \sin \theta_1}{\sin(\theta_1 + \theta_2)}$
 (D) $P_1 = \frac{MV \cos \theta_2}{\cos(\theta_1 + \theta_2)}$, and $P_2 = \frac{MV \cos \theta_1}{\cos(\theta_1 + \theta_2)}$

ANSWER: C

20. A 5Kg mass pushed upward along an inclined plane of inclinations 30° with constant force F . If the acceleration of the block for this motion is 1.0 m/s^2 and the plane is assumed to be friction less, what is the magnitude of the constant force F ?

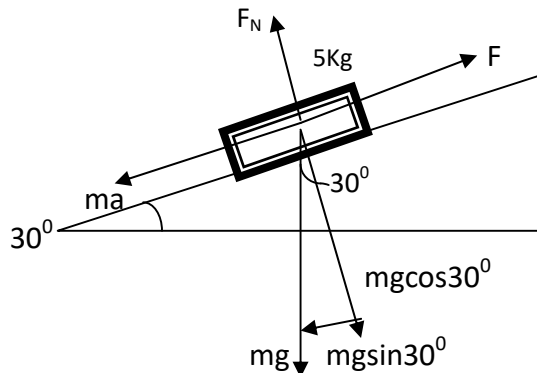
(A) 30.0N

(B) 25.0N

(C) 20.0N

(D) 5.0N

EXPLANATION:



$$\begin{aligned}
 F &= mg \sin 30^\circ + ma \\
 F &= (5)(10)(\sin 30^\circ) + (5)(1) \\
 F &= 25\text{N} + 5\text{N} = 30\text{N}
 \end{aligned}$$

ANSWER: A

21. The statement of Kirchoff's point rule follows from:
- (A) Dependence of resistance on temperature
 - (B) Conservation of energy
 - (C) Ohm's law
 - (D) Conservation of charge

EXPLANATION: Kirchoff's point rule states that the total current flowing into a point is equal to the total current flowing out the point.

This means, conservation of current in other word conservation of charge.

ANSWER: D

22. A metal rod is measured to have a resistance R. if the same metal rod is stretched to reduce its radius by half without affecting its density. What is its new resistance?
- (A) 2R (B) 16R (C) 8R (D) 4R

SOLUTION: Assume the metal before stretching has resistance R, radius r, length ℓ , volume V and after stretching has resistance R_1 , radius r_1 , length ℓ_1 , volume V_1 .

Since the density is constant and the same metal is stretched mass is constant. Thus, volume is constant.

$$V = V_1 \Rightarrow A\ell = A_1\ell_1, \quad A = \pi r^2 \quad \text{and} \quad A_1 = \pi r_1^2 = \pi \left(\frac{r}{2}\right)^2, \quad \text{since } r_1 = \frac{r}{2}$$

$$\Rightarrow \pi r^2 \ell = \pi \left(\frac{r}{2}\right)^2 \ell_1$$

$$\Rightarrow \ell_1 = 4\ell$$

Know, $R = \frac{\rho \ell}{\pi r^2}$ and,

$$R_1 = \frac{\rho \ell_1}{A_1} = \frac{\rho \times 4\ell}{\pi \left(\frac{r}{2}\right)^2} = \frac{4\rho \ell}{\frac{\pi r^2}{4}} = \frac{16\rho \ell}{\pi r^2} = 16\left(\frac{\rho \ell}{\pi r^2}\right) = 16R$$

ANSWER: B

23. A sheet of polythene ($\epsilon_r = 2.3$) and 0.25mm thick is to be used in a capacitor by sandwiching it between two sheets of aluminum foil. What area must the sheets have if the capacitor is to have a capacitance of $0.5\mu\text{F}$?

