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KCET-2017-2nd May
Questions – Physics

1. A substance of mass 49.53 g occupies $1.5\,cm^3$ of volume. The density of the substance (in $g\,cm^{-3}$) with correct number of significant figures is

   (A) 3.302

   (B) 3.300

   (C) 3.3

   (D) 3.30

2. A car moving with a velocity of $20\,ms^{-1}$ is stopped in a distance of 40 m. If the same car is travelling at double the velocity, the distance travelled by it for same retardation is

   (A) 640 m

   (B) 320 m

   (C) 1280 m

   (D) 160 m

3. The angle between velocity and acceleration of a particle describing uniform circular motion is

(A) $45°$

(B) $60°$

(C) $90°$

(D) $180°$

4. If $A = 2\hat{i} + 3\hat{j} + 8\hat{k}$ is perpendicular to $B = -4\hat{i} + 4\hat{j} + \alpha\hat{k}$, then the value of α is

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

(B) $-\frac{1}{2}$

(C) 1

(D) -1

5. A body of mass 50 kg is suspended using a spring balance inside a lift at rest. If the lift starts falling freely, the reading of the spring balance is

(A) $= 50$ kg

(B) > 50 kg

(C) < 50 kg

(D) $= 0$

6. A motor pump lifts 6 tonnes of water from a well of depth 25 m to the first floor of height 35 m from the ground floor in 20 minutes. The power of the pump (in kW) is [$g = 10\,ms^{-2}$]

   (A) 3

   (B) 6

   (C) 1.5

   (D) 12

7. Two balls are thrown simultaneously in air. The acceleration of the centre of mass of the two balls when in air,

   (A) depends on the masses of the two balls

   (B) depends on the speeds of the two balls

   (C) is equal to g (Acceleration due to gravity)

   (D) depends on the direction of motion of the two balls.

8. The value of acceleration due to gravity at a depth of 1600 km is equal to [Radius of earth = 6400 km]

   (A) $9.8\,ms^{-2}$

(B) $4.9\ ms^{-2}$

(C) $19.6\ ms^{-2}$

(D) $7.35\ ms^{-2}$

9. 'Young's modulus' is defined as the ratio of

(A) tensile stress and longitudinal strain

(B) hydraulic stress and hydraulic strain

(C) shearing stress and shearing strain

(D) bulk stress and longitudinal strain

10. 'Hydraulic lift' works on the basis of

(A) Stoke's law

(B) Toricelli's law

(C) Pascal's Law

(D) Bernoulli's Law

11. The S.I. unit of specific heat capacity is

(A) $J\ mol^{-1}\ K^{-1}$

(B) $J\ kg^{-1}\ K^{-1}$

(C) $J\ K^{-1}$

(D) $J\ kg^{-1}$

12. For which combination of working temperatures, the efficiency of 'Carnot's engine' is the least ?

(A) 60 K, 40 K

(B) 40 K, 20 K

(C) 80 K, 60 K

(D) 100 K, 80 K

13. The mean energy of a molecule of an ideal gas is

(A) 2 KT

(B) $\frac{3}{2}KT$

(C) KT

(D) $\frac{1}{2}KT$

14. Two simple pendulums A and B are made to oscillate simultaneously and it is found that A completes 10

oscillations in 20 sec and B completes 8 oscillations in 10 sec. The ratio of the lengths of A and B is

(A) $\frac{8}{5}$

(B) $\frac{64}{25}$

(C) $\frac{5}{4}$

(D) $\frac{25}{64}$

15. The waves set up in a closed pipe are

(A) Transverse and Progressive

(B) Longitudinal and Stationary

(C) Transverse and Stationary

(D) Longitudinal and Progressive

16. Two spheres of electric charges +2 nC and −8 nC are placed at a distance ‘d’ apart. If they are allowed to touch each other, what is the new distance between them to get a repulsive force of same magnitude as before?

(A) $\frac{4d}{3}$

(B) $\frac{3d}{4}$

(C) d

(D) $\frac{d}{2}$

17. Three point charges of + 2q, + 2q and − 4q are placed at the corners A, B and C of an equilateral triangle ABC of side . The magnitude of the electric dipole moment of this system is

(A) $2\,qx$

(B) $2\sqrt{3}\,qx$

(C) $3\sqrt{2}\,qx$

(D) $3\,qx$

18. 4×10^{10} electrons are removed from a neutral metal sphere of diameter 20 cm placed in air. The magnitude of the electric field (in NC^{-1}) at a distance of 20 cm from its center is

(A) 5760

(B) 1440

(C) 640

(D) zero

19. Two point charges $A = +3\,nC$ and $B = +1\,nC$ are placed 5 cm apart in air. The work done to move charge B towards A by 1 cm is

(A) 1.35×10^{-7} J

(B) 2.7×10^{-7} J

(C) 2.0×10^{-7} J

(D) 12.1×10^{-7} J

20. A system of 2 capacitors of capacitance 2 μ F and 4 μ F is connected in series across a potential difference of 6V. The electric charge and energy stored in the system are

(A) $10\,\mu C$ and $30\,\mu J$

(B) $36\,\mu C$ and $108\,\mu J$

(C) $8\,\mu C$ and $24\,\mu J$

(D) $1\,\mu C$ and $3\,\mu J$

21. The minimum value of effective capacitance that can be obtained by combining 3 capacitors of capacitances 1 pF, 2 pF and 4 pF is

(A) $\frac{4}{7}$ pF

(B) $1\,\text{pF}$

(C) $\frac{7}{4}$ pF

(D) $2\,\text{pF}$

22. A cylindrical conductor of diameter 0.1 mm carries a current of 90 mA. The current density $\left(\text{in Am}^{-2}\right)$ is $\left(\pi \simeq 3\right)$

(A) 1.2×10^{7}

(B) 2.4×10^{7}

(C) 3×10^{6}

(D) 6×10^{6}

23. A piece of copper is to be shaped into a conducting wire of maximum resistance. The suitable length and diameter are _____ and _____ respectively.

