PHYSICS

SECTION-A

1. Match List-I with List-II

	List-I (Electromagnetic waves)		List-II (Wavelength)
(a)	AM radio waves	(i)	10^{-10} m
(b)	Microwaves	(ii)	10^{2} m
(c)	Infrared radiations	(iii)	10^{-2} m
(d)	X-rays	(iv)	10^{-4} m

Choose the correct answer from the options given below

(1) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

(2) (a) - (iii), (b) - (ii), (c) - (i), (d) - (iv)

(3) (a) - (iii), (b) - (iv), (c) - (ii), (d) - (i)

(4) (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i)

Answer (4)

Sol.

Waves	Wavelength
AM radio waves	10^{2} m
Microwaves	10^{-2} m
Infrared radiations	10^{-4} m
X-rays	10^{-10} m

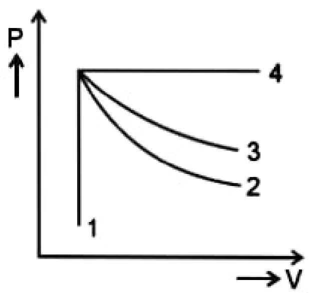
(a) - (ii)

(b) - (iii)

(c) - (iv)

(d) - (i)

2. An ideal gas undergoes four different processes from the same initial state as shown in the figure below. Those processes are adiabatic, isothermal, isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is



(1) 1

(2) 2

(3) 3

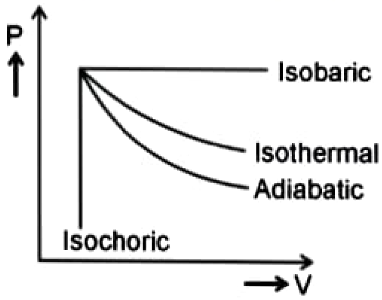
(4) 4

Answer (2)

Sol. $\left(\dfrac{dP}{dV}\right)_{\text{adiabatic}} = -\gamma P$

$$\left(\dfrac{dP}{dV}\right)_{\text{isothermal}} = -P$$

$$\left(\dfrac{dP}{dV}\right)_{\text{adiabatic}} > \left(\dfrac{dP}{dV}\right)_{\text{isothermal}}$$



3. The angular speed of a fly wheel moving with uniform angular acceleration changes from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration in rad/s² is

(1) 2π (2) 4π

(3) 12π (4) 104π

Answer (2)

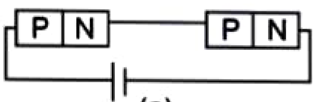
Sol. Angular acceleration $\alpha = \dfrac{\omega_f - \omega_i}{t}$

$$\omega_f = 3120 \times \frac{2\pi}{60} \text{ rad/s}$$

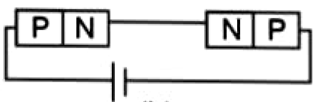
$$\omega_i = 1200 \times \frac{2\pi}{60} \text{ rad/s}$$

$$\Rightarrow \alpha = \frac{(3120 - 1200)}{16} \times \frac{2\pi}{60} = 4\pi$$

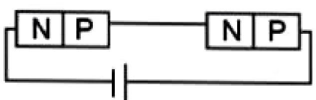
4.



(a)



(b)



(c)

In the given circuits (a), (b) and (c), the potential drop across the two *p-n* junctions are equal in

(1) Circuit (a) only (2) Circuit (b) only

(3) Circuit (c) only (4) Both circuits (a) and (c)

Answer (4)

Sol. Potential drops across the *p-n* junctions will be same if either both junctions are forward biased or both junction are reverse biased.

In figure (a) and (c), both junctions are forward biased therefore both have same potential.

In figure (b) first junction is forward biased and second junction is reverse biased, so both junctions have different potential difference.

