

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. A has half life of 5 years. Find the amount of A left after 15 years.

- (1) $\frac{1}{8}$ of initial value
- (2) $\frac{7}{8}$ of initial value
- (3) $\frac{1}{4}$ of initial value
- (4) $\frac{3}{4}$ of initial value

Answer (1)

Sol. $N = \frac{N_0}{(2)^3}$ as 15 years = 3 half life

$$N = \left(\frac{N_0}{8}\right)$$

2. A variable force $F = 5kx$ N acts on a body moving along x-axis. Find the work done by this force in displacing the body from $x = 2$ m to $x = 5$ m.

(k is a constant)

- (1) $\left(\frac{205}{2}k\right)$ J
- (2) $\left(\frac{105}{2}k\right)$ J
- (3) $(52k)$ J
- (4) $(51k)$ J

Answer (2)

Sol. $W = \int F dx = \int_{x=2}^{x=5} 5kx \cdot dx$

$$= 5k \left. \frac{x^2}{2} \right|_{x=2}^{x=5} = \frac{5}{2}k \times 21$$

3. If de-Broglie wavelength is λ when energy is E , find wavelength at $\frac{E}{4}$ (kinetic energy).

- (1) 2λ
- (2) $\sqrt{2}\lambda$
- (3) λ
- (4) $\frac{\lambda}{\sqrt{2}}$

Answer (1)

Sol. $\therefore \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mk}}$

$$\lambda' = \frac{h}{\sqrt{\frac{2mk}{4}}} = 2\lambda$$

4. If position of particle is changing with time as $r = t^2 - 2t$ (m). Find the velocity at $t = 2$ second

- (1) 2 m/s
- (2) 3 m/s
- (3) 0 m/s
- (4) 4 m/s

Answer (1)

Sol. $\frac{dr}{dt} = (2t - 2)$

$$\left. \frac{dr}{dt} \right|_{t=2} = 4 - 2 = 2 \text{ m/s}$$

5. Height of receiving and transmitting antenna in communication of a signal are 245 m and 180 m respectively. Find the maximum distance between the two antenna for proper communication

- (1) 104 km
- (2) 208 km
- (3) 52 km
- (4) 96 km

Answer (1)

Sol. Maximum distance = $\sqrt{2Rh_r} + \sqrt{2Rh_t}$

$$= \sqrt{2 \times 6400 \times 10^3 \times 180} + \sqrt{2 \times 6400 \times 10^3 \times 245}$$

$$= 1,04,000 \text{ m} = 104 \text{ km}$$

6. If position vector of a particle is given by $\vec{r}(t) = 8t\hat{i} + 5t^2\hat{j} + 6t\hat{k}$, then the correct statement about the acceleration of the particle is

- (1) It is along positive y-axis
- (2) It is along positive x-axis
- (3) It is equally inclined to x and y-axes
- (4) It is along positive z-axis

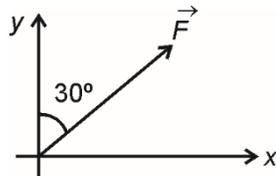
Answer (1)

Sol. $\vec{v} = 8\hat{i} + 10t\hat{j}$

$$\vec{a} = 10\hat{j}$$

\therefore It is along positive y-axis

7. If y -component of a force acting in x - y plane is $2\sqrt{3}$ N. Then the x -component will be



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

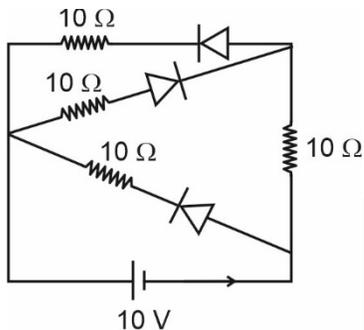
Answer (2)

Sol. $F_y = F \cos 30^\circ = 2\sqrt{3}$

$F = 4$ N

$\therefore F_x = F \sin 30^\circ = 2$ N

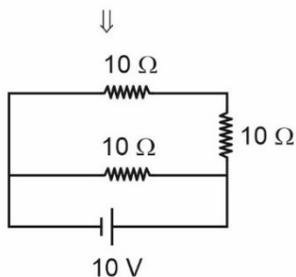
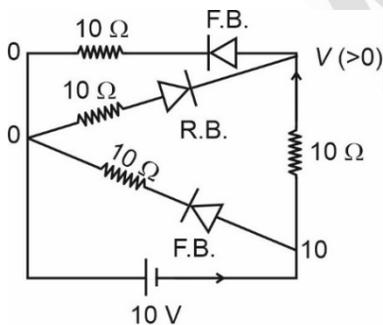
8. Find the value of current passing through battery.