(A) L and d

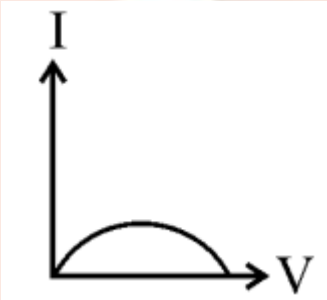
(B) 2L and d

(C) L / 2 and 2d

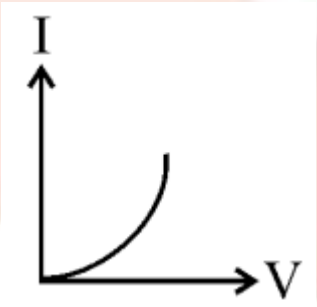
(D) 2L and d / 2

24. Of the following graphs, the one that correctly represents the I-V. Characteristics of a 'Ohmic device' is

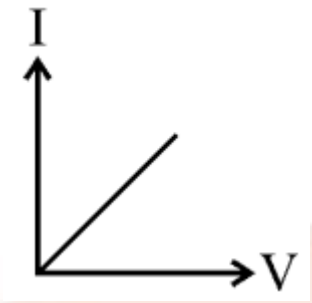
(A)



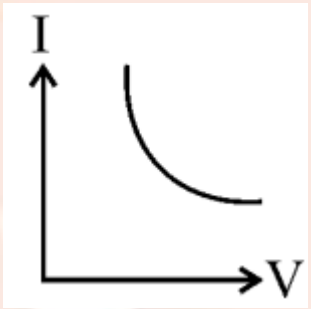
(B)



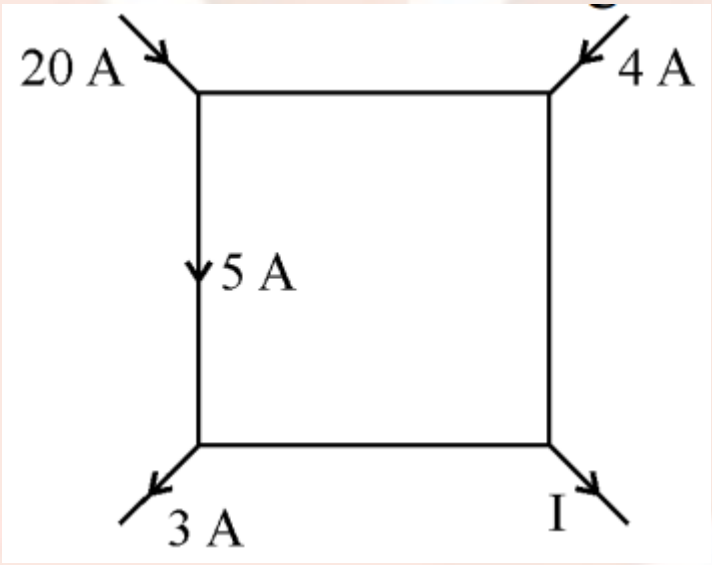
(C)



(D)



25. The value of I in the figure shown below is



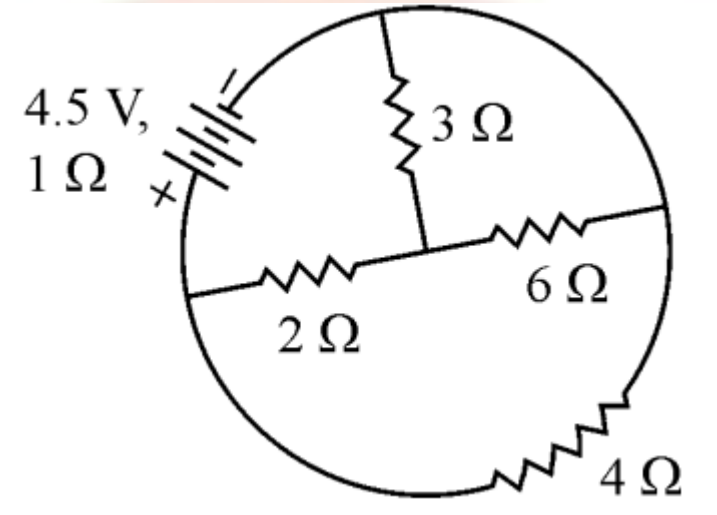
(A) 8 A

(B) 21 A

(C) 19 A

(D) 4 A

26. The power dissipated in resistance in the following circuit is



(A) 0.75 W

(B) 0.25 W

(C) 1 W

(D) 0.5 W

27. In metre bridge experiment, with a standard resistance in the right gap and a resistance coil dipped in water (in a beaker) in the left gap, the balancing length obtained is 'l'. If the temperature of water is increased, the new balancing length is

(A) >1

(B) < 1

(C) $= 1$

(D) $= 0$

28. A proton, a deuteron and an α - particle are projected perpendicular to the direction of a uniform magnetic field with same kinetic energy. The ratio of the radii of the circular paths described by them is

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

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

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

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

29. A galvanometer of resistance 50 Ω is connected to a battery of 3V along with a resistance of 2950 Ω in series shows full-scale deflection of 30 divisions. The additional series resistance required to reduce the deflection to 20 divisions is

(A) $1500\,\Omega$

(B) $4440\,\Omega$

(C) $7400\,\Omega$

(D) $2950\,\Omega$

30. The magnetic field at the center of a current carrying loop of radius 0.1 m is times that at a point along its axis. The distance of this point from the centre of the loop is

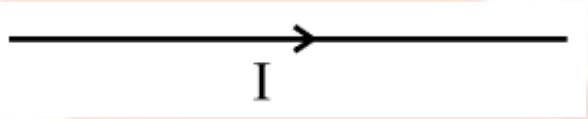
(A) 0.2 m

(B) 0.1 m

(C) 0.05 m

(D) 0.25 m

31. A straight wire of length 50 cm carrying a current of 2.5 A is suspended in mid-air by a uniform magnetic field of 0.5 T (as shown in figure). The mass of the wire is ($g = 10\,ms^{-2}$)



(A) 62.5 gm

(B) 250 gm

(C) 125 gm

(D) 100 gm

32. Which of the following properties is 'False' for a bar magnet ?

(A) Its poles cannot be separated.