5. A biconvex lens has radii of curvature, 20 cm each. If the refractive index of the material of the lens is 1.5, the power of the lens is

(1) +2 D

(2) +20 D

(3) +5 D

(4) Infinity

Answer (3)

Sol. Power of lens is given by

$$P = \frac{1}{f(m)}$$

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left\{\frac{3}{2} - 1\right\}\left(\frac{1}{20} + \frac{1}{20}\right)$$

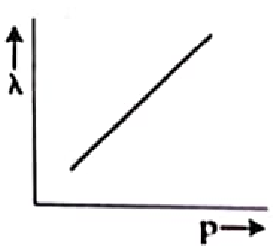
$f = 20$ cm

$$P = \frac{1}{20 \times 10^{-2}}$$

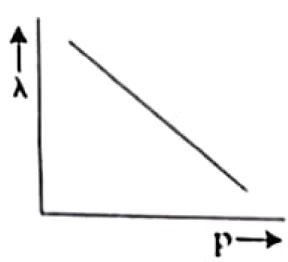
$= 5$ D

6. The graph which shows the variation of the de Broglie wavelength (λ) of a particle and its associated momentum (p) is

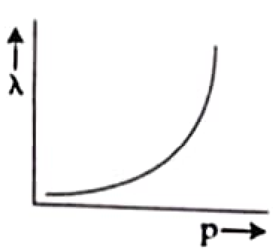
(1)



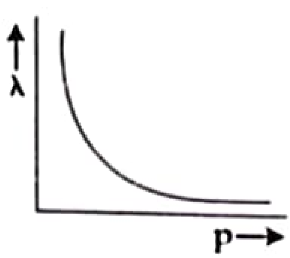
(2)



(3)



(4)

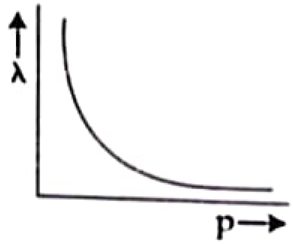


Answer (4)

Sol. de-Broglie wavelength associated with a particle is given by

$$\lambda = \frac{h}{p}$$

$$\lambda \propto \frac{1}{p}$$



7. As the temperature increases, the electrical resistance

(1) Increases for both conductors and semiconductors

(2) Decreases for both conductors and semiconductors

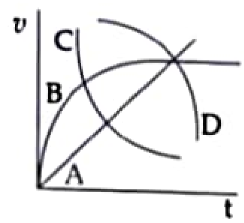
(3) Increases for conductors but decreases for semiconductors

(4) Decreases for conductors but increases for semiconductors

Answer (3)

Sol. As the temperature increases the resistivity of the conductor increases hence the electrical resistance increases. However for semiconductor the resistivity decreases with the temperature. Hence electrical resistance of semiconductor decreases.

8. A spherical ball is dropped in a long column of a highly viscous liquid. The curve in the graph shown, which represents the speed of the ball (v) as a function of time (t) is

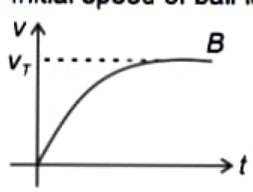


(1) A (2) B

(3) C (4) D

Answer (2)

Sol. Initial speed of ball is zero and it finally attains terminal speed



9. The dimensions $[MLT^{-2}A^{-2}]$ belong to the

(1) Magnetic flux (2) Self inductance

(3) Magnetic permeability (4) Electric permittivity

Answer (3)

Sol. Dimensional formula of magnetic permeability is $[MLT^{-2}A^{-2}]$

10. In half wave rectification, if the input frequency is 60 Hz, then the output frequency would be

(1) Zero (2) 30 Hz
(3) 60 Hz (4) 120 Hz

Answer (3)

Sol. In half wave rectifier, the output frequency is same as that of input frequency.

