



SHIFT - 1

QUESTIONS & SOLUTIONS

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 27 JANUARY, 2024

 9:00 AM to 12:00 Noon

Duration : 3 Hours

Maximum Marks : 300

SUBJECT - PHYSICS

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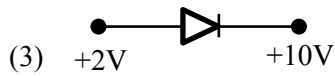
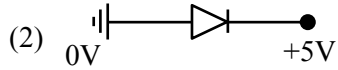
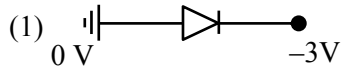
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PHYSICS

SECTION-A

1. Which among the following is forward biased:



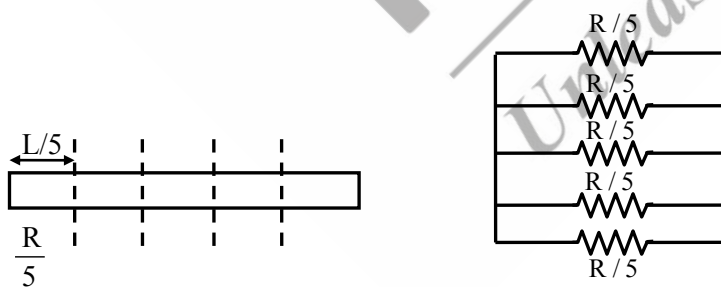
Ans. (1)

Sol. Basic theory.

2. A uniform and homogeneous rod has resistance R. If rod is cut into 5 equal parts and connected in parallel find equivalent resistance ?

Ans. $\frac{R}{25}$

Sol.



$\Rightarrow \frac{R}{25}$ Answer

3. Acceleration due to earth on the surface is g_0 . If mass of earth remains same but radius is half, then find the acceleration on the surface for new system :

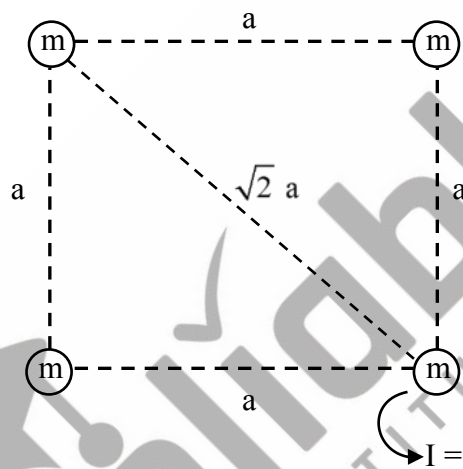
- (1) $\frac{g_0}{2}$ (2) g_0 (3) $2 g_0$ (4) $4 g_0$

Ans. (D)

Sol. $g_0 = \frac{Gm}{R^2}$

$$g = \frac{Gm}{(R/2)^2} = \frac{4Gm}{R^2} = 4g_0$$

4. Find moment of inertia about an axis passing through one corner and perpendicular to the plane.



Ans. $4 ma^2$

Sol. $I = ma^2 + ma^2 + m(\sqrt{2}a)^2 + 0 = 4 ma^2$

5. Two particles having mass 4g & 25g have same kinetic energy. Find ratio of their momentum?

- (1) $\frac{2}{5}$ (2) $\frac{2}{3}$ (3) $\frac{4}{5}$ (4) $\frac{3}{4}$

Ans. (1)

Sol. $KE_1 = KE_2$

$$\frac{P_1^2}{2m_1} = \frac{P_2^2}{2m_2}$$

$$\frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{25}} = \frac{2}{5}$$

6. An object of mass 1000 kg is moving with 6 m/s. Find speed of object is mass 200 kg is added to it ?
 (1) 4 m/s (2) 5 m/s (3) 8 m/s (4) 6 m/s

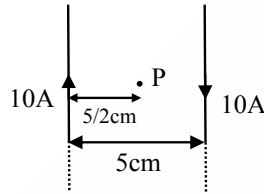
Ans. (2)

Sol. Linear momentum is conserved.

$$1000 \times 6 = 1200 (v_f)$$

$$\therefore v_f = 5 \text{ m/s}$$

7. Two very long wire having current as shown. Find the magnetic field at point 'P' (in micro tesla).



Ans. 160

Sol. $B = \frac{\mu_0 I}{2\pi D} \times 2$

$$B = \frac{2 \times 10^{-7} \times 10}{\frac{5}{2} \times 10^{-2}} \times 2$$

$$B = 16 \times 10^{-5} \text{ Tesla}$$

$$B = 160 \mu\text{T}$$

8. If the electron revolving in the third Bohr's orbit of hydrogen species has radius R, then what will be its radius in fourth orbit in terms of R.