(B) It points in North-South direction when suspended.

(C) Its like poles repel and unlike poles attract.

(D) It doesn't produce magnetic field.

33. A magnetic dipole of magnetic moment 6×10^{-2} Am^2 and moment of inertia 12×10^{-6} kgm^2 performs oscillations in a magnetic field of 2×10^{-2} T. The time taken by the dipole to complete 20 oscillations is $(\pi\simeq3)$

(A) 36 s

(B) 6 s

(C) 12 s

(D) 18 s

34. The susceptibility of a ferromagnetic substance is

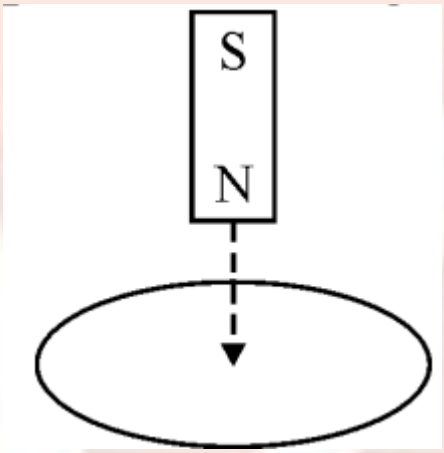
(A) $>>1$

(B) >1

(C) <1

(D) Zero

35. A bar magnet is allowed to fall vertically through a copper coil placed in a horizontal plane. The magnet falls with a net acceleration



(A) = g

(B) > g

(C) < g

(D) Zero

36. The working of magnetic braking of trains is based on

(A) Alternating current

(B) Eddy current

(C) Steady current

(D) Pulsating current

37. A jet plane of wing span 20 m is travelling towards west at a speed of 400 . If the earth's total magnetic field is 4×10^{-4} T and the dip angle is $30°$, at that place, the voltage difference developed across the ends of the wing is

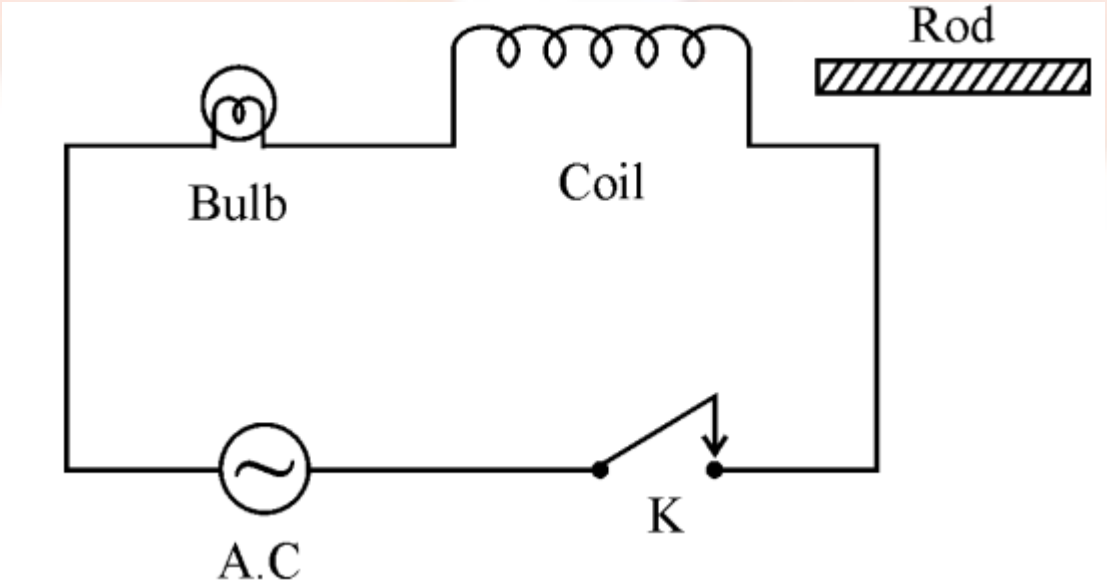
(A) 1.6 V

(B) 3.2 V

(C) 0.8 V

(D) 6.4 V

38. In the A.C. circuit shown, keeping 'K' pressed, if an iron rod is inserted into the coil, the bulb in the circuit,



(A) glows more brightly

(B) glows less brightly

(C) glows with same brightness (as before the rod is inserted)

(D) get damaged

39. The output of a step down transformer is measured to be 48 V when connected to a 12 W bulb. The value of peak current is

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

(B) $\sqrt{2}$ A

(C) $\frac{1}{2\sqrt{2}}$ A

(D) $\frac{1}{4}$ A

40. A coil of inductive reactance $1/\sqrt{3}\,\Omega$ and resistance 1 Ω is connected to a 200 V, 50 Hz A.C. supply. The time lag between maximum voltage and current is

(A) $\frac{1}{300}$ s

(B) $\frac{1}{600}$ s

(C) $\frac{1}{500}$ s

(D) $\frac{1}{200}$ s

41. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of an electromagnetic wave, the direction of propagation of the wave is along

(A) $\vec{E}$

(B) $\vec{B}$

(C) $\vec{E} \times \vec{B}$

(D) $\vec{B} \times \vec{E}$

42. According to Cartesian sign convention, in ray optics

(A) all distances are taken positive

(B) all distances are taken negative

(C) all distances in the direction of incident ray are taken positive

(D) all distances in the direction of incident ray are taken negative

43. A linear object of height 10 cm is kept in front of a concave mirror of radius of curvature 15 cm, at a distance of 10 cm. The image formed is

