COMED K – PHYSICS – 2012

VERSION CODE: C

1. The number of neutrons in $_{92}U^{235}$ nucleus is

   a) 327 b) 235 c) 143 d) 92

Ans: (c)

The number of neutrons = A – Z

= 238 – 92 = 143

2. Reverse saturation current of a diode

   a) is independent of temperature

   b) increases with increase in temperature

   c) Decreases with increase in temperature

   d) May increase or decrease with increase in temperature depending on the semiconductor

Ans: (b)

3. A radioactive sample has a half – life of 10 minutes. If 64 nuclei are contained in the sample the number of nuclei that would decay after 50 minutes is

   a) 2 b) 5 c) 59 d) 62

Ans: (d)

$$t = nT_{1/2} \Rightarrow n = \frac{t}{T_{1/2}} = \frac{50}{10} = 5$$

$$N = \frac{N_0}{2^n} = \frac{64}{2^5} = 2$$

$\therefore$ Number of nuclei decayed during 50 minutes = $N_0 - N = 62$

4. The carrier of electromagnetic interaction is

   a) Gluon b) Photon c) Meson d) Graviton

Ans: (b)

5. The output of NOT gate when its input is 0

   a) is 1 b) is 0 c) can be 0 or 1 d) is 0 and 1

Ans: (a)

6. LCD stands for

   a) Light Carrying Diode b) Liquid-Crystal Display

   c) Long Crystal Display d) Light Crystal Display

Ans: (b)

7. Which of the following statement is false

   a) Sound and light wave exhibit interference

   b) Sound and light wave exhibit diffraction

   c) Light wave exhibits polarization while sound wave does not

   d) Sound wave exhibits polarization while light wave does not

Ans: (d)

8. The correct relation between S, θ, L and C for an optically active solution is

a) $S = \theta LC$ b) $\theta = SLC$ c) $L = \theta SC$ d) $C = \theta LS$

Ans: (b)

9. An inductor and a resistor are connected to an ac supply of 50V and 50Hz. If the voltage across the resistor is 40V the voltage across the inductor will be

a) 10V b) 20V c) 30V d) 60V

Ans: (c)

For an LR circuit, applied voltage $V = \sqrt{V_R^2 + V_L^2}$ $\therefore V_L = \sqrt{50^2 - 40^2} = 30V$

10. A 10μF capacitor is charged to 10V and disconnected from the battery. If another uncharged 10μF capacitor is connected across it in parallel the voltage across the combination will be

a) 5V b) 10V c) 20V d) 0

Ans: (a)

Common potential difference $V_c = \dfrac{V_1C_1 + V_2C_2}{C_1 + C_2}$

Here $V_2 = 0$

$\therefore V_C = \dfrac{10x10x10^{-6}}{(10+10)x10^{-6}} = 5V$

11. When two light nuclei fuse to form a relatively heavier nucleus, the Specific binding energy of the product nucleus is

a) Lower than that of the reacting nuclei

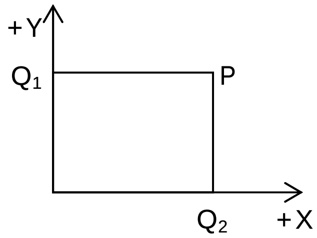
b) Equal to that of the reacting nuclei

c) Greater than that of the reacting nuclei

d) Equal to exactly half of either of the reacting nuclei

Ans: (c)

12. Two point charges $Q_1 = 2\mu C$ and $Q_2 = 1\mu C$ are placed as shown. The coordinates of the point P. are (2cm, 1cm). The electric intensity vector at P subtends an angle θ with the positive X axis. The value of θ is given by



a) $\tan \theta = 1$

b) $\tan \theta = 2$

c) $\tan \theta = 3$

d) $\tan \theta = 4$

Ans: (b)