- (1) 4 A (2) 1.5 A
 (3) 0.5 A (4) 1 A

Answer (2)

Sol. The biasing of diode will be as shown in figure.



$$I_b = \frac{10(20+10)}{20 \times 10} = \frac{3}{2} \text{ A}$$

9. A particle is released from a height equal to radius of earth. Find its velocity when it strikes the ground.

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

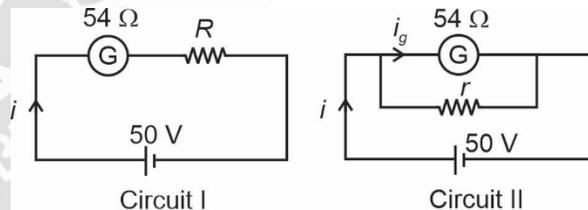
Answer (1)

Sol. From mechanical energy conservation-

$$-\frac{GMm}{2R} + 0 = -\frac{GMm}{R} + \frac{1}{2}mv^2$$

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

10. Circuit I is converted to voltmeter after adding resistance R and current in circuit I is 1 mA. Circuit II is converted to ammeter after adding resistance r as shown. If current through battery in circuit II is 10 mA and current through galvanometer is 1 mA, then find R and r if resistance of galvanometer is 54Ω .



- (1) $R = 49946 \Omega, r = 54 \Omega$
 (2) $R = 6 \Omega, r = 49946 \Omega$
 (3) $R = 49946 \Omega, r = 49946 \Omega$
 (4) $R = 49946 \Omega, r = 6 \Omega$

Answer (4)

Sol. $1 \times 10^{-3} = \frac{50}{54 + R}$

$54 + R = 50000$

$R = 49946 \Omega$

Now, $i_g = 1$ mA and current through $r = 9$ mA

So, $54 \times 1 = r \times 9$

$$r = \left(\frac{54}{9}\right) = 6 \Omega$$

11. Match the List-I with List-II and choose the correct option.

	List-I		List-II
A.	Micro-wave	(p)	400 nm – 1 nm
B.	Ultra violet	(q)	1 nm – 1 pm
C.	X-rays	(r)	2.5 μm – 750 nm
D.	Infrared	(s)	1 mm – 25 μm

- (1) A(s), B(q), C(r), D(p)
 (2) A(s), B(p), C(q), D(r)
 (3) A(p), B(s), C(q), D(r)
 (4) A(r), B(q), C(s), D(p)

Answer (2)

Sol. Theory based.

12. In a single slit diffraction experiment $\lambda = 600 \text{ nm}$, if at $\theta = 30^\circ$, first minima is formed then find the value of width of slit (a) in μm .

- (1) 1.2 (2) 1.5
 (3) 1 (4) 1.8

Answer (1)

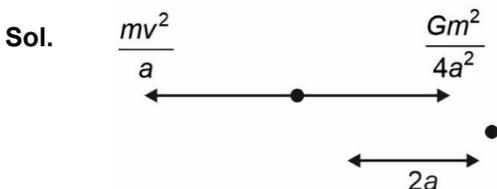
Sol. For first minima, $\sin\theta = \frac{\lambda}{a}$

$$\Rightarrow a = 2\lambda = 1200 \text{ nm} = 1.2 \mu\text{m}$$

13. Two identical particles each of mass m , move in circular path due to their own mutual gravitational force. Find the velocity of the particle if the radius of circular path is a

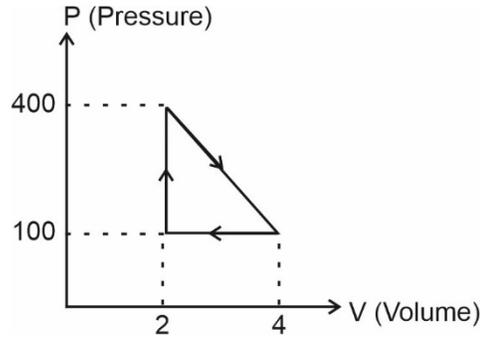
- (1) $\sqrt{\frac{4Gm}{a}}$
 (2) $\sqrt{\frac{Gm}{2a}}$
 (3) $\sqrt{\frac{2Gm}{a}}$
 (4) $\sqrt{\frac{Gm}{4a}}$