(A) magnified and erect

(B) magnified and inverted

(C) diminished and erect

(D) diminished and inverted

44. During scattering of light, the amount of scattering is inversely proportional to _____ of wavelength of light.

(A) cube

(B) square

(C) fourth power

(D) half

45. In Young's double-slit experiment if yellow light is replaced by blue light, the interference fringes become

(A) wider

(B) narrower

(C) brighter

(D) darker

46. According to Huygens' Principle, during refraction of light from air to a denser medium

(A) Wavelength and speed decrease

(B) Wavelength and speed increase

(C) Wavelength increases but speed decreases

(D) Wavelength decreases but speed increases

47. In a system of two crossed polarisers, it is found that the intensity of light from the second polariser is half from that of first polariser. The angle between their pass axes is

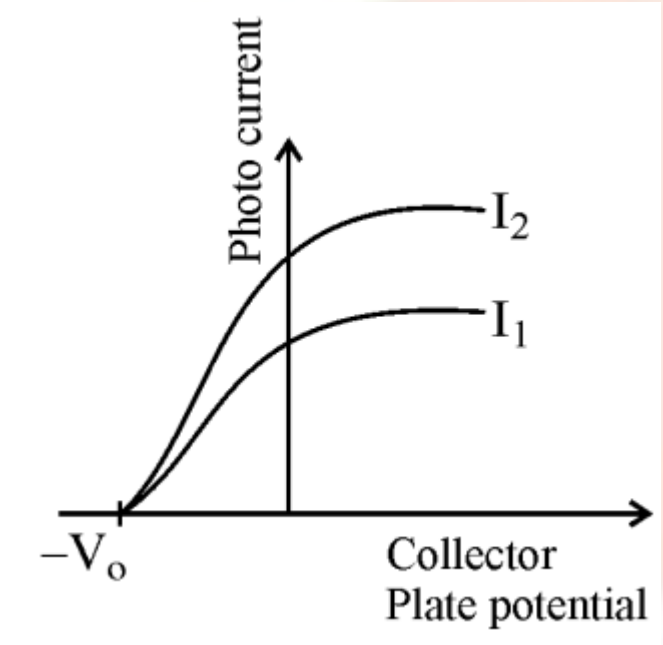
(A) 45°

(B) 60°

(C) 30°

(D) 0°

48. From the following graph of photo current against collector plate potential, for two different intensities of light I_1 and I_2, one can conclude



(A) $I_1 = I_2$

(B) $I_1 > I_2$

(C) $I_1 < I_2$

(D) Comparison is not possible.

49. A particle is dropped from a height 'H'. The de'Broglie wavelength of the particle depends on height as

(A) H

(B) H^0

(C) $H^{1/2}$

(D) $H^{-1/2}$

50. The scientist who is credited with the discovery of 'nucleus' in an atom is

(A) J.J. Thomson

(B) Rutherford

(C) Niels Bohr

(D) Balmer

51. The energy (in eV) required to excite an electron from n = 2 to n = 4 state in hydrogen atom is

(A) +2.55

(B) -3.4

(C) -0.85

(D) +4.25

52. In a nuclear reactor the function of the Moderator is to decrease

(A) number of neutrons

(B) speed of neutrons

(C) escape of neutrons

(D) temperature of the reactor

53. The particles emitted in the decay of $^{238}_{92}U$ to $^{234}_{92}U$

(A) 1α and 2β

(B) 1α only

(C) 1α and 1β

(D) 2α and 2β

54. The mass defect of $^{4}_{2}He$ is 0.03 u. The binding energy per nucleon of helium (in MeV) is

(A) 27.93

(B) 6.9825

(C) 2.793

(D) 69.825

55. The energy gap in case of which of the following is less than 3 eV ?

(A) Copper

(B) Iron

(C) Aluminium

(D) Germanium

56. Which of the following semi-conducting devices is used as voltage regulator ?

(A) Photo diode

(B) LASER diode

(C) Zener diode

(D) Solar cell

57. In the three parts of a transistor, 'Emitter' is of

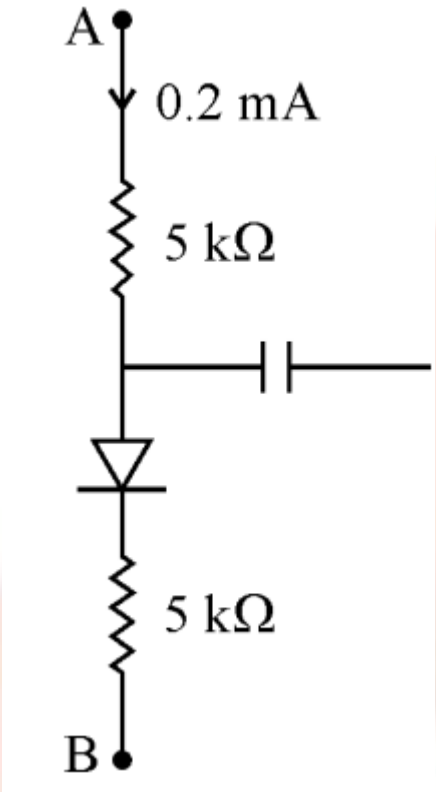
(A) moderate size and heavily doped

(B) large size and lightly doped

(C) thin size and heavily doped

(D) large size and moderately doped

58. In the figure shown, if the diode forward voltage drop is 0.2 V, the voltage difference between A and B is



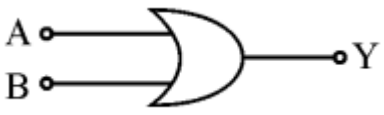
(A) 1.3 V

(B) 2.2 V

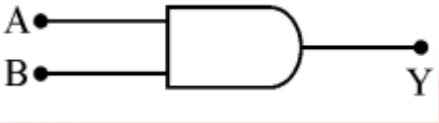
(C) 0

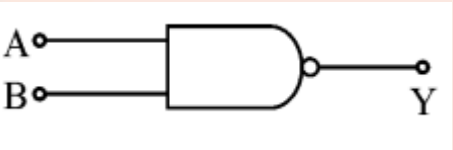
(D) 0.5 V

59. Which of the following logic gates is considered as 'universal' ?

(A) 