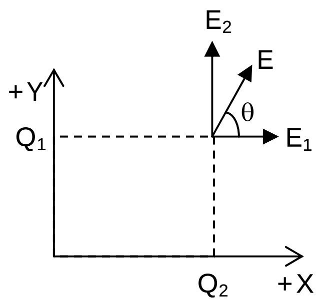
As $E \propto \dfrac{Q}{d^2}$

$\dfrac{E_1}{E_2} = \dfrac{2\mu}{(2cm)^2} x \dfrac{(1cm)^2}{1\mu} = \dfrac{1}{2} \therefore E_2 = 2E_1$

As $\vec{E_1}$ is directed along +ve x – axis & $\vec{E_2}$ along +ve y-axis,

angle made by their resultant $\vec{E}$ with +ve x-axis is given by

$\tan\theta = \dfrac{E_2}{E_1} = 2$



13. The direction of the force on a current carrying conductor held perpendicular to an Uniform magnetic field is given by

a) Fleming's right hand rule
b) Ampere's swimming rule
c) Maxwell's right hand cork screw rule
d) Fleming's left hand rule

Ans: (d)

14. A convex lens of focal length F is placed in contact with a concave lens of focal length F. The equivalent focal length of the combination is

a) Infinity
b) F/2
c) 2F
d) Zero

Ans: (a)

Here $f_1 = F$ & $f_2 = -F$

Equivalent focal length is f

Then $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F} + \frac{1}{-F} = 0 \therefore f = \frac{1}{0} = \infty$

15. If $x = at + bt^2$ where x is measured in m and t in s, then the dimension of (b/a) is

a) LT^{-2}
b) LT^{-1}
c) T
d) T^{-1}

Ans: (d)

The given equation is $x = at + bt^2$

The standard equation is $s = ut + \frac{1}{2}at^2$

$\therefore [a] = [u] = LT^{-1}$ & $[b] = [a] = LT^{-2}$

$\therefore \left[\frac{b}{a}\right] = \frac{LT^{-2}}{LT^{-1}} = T^{-1}$

16. A particle is moving eastward with a velocity $5ms^{-1}$. In 10s the velocity changes to 5 ms^{-1} northwards. The average acceleration in this time is

a) $\frac{1}{\sqrt{2}}ms^{-2}$ towards North West
b) $\frac{1}{2}ms^{-2}$ towards North West
c) $\frac{1}{\sqrt{2}}ms^{-2}$ towards North East
d) $\frac{1}{2}ms^{-2}$ towards North East

Ans: (a)

$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} = \frac{5\hat{j} - 5\hat{i}}{10} = 0.5\hat{j} - 0.5\hat{i}$

$\therefore |\vec{a}| = \sqrt{0.5^2 + 0.5^2} = \sqrt{2} \times 0.5 = \frac{1}{\sqrt{2}}ms^{-2}$ and directed North-West

17. A mass of 0.1 kg is hung at the 20cm mark from a 1m rod weighing 0.25kg pivoted at its centre. The rod will not topple if

a) No other mass is attached to the rod
b) 0.15 kg is hung at 80 cm mark
c) 0.15 kg is hung at 70cm mark
d) 0.10 kg is hung at 70 cm mark

Ans: (c)

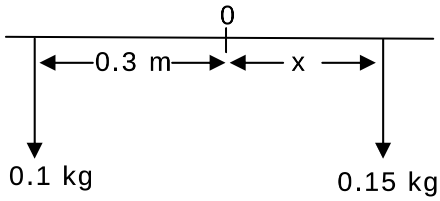
The rod will not topple if net torque about pivot is zero. Therefore one more mass should be suspended from the rod on other side of the pivot. If we take 0.1 kg mass, then it must be placed symmetrically i.e., at 80cm mark. Therefore let us consider 0.15 kg mass.

From Fig,

0.1 x 0.3 = 0.15 x x

$\Rightarrow$ x = 0.2m = 20cm

Then actual position is 50 + 20 = 70cm mark.



