

6. A ray is incident at an angle of incidence i on one surface of a small angle prism (with angle of prism A) and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ , then the angle of incidence is nearly equal to:

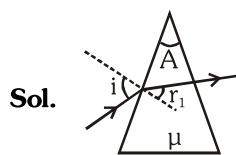
(1) $\frac{\mu A}{2}$

(2) $\frac{A}{2\mu}$

(3) $\frac{2A}{\mu}$

(4) μA

Ans. (4)



$r_2 = 0$

$r_1 = A$

Apply Snell's law

$\sin i = \mu \sin r_1$

for small angle ($r_1 = A$)

$i = \mu A$

7. A body weighs 72 N on the surface of the earth. What is the gravitational force on it, at a height equal to half the radius of the earth?

(1) 24 N

(2) 48 N

(3) 32 N

(4) 30 N

Ans. (3)

Sol. $W_s = mg_s = 72 \text{ N}$

$$W_h = mgh_h = \frac{mg_s}{\left(1 + \frac{h}{R}\right)^2} = \frac{72 \text{ N}}{\left(1 + \frac{R/2}{R}\right)^2} = \frac{72}{9/4}$$

$W_h = 32 \text{ N}$

8. An iron rod of susceptibility 599 is subjected to a magnetising field of 1200 A m^{-1} . The permeability of the material of the rod is :

$(\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1})$

(1) $2.4\pi \times 10^{-7} \text{ T m A}^{-1}$

(2) $2.4\pi \times 10^{-4} \text{ T m A}^{-1}$

(3) $8.0 \times 10^{-5} \text{ T m A}^{-1}$

(4) $2.4\pi \times 10^{-5} \text{ T m A}^{-1}$

Ans. (2)

Sol. $\mu_r = x_m + 1 = 599 + 1 = 600$

$\mu = \mu_0 \mu_r = 4\pi \times 10^{-7} \times 600$

$= 2.4\pi \times 10^{-4} \frac{\text{Tm}}{\text{A}}$

9. For transistor action, which of the following statements is **correct**?

(1) The base region must be very thin and lightly doped.

(2) Base, emitter and collector regions should have same doping concentrations.

(3) Base, emitter and collector regions should have same size.

(4) Both emitter junction as well as the collector junction are forward biased.

Ans. (1)

Sol. Base region is very thin and lightly doped.

10. Light with an average flux of 20 W/cm^2 falls on a non-reflecting surface at normal incidence having surface area 20 cm^2 . The energy received by the surface during time span of 1 minute is :

(1) $48 \times 10^3 \text{ J}$

(2) $10 \times 10^3 \text{ J}$

(3) $12 \times 10^3 \text{ J}$

(4) $24 \times 10^3 \text{ J}$

Ans. (4)

Sol. $I = \frac{E}{At}$

$E = IAt$

$= \frac{20}{10^{-4}} \times 20 \times 10^{-4} \times 60$

$= 24 \times 10^3 \text{ J}$

11. A short electric dipole has a dipole moment of $16 \times 10^{-9} \text{ C m}$. The electric potential due to the dipole at a point at a distance of 0.6 m from the centre of the dipole, situated on a line making an angle of 60° with the dipole axis is :

$$\left(\frac{1}{4\pi \epsilon_0} = 9 \times 10^9 \text{ N m}^2 / \text{C}^2 \right)$$

(1) zero

(2) 50 V

(3) 200 V

(4) 400 V

Ans. (3)

Sol. $V = \frac{kP \cos \theta}{r^2} = \frac{9 \times 10^9 \times 16 \times 10^{-9}}{(0.6)^2} \times \frac{1}{2}$

$V = 200 \text{ V}$

18. The ratio of contributions made by the electric field and magnetic field components to the intensity of an electromagnetic wave is :

(c = speed of electromagnetic waves)

(1) $1 : c^2$ (2) $c : 1$
(3) $1 : 1$ (4) $1 : c$

Ans. (3)

Sol. In EMW, electric field and magnetic field have same energy density and same intensities.