Answer (4)



$$\frac{mv^2}{a} = \frac{Gm^2}{4a^2} \Rightarrow v = \sqrt{\frac{Gm}{4a}}$$

14. Calculate the work done by the cyclic process given in indicator diagram (Assume all values in S.I. unit)

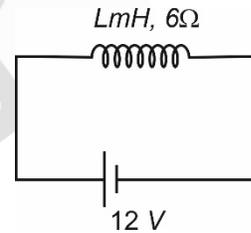


- (1) 300
 (2) - 300
 (3) 600
 (4) - 600

Answer (1)

Sol. $W = \frac{1}{2} \times 2 \times 300 = 300$

15. In given L-R circuit connected with a D.C source of 12V, inductance is $L\text{mH}$ and resistance is 6Ω . If the emf induced in the inductor at $t = 1\text{mS}$ is 10V, value of L is



- (1) $\frac{3}{\ln(1.2)}$
 (2) $\frac{6}{\ln(1.2)}$
 (3) $\frac{3}{\ln(1.8)}$
 (4) $\frac{6}{\ln(2.4)}$

Answer (2)

Sol. $i = i_0 (1 - e^{-Rt/L})$

$$\therefore \text{Emf} = \left| \frac{L di}{dt} \right| = L \left(\frac{V}{R} \right) \left(\frac{R}{L} \right) e^{-Rt/L} = V e^{-Rt/L}$$

$$10 = 12 \left(e^{-6/L} \right) \Rightarrow L = \frac{6}{\ln(1.2)}$$

16. In a linear SHM,
- acceleration is maximum at mean position,
 - velocity is maximum at extreme position,
 - acceleration is maximum at extreme position,
 - velocity is maximum at mean position.
- B, C and D are correct
 - A and D are correct
 - A and B are correct
 - C and D are correct

Answer (4)

Sol. $|a| = \omega^2 x$ and $v = \omega \sqrt{A^2 - x^2}$

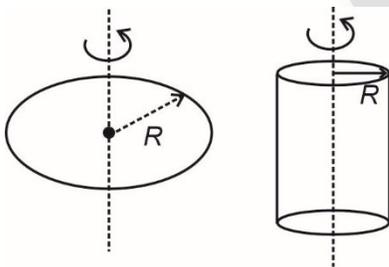
17. **Statement-I:** In a series combination of resistor, equivalent resistance is smaller than the individual resistance.
- Statement-II:** Resistivity of wire depends on the temperature.
- Statement-I is true, statement-II is false
 - Statement-I is false, statement-II is true
 - Both statement-I and statement-II are true
 - Both statement-I and statement-II are false

Answer (2)

Sol. $R_{eq} = R_1 + R_2 \Rightarrow R_{eq} > (R_1, R_2, \dots)$

$\rho = f(T)$

18. Find radius of gyration of solid sphere and solid cylinder, both having same mass and radius.



- $\frac{2}{\sqrt{5}}$
- $\frac{\sqrt{5}}{2}$
- $\frac{\sqrt{2}}{\sqrt{5}}$
- $\frac{2}{\sqrt{3}}$

Answer (1)

Sol. For solid sphere

$$\frac{2}{5} mR^2 = mk^2$$

$$k = \sqrt{\frac{2}{5}} R$$

For solid cylinder

$$\frac{mR^2}{2} = mk'^2$$

$$\Rightarrow k' = \frac{R}{\sqrt{2}}$$

$$\Rightarrow \frac{k}{k'} = \frac{2}{\sqrt{5}}$$

19. In sonometer experiment, string of mass 18 g having linear mass density 20 g/m oscillates in fundamental mode of frequency 50 Hz. Find the velocity of transverse waves in the string.
- 70 m/s
 - 60 m/s
 - 90 m/s
 - 110 m/s

Answer (3)

Sol. $f = \frac{1}{2l} \sqrt{\frac{T}{\mu}} = \frac{v}{2r}$

$$\therefore 50 = \frac{1}{2 \left(\frac{18}{20} \right)} (v)$$

$$\Rightarrow v = 90 \text{ m/s}$$

20. Velocity of is defined as $v = \lambda^a g^b \rho^c$, where ρ is density of water, λ is wavelength and g is acceleration due to gravity.