11. If the initial tension on a stretched string is doubled, then the ratio of the initial and final speeds of a transverse wave along the string is

(1) 1 : 1 (2) $\sqrt{2} : 1$
(3) $1 : \sqrt{2}$ (4) 1 : 2

Answer (3)

Sol. We know, velocity of transverse wave

$$v = \sqrt{\frac{T}{\mu}}$$

$$\therefore \quad v_i = \sqrt{\frac{T}{\mu}} \text{ and } v_f = \sqrt{\frac{2T}{\mu}}$$

$$\therefore \quad \frac{v_i}{v_f} = \frac{1}{\sqrt{2}}$$

12. A shell of mass *m* is at rest initially. It explodes into three fragments having mass in the ratio 2 : 2 : 1. If the fragments having equal mass fly off along mutually perpendicular directions with speed *v*, the speed of the third (lighter) fragment is

(1) v (2) $\sqrt{2}v$
(3) $2\sqrt{2}v$ (4) $3\sqrt{2}v$

Answer (3)

Sol. Momentum of the system would remain conserved.

Initial momentum = 0

Final momentum should also be zero.

Let masses be 2*m*, 2*m*, and *m*

Momentum along *x*-direction = $2mv\hat{i}$

Momentum along *y*-direction = $2mv\hat{j}$

Net momentum $= \sqrt{(2mv)^2 + (2mv)^2} = \sqrt{2} \cdot 2mv$

Now, $2\sqrt{2}mv = mv'$

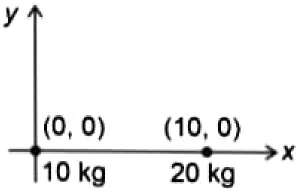
$$\boxed{v' = 2\sqrt{2}v}$$

13. Two objects of mass 10 kg and 20 kg respectively are connected to the two ends of a rigid rod of length 10 m with negligible mass. The distance of the center of mass of the system from the 10 kg mass is

(1) $\frac{10}{3}$ m (2) $\frac{20}{3}$ m
(3) 10 m (4) 5 m

Answer (2)

Sol.



$$X_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

$$= \frac{10\times 0 + 20\times 10}{10+20}$$

$$= \frac{200}{30}$$

$$= \frac{20}{3}\text{ m}$$

14. If a soap bubble expands, the pressure inside the bubble

(1) Decreases
(2) Increases
(3) Remains the same
(4) Is equal to the atmospheric pressure

Answer (1)

Sol. Excess pressure inside the bubble = $\Delta P = \frac{4T}{R}$

$$P_{in} = P_{out} + \frac{4T}{R}$$

as '*R*' increases '*P*' decreases

15. An electric lift with a maximum load of 2000 kg (lift + passengers) is moving up with a constant speed of 1.5 ms^{-1}. The frictional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is : (g = 10 m s^{-2})

(1) 23000
(2) 20000
(3) 34500
(4) 23500

Answer (3)

Sol. $F_{up} = 2000g + 3000$

$= 23000$ N

Minimum power $P_{min} = \vec{F}\cdot\vec{v}$

$$P_{min} = Fv = 23000\times\frac{3}{2}$$

$= 34500$ W

16. The angle between the electric lines of force and the equipotential surface is

(1) 0°
(2) 45°
(3) 90°
(4) 180°

Answer (3)

Sol. $dV = -\vec{E}\cdot d\vec{r}$

$dV = -Edr\cos\theta$

For equipotential surface,

$dV = 0$

$\cos\theta = 0$

$\Rightarrow \theta = 90°$

17. When two monochromatic lights of frequency, ν and $\frac{\nu}{2}$ are incident on a photoelectric metal, their stopping potential becomes $\frac{V_s}{2}$ and V_s respectively. The threshold frequency for this metal is

(1) 2ν

(2) 3ν

(3) $\frac{2}{3}\nu$

(4) $\frac{3}{2}\nu$

Answer (4*)

Sol. Since $k_{max} = eV_s = h\nu - \phi$

$$\frac{eV_S}{2} = h\nu - h\nu_0 \quad \text{...(i)}$$

$$eV_S = \frac{h\nu}{2} - h\nu_0 \quad \text{...(ii)}$$

$$\frac{1}{2}\left[\frac{h\nu}{2} - h\nu_0\right] = h\nu - h\nu_0$$

$$\Rightarrow \quad h\nu_0 - \frac{h\nu_0}{2} = h\nu - \frac{h\nu}{4}$$

$$\Rightarrow \quad \frac{h\nu_0}{2} = \frac{3h\nu}{4}$$

$$\nu_0 = \frac{3\nu}{2}$$

* Language of question is wrongly framed. The values of stopping potentials should be interchanged.