18. Which of the following cannot be explained on the basis of Bernoulli's principle?

a) Lift on an aircaft's wing b) Ink filler

c) Swing of a cricket ball d) Atomizer

Ans: (b)

19. The layer in the earth's atmosphere which reflects radio waves from the earth thus, helping radio communication is

a) stratosphere b) Mesosphere c) Troposphere d) Ionosphere

Ans: (d)

20. The reaction of the floor on an object placed on the floor of an elevator is maximum when elevator

a) is stationary

b) Accelerates upwards

c) Cable snaps and it falls freely towards the earth

d) Accelerates downwards

Ans: (b)

Normal reaction N = m (g + a)

21. A particle is projected at an angle of 30^0 with the horizontal with a momentum P. At the highest point its momentum is

a) $\frac{\sqrt{3}}{4}P$ b) $\frac{2}{\sqrt{3}}P$ c) P d) $\frac{1}{2}P$

Ans: OPTIONS DOES NOT MATCH

P = mu

$P^1 = m\ (u\cos\theta)$

$= mu\ \frac{\sqrt{3}}{2} = \frac{P\sqrt{3}}{2}$

22. A block of mass 0.1 kg is held against a wall by applying a horizontal force of 5N on it. If μ_s between the wall and the block is 0.5 the magnitude of the frictional force acting on the block is

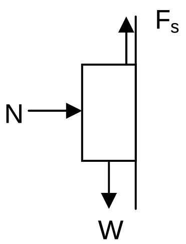
a) 0.98N b) 0.49N c) 4.9 N d) 2.5 N

Ans: (a)

As the block is at rest,

$F_s = W = 0.1 \times 9.8$

= 0.98 N



23. A ring rolls down an inclined plane. The ratio of the rotational kinetic energy to translational kinetic energy is

a) 1 : 3 b) 1 : 1 c) 3 : 1 d) 2 : 1

Ans: (b)

For a rolling ring, Rotational Kinetic energy $K_R = \frac{1}{2}IW^2 = \frac{1}{2}(mR^2)\left(\frac{v}{R}\right)^2 = \frac{1}{2}mv^2 = K_T$

$\therefore \frac{K_R}{K_T} = 1$

24. If 120 J of work is done in 2 minutes by a water pump, the power of the pump is

a) 14.4 KW b) 240 W c) 60W d) 1W

Ans: (d)

$P = \frac{W}{t} = \frac{120}{2x60} = 1W$

25. Assuming $g_{(moon)} = \left(\frac{1}{6}\right)g_{earth}$ and $D_{(moon)} = \left(\frac{1}{4}\right)D_{earth}$ where g and D are the acceleration due to gravity and diameter respectively, the escape velocity from the moon is

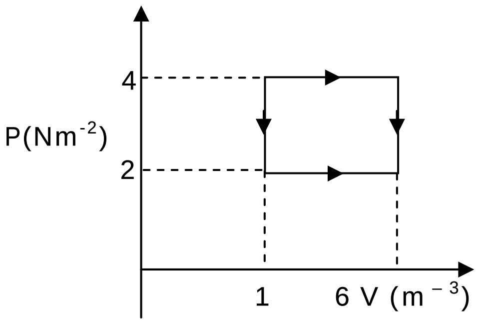
a) $\frac{11.2}{24}\,kms^{-1}$ b) $11.2 \times \sqrt{24}\,kms^{-1}$ c) $\frac{11.2}{\sqrt{24}}\,kms^{-1}$ d) $11.2 \times 24\,kms^{-1}$

Ans: (c)

Escape velocity $v_e = \sqrt{2gR}$

$\therefore \frac{v_m}{v_e} = \sqrt{\frac{\frac{1}{6}g_e \times \frac{1}{4}R_e}{g_e x R_e}} = \frac{1}{\sqrt{24}} \quad \therefore v_m = \frac{11.2}{\sqrt{24}}\,kms^{-1}$

26. The work done in taking an ideal gas through one cycle of operation as shown in the indicator diagram below



a) 10^{-5} J

b) 10^{-3} J

c) 10^{-2} J

d) 10J

Ans: (d)