19. Assume that light of wavelength 600 nm is coming from a star. The limit of resolution of telescope whose objective has a diameter of 2 m is :

(1) 6.00×10^{-7} rad (2) 3.66×10^{-7} rad
(3) 1.83×10^{-7} rad (4) 7.32×10^{-7} rad

Ans. (2)

Sol. Limit of resolution = $\frac{1.22\lambda}{a}$

$$= \frac{1.22 \times 6 \times 10^{-7}}{2}$$

$$= 3.66 \times 10^{-7} \text{ rad}$$

20. A wire of length L, area of cross section A is hanging from a fixed support. The length of the wire changes to L_1 when mass M is suspended from its free end. The expression for Young's modulus is :

(1) $\frac{MgL}{A(L_1 - L)}$ (2) $\frac{MgL_1}{AL}$
(3) $\frac{Mg(L_1 - L)}{AL}$ (4) $\frac{MgL}{AL_1}$

Ans. (1)

Sol. $Y = \frac{FL}{A\Delta L} = \frac{MgL}{A(L_1 - L)}$

21. The energy required to break one bond in DNA is 10^{-20} J. This value in eV is nearly :

(1) 0.006 (2) 6
(3) 0.6 (4) 0.06

Ans. (4)

Sol. $E = \frac{10^{-20}}{1.6 \times 10^{-19}} \text{ eV}$
 $= 0.625 \times 10^{-1}$
 $= 0.0625 \text{ eV}$

22. In a certain region of space with volume 0.2 m^3 the electric potential is found to be 5 V throughout. The magnitude of electric field in this region is :

(1) 5 N/C (2) Zero
(3) 0.5 N/C (4) 1 N/C

Ans. (2)

Sol. Potential is constant throughout the volume
 \therefore Electric field is zero.

23. The mean free path for a gas, with molecular diameter d and number density n can be expressed as :

$$(1) \frac{1}{\sqrt{2} n^2 \pi^2 d^2} \quad (2) \frac{1}{\sqrt{2} n \pi d}$$

$$(3) \frac{1}{\sqrt{2} n \pi d^2} \quad (4) \frac{1}{\sqrt{2} n^2 \pi d^2}$$

Ans. (3)

Sol. Mean free path for a gas sample

$$\lambda_m = \frac{1}{\sqrt{2} \pi d^2 n}$$

where d is diameter of a gas molecule and n is molecular density

24. An electron is accelerated from rest through a potential difference of V volt. If the de Broglie wavelength of the electron is 1.227×10^{-2} nm, the potential difference is :

(1) 10^4 V (2) 10 V
(3) 10^2 V (4) 10^3 V

Ans. (1)

Sol. $\lambda = 1.227 \times 10^{-2} \text{ nm}$

$$= 0.1227 \text{ \AA}$$

$$\lambda = \frac{12.27}{\sqrt{v}} \text{ \AA}$$

$$0.1227 = \frac{12.27}{\sqrt{v}} \text{ \AA}$$

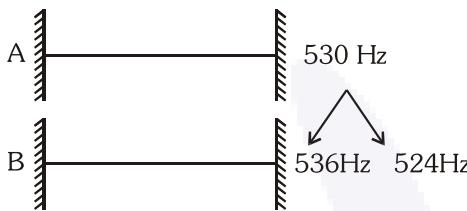
$$\sqrt{v} = 10^2 \Rightarrow v = 10^4 \text{ volt}$$

25. In a guitar, two strings A and B made of same material are slightly out of tune and produce beats of frequency 6 Hz. When tension in B is slightly decreased, the beat frequency increases to 7 Hz. If the frequency of A is 530 Hz, the original frequency of B will be:

(1) 537 Hz (2) 523 Hz
(3) 524 Hz (4) 536 Hz

Ans. (3)

Sol. Guitar string i.e. string is fixed from both ends



$$\text{Frequency} \propto \sqrt{\text{Tension}}$$

If tension in B slightly decrease then frequency of B decrease.

If B is 536 Hz, as the frequency decreases, beats with A also decreases.

If B is 524 Hz, as the frequency decreases, beats with A increases.

\therefore Original frequency of B will be 524 Hz.