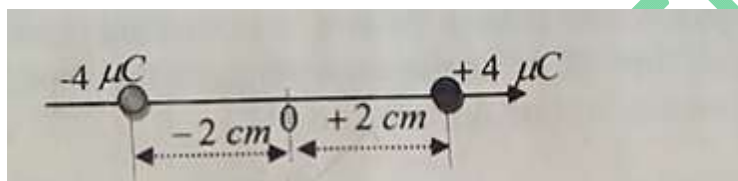
(A) 12m^2 (B) 0.6m^2 (C) 6.14m^2 (D) 0.12m^2

SOLUTION: Given: $\epsilon_r = 2.3$, $d = 0.25\text{mm} = 2.5 \times 10^{-4}\text{m}$, $C = 0.5\mu\text{F}$

$$C = \frac{\epsilon_0 \epsilon_r A}{d} \Rightarrow A = \frac{Cd}{\epsilon_0 \epsilon_r} = \frac{(5 \times 10^{-7})(2.5 \times 10^{-4})}{(2.3)(8.85 \times 10^{-12})} = 6.14\text{m}^2$$

ANSWER: C

24. Two equal and opposite charges are located along x – axis at -2.0cm and $+2.0\text{cm}$ as shown in the figure below. How much would be the electric potential at the origin?



(A) 1.8MV (B) Zero (C) 3.6MV (D) 4.5MV

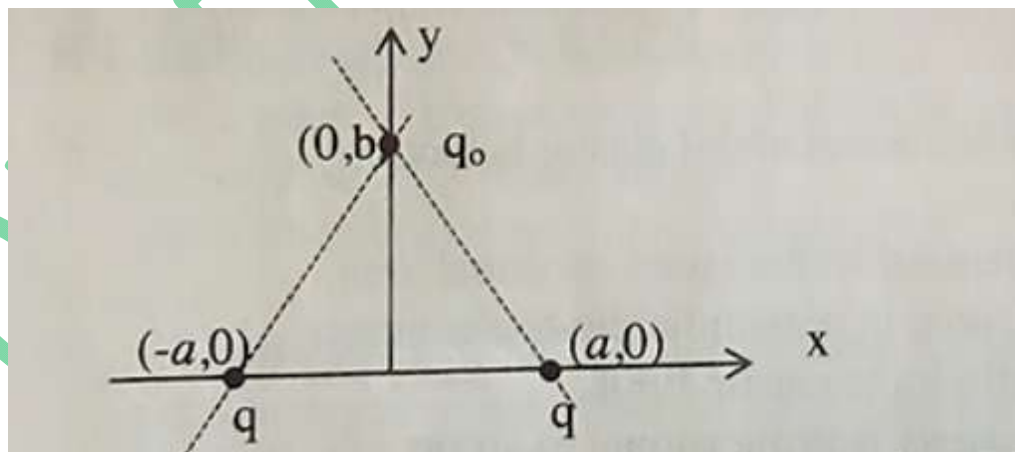
EXPLANATION:

In this question $Q = 4\mu\text{C}$ and $V = V_1 + V_2$

$$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2} = \frac{(9 \times 10^9)(-4 \times 10^{-6})}{0.02} + \frac{(9 \times 10^9)(4 \times 10^{-6})}{0.02} = 0\text{ V}$$

ANSWER: B

25. Two like charges of value q are fixed at $x = a$ and $x = -a$ in the diagram below.



If a test charge q_0 is released at $y = b$, which path will it follow?

(A) along y-axis (C) along a line $y = \frac{b}{a}x + b$
 (B) along a line $y = -\frac{b}{a}x + b$ (D) It stays at $y = b$

EXPLANATION:

- The test charge move due to the force exerted on it from both charges.
 - The charge q found at (a,0) push or pull (depending on the sign of the charge) the test charge along the line $y = -\frac{b}{a}x + b$.
 - The charge q found at (-a,0) push or pull (depending on the sign of the charge) the test charge along the line $y = \frac{b}{a}x + b$.
- ❖ Since , the net Electrostatic force on the test charge from both charges moves the test charge along y – axis

ANSWER: A

26. In Young's double slit experiment, if the slit separation is 1.2mm and the average spacing of the bright fringes observed on a screen placed 4m away from the source is 2mm. What is the wavelength of the light source?
- (A) 550nm (B) 750nm (C) 630nm (D) 600nm

SOLUTION: given:

- slit separation (s)=1.2mm
- distance from slits to screen(D)=4m
- distance b/n successive fringes(w)=2mm
- wavelength(λ)=?

$$\frac{\lambda}{s} = \frac{w}{D} \Rightarrow \lambda = \frac{ws}{D} = \frac{2mm \times 1.2mm}{4m} = 0.6 \times 10^{-6}m = 600nm$$

ANSWER: D

27. The colors seen from soap bubbles and oil slicks are a manifestation of thin film interference. What is the cause of this interference?
- (A) Interference from refraction of light.
 (B) Interference from diffraction of light.
 (C) Interference from reflection of light from the two surfaces of the film.
 (D) Interference from superposition of lights that are incident and reflected.