Work done = Area enclosed

$= (\Delta P)\,(\Delta V) = (4 - 2)\,(6 - 1) = 2 \times 5 = 10J$

27. The ratio of speed of sound in Hydrogen to that in Oxygen at the same temperature is

a) 1 : 4 b) 4 : 1 c) 1 : 1 d) 16 : 1

Ans: (b)

Speed of sound $v = \sqrt{\frac{RT}{M}}$

Both hydrogen and oxygen are diatomic gasses

Molecular weight of hydrogen = 2 and that of oxygen = 32

$\therefore \frac{v_H}{v_0} = \sqrt{\frac{M_0}{M_H}} = \sqrt{\frac{32}{2}} = 4$

28. A black body at a temperature T radiates energy at the rate of E Wm^{-2}. If the temperature is decreased by (T/2) the energy radiated will be

a) E/4 b) E/16 c) E/8 d) E/32

Ans: (c)

$E \propto T^4$

$$\frac{E^1}{E} = \frac{(T/2)^4}{T^4} = \frac{1}{2^4} = \frac{1}{16}$$

29. A particle executes simple harmonic motion with amplitude A. The distance moved by the particle in one oscillation is

a) Zero b) A c) 2A d) 4A

Ans: (d)

30. A capacitor of 10μF is connected to a 10V cell. The maximum charge on the capacitor will be

a) 1μC b) 10μC c) 100μC d) 1000μC

Ans: (c)

q = CV ($\because$ capacitor will charge up to the potential of the cell)

$= 10 \times 10^{-6} \times 10$

$= 100\ \mu C$

31. A wire of uniform cross section has a resistance R. It is cut into ten equal parts. The parts are connected in parallel between two points A and B. The effective resistance between A and B will

a) 0.01 R b) 0.1 R c) R d) 10 R

Ans: (a)

Resistance of each part $R^1 = \frac{R}{10} = 0.1R$

$R_{AB} = \frac{R^1}{10} = 0.01R$

32. Wires made of Iron and Silicon is cooled from 50^0C to 30^0C

a) Resistance of both wires decreases

b) Resistance of both wires increases

c) Resistance of Iron increases and that of Silicon decreases

d) Resistance of Iron decreases and that of Silicon increases

Ans: (d)

When cooled, resistance of conductors decreases while that of semiconductors increases.

33. In a metre bridge a copper coil is connected in the right gap and a resistance of 10Ω in the left gap. The balance point is obtained at 0.2m. The resistance of the coil is

a) 40Ω b) 5Ω c) 20Ω d) 2.5Ω

Ans: (a)

$$\frac{P}{Q} = \frac{\ell}{1-\ell} \Rightarrow \frac{10}{Q} = \frac{0.2}{0.8}$$

$Q = 40\Omega$

34. Two identical concentric coils X and Y carrying currents in the ratio 1 : 2 are arranged in mutually perpendicular planes. If the magnetic field due to coil X is B the net field at their common centre is

a) B b) 2B c) 3B d) $\sqrt{5}$ B

Ans: (d)

As the coils are arranged in mutually perpendicular planes, the field produced at their common centre B_x and B_y will be perpendicular to each other. More over, except current, all other parameters being same

$\frac{Bx}{B_y} = \frac{I_x}{I_y} = \frac{1}{2}$ $\therefore B_x = B$ & $B_y = 2B$

The net magnetic field is given by $B_{net} = \sqrt{B_x^2 + B_y^2} = \sqrt{B^2 + (2B)^2} = \sqrt{5}\,B$

35. Which of the following is based on mechanical effect of electric current?

a) AC Dynamo b) DC Dynamo c) AC or DC motor d) Electric Geyser

Ans: (c)

36. According to Faraday's law of electromagnetic induction an emf is induced in a coil if

a) An Electric flux links with the coil b) Magnetic flux links with the coil

c) Magnetic flux linked with the coil changes d) Electric flux linked with the coil changes

Ans: (c)