Find the value of a, b and c in order (a, b, c)

- $\left(\frac{1}{2}, \frac{1}{2}, 0 \right)$
- $\left(1, \frac{1}{2}, 0 \right)$
- $\left(\frac{1}{2}, 1, 0 \right)$
- (1, 1, 0)

Answer (1)

Sol. $M^0 L T^{-1} = L^a L^b T^{-2b} M^c L^{-3c} = M^c L^{(a+b-3c)} T^{-2b}$

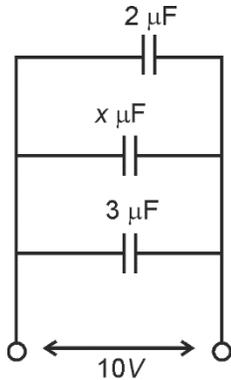
$$\Rightarrow c = 0, -2b = -1 \Rightarrow b = \frac{1}{2}$$

$$a + b - 3c = 1 \Rightarrow a + b = 1 \Rightarrow a = \frac{1}{2}$$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. If total charge stored in capacitors is equal to $50 \mu\text{C}$, then $x = ?$

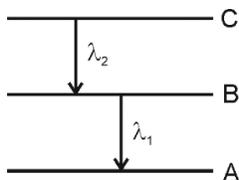


Answer ($x = 0$)

Sol. $q_{\text{Total}} = 20 \mu\text{C} + 10x \mu\text{C} + 30 \mu\text{C} = 50 \mu\text{C}$
 $x = 0$

22. In the given transition states, A, B and C are first, second and third excited states respectively then

$$\frac{\lambda_1}{\lambda_2} = \frac{7}{4n}, \text{ find the value of } n$$



Answer (5)

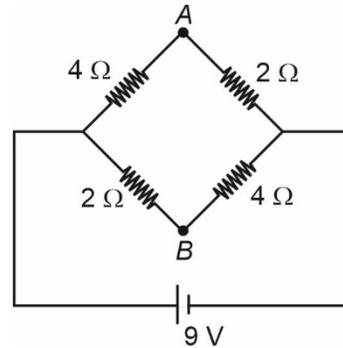
Sol. $A \rightarrow n = 2$
 $B \rightarrow n = 3$
 $C \rightarrow n = 4$

$$\lambda_1 = \frac{hc}{\Delta E_{AB}} \quad \Delta E_{AB} = Rz^2 \left(\frac{1}{4} - \frac{1}{9} \right) = \frac{5Rz^2}{36}$$

$$\lambda_2 = \frac{hc}{(\Delta E)_{BC}} \quad (\Delta E)_{BC} = Rz^2 \left(\frac{1}{9} - \frac{1}{16} \right) = \frac{7Rz^2}{144}$$

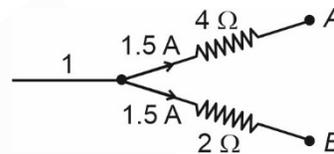
$$\frac{\lambda_1}{\lambda_2} = \frac{\Delta E_{BC}}{\Delta E_{AB}} = \frac{7}{144} \times \frac{36}{5} = \left(\frac{7}{20} \right) = \frac{7}{4n} = n = 5$$

23. Find the magnitude of potential difference in volt between A and B in given circuit.



Answer (3)

Sol. $i = \frac{9}{3} = 3\text{A}$



$$\Rightarrow V_1 - 4 \times 1.5 = V_A = V_1 - 6$$

$$\Rightarrow V_1 - 1.5 \times 2 = V_B = V_1 - 3$$

$$V_A - V_B = (V_1 - 6) - (V_1 - 3)$$

$$= -3$$

$$|V_A - V_B| = 3\text{V}$$

24. The refractive index of equilateral prism is $\mu = \sqrt{2}$, then find its minimum angle of deviation in degree.

Answer (30)

Sol. For minimum deviation, $\delta_{\text{min}} = 2i - A$

$$\text{Also, } \sin i = \sqrt{2} \sin(90^\circ - 60^\circ)$$

$$i = 45^\circ$$

$$\delta_{\text{min}} = 90^\circ - 60^\circ = 30^\circ$$

25. Electric field due to a dipole at an equatorial point depends upon r^{-n} . Value of n is

Answer (3)

Sol. $\vec{E} = \frac{kP}{r^3} \Rightarrow E \propto \frac{1}{r^3}$

26.
27.
28.
29.
30.