ANSWER:

28. A 50 cm pipe is open at one end and closed at the other end. When air is blow at 150 Hz. What is the velocity of the sound along the pipe?

(A) 300m/s (B) 100m/s (C) 330m/s (D) 150m/s

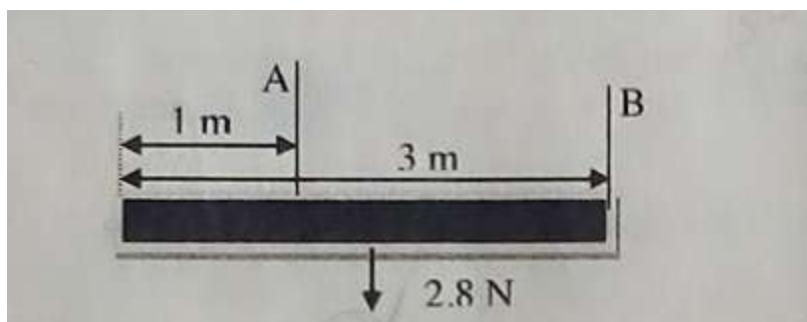
SOLUTION: since its open at one end and closed at one end its velocity is given by

$$V=4Lf$$

$$V=4Lf=4 \times 0.5m \times 150Hz=300m/s$$

ANSWER: A

29. The rod is shown in the figure below is uniform and its weight is 2.8N. The length of the rod is 3.0 m. Two ropes A and B keep the rod in the horizontal position. Rope A is 1.0m from one end and rope B is at the other end of the rope. What is the calculated value of the tension in rope A?



- (A) 1.4N (B) 0.7N (C) 2.8N (D) 2.1N

SOLUTION: assume the rod is at equilibrium and the weight of the rod is at the middle since, its weight is uniformly distributed.

By using second condition of equilibrium, find moment about point B.

$$\sum \tau_B = 0$$

$$(T_A)(2) = (2.8)(1.5) \Rightarrow T_A = 2.1\text{N}$$

ANSWER: D

30. Which of the following statement is correct about elastic behavior of materials?

- (A) In tensile stress the force is parallel to the cross-sectional area, where as in shear stress, the force is perpendicular to the area.
 (B) All materials do not necessarily have elastic limit.
 (C) For sufficiently small stress, stress is proportional to strain.
 (D) With plastic materials, the body goes to original dimensions after removal of the force that caused deformation.

EXPLANATION:

- From Hooke's law $F \sim X$
- All materials necessarily have elastic limit.
- With plastic materials, irreversible changes occurred while the body was being deformed.

ANSWER: C

31. A fluid of unknown density filled in a beaker of 250.0cm^3 . The pressure due to the fluid at the base of the beaker is 2.30 Pa . The base area of the beaker is 102cm^2 . What is the density of the fluid?

- (A) $9.2 \times 10^1 \text{ Kg/m}^3$ (C) $9.2 \times 10^6 \text{ Kg/m}^3$
 (B) $7.9 \times 10^3 \text{ Kg/m}^3$ (D) $9.2 \times 10^3 \text{ Kg/m}^3$

EXPLANATION: $P = \rho gh = \rho g \frac{V}{A}$

$$\Rightarrow \rho = \frac{PA}{gV} = \frac{(2.3)(102 \times 10^{-4})}{(10)(250 \times 10^{-6})} = 9.2 \text{ Kg/m}^3$$

ANSWER: NO ANSWER

32. Which of the following statement is correct?

- (A) Surface tension is proportional to the length along with the surface tension force acts

- (B) Surface tension pulls the liquid column up until there is sufficient mass of liquid for weight to overcome the intermolecular force.
- (C) The angle between the wall of a container and the liquid surface has no role on the capillary action.
- (D) In a given tube, the capillary action is large for a liquid of larger density.