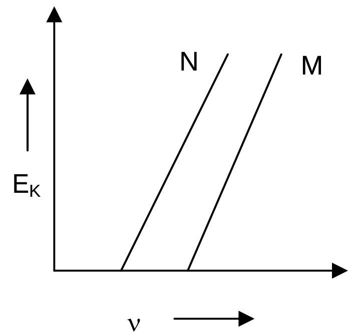
37. The current in a coil changes form 1 mA to 5mA in 4 milli second. If the coefficient of self-induction of the coil is 10mH the magnitude of the "self-induced" emf is

a) 10mV b) 5mV c) 2.5mV d) 1mV

Ans: (a)

Self induced emf e = $L\frac{dI}{dt} = 10 \times 10^{-3} \times \frac{4 \times 10^{-3}}{4 \times 10^{-3}} = 10mV$

38. The graph of kinetic energy of photoelectron versus frequency of incident radiation is shown for two metals M and N. We may definitely conclude



a) Work function of M > work function of N

b) Work function of M < work function of N

c) Work function of M = work function of N

d) At the threshold frequency of M the kinetic energy of the photoelectron emitted by M is more than that emitted by N

Ans: (a)

Work function = $h\nu_0$

As the threshold frequency of M is more than that of N, its work function is also more

39. Choose the wrong statement

a) Alpha particles can be scattered by Gold nucleus

b) X-ray can be diffracted by crystals

c) UV radiation can cause Photoelectric effect

d) Electrons cannot be diffracted by crystals

Ans: (d)

Fast moving electrons associated with wave and hence show diffraction

40. In the case of the Bohr atom model if E_K and U are the kinetic and potential energies of an electron in an orbit then

a) $E_K + U = 0$ b) $E_K - U = 0$ c) $2E_K + U = 0$ d) $E_K + 2U = 0$

Ans: (c)

According to Bohr atom model, U is negative and K is +ve. More over $E_K = \frac{1}{2}|U|$

$\therefore 2E_K + U = 0$

41. The ratio of the magnetic fields at the centre of a circular coil carrying current to that at a point whose distance is half of the radius of the coil is

a) $2\sqrt{5} : 8$ b) $5\sqrt{5} : 8$ c) $5\sqrt{5} : 4$ d) $2\sqrt{5} : 4$

Ans: (b)

$$\frac{B_c}{B_x} = \frac{\left(r^2 + x^2\right)^{3/2}}{r^3} = \frac{\left(r^2 + \frac{r^2}{4}\right)^{3/2}}{r^3} = \frac{\left(\frac{5}{4}r^3\right)^{3/2}}{r^3} = \left(\frac{5}{4}\right)^{3/2} = \frac{5\sqrt{5}}{8}$$

42. The difference between the wavelengths of the Stokes line and Anti-Stokes lines in the Raman spectrum of H-Br molecule is 100Å. If the wavelength of the Anti-Stokes line is 5000 Å the wavelength of the incident radiation is

a) 5050 Å b) 4950 Å c) 5100 Å d) 4900 Å

Ans: (a)

Stokes and antistokes lines are symmetrically placed about main line. Therefore if the difference between the wavelengths of a stokes line and its corresponding antistokes lines is 100 Å, then the difference between antistokes line and main line is 50 Å. More over wavelength of antistokes line is less than main line. $\therefore$ wavelength of incident radiation is 5050 Å.

43. Optical pumping means transferring electrons

a) from ground state to metastable state

b) from metastable state to a higher excited state

c) from a state higher than the metastable state to the metastable state

d) from a state lower than the metastable state to a state higher than the metastable state

Ans: (d)

44. An open pipe immersed in water to half its length. The ratio of the fundamental frequency of the pipe before and after immersion in water is

a) 1 : 2 b) 1 : 1 c) 1 : 3 d) 1 : 4

Ans: (b)

$$\gamma_c = \frac{\ell_0}{2} \quad \therefore \quad \frac{f_0}{f_c} = \frac{v / 2\ell_0}{v / 4\ell_c} = \frac{4\left(\frac{\ell_0}{2}\right)}{2\ell_0} = 1$$