18. A long solenoid of radius 1 mm has 100 turns per mm. If 1 A current flows in the solenoid, the magnetic field strength at the centre of the solenoid is

(1) 6.28×10^{-2} T

(2) 12.56×10^{-2} T

(3) 12.56×10^{-4} T

(4) 6.28×10^{-4} T

Answer (2)

Sol. We know, magnetic field at centre of solenoid

$$B = \mu_0 \frac{N}{\ell} I = \mu_0 n I \quad \left[n = \frac{N}{\ell}\right]$$

$$= 4\pi \times 10^{-7} \times 100 \times 10^3 \times 1 \quad \left[n = \frac{100}{10^{-3}}\right]$$

$$= 4\pi \times 10^{-2}\ \text{T}$$

$$B = 12.56 \times 10^{-2}\ \text{T}$$

19. In the given nuclear reaction, the element X is

$${}^{22}_{11}\text{Na} \rightarrow X + e^{+} + \nu$$

(1) ${}^{23}_{11}\text{Na}$

(2) ${}^{23}_{10}\text{Ne}$

(3) ${}^{22}_{10}\text{Ne}$

(4) ${}^{22}_{12}\text{Mg}$

Answer (3)

Sol. The nuclear reaction is given as

$^{22}_{11}\text{Na} \rightarrow {}^{A}_{Z}X + {}_{+1}e^{0} + \nu$

From conservation of atomic number

$11 = Z + 1 \Rightarrow Z = 10 \Rightarrow \text{Ne}$

From conservation of mass number

$22 = A + 0 \Rightarrow A = 22$

$\therefore \; {}^{A}_{Z}X = {}^{22}_{10}\text{Ne}$

20. Given below are two statements

Statement I : Biot-Savart's law gives us the expression for the magnetic field strength of an infinitesimal current element (Idl) of a current carrying conductor only.

Statement II : Biot-Savart's law is analogous to Coulomb's inverse square law of charge q, with the former being related to the field produced by a scalar source, Idl while the latter being produced by a vector source, q.

In light of above statements choose the most appropriate answer from the options given below

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct and Statement II is incorrect

(4) Statement I is incorrect and Statement II is correct

Answer (3)

Sol. According to Biot-Savart's law $d\vec{B} = \dfrac{\mu_0}{4\pi}\dfrac{Id\vec{l} \times \vec{r}}{r^3}$ which is applicable for infinitesimal element. It is analogous to Coulomb's law, where $Id\vec{l}$ is vector source and electric field is produced by scalar source q.

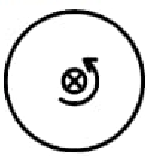
Here statement I is correct and statement II is incorrect.

21. The ratio of the radius of gyration of a thin uniform disc about an axis passing through its centre and normal to its plane to the radius of gyration of the disc about its diameter is

(1) 2 : 1 (2) $\sqrt{2} : 1$

(3) 4 : 1 (4) $1 : \sqrt{2}$

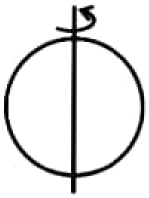
Answer (2)

Sol. 