26. A 40 μF capacitor is connected to a 200 V, 50 Hz ac supply. The rms value of the current in the circuit is, nearly :

(1) 25.1 A (2) 1.7 A
(3) 2.05 A (4) 2.5 A

Ans. (4)

$$\text{Sol. } I = \frac{V}{X_C} = \frac{V}{1/C\omega} = VC\omega$$

$$= 200 \times 40 \times 10^{-6} \times 2\pi \times 50 \\ = 2.5 \text{ A}$$

27. The increase in the width of depletion region in a p-n junction diode is due to :

(1) increase in forward current
(2) forward bias only
(3) reverse bias only
(4) both forward bias and reverse bias

Ans. (3)

Sol. In reverse bias external battery attract majority charge carriers.
so width of the depletion region increase

28. The Brewster's angle i_b for an interface should be:

(1) $i_b = 90^\circ$ (2) $0^\circ < i_b < 30^\circ$
(3) $30^\circ < i_b < 45^\circ$ (4) $45^\circ < i_b < 90^\circ$

Ans. (4)

$$\text{Sol. } \tan i_b = \frac{\mu_2}{\mu_1} = \frac{\mu_2}{1}$$

$$\mu_2 > 1$$

$$\therefore \tan i_b > 1$$

$$\therefore 90^\circ > i_b > 45^\circ$$

29. The phase difference between displacement and acceleration of a particle in a simple harmonic motion is :

(1) Zero (2) π rad
(3) $\frac{3\pi}{2}$ rad (4) $\frac{\pi}{2}$ rad

Ans. (2)

Sol. Displacement (x) equation of SHM

$$x = A \sin (\omega t + \phi) \quad \dots(1)$$

$$\frac{dx}{dt} = A\omega \cos (\omega t + \phi)$$

$$\text{acceleration (a)} = \frac{d^2x}{dt^2}$$

$$a = -\omega^2 A \sin (\omega t + \phi)$$

$$a = \omega^2 A \sin (\omega t + \phi + \pi) \quad \dots(2)$$

from (1) & (2), phase difference between displacement and acceleration is π .

30. A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere ?

$$\left(\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 / \text{C}^2 \right)$$

(1) $1.28 \times 10^7 \text{ N/C}$
(2) $1.28 \times 10^4 \text{ N/C}$
(3) $1.28 \times 10^5 \text{ N/C}$
(4) $1.28 \times 10^6 \text{ N/C}$

Ans. (3)

$$\text{Sol. } E = \frac{kQ}{r^2} = \frac{9 \times 10^9 \times 3.2 \times 10^{-7}}{(15 \times 10^{-2})^2}$$

$$E = 1.28 \times 10^5 \text{ N/C}$$

31. The capacitance of a parallel plate capacitor with air as medium is $6 \mu\text{F}$. With the introduction of a dielectric medium, the capacitance becomes $30 \mu\text{F}$. The permittivity of the medium is :
 $(\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2})$
 (1) $5.00 \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
 (2) $0.44 \times 10^{-13} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
 (3) $1.77 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$
 (4) $0.44 \times 10^{-10} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$

Ans. (4)

Sol. $C_m = \epsilon_r C_0$

$$\epsilon_r = \frac{30}{6} = 5$$

$$\epsilon = \epsilon_0 \cdot \epsilon_r = 8.85 \times 10^{-12} \times 5$$

$$\epsilon = 0.44 \times 10^{-10}$$

32. Taking into account of the significant figures, what is the value of $9.99 \text{ m} - 0.0099 \text{ m}$?
 (1) 9.9 m (2) 9.9801 m
 (3) 9.98 m (4) 9.980 m

Ans. (3)

Sol. In subtraction the number of decimal places in the result should be equal to the number of decimal places of that term in the operation which contain lesser number of decimal places.

$$\begin{array}{r}
 9.99 \\
 -0.0099 \\
 \hline
 9.98 \rightarrow 3 \text{ significant figures}
 \end{array}$$

33. A series LCR circuit is connected to an ac voltage source. When L is removed from the circuit, the phase difference between current and voltage is $\frac{\pi}{3}$. If instead C is removed from the circuit, the phase difference is again $\frac{\pi}{3}$ between current and voltage. The power factor of the circuit is :
 (1) -1.0 (2) zero
 (3) 0.5 (4) 1.0

Ans. (4)

Sol. When L removed $\tan \phi = \frac{X_C}{R}$

When L removed $\tan \phi = \frac{X_L}{R}$

$$\frac{X_C}{R} = \frac{X_L}{R} \Rightarrow \text{Resonance}$$

$$Z = R$$

$$\cos \phi = \frac{R}{Z} = \frac{R}{R} = 1$$

34. Dimensions of stress are :

(1) $[\text{M L}^{-1} \text{ T}^{-2}]$ (2) $[\text{M L T}^{-2}]$
 (3) $[\text{M L}^2 \text{ T}^{-2}]$ (4) $[\text{M L}^0 \text{ T}^{-2}]$

Ans. (1)

Sol. stress = $\frac{\text{Force}}{\text{Area}}$

$$= \frac{\text{M}^1 \text{L}^1 \text{T}^{-2}}{\text{L}^2}$$

$$\text{stress} = \text{M}^1 \text{L}^{-1} \text{T}^{-2}$$

35. Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. What will be the photoelectric current if the frequency is halved and intensity is doubled ?