- (1) $\frac{25R}{9}$ (2) $\frac{16R}{9}$ (3) $\frac{36R}{9}$ (4) $\frac{9R}{16}$

Ans. (B)

Sol. $R = \frac{kn^2}{Z}$

$$\frac{R}{R'} = \frac{\frac{k3^2}{Z}}{\frac{k4^2}{Z}}$$

$$\Rightarrow \frac{R}{R'} = \frac{9}{16}$$

$$\Rightarrow R' = \frac{16}{9}R$$

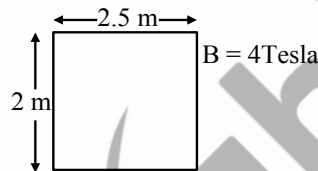
9. A charge of magnitude $10^{-6}\mu\text{C}$ is placed at origin in x-y co-ordinate system. Find the potential difference between the two point $(\sqrt{3}, \sqrt{3})$ and $(\sqrt{6}, 0)$. (Axis are in meters)

- (1) $3\sqrt{3} \times 10^3 \text{ V}$ (2) $\frac{3}{\sqrt{3}} \times 10^3 \text{ V}$
(3) 0 V (4) $2\sqrt{3} \times 10^3 \text{ V}$

Ans. (3)

Sol. Same radial distance from origin Hence Potential is same at the two given point. Thus potential difference is zero

10. Magnetic field having magnitude 4 Tesla makes an angle 60° with perpendicular to loop and loop has been removed from magnetic field region within 10 seconds. Find average induced emf in loop in 10 seconds in Volts?

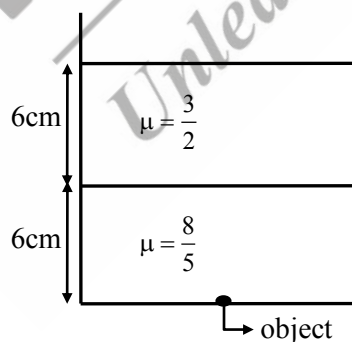


Ans. 1

Sol.
$$e_{\text{avg}} = \frac{\Delta\phi}{\Delta t} = \frac{BA \cos\theta}{10}$$

$$= 4 \times 2 \times \frac{5}{2} \times \frac{\cos 60}{10} = 1 \text{ volt}$$

11. Find apparent depth of the object shown in figure ?



Ans. $\frac{31}{4}$

Sol. Apparent depth = $\frac{6}{3/2} + \frac{6}{8/5} = 4 + \frac{15}{4} = \frac{31}{4} \text{ cm}$

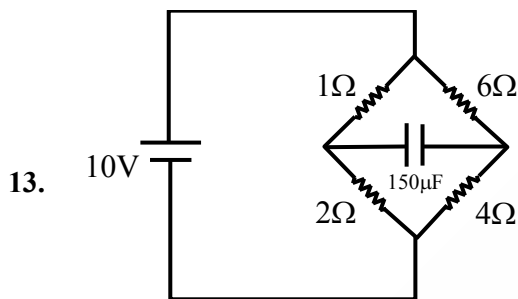
12. An EM wave is given by
 $E = 200 \sin [1.5 \times 10^7 t - 0.05 x] \text{ N/C}$
 Find the intensity of wave. [$\epsilon_0 = 8.85 \times 10^{-12} \text{ SI units}$]

Ans. 53.1

Sol. $I = \frac{1}{2} \epsilon_0 E_0^2 C_{\text{mid}}$

$$I = \frac{1}{2} \times 8.85 \times 10^{-12} \times [200]^2 \frac{1.5 \times 10^7}{0.05}$$

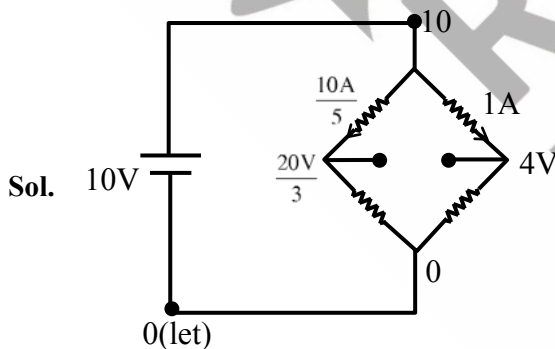
$$I = 53.1 \text{ W/m}^2$$



Find charge on capacitor at steady state?