$I_1 = \dfrac{MR^2}{2}$

$k_1 = \sqrt{\dfrac{I_1}{M}}$

$= \dfrac{R}{\sqrt{2}}$



$I_2 = \frac{MR^2}{4}$

$k_2 = \sqrt{\frac{I_2}{M}}$

$= \frac{R}{2}$

$\frac{k_1}{k_2} = \frac{\frac{R}{\sqrt{2}}}{\frac{R}{2}}$

$= \sqrt{2} : 1$

22. The peak voltage of the ac source is equal to

(1) The value of voltage supplied to the circuit
(2) The rms value of the ac source
(3) $\sqrt{2}$ times the rms value of the ac source
(4) $1/\sqrt{2}$ times the rms value of the ac source

Answer (3)

Sol. We know,

RMS value of A.C. $E_{rms} = \frac{E_0}{\sqrt{2}}$

$E_0 = \sqrt{2}E_{rms}$

23. The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is

(1) 36×10^7 J
(2) 36×10^4 J
(3) 36×10^5 J
(4) 1×10^5 J

Answer (1)

Sol. Energy = Power × time

$E = 100 \times 10^3 \times 3600$

$= 36 \times 10^7$ J

24. In a Young's double slit experiment, a student observes 8 fringes in a certain segment of screen when a monochromatic light of 600 nm wavelength is used. If the wavelength of light is changed to 400 nm, then the number of fringes he would observe in the same region of the screen is

(1) 6
(2) 8
(3) 9
(4) 12

Answer (4)

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

Let length of segment of screen = l

$\Rightarrow l = 8\beta_1 = \frac{8\lambda_1 D}{d}$ ...(1)

and $l = n\beta_2 = \frac{n\lambda_2 D}{d}$ ...(2)

from (1) and (2)

$8\lambda_1 = n\lambda_2$

$8(600 \text{ nm}) = n(400 \text{ nm})$

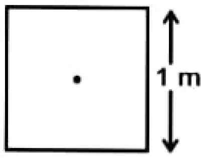
$n = 12$

25. A square loop of side 1 m and resistance 1 Ω is placed in a magnetic field of 0.5 T. If the plane of loop is perpendicular to the direction of magnetic field, the magnetic flux through the loop is

(1) 2 weber
(2) 0.5 weber
(3) 1 weber
(4) Zero weber

Answer (2)

Sol.



Magnetic flux $(\phi_B) = \vec{B} \cdot \vec{A}$

$\vec{B}$ and $\vec{A}$ are in same direction, therefore

$\phi_B = B.A = 0.5 \times 1^2$

$= 0.5$ Wb

26. Two resistors of resistance, 100 Ω and 200 Ω are connected in parallel in an electrical circuit. The ratio of the thermal energy developed in 100 Ω to that in 200 Ω in a given time is

(1) 1 : 2
(2) 2 : 1
(3) 1 : 4
(4) 4 : 1

Answer (2)

Sol. For parallel combination

$$P = \frac{V^2}{R}$$

$$\frac{P_1}{P_2} = \frac{R_2}{R_1}$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{200}{100} = \frac{2}{1}$$

27. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second

(1) 1 : 2 : 3 : 4
(2) 1 : 4 : 9 : 16
(3) 1 : 3 : 5 : 7
(4) 1 : 1 : 1 : 1

Answer (3)

Sol. $S_{n^{th}} = u + \frac{1}{2}a(2n-1)$

$$S_{1^{st}} = \frac{1}{2}g(2\times 1-1) = \frac{g}{2}$$

$$S_{2^{nd}} = \frac{1}{2}g(2\times 2-1) = 3\left(\frac{1}{2}g\right)$$

$$S_{3^{rd}} = \frac{1}{2}g(2\times3-1) = 5\times\left(\frac{1}{2}g\right)$$

$$S_{4^{th}} = \frac{1}{2}g(2\times4-1) = 7\times\left(\frac{1}{2}g\right)$$

$$S_{1^{st}} : S_{2^{nd}} : S_{3^{rd}} : S_{4^{th}}$$

$$= 1 : 3 : 5 : 7$$

28. A body of mass 60 g experiences a gravitational force of 3.0 N, when placed at a particular point. The magnitude of the gravitational field intensity at that point is