EXPLANATION:

- ❖ Surface tension $f = \frac{F}{l}$
 - Surface tension(f) is inversely proportional with length (l)
- ❖ Capillary action $h = \frac{2f \cos \theta}{\rho g r}$
 - Capillary action is **smaller** for liquid of **larger** density.
- ❖ Surface tension pulls the liquid column up until there is sufficient mass of

ANSWER: B

33. Water flows at a rate of 0.4 litter per second through garden hose of inside diameter 4.0cm. The nozzle of the hose is a circular opening of diameter 2.cm. What is the speed of the water when, it emerges? ($\pi = 3.14$)
- (A) 0.32m/s (B) 12.7m/s (C) 3.2m/s (D) 1.27m/s

SOLUTION: from continuity equation $A_1 V_1 = A_2 V_2 = \text{discharge}$

Where, $A_1 V_1$ is Volume flow rate at the inlet

$$A_1 V_1 = 0.4 \text{ L/s} = 0.4 \times 10^{-3} \text{ m}^3/\text{s},$$

And $A_2 V_2$ is Volume flow rate at the outlet (emerge)

$$A_2, \text{ Area of the outlet } A_2 = \pi r_2^2 = 3.14 \times \left(\frac{0.02}{2}\right)^2 = 3.14 \times 0.0001 = 3.14 \times 10^{-4} \text{ m}^2$$

$$\text{Know} \Rightarrow A_1 V_1 = A_2 V_2$$

$$\Rightarrow 0.4 \times 10^{-3} \text{ m}^3/\text{s} = (3.14 \times 10^{-4} \text{ m}^2)(V_2)$$

$$\Rightarrow V_2 = 1.27 \text{ m/s}$$

ANSWER: D

34. How much heat would be absorbed by 2g of ice at 0°C dropped into water at 0°C , to melt it totally to water at 0°C ? (Latent heat of melting, $L=340,000\text{J/Kg}$)
- (A) 340J (B) 840J (C) 680J (D) 420J

SOLUTION: Given $m = 2\text{g} = 2 \times 10^{-3} \text{ Kg}$, $L = 340,000\text{J/Kg}$

$$E_H = mL_f$$

$$= (2 \times 10^{-3} \text{ Kg}) \times (340,000\text{J/Kg})$$

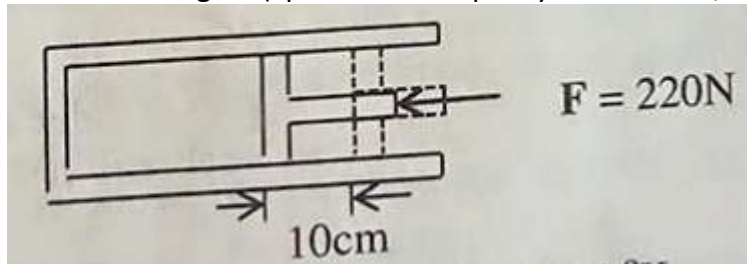
$$= 680\text{J}$$

ANSWER: C

35. The direction of heat flow is from:
- (A) high pressure to low pressure
- (B) a point of higher emissivity to lower one
- (C) high density to low density
- (D) high temperature to low temperature

ANSWER: D

36. External force of 220N applied on a piston of a cylinder containing 1.25g of ammonia gas move 10cm as shown in the diagram below. Assuming adiabatic process, what is the rise in temperature of the gas? (Specific heat capacity of ammonia, $c=2200\text{J/Kg } ^\circ\text{K}$)



- (A) 4°K (B) 0.004°K (C) 8°K (D) 0.008°K

SOLUTION: since the process is adiabatic $\Delta Q = 0$

$$\text{Then, } \Delta U = \Delta W = F\Delta x$$

$$\Rightarrow \Delta U = F\Delta x \quad \text{but } \Delta U = mc\Delta T$$

$$\Rightarrow mc\Delta T = F\Delta x$$

$$\Rightarrow \Delta T = \frac{F\Delta x}{mc} = \frac{(220)(0.1)}{(1.25 \times 10^{-3})(2200)} = 8^\circ\text{K}$$