- (1) 200 μC (2) 300 μC (3) 400 μC (4) 500 μC

Ans. (3)



$$\therefore \Delta V)_{\text{capacitor}} = \left| 4 - \frac{20}{3} \right| = \frac{8}{3} \text{ V}$$

$$\therefore q = \frac{8}{3} \times 150 = \boxed{400 \mu\text{C}}$$

14. A particle performs SHM with an amplitude 4 cm. Speed of particle at mean position is 10 cm/sec. Find position from mean where speed is 5 cm/sec

- (1) 2 cm (2) $2\sqrt{3}$ cm (3) 0.5 cm (4) $\sqrt{3}$ cm

Ans. (2)

Sol. $10 \text{ cm/s} = A\omega$... (i)

$5 \text{ cm/s} = \omega\sqrt{A^2 - x^2}$... (ii) using (i) and (ii)

$$x = \frac{\sqrt{3}A}{2} = 2\sqrt{3} \text{ cm}$$

15. Given :

$$m = 0.08 \text{ kg}$$

$$s_v = 0.17 \text{ kcal/kg-}^\circ\text{C}$$

$$\Delta T = 5^\circ\text{C}$$

Find change in internal energy (in Joule) of gas.

Ans. 284

Sol. $\Delta U = ms_v\Delta T$

$$\Delta U = 0.08 \times 0.17 \times 10^3 \times 5$$

$$\Delta U = 68 \text{ cal}$$

$$\Delta U = 284.24 \text{ Joule}$$

16. A gas undergoes isothermal expansion from 30 dm^3 to 45 dm^3 . Find heat absorbed by gas if external pressure is 10 kPa?

- (1) 100 J (2) 150 J (3) 120 J (4) 200 J

Ans. (C)

Sol. $\Delta V = 0$

$$\therefore \Delta Q = w$$

$$= nRT \ln \left(\frac{V_2}{V_1} \right)$$

$$= P_1 V_1 \ln \left(\frac{V_2}{V_1} \right)$$

$$= 10 \times 10^3 \times 30 \times 10^{-3} \ln \left(\frac{3}{2} \right)$$

$$= 300 \times 0.4$$

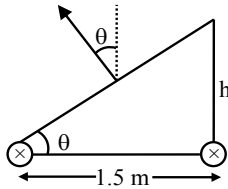
$$= 120 \text{ J}$$

17. A banked road of radius 400 m is there with base separation between the rails is 1.5 m, if speed of a car for safe turning is 12 m/s, then find height of one rail w.r.t to second rail?

(1) $h = 0.054$ m (2) $h = 0.1$ m (3) $h = 0.001$ m (4) $h = 0.2$ m

Ans. (1)

Sol.



$$N \cos \theta = mg$$

$$N \sin \theta = \frac{mv^2}{r}$$

$$\tan \theta = \frac{v^2}{rg}$$

$$\frac{h}{1.5} = \frac{12 \times 12}{400 \times 10}$$

$$h = \frac{12 \times 12}{4000} \times \frac{3}{2} = \frac{54}{1000}$$

$$h = 0.054 \text{ m}$$

18. A particle is moving from origin with initial velocity $5\hat{i}$ m/s and constant acceleration $3\hat{i} + 2\hat{j}$ m/s². When position of particle is 84 m, its velocity is $\sqrt{\alpha}$ m/s. Find out α :

Ans. 673

Sol. $x = u_x t + \frac{1}{2} a_x t^2$

$$84 = 5t + \frac{3}{2} t^2$$

$$t = 6 \text{ sec.}$$

$$\dot{v} = \dot{u} + \dot{a}t$$

$$\dot{v} = 5\hat{i} + (3\hat{i} + 2\hat{j}) 6$$

$$= 23\hat{i} + 12\hat{j}$$

$$= 529 + 144$$

$$= \sqrt{673} \text{ m/s}$$

$$\alpha = 673$$

19. **Statement-1** : Angular momentum and Plank constant have same dimensions.

Statement-2 : Moment of force and linear momentum have same dimensions.

- (1) Both statements are true
- (2) Both statements are false
- (3) Statement 1 is true and 2nd is false
- (4) Statement 2 is true and 1st is false

Ans. (3)

Sol. $L = \frac{nh}{2\pi}$, $F = \frac{dp}{dt}$

$[L] = M^1L^2T^{-1}$

$[h] = ML^2T^{-1}$

$[\tau] = M^1L^2T^{-2}$

$[P] = M^1L^1T^{-1}$

20. A proton is moving in gravity free space with constant velocity v and goes undeviated. What can be the possible conditions.

- (A) $E = 0, B = 0$
 - (B) $E = 0, B \neq 0$
 - (C) $E \neq 0, B = 0$
 - (D) $E \neq 0, B \neq 0$
- (1) A, B, D (2) A, B, C (3) A, B, C, D (4) B, C, D

Ans. (1)

21. $S_1 \rightarrow$ Viscosity coefficient of gas is less than liquid.

$S_2 \rightarrow$ Surface tension decreases if insoluble impurities are added.

