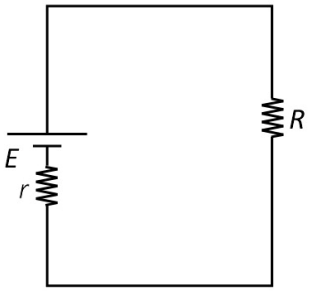
PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. In a circuit there is a battery with internal resistance r and Emf E, which is connected to external load resistance R as shown. Find value of R so that maximum power dissipates across R.



(1) $R = r$

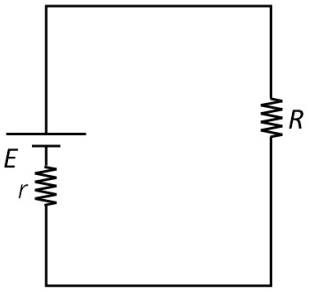
(2) $R = r/2$

(3) $R = \sqrt{2}r$

(4) $R = 2r$

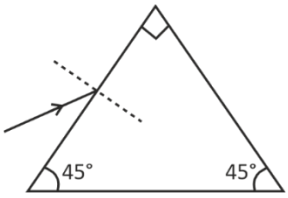
Answer (1)

Sol.



Maximum power transfer occurs for $R = r$.

2. Refractive index of prism is $\sqrt{2}$. What should be angle of incidence for a light ray such that the emerging ray grazes out of the surface.



(1) 90°

(2) 60°

(3) 30°

(4) 45°

Answer (1)

Sol. $r_1 + r_2 = 90°$

$$\sqrt{2} = \frac{\sin i}{\sin r_1}$$

and $$\sqrt{2} = \frac{1}{\sin r_2}$$

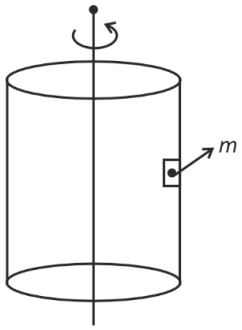
$$\sin r_2 = \frac{1}{\sqrt{2}}$$

$r_2 = 45°$

$r_1 = 45°$

$\therefore \quad i = 90°$

3. A block of mass m is at rest w.r.t. hollow cylinder which is rotating with angular speed ω, radius of cylinder is R. Find minimum coefficient of friction between block and cylinder.



(1) $\frac{3g}{2\omega^2 R}$

(2) $\frac{g}{\omega^2 R}$

(3) $\frac{g}{4\omega^2 R}$

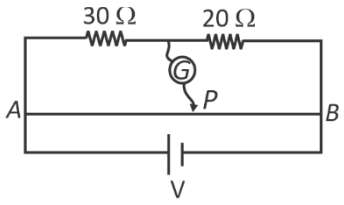
(4) $\frac{2g}{\omega^2 R}$

Answer (2)

Sol. $\mu m\omega^2 R = mg$

$$\mu = \frac{g}{\omega^2 R}$$

4. In a meter bridge two balancing resistances are 30 Ω and 20 Ω. If galvanometer shows zero deflection for the jockey's contact point *P*. Then find the length A.P.



(1) 40 cm (2) 30 cm

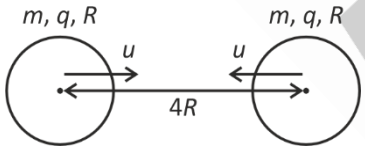
(3) 60 c, (4) 70 cm

Answer (3)

Sol. $\frac{30}{20} = \frac{\ell}{100-\ell}$

ℓ = 60 cm

5. Two spheres having equal mass *m*, charge *q* and radius *R*, are moving towards each other. Both have speed *u* at an instant when distance between their centers is 4*R*. Minimum value of *u* so that they touch each other is



(1) $\sqrt{\frac{q^2}{4\pi\varepsilon_0 mR}}$ (2) $\sqrt{\frac{q^2}{16\pi\varepsilon_0 mR}}$

(3) $\sqrt{\frac{q^2}{\pi\varepsilon_0 mR}}$ (4) $\sqrt{\frac{q^2}{8\pi\varepsilon_0 mR}}$

Answer (2)

Sol. Energy conservation,

$$2\times\frac{1}{2}mu^2 + \frac{Kq^2}{4R} = \frac{Kq^2}{2R}$$

$$\Rightarrow \quad mu^2 = \frac{Kq^2}{4R}$$

$$\Rightarrow \quad u = \sqrt{\frac{Kq^2}{4mR}} = \sqrt{\frac{q^2}{16\pi\varepsilon_0 mR}}$$

6. RMS speed for H_2 and O_2 are same. If temperature of O_2 gas is 23°C. Find temperature of H_2 gas.

(1) 18.5 K (2) 2.5°C

(3) 18°C (4) 164 K

Answer (1)