(1) 0.05 N/kg
(2) 50 N/kg
(3) 20 N/kg
(4) 180 N/kg

Answer (2)

Sol. $F = mE_G$

$$3 = \frac{60}{1000}E_G$$

$E_G = 50$ N/kg

29. A light ray falls on a glass surface of refractive index $\sqrt{3}$, at an angle 60°. The angle between the refracted and reflected rays would be

(1) 30°
(2) 60°
(3) 90°
(4) 120°

Answer (3)

Sol. Given $i = 60°$ and $\mu = \sqrt{3}$

$\Rightarrow$ Here, angle of incidence $\Rightarrow i = \tan^{-1}(\mu)$

Hence, reflected and refracted rays would be perpendicular to each other.

30. When light propagates through a material medium of relative permittivity ε_r and relative permeability μ_r, the velocity of light, v is given by (c-velocity of light in vacuum)

(1) $v = c$
(2) $v = \sqrt{\frac{\mu_r}{\varepsilon_r}}$
(3) $v = \sqrt{\frac{\varepsilon_r}{\mu_r}}$
(4) $v = \frac{c}{\sqrt{\varepsilon_r\mu_r}}$

Answer (4)

Sol. $v = \frac{1}{\sqrt{\varepsilon_m\mu_m}}$

$$v = \frac{1}{\sqrt{\varepsilon_0\varepsilon_r\mu_0\mu_r}}$$

Since $c = \frac{1}{\sqrt{\varepsilon_0\mu_0}}$

$$\Rightarrow v = \frac{c}{\sqrt{\varepsilon_r\mu_r}}$$

31. Two hollow conducting spheres of radii R_1 and R_2 ($R_1 >> R_2$) have equal charges. The potential would be

(1) More on bigger sphere
(2) More on smaller sphere
(3) Equal on both the spheres
(4) Dependent on the material property of the sphere

Answer (2)

Sol. Potential of conducting hollow sphere $= \frac{KQ}{R}$

Now, Q = same

$\Rightarrow V \propto \frac{1}{R} \Rightarrow$ more the radius less will be the potential.

$\Rightarrow$ Hence potential would be more on smaller sphere

32. A copper wire of length 10 m and radius $\left(\frac{10^{-2}}{\sqrt{\pi}}\right)$ m has electrical resistance of 10 Ω. The current density in the wire for an electric field strength of 10 (V/m) is

(1) 10^4 A/m^2
(2) 10^6 A/m^2
(3) 10^{-5} A/m^2
(4) 10^5 A/m^2

Answer (4)

Sol. Resistance, $R = \rho\frac{L}{A} = \frac{L}{\sigma A}$

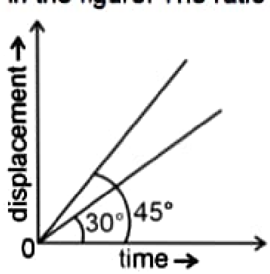
$\Rightarrow \quad \sigma = \frac{L}{RA}$

Also current density $j = \sigma E = \frac{LE}{RA}$

$$j = \frac{10 \times 10}{10 \times \pi\left(\frac{10^{-2}}{\sqrt{\pi}}\right)^2} = \frac{100}{10 \times \pi \times \left(\frac{10^{-4}}{\pi}\right)}$$

$= 10^5$ A/m^2

33. The displacement-time graphs of two moving particles make angles of 30° and 45° with the x-axis as shown in the figure. The ratio of their respective velocity is



(1) $\sqrt{3} : 1$
(2) $1 : 1$
(3) $1 : 2$
(4) $1 : \sqrt{3}$

Answer (4)

Sol. Slope of x-t curves gives the velocity

$$\Rightarrow \text{Ratio} = \frac{\tan 30°}{\tan 45°} = \frac{\frac{1}{\sqrt{3}}}{1} = 1 : \sqrt{3}$$