45. Assuming R = 8.3 J mol^{-1} K^{-1} and γ = 1.4 the values of C_p and C_v of a gas are

a) 29.05 J mol^{-1} K^{-1}, 20.75 J mol^{-1} K^{-1} b) 20.75 J mol^{-1} K^{-1}, 29.05 J mol^{-1} K^{-1}

c) 16.60 J mol^{-1} K^{-1}, 8.300 J mol^{-1} K^{-1} d) 8.300 J mol^{-1} K^{-1}, 16.60 J mol^{-1} K^{-1}

Ans: (a)

$r = \frac{C_p}{C_v} = 1.4 \Rightarrow C_p = 1.4\ C_v$

$R = C_p - C_v = 8.3$

$\Rightarrow 1.4\ C_v - C_v = 8.3 \Rightarrow 0.4\ C_v = 8.3$

$\Rightarrow C_v = \frac{8.3}{0.4} = \frac{83}{4} = 20.75\ J\ mol^{-1}\ K^{-1}$ $\therefore C_p = C_v + R$

$= 20.75 + 8.3 = 29.05\ J\ mol^{-1}\ K^{-1}$

46. A star A is 100 times brighter than star B. Then $m_B - m_A$ the difference in their apparent magnitudes is

a) 100 b) 0.01 c) 5 d) 0.2

Ans: (c)

$m_B - m_A = -2.5 \log\left[\frac{I_B}{I_A}\right] = -2.5 \log\left(\frac{1}{100}\right)$

$= -2.5\ [\log 1 - \log 100]$

$= -2.5 \times -2 = 5$

47. A monochromatic ray of light enters a glass slab (n = 1.5) along the normal to the surface. The angle of deviation of the refracted ray is

a) 90^0 b) 45^0 c) 30^0 d) 0^0

Ans: (d)

During refraction, the ray does not undergo deviation when incident along normal

48. A ray of light passing from glass to water is incident on the glass-water interface at 65^0. If the critical angle for the pair of media is 63^0.

a) The ray will emerge into water with a deviation of 2^0 from the normal

b) The ray will be refracted into water with a deviation of 2^0

c) The ray will be totally internally reflected back into glass with a deviation of 50^0

d) The ray will be totally internally reflected back into glass with a deviation of 2^0

Ans: (c)

As i > C, the ray undergo total internal reflection.

Deviation $d = \pi - 2i = 180 - 2 \times 65 = 50^0$

49. An equilateral prism is kept in the minimum deviation position. If the angle of incidence of a monochromatic ray at a refracting face is $49^o\,30^I$ the angle of minimum deviation of the ray will be

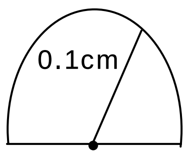
a) 39^0 b) $49^0 30^I$ c) $40^0 30^I$ d) 51^0

Ans: (a)

The angle of deviation D = 2i – A

$= 2 \times 49^0 30^1 - 60 = 39^0$

50. A glass hemisphere of radius 0.1cm and refractive index 1.5 is placed over a spot on a table and the spot is viewed from above. The spot appears to be



a) 0.1m above the top surface of the hemisphere

b) 0.1m below the top surface of the hemisphere

c) 0.033m above the top surface of the hemisphere

d) Exactly on the top surface of the hemisphere

Ans: OPTIONS DOES NOT MATCH

$\frac{n_0}{u} + \frac{n_I}{v} = \frac{n_0 \sim n_I}{R}$

$\frac{1.5}{0.1} + \frac{1}{v} = \frac{0.5}{0.1} \Rightarrow \frac{1}{v} = \frac{0.5}{0.1} - \frac{1.5}{0.1} = \frac{-1}{0.1}$ $\therefore v = -0.1cm$

51. Photoelectric Effect and Raman Effect can be explained on the basis of

a) Newton's Corpuscular theory of light
b) Huygens wave theory of light
c) Maxwell's Electromagnetic theory of light
d) Planck's Quantum theory of light