ANSWER: C

37. Which of the following statement is correct?
(Here ρ is density of an ideal gas, m is the mass of the gas and c is speed of particles)

- (A) P (Pressure of an ideal gas) $= \frac{1}{2}\rho\langle c^2 \rangle$
 (B) For a mixture of two different gases with equal partial pressure and equal number of molecules in a container, $\frac{m_2}{m_1} = \frac{\langle c_1^2 \rangle}{\langle c_2^2 \rangle}$
 (C) For a mixture of two gases in equilibrium in a container, $\frac{\rho_2}{\rho_1} = \sqrt{\frac{\langle c_1^2 \rangle}{\langle c_2^2 \rangle}}$
 (D) For a mixture of two gases in equilibrium in a container, $\frac{\rho_1}{\rho_2} = \sqrt{\frac{\langle c_2^2 \rangle}{\langle c_1^2 \rangle}}$

EXPLANATION:

- P (Pressure of an ideal gas) $= \frac{1}{3}\rho\langle c^2 \rangle$
- For a mixture of two different gases with equal partial pressure and equal number of molecules in a container, $\frac{m_2}{m_1} = \frac{\langle c_1^2 \rangle}{\langle c_2^2 \rangle}$

ANSWER: B

38. Traveling wave is given by the equation $Y = A\cos(kx - \omega t)$, where k is the wave number and ω is the angular frequency. What is the distance that the wave travels in the time $t = T/2$?

- (A) half the wavelength
 (B) full wavelength
 (C) a quarter of the wavelength

(D) at the origin

SOLUTION: $Y = A \cos(kx - \omega t)$

$$\begin{aligned} \text{At } t = T/2, Y = A &\Rightarrow A = A \cos\left(2\pi \frac{x}{\lambda} - \left(\frac{2\pi}{T}\right)\left(\frac{T}{2}\right)\right) \\ &\Rightarrow 1 = \cos\left(2\pi \frac{x}{\lambda} - \pi\right) \\ &\Rightarrow 2\pi \frac{x}{\lambda} - \pi = \cos^{-1}(1) \\ &\Rightarrow x = \frac{\lambda}{2} \end{aligned}$$

ANSWER: A

39. Which of the following is not an example of simple harmonic motion?
- (A) A mass attached to a spring system oscillating in horizontal direction to the surface of the Earth.
 - (B) Rotation of second pointer in hand watch
 - (C) Oscillation of simple pendulum
 - (D) A mass attached to a spring system oscillating in vertical direction to the surface of the Earth.

EXPLANATION: Rotation of second pointer in hand watch is not an example of simple harmonic motion

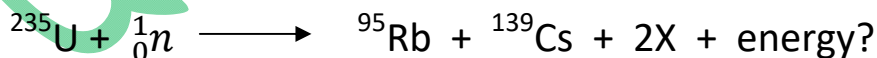
ANSWER: B

40. Which of the following statement is **NOT** correct?
- (A) No process is possible in which there is an overall decrease in the entropy of the universe.
 - (B) The spontaneous transfer of energy from cooler body to a hotter body is not possible.
 - (C) The complete conversion of energy from a hot source into work is not possible
 - (D) Spreading out of random kinetic energy through heating does not represent an overall increase in entropy.

EXPLANATION: Spreading out of random kinetic energy through heating represent an overall increase in entropy.

ANSWER: D

41. Complete the following equation which represents a nuclear fission. What is the particle represented by X?



- (A) electron (B) neutron (C) proton (D) alpha particle

EXPLANATION: The equation is balanced only when X is a neutron.

ANSWER: B

42. When ultraviolet light is shone on a clean metal surface the surface will emit electrons. What is the necessary preconditions for electrons to be ejected from the metal surface?

- (A) The intensity of light must be high enough
- (B) The frequency of the metal has to be less than that of ultraviolet light
- (C) The wavelength of the light has to be greater than that of ultraviolet light.
- (D) The minimum energy required to release the electron is the same as the work function of the metal.

EXPLANATION: The minimum energy required to release the electron is the same as the work function of the metal

ANSWER: D

43. A series circuit consisting of 50Ω resistor and capacitor of capacitive reactance 50Ω are connected to alternating source of voltage (rms) $100V$. What is the average power output and power factor of the circuit?

- (A) $141.8W$, 0.8
- (B) $200W$, 0.8
- (C) $100W$, 0.707
- (D) $70.7W$, 0.707

EXPLANATION: $R = 50\Omega$, $X_c = 50\Omega$, $V_{rms} = 100V$,

$$P_{av} = (V_{rms})(I_{rms})\cos\theta$$

$$\Rightarrow I_{rms} = \frac{V_{rms}}{Z}, \quad Z = \sqrt{R^2 + (X_L^2 - X_C^2)} = \sqrt{50^2 + 50^2} = 50\sqrt{2}$$

$$\Rightarrow I_{rms} = \frac{100}{50\sqrt{2}} = \frac{2}{\sqrt{2}} A$$

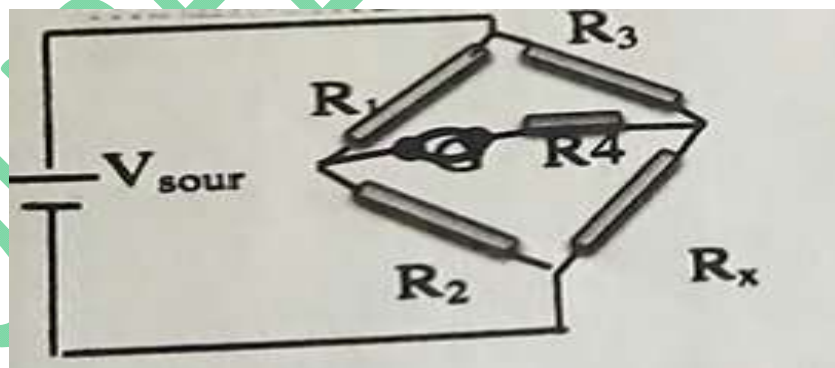
$$\Rightarrow \theta = \tan^{-1}\left(\frac{X_L - X_C}{R}\right) = \tan^{-1}\left(\frac{50}{50}\right) = \tan^{-1}(1) = 45^\circ$$

$$P_{av} = (V_{rms})(I_{rms})\cos\theta = (100)\left(\frac{2}{\sqrt{2}}\right)(\cos 45^\circ) = 100W$$

$$\text{Power factor} = \cos\theta = \cos 45^\circ = 0.707$$

ANSWER: C

44. You are given the bridge circuit as shown in the diagram below. The resistance R is used to limit the current in the galvanometer. Which of the following is correct in measuring R_x ?



- (A) The bridge balance condition is given by $\frac{R_x}{R_3} = \frac{R_2}{R_1}$
- (B) The bridge balanced when $\frac{R_1}{R_2} = \frac{R_3}{R_4}$
- (C) $\frac{R_x}{R_3} = \frac{R_1}{R_4}$
- (D) $\frac{R_x}{R_3} = \frac{R_2}{R_4}$

EXPLANATION: : the bridge is balanced if and only if : $\frac{R_X}{R_3} = \frac{R_2}{R_1}$

ANSWER: A

45. A rectangular loop of area 0.4m^2 is placed in a magnetic field that is changing at a rate of 100T/s . If the normal of the loop makes angle 60° with field, what is the magnitude of induced emf?

(A) 80V (B) 40V (C) 34,64V (D) 20V

SOLUTION: Given: $A = 0.4\text{m}^2$, $\theta = 60^\circ$, $\frac{\Delta B}{\Delta t} = 100\text{T/s}$

$$\varepsilon = \frac{A \Delta B \cos \theta}{\Delta t} = 0.4 \times 100 \times \cos 60^\circ = 20\text{V}$$

ANSWER: D

46. Two long wires of 10m in the length carries a current of 2.0A and 0.5A in the same direction. The wires are separated by 4.0cm . What is the magnetic force that the wires exerted on each other?

(A) $5 \times 10^{-6}\text{N}$ (C) $5 \times 10^{-7}\text{N}$
(B) $5 \times 10^{-5}\text{N}$ (D) $4 \times 10^{-6}\text{N}$

SOLUTION: Given $I_1 = 2\text{A}$, $I_2 = 0.5\text{A}$, $r = 4\text{cm} = 0.04\text{m}$, $\ell = 10\text{m}$, $\mu_0 = 4\pi \times 10^{-7}\text{H/m}$

$$F = \frac{\mu_0 I_1 I_2 \ell}{2\pi r} = \frac{4\pi \times 10^{-7} \times 2 \times 0.5 \times 10}{2\pi \times 0.04} = 500 \times 10^{-7}\text{N} = 5 \times 10^{-5}\text{N}$$

ANSWER: B

47. Lenz's law in electromagnetic induction follows from which law of conservation?
(A) charge (B) momentum (C) energy (D) mass

EXPLANATION: Lenz's law in electromagnetic induction follows the law of conservation
Of energy.

ANSWER: C

48. What is the expression of the centripetal acceleration of a particle of charge q and mass m moving in uniform in a uniform magnetic field $\mathbf{B}$ on a circle of radius r if $\mathbf{B}$ is perpendicular to the particle's direction of motion?

(A) $\frac{q^2 B^2}{m^2} r$ (B) $\frac{2qB}{mr}$ (C) $\frac{q^2 B^2}{m} r$ (D) $\frac{qB}{m}$

EXPLANATION: you know that $F_c = \frac{mv^2}{r}$ and $F_B = qvB$

Equate them $F_c = F_B$

$$\Rightarrow \frac{mv^2}{r} = qvB$$

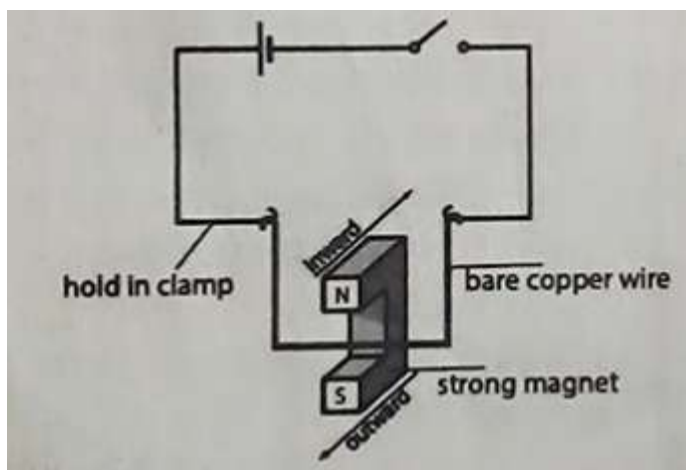
$$\Rightarrow v = \frac{qB}{m} r$$

Also you know that $a_c = \frac{v^2}{r}$

$$\Rightarrow a_c = \frac{v^2}{r} = \frac{\left(\frac{qB}{m} r\right)^2}{r} = \frac{q^2 B^2}{m^2} r$$

ANSWER: A

49. A current of 5A flows through the circuit when the switch in the figure below is closed.



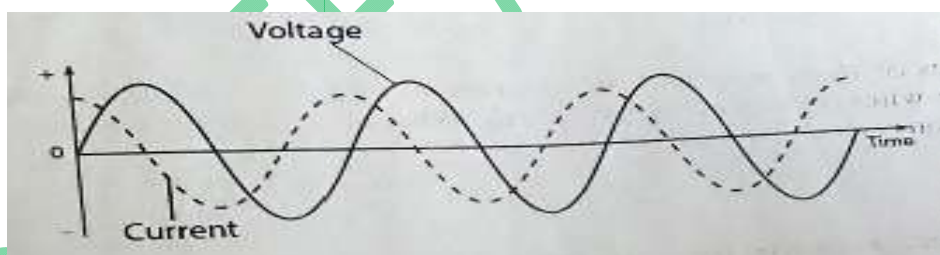
What would be the copper wire suspended on the clamp?

- (A) experience no force (C) be lifted upward
(B) be deflected outward (D) be deflected inward

EXPLANATION: by using right hand rule the wire deflected inward.

ANSWER: D

50. The applied ac voltage and the resulting current, in a circuit element, is shown below



What is the circuit element?

- (A) Inductor (B) Resistor (C) Capacitor (D) Diode

EXPLANATION: In this case current leads the voltage, thus its capacitive circuit element.

ANSWER: C