(B) 

(C) 

(D) 

60. A basic communication system consists of

(a) Transmitter

(b) Information source

(c) User of information

(d) Channel

(e) Receiver

The correct sequence of the arrangement is

(A) a, b, c, d and e

(B) b, a, d, e and c

(C) b, d, a, c and e

(D) b, e, a, d and c

KCET-2017-2nd May
Answer keys

1	*	16	B	31	A	46	A
2	D	17	B	32	D	47	A
3	C	18	B	33	C	48	C
4	B	19	A	34	A	49	D
5	D	20	C	35	C	50	B
6	A	21	A	36	B	51	A
7	A	22	A	37	A	52	B
8	D	23	D	38	B	53	A
9	A	24	C	39	C	54	B
10	C	25	B	40	B	55	D
11	B	26	D	41	C	56	C
12	D	27	A	42	C	57	A
13	B	28	A	43	B	58	B
14	B	29	B	44	C	59	D
15	B	30	A	45	B	60	B

KCET-2017-2nd May
Solutions – Physics

1. The expression of the density of substance is given as,

$$\rho = \frac{M}{V}$$

Substitute values as,

$$\rho = \frac{M}{V}$$
$$= \frac{49.3\,g}{1.5\,cm^3}$$
$$= 32.87\ g\ cm^{-3}$$

2. The velocity of the car is $(u) = 20\ ms^{-1}$.

The distance $(s) = 40\ m$.

From the Newton third equation of velocity,

$$v^2 - u^2 = -2as$$

Substitute values as,

$$(0)^2-(20)^2=-2(a)(40)$$

$$400=2(a)(40)$$

$$a=\frac{400}{2\times 40}$$

$$=5\ ms^{-2}$$

As given that, in the second condition, the velocity becomes twice. Therefore,

$$u'=2u$$

Use the Newton third equation of velocity,

$$(0)^2-(2u)^2=-2(5)(s)$$

$$s=\frac{4u^2}{10}$$

$$s=\frac{4\times 20\times 20}{10}$$

$$=160\ m$$

3. When an object is traveling in a circular path at a constant speed, the motion of object is called uniform circular motion.

The speed does not vary the when particle is accelerating because the velocity changes its direction at every point on circular track. The acceleration is centripetal, which is

perpendicular to motion at every point and acts along the radius and directed towards the centre of the curved circular path.

Therefore, the angle will be $90°$.

4. If A is perpendicular to the B then,

$$A \cdot B = 0$$

Therefore,

$$\left(2\hat{i}+3\hat{j}+8\hat{k}\right)\cdot\left(-4\hat{i}+4\hat{j}+\alpha\hat{k}\right)=0$$

$$-8+12+8\alpha=0$$

$$8\alpha+4=0$$

$$\alpha=-\frac{1}{2}$$

5. When the lift is moving down, the scale reading is given by,

$$\text{Scale reading}=\frac{m\left(g-a\right)}{g}$$

If the lift start falling freely, then

$$a=g$$

$$\text{Scale reading}=\frac{m\left(g-g\right)}{g}$$

$$=0$$

6. The power of pump is given by,

$$P = \frac{mgh}{t}$$

Substitute values as,

$$P = \frac{mgh}{t}$$
$$= \frac{(600)\times 10 \times (35-25)}{20}$$
$$= \frac{(600)(10)(10)}{20}$$
$$= 3\,kW$$

7. The acceleration of center of mass is given by,

$$a_{cm} = \frac{m_1 a_1 + m_2 a_2}{m_1 + m_2}$$

Here, $a_1 = a_2 = g$

Because balls are thrown in air under gravity, therefor

$$a_{cm} = \frac{m_1 g + m_2 g}{m_1 + m_2}$$
$$= \frac{g(m_1 + m_2)}{m_1 + m_2}$$
$$= g$$

Therefore, the acceleration of center of mass of the two balls when in air is depends on the masses of the two balls.

8. The expression of acceleration due to gravity is given by,

$$g_d = g\left(1 - \frac{d}{R}\right)$$

Substitute values as,

$$g_d = 9.8\left(1 - \frac{1600}{6400}\right)$$
$$= 9.8\left(1 - \frac{1}{4}\right)$$
$$= \frac{9.8 \times 3}{4}$$
$$= 7.35\ ms^{-2}$$

9. Young's modulus is given as,

$$\text{Young's modulus} = \frac{\text{Tensile stress}}{\text{Longitudinal strain}}$$

10. Hydraulic lift is used to lift objects by applying force created by exerting pressure on liquid in a piston. So, the basic principle used in hydraulic lift is Pascal's law.

11. The SI unit of specific heat capacity is $\text{J kg}^{-1}\ \text{K}^{-1}$.

12. The efficiency of carnet engine is given by,

$$\eta = \left(1 - \frac{T_L}{T_H}\right) \times 100$$

Use trial and error method.

Take temperature $100\ \text{K}$ and $80\ \text{K}$.

$$\eta = \left(1 - \frac{80}{10}\right) \times 100$$

$$= \left(\frac{20}{100}\right) \times 100$$

$$= 20\%$$

13. The mean energy of molecule of an ideal gas is given by,

$$E = \frac{3}{2}KT$$

14. The expression of time period of pendulum is given by,

$$T = 2\pi\sqrt{\frac{l}{g}}$$

For pendulum A,

$$T_A = 2\pi\sqrt{\frac{l_A}{g}}$$

$$\frac{20}{10} = 2\pi\sqrt{\frac{l_A}{g}}$$

For pendulum B,

$$T_B = 2\pi\sqrt{\frac{l_B}{g}}$$

$$\frac{10}{8} = 2\pi\sqrt{\frac{l_B}{g}}$$

Take the ratio.

$$\frac{l_A}{l_B} = \left(\frac{160}{100}\right)^2$$

$$= \frac{64}{25}$$

15. In a closed pipe, the oscillations are in the direction of propagation. So, longitudinal; stationary waves are formed in a closed pipe.