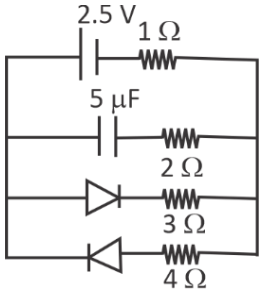
Sol. $V = \sqrt{\frac{3RT}{M}}$

$$T_{H_2} = T_{O_2}\frac{M_{H_2}}{M_{O_2}}$$

$$= 296\times\frac{1}{16}$$

$$T_{H_2} = 18.5\,K$$

7. For the given circuit arrangement, find the charge on the capacitor in steady state.



(1) 5 μF (2) $\frac{75}{8}\mu C$

(3) $\frac{15}{2}\mu F$ (4) $\frac{55}{4}\mu C$

Answer (2)

Sol. Forward biased diode will be allowing current. So current through battery $I = \frac{2.5}{4} = \frac{5}{8} A$

So ΔV across capacitor is

$\Delta V = \left(\frac{5}{8}\right) \times 3 = \frac{15}{8}$ volt

So, $q = \frac{5 \times 15}{8} = \frac{75}{8} \mu C$

8. An electron in a hydrogen like atom has energy equal to $-0.04\ E_0$, where E_0 is magnitude of energy of this electron in ground state in eV. If angular momentum of this electron is L, then value of $\frac{2\pi L}{h}$ is ($h \rightarrow$ Planck's constant)

(1) 1 (2) 4

(3) 5 (4) 6

Answer (3)

Sol. $13.6\ Z^2 = E_0$

and $\frac{-13.6\ Z^2}{n^2} = -0.04\ E_0$

$n^2 = \frac{1}{0.04} = 25$

$n = 5$

$\frac{2\pi L}{n} = \frac{2\pi}{n} \frac{nh}{2\pi} = 5$

9. During SHM, K.E. of particle in SHM varies with frequency of 176 Hz. Find out frequency of SHM of the particle.

(1) 352 (2) 176

(3) 88 (4) 44

Answer (3)

Sol. Conceptual.

KE varies with twice the frequency of SHM.

10. Position x of the particle of mass 2kg varies as function of time as $x = t^2 + t + 1$. Find out work done on the particle from $t_1 = 2$ sec to $t_2 = 3$ sec.

(1) 18 joule (2) 30 joule

(3) 34 joule (4) 24 joule

Answer (4)

Sol. $\Delta W = K.E_f - K.E_i$

$v = \frac{dx}{dt} = 2t + 1$

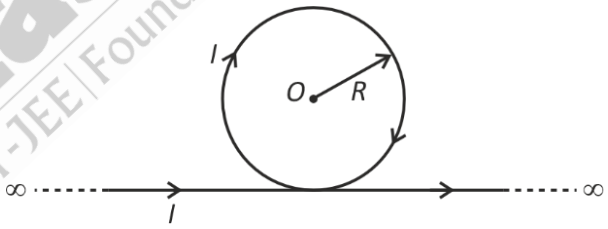
So, $V_{(1)} = 5$ m/s

$V_{(2)} = 7$ sec.

$\Delta\omega = \frac{1}{2} \times 2\left|V_2^2 - V_1^2\right|$

$\Delta w = 49 - 25 = 24$ Joule

11. Find magnetic field at point 'O' in the given figure shown.



(1) $\frac{\mu_0 I}{R}\left(2 + \frac{1}{\pi}\right)$ (2) $\frac{\mu_0 I}{2R}\left(1 + \frac{1}{\pi}\right)$

(3) $\frac{\mu_0 I}{2R}\left(1 - \frac{1}{\pi}\right)$ (4) $\frac{\mu_0 I}{4R}\left(2 + \frac{1}{\pi}\right)$

Answer (3)

Sol. $\frac{\mu_0 I}{2R}\left(1 - \frac{1}{\pi}\right)$

12. Two physical quantities x and y has measured value 23.01 and 37.3 respectively. Then value of $x + y$ is

(1) 60.3 (2) 60.31

(3) 60.03 (4) 60.310

Answer (1)

Sol. 23.01 + 37.3 = 60.31

= 60.3

13. Consider two statements given below :

Statement-I: In YDSE, if distance between slits & screen increases, fringe width also increases.

Statement-II: If wavelength of light used in YDSE increases, fringe width also increases.

Which of the following options is correct.