(1) zero
 (2) doubled
 (3) four times
 (4) one-fourth

Ans. (1)

Sol. $K_1 = 1.5 h\nu_0 - \phi_0 = 0.5 h\nu_0$

$$K_2 = \frac{1.5}{2} h\nu_0 - h\nu_0 = -0.25 h\nu_0$$

\therefore Kinetic energy can never be negative
 So, no emission and $i = 0$

OR

In second case the incident frequency is halved

$$\text{Incident frequency} = \frac{1.5}{2} \nu_0 = 0.75 \nu_0$$

Now the incident frequency is less than threshold frequency so no emission of electron take place therefore no current. ($i = 0$)

36. The solids which have the negative temperature coefficient of resistance are :
 (1) insulators and semiconductors
 (2) metals
 (3) insulators only
 (4) semiconductors only

Ans. (1)

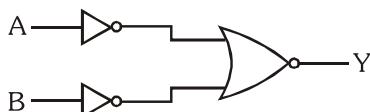
37. A charged particle having drift velocity of $7.5 \times 10^{-4} \text{ ms}^{-1}$ is an electric field of $3 \times 10^{-10} \text{ Vm}^{-1}$, has a mobility in $\text{m}^2 \text{ V}^{-1} \text{ s}^{-1}$ of :

(1) 2.25×10^{-15}
 (2) 2.25×10^{15}
 (3) 2.5×10^6
 (4) 2.5×10^{-6}

Ans. (3)

Sol. $\mu = \frac{v_d}{E} = \frac{7.5 \times 10^{-4}}{3 \times 10^{-10}}$
 $= 2.5 \times 10^6$

42. For the logic circuit shown, the truth table is :



	A	B	Y
(1)	0	0	1
	0	1	0
	1	0	0
	1	1	0
(2)	A	B	Y
	0	0	0
	0	1	0
	1	0	0
	1	1	1
(3)	A	B	Y
	0	0	0
	0	1	1
	1	0	1
	1	1	1
(4)	A	B	Y
	0	0	1
	0	1	1
	1	0	1
	1	1	0

Ans. (2)

Sol. $Y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}} = A \cdot B = \text{AND gate}$

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

43. The energy equivalent of 0.5 g of a substance is:

- $0.5 \times 10^{13} \text{ J}$
- $4.5 \times 10^{16} \text{ J}$
- $4.5 \times 10^{13} \text{ J}$
- $1.5 \times 10^{13} \text{ J}$

Ans. (3)

Sol. $E = mc^2$
 $= 0.5 \times 10^{-3} \times 9 \times 10^{16}$
 $= 4.5 \times 10^{13} \text{ J}$

44. For which one of the following, Bohr model is **not** valid?

- Singly ionised neon atom (Ne^+)
- Hydrogen atom
- Singly ionised helium atom (He^+)
- Deuteron atom

Ans. (1)

Sol. Bohr model is applicable for only single electron species.

45. The quantities of heat required to raise the temperature of two solid copper spheres of radii r_1 and r_2 ($r_1 = 1.5 r_2$) through 1 K are in the ratio:

- $\frac{5}{3}$
- $\frac{27}{8}$
- $\frac{9}{4}$
- $\frac{3}{2}$

Ans. (2)

Sol. Heat supplied $\Delta Q = Ms\Delta T$
 For same material 's' same.

$$\Delta Q \propto M \quad \text{and} \quad M = \frac{4}{3}\pi r^3 \rho$$

$$\Delta Q \propto r^3$$

$$\frac{\Delta Q_1}{\Delta Q_2} = \left(\frac{r_1}{r_2} \right)^3 = \left(\frac{1.5}{1} \right)^3 = \frac{27}{8}$$