16. Take first condition.

The force between the charges is given by,

$$F = \frac{kq_1q_2}{r^2}$$

Substitute values as,

$$F = \frac{k\left(2\times10^{-9}\right)\left(8\times10^{-9}\right)}{d^2}$$

$$= \frac{k\left(16\times10^{-18}\right)}{d^2}$$

After touching of sphere to each other the total charge will be as,

$$\text{Total charge} = 2-8$$

$$= -6\ \text{nC}$$

Therefore charge on each sphere will be $3\ \text{nC}$.

Take second condition.

The force between the charges is given by,

$$F = \frac{kq_1q_2}{r^2}$$

$$F = \frac{k\left(3\times10^{-9}\right)\left(3\times10^{-9}\right)}{\left(d'\right)^2}$$

$$= \frac{k\left(9\times10^{-18}\right)}{\left(d'\right)^2}$$

Solve above expressions as,

$$\frac{k\left(16\times10^{-18}\right)}{d^2} = \frac{k\left(9\times10^{-18}\right)}{\left(d'\right)^2}$$

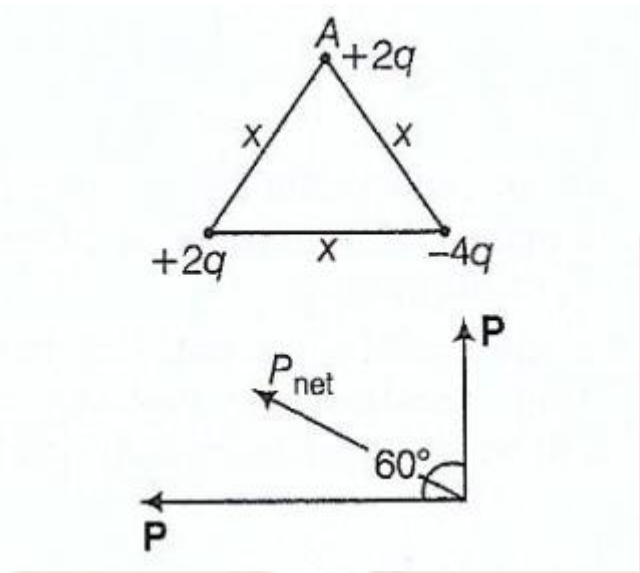
$$\frac{d^2}{\left(d'\right)^2} = \frac{16\times10^{-18}}{9\times10^{-18}}$$

$$= \frac{16}{9}$$

$$d' = \frac{3}{4}d$$

17. As per the question.

The magnitude of electric dipole moment can be shown as,



The magnitude of electric dipole moment is calculated as,

$$P_{net} = \sqrt{p^2 + p^2 + 2pp\cos 60^\circ}$$

$$= \sqrt{2p^2 + 2p^2 \times \frac{1}{2}}$$

$$= \sqrt{3}p$$

As we know that,

$$p = 2q \cdot x$$

Therefore,

$$p = 2\sqrt{3}qx$$

18. The expression of magnitude of the electric field is given by,

$$E = \frac{q}{4\pi\varepsilon_0 r^2}$$

$$= \frac{ne}{4\pi\varepsilon_0 r^2}$$

Substitute values as,

$$E = \frac{4\times10^{10}\times1.6\times10^{-19}\times9\times10^{9}}{\left(20\times10^{-2}\right)^2}$$

$$= \frac{4\times1.6\times9}{400\times10^{-4}}$$

$$= 1.6\times9\times10^{2}$$

$$= 1440\ \text{NC}^{-1}$$

19. The expression of work done is given by,

$$W = U_B - U_A$$

$$= \frac{kq_1q_2}{r_2} - \frac{kq_1q_2}{r_1}$$

$$= kq_1q_2\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$$

Here, $r_2 = r_1 - 1$

Therefore,

$r_2 = 4 - 1$

$= 4\,\text{cm}$

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

Substitute values as,

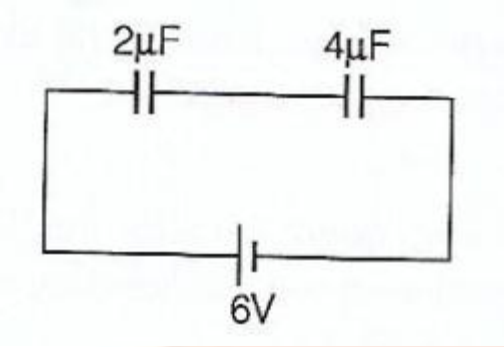
$$W = \left(9 \times 10^{9}\right)\left(3 \times 10^{-9}\right)\left(1 \times 10^{-9}\right)\left(\frac{1}{4 \times 10^{-2}} - \frac{1}{5 \times 10^{-2}}\right)$$

$$= \frac{27 \times 10^{-9} \times 1}{5 \times 4 \times 10^{-2}}$$

$$= \frac{27}{20} \times 10^{-7}$$

$$= 1.35 \times 10^{-7}\ \text{J}$$

20. Consider the following figure.



The capacitors are connected in series therefore equivalent capacitance is given as,

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

Substitute values as,

$$\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{4}$$

$$= \frac{3}{4}\,\mu F$$

$$C_{eq} = \frac{4}{3}\,\mu F$$

The expression of electric charge is given by,

$$Q = CV$$

Substitute the all values as,

$$Q = \frac{4}{3}(6)$$

$$= 8\,\mu C$$

The expression of energy stored in the system is given by,

$$E = \frac{1}{2}CV^2$$

Substitute the values as,

$$E = \frac{1}{2}\left(\frac{4}{3}\right)(6)^2$$

$$= 24\,\mu J$$

21. The minimum value of effective capacitance is get in series combination.

The equivalent capacitance is given as,

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

Substitute the values as,

$$\frac{1}{C_{eq}} = \frac{1}{1} + \frac{1}{2} + \frac{1}{4}$$

$$= \frac{4+2+1}{4}$$

$$= \frac{7}{4}$$

$$C_{eq} = \frac{4}{7}\,pF$$

22. The expression of current density is given by,

$$J = \frac{I}{A}$$

$$= \frac{I}{\pi r^2}$$

Substitute the values as,

$$J = \frac{90\times10^{-3}}{\left(\frac{22}{7}\right)\left(\frac{0.1\times10^{-3}}{2}\right)^2}$$

$$= 12000\times10^{3}$$

$$= 1.2\times10^{7}\ \mathrm{A/m^2}$$

23. As we know that,

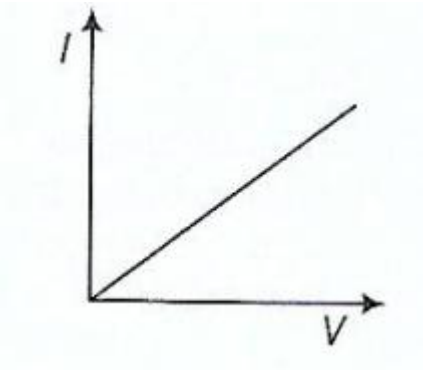
$$R = \frac{\rho l}{A}$$

$$= \frac{\rho l}{\pi r^2}$$

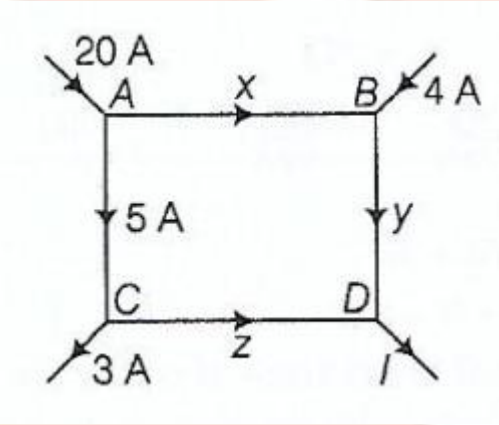
If the length of wire is increases, then the radius of wire is decreases. To get the maximum resistance the suitable length and diameter are 2L and $\frac{d}{2}$.

24. According to Ohm's Law, the current flowing through a conductor is directly proportional to the potential difference (V) across the ends of the conductor, provided physical conduction of the conductor such as temperature, mechanical strain etc, are kept constant.

Therefore, the curve between V and I will be as follows.



25. Consider the following figure.



At junction A,

$20 = 5 + x$

$x = 20 - 5$

$= 15\ A$

At junction B,

$4 + x = y$

$4 + 15 = y$

$y = 19\ A$

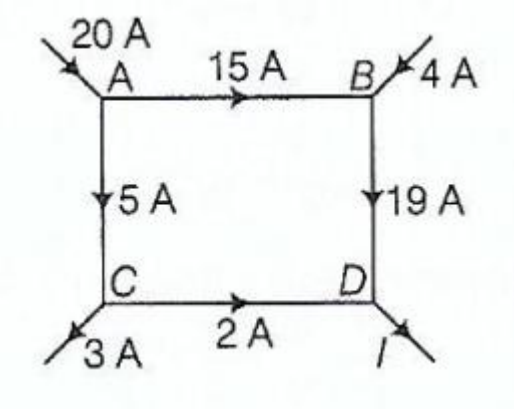
At junction C,

$5 = 3 + z$

$z = 5 - 3$

$= 2\ A$

Show the network as follows.

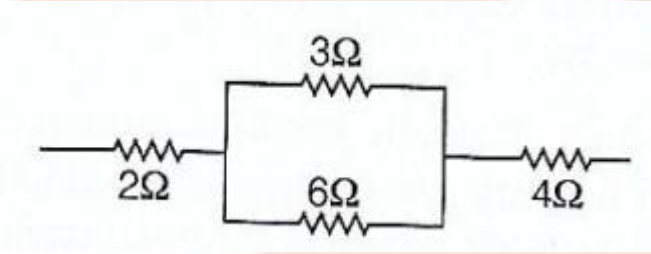


At junction D,

$I = 19 + 2$

$= 21\ A$

26. The equivalent circuit of the given circuit is as follows.



From circuit,

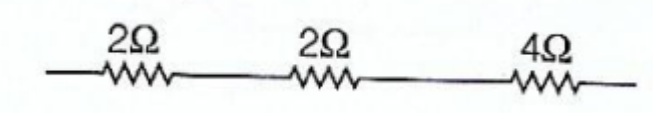
$$\frac{1}{R_1} = \frac{1}{3} + \frac{1}{6}$$

$$= \frac{2+1}{6}$$

$$= \frac{3}{6}\,\Omega$$

$$R_1 = 2\,\Omega$$

Consider the following figure.



From the above figure,

$$R_2 = 2 + 2 + 4$$

$$= 8\,\Omega$$

The internal resistance of the battery is $1\,\Omega$.

Therefore, the equivalent resistance given as,

$$R = 8 + 1$$

$$= 9\,\Omega$$

The current in the circuit is calculated as,

$$I = \frac{V}{R}$$
$$= \frac{4.5}{9}$$
$$= \frac{1}{2} A$$

27. As per the question.

$$\frac{R_{unknown}}{R_{standard}} = \frac{l}{(1-l)}$$

Therefore, if the temperature increases then resistance will increase.

Thus, the new balancing is greater than 1.

28. Given that, the magnetic field is uniform and the kinetic energy for each particle are same.

As we know that,

$$r = \frac{mv}{qB}$$

$$= \frac{\sqrt{2m(KE)}}{qB}$$

$$r \propto \frac{\sqrt{m}}{q}$$

Therefore,

$$(r_p : r_d : r_\alpha) = \frac{\sqrt{m}}{q} : \frac{\sqrt{2m}}{q} : \frac{\sqrt{m}}{q}$$

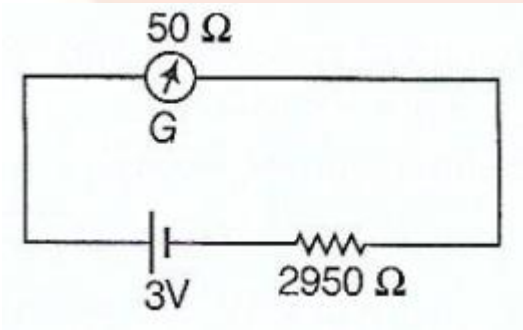
$$= 1 : \sqrt{2} : 1$$

29. Calculate the current flowing in galvanometer as follows.

$$I = \frac{3}{50 + 2950}$$

$$= 10^{-3}\ A$$

Consider the following figure.



Current for 30 division is 10^{-3} A.

Calculate the Current for 20 divisions as follows,

$$I' = \frac{10^{-3}}{30} \times 20$$

$$= \frac{2}{3} \times 10^{-3}\ A$$

Let the series resistance is R. Therefore,

$$\frac{2}{3} \times 10^{-3}\ A = \frac{3}{50 + R}$$

$$R = 4450\ \Omega$$

$$\approx 4440\ \Omega$$

30. As we know that,

$$\frac{B_{centre}}{B_{axis}} = \left(1 + \frac{x^2}{r^2}\right)^{3/2}$$

Given that,

$$B_{centre} = 5\sqrt{5}\ B_{axis}$$

So,

$$\frac{B_{centre}}{B_{axis}} = 5\sqrt{5}$$

Therefore,

$$5\sqrt{5} = \left(1 + \frac{x^2}{r^2}\right)^{3/2}$$

$$25 \times 5 = \left(1 + \frac{x^2}{(0.1)^2}\right)^3$$

$$1 + \frac{x^2}{(0.1)^2} = \sqrt[3]{125}$$

$$x \approx 0.2\ \text{m}$$

31. From the balancing condition.

$$F_B = mg$$

$$BI\ell = mg$$

$$m = \frac{BI\ell}{g}$$

Substitute the values as,

$$m = \frac{(0.5)(2.5)\left(50 \times 10^{-2}\right)}{10}$$

$$\approx 62.5\ \text{g}$$

32. The option (D) is incorrect because bar magnet can produce magnetic field.

33. The expression of time period of oscillation is given by,

$$\text{Time}(t) = 2\pi\sqrt{\frac{I}{MB}}$$

Substitute the values as,

$$\text{Time}(t) = 2\pi\sqrt{\frac{12\times10^{-6}}{\left(6\times10^{-2}\right)\left(2\times10^{-2}\right)}}$$

$$= 2\pi\sqrt{\frac{12\times10^{-2}}{12}}$$

$$= 2\pi\times10^{-1}$$

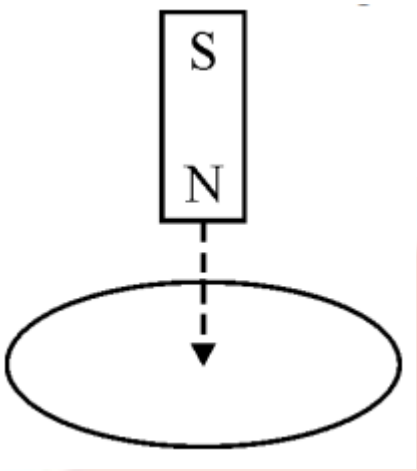
For 20 oscillations the time is as,

$$t = 20\times2\pi\times10^{-1}$$

$$= 12\ \text{s}$$

34. The susceptibility of a ferromagnetic substance is $>>1$ because it is strongly attracted in an external magnetic field.

35. Consider the give figure.



When the magnet is allowed to fall vertically along the axis of loop with its north pole towards the coil then the upper face of the coil will become North Pole in an attempt to oppose the approaching north pole of the magnet.

Therefore, the acceleration in the magnet is less than g.

36. The working of magnetic breaking of train is based on eddy current.

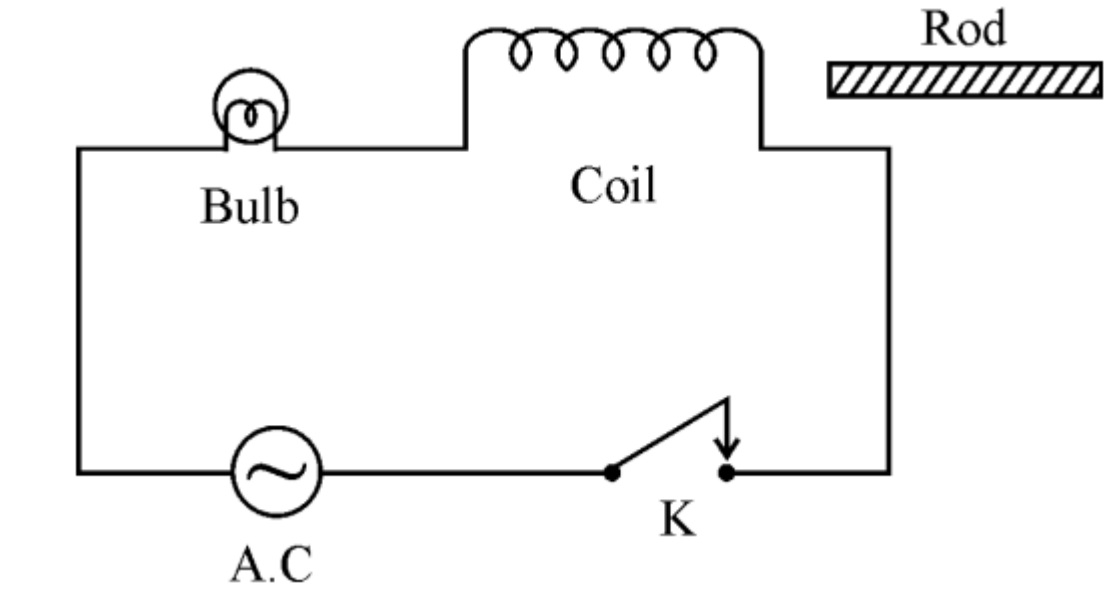
37. The expression of voltage difference is given by,

$\text{Voltage difference