Ans: (d)

52. In an interference pattern the ratio of the intensity of light at the bright fringe to that at the dark fringe is 9 : 1. Then the ratio of the amplitudes of the two interfering waves

a) 3 : 1
b) 2 : 1
c) 1 : 4
d) 5 : 4

Ans: (b)

$$\frac{I_{max}}{I_{min}} = \frac{9}{1}$$

As $I \propto a^2$

$$\frac{a_{max}}{a_{min}} = \frac{3}{1} = \frac{a_1 + a_2}{a_1 - a_2}$$

$\Rightarrow 3a_1 - 3a_2 = a_1 + a_2$

$\Rightarrow 2a_1 = 4a_2$ or $a_1 = 2a_2$

53. Diffraction effects are more easily detected in the case of sound waves than light waves because

a) Sound waves are longitudinal
b) Sound waves have smaller wavelength
c) Sound waves have larger wavelength
d) Sound waves are transverse

Ans: (c)

54. If θ is the polarizing angle for a medium in which the speed of light is v then according to Brewster's Law

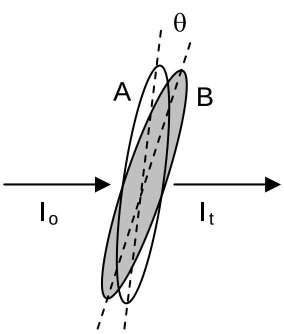
a) $\theta = \sin^{-1}(c/v)$
b) $\theta = \tan^{-1}(c/v)$
c) $\theta = \cos^{-1}(c/v)$
d) $\theta = \sin^{-1}(v/c)$

Ans: (b)

$\theta = \tan^{-1}(n)$

and $n = \frac{c}{v}$

55. Two polaroid A and B are kept with their transmission axes at an angle θ with respect to one another. If the transmitted intensity of light $I_t = 0.75\ I_0$ where I_0 is the intensity of light incident on the system then θ is



a) 30^0
b) 45^0
c) 60^0
d) 90^0

Ans: (a)

$$I_t = \frac{I_0}{2}\cos^2\theta$$

$$\therefore 0.75\ I_0 = \frac{I_0}{2}\cos^2\theta$$

$$\Rightarrow \cos^2\theta = \frac{3}{2}$$

$$\Rightarrow \theta = 30^0$$

56. The electric force between two point charges separated by a certain distance in air is F the distance at which they should be placed in a medium of relative permittivity k so that the force remain the same is

a) d b) $\frac{d}{k}$ c) kd d) $\frac{d}{\sqrt{k}}$

Ans : (d)

$F_m = F_a$

$$\frac{1}{4\pi\varepsilon_0 K}\frac{q_1q_2}{d^2{}_m} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{d_a^2} \Rightarrow d_a^2 = kd^2{}_m \Rightarrow d_m = \frac{d}{\sqrt{k}}$$

57. A positively charged particle is released from rest in a region of uniform electric field. The particle will move

a) With constant speed b) With constant velocity

c) With constant acceleration d) With variable acceleration

Ans : (c)

$F = qE$

$$a = \frac{F}{m} = \frac{qE}{m}$$

If E is uniform then a is constant

58. Two charges q and -2q are separated by a distance d. If the electric intensity at the site of q is E then the electric field at the site of -2q is

a) E b) E/2 c) -2E d) –E/2

Ans: (b)

As the force between two charges is mutual

Electric intensity at the site of q is $E = \frac{F}{q}$

Electric intensity at the site of -2q is $E^1 = \frac{F}{+2q} = +\frac{E}{2}$

59. Choose the correct statement

a) A p-type semiconductor is positively charged

b) The Boolean expression 1 . 0 = 0

c) The majority carrier in N type semiconductor is hole

d) A transistor cannot be used as a switch

Ans: (b)

60. "Plum pudding" model of an atom was proposed by

a) C.V.Raman b) N. Bohr c) E. Rutherford d) J.J. Thomson

Ans: (d)