(1) Both statements I & II are correct

(2) Statement I is correct but statement II is incorrect

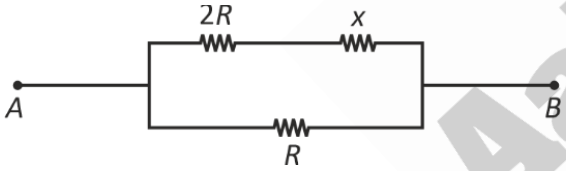
(3) Statement I is incorrect but statement II is correct

(4) Both statements I & II are incorrect

Answer (1)

Sol. $\beta = \frac{\lambda D}{d}$

14. For the given resistive network, the net resistance across $AB = x$. Then find the value of x.



(1) $x = R\left(\sqrt{2}-1\right)$ (2) $x = R\left(\sqrt{3}+1\right)$

(3) $x = R\left(\sqrt{2}+1\right)$ (4) $x = R\left(\sqrt{3}-1\right)$

Answer (4)

Sol. $R_{(AB)} = \frac{R(2R+x)}{R+2R+x} = x$

$2R^2 + Rx = 3Rx + x^2$

$x^2 + 2Rx - 2R^2 = 0$

$x = R\left(\sqrt{3}-1\right)$

15. Work done in a isobaric process is 100 Joule. If adiabatic constant for the gas is 1.4. Find heat given to the gas.

(1) 250 J (2) 350 J

(3) 150 J (4) 160 J

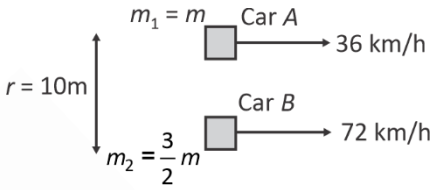
Answer (2)

Sol. $\frac{\Delta U}{W} = \frac{C_V}{R} = \frac{5}{2}$

$\Delta U = 250$

$Q = 350$ J

16. Two cars moving parallelly to each other with the velocities shown. Initial separation between cars is r = 10m. Find angular momentum of car A w.r.t. car B



(1) 100 m (2) 200 m

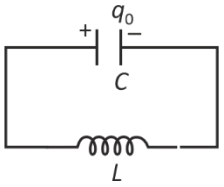
(3) 150 m (4) 75 m

Answer (1)

Sol. $L_{A/B} = m(36-72)(10)\times\frac{5}{18}$

= 100 m

17. In the given L-C circuit, charge on the capacitor is maximum at t = 0, find time at which charge becomes 25% of it's initial value first time.



(1) $\sqrt{LC}\cos^{-1}\left(\frac{1}{4}\right)$ (2) $\frac{L}{R}\ln 2$

(3) $\sqrt{LC}\sin^{-1}\left(\frac{1}{4}\right)$ (4) $\sqrt{LC}\cos^{-1}\left(\frac{1}{2}\right)$

Answer (1)

Sol. $q = q_0\cos(\omega t)$

$$\frac{q_0}{4} = q_0\cos(\omega t)$$

$$\frac{1}{\sqrt{LC}}t = \cos^{-1}\left(\frac{1}{4}\right)$$

18. A boat crosses a river, 200 m wide, in minimum possible time. If velocity of river is 5 m/s and velocity of boat is still water is 10 m/s. Then, find time taken to cross the river and displacement of the boat.

(1) 20 sec. and $100\sqrt{5}$ m

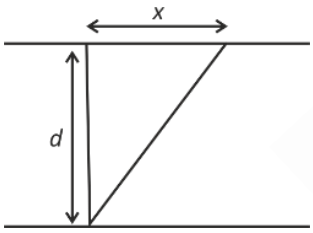
(2) 10 sec. and $100\sqrt{5}$ m

(3) 20 sec. and $200\sqrt{5}$ m

(4) 20 sec. and 200 m

Answer (1)

Sol.



$$10 = \frac{200}{t_{min}}$$

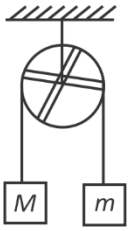
t_{min} = 20 sec.

$x = 5 \times 20 = 100$ m

displacement = $\sqrt{100^2 + 200^2}$

= $100\sqrt{5}$

19. In diagram given below, pulley is a ring of mass M radius R fitted with two rods each of mass m & length $2R$ along diameter such that if pulley rotates, Rods also rotate with same angular velocity.



Find magnitude of acceleration of m when system is released.

(1) $\frac{3(M-m)g}{(6M+5m)}$ (2) $\frac{6(M-m)g}{(6M+5m)}$

(3) $\frac{3(M-m)g}{(M+m)}$ (4) $\frac{6(M-m)g}{(M+m)}$

Answer (1)

Sol. $(M-m)gR = \left(MR^2 + mR^2 + MR^2 + \frac{2}{3}mR^2\right)\alpha$

$$a = \frac{3(M-m)g}{6M+5m}$$

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21.

22.

23.

24.

25.