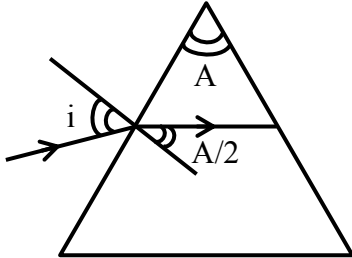
- (1) S_1 is true, S_2 is true
- (2) S_1 is false, S_2 is false
- (3) S_1 is true, S_2 is false
- (4) S_1 is false, S_2 is true

Ans. (1)

22. There is a prism of apex angle of 'A'. Its refractive index is equal to $\cot \frac{A}{2}$, then find minimum angle of deviation?

Ans. 2

Sol.



$$1 \sin i = \mu \sin \frac{A}{2}$$

$$\sin i = \left(\cot \frac{A}{2} \right) \sin \frac{A}{2}$$

$$\sin i = \cos \frac{A}{2} = \sin \left(\frac{\pi}{2} - \frac{A}{2} \right)$$

$$i = \frac{\pi}{2} - \frac{A}{2}$$

$$\delta_{\min} = 2i - A = \pi - 2A$$

Alternate Solution

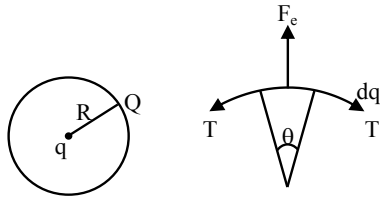
$$n = \frac{\sin \frac{A + \delta_{\min}}{2}}{\sin \frac{A}{2}}$$

$$\frac{\cos \frac{A}{2}}{\sin \frac{A}{2}} = \frac{\sin \frac{A + \delta_{\min}}{2}}{\sin \frac{A}{2}}$$

$$\Rightarrow \delta_{\min} = \pi - 2A$$

23. A point charge q is placed at a centre of a charged ring of total charge Q. Find tension in the ring.

Ans. $\frac{KQq}{2\pi R^2}$



Sol.

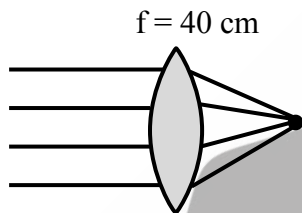
$$\frac{kq dq}{R^2} = 2T \sin\left(\frac{\theta}{2}\right) \quad \theta \approx \text{small}$$

$$\frac{kq Q \theta}{2\pi R^2} = T \theta \quad \text{Also } \frac{Q}{dq} = \frac{2\pi}{\theta}$$

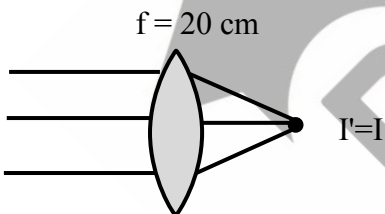
$$T = \frac{KQq}{2\pi R^2}$$

24. Light is incident on a convex lens of focal length 40 cm. And a metal plate is placed on focus of lens & photo current is measure to be I. Find new photocurrent if lens is replaced by another lens focal length of 20 cm & metal plate is kept on its focus?

Ans. $I' = I$



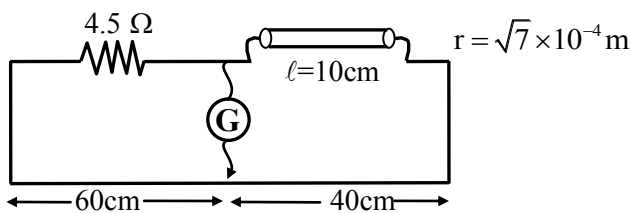
Sol.



25. In meter bridge experiment there is a resistance in right slot of length 10 cm and radius of cross section is $\sqrt{7} \times 10^{-4}$ m. In left slot these is a resistance of 4.5Ω . If balance length from left is 60 cm. If unknown resistivity is $x \times 10^{-7}$. Find 'x'.

Ans. 66

Sol.



$$\frac{60}{40} = \frac{4.5}{R} \quad \Rightarrow \quad R = 3\Omega$$

$$R = \frac{\rho \ell}{A}$$

$$3 = \rho \times \frac{1}{10 \times \pi \times 7 \times 10^{-8}} \quad \Rightarrow \quad \rho = 21\pi \times 10^{-7} = 21 \times \frac{20}{7} \times 10^{-7} = 66 \times 10^{-7} = x \times 10^{-7}$$

$$x = 66$$

26. Spherometer can't be used for measurement of :

- (1) Radius of curvature of convex mirror
- (2) Radius of curvature of concave mirror
- (3) Thickness of capacitor plates
- (4) Specific rotation of liquid

Ans. (4)

Sol. Spherometer is used to measure radius of curvature of any spherical surface and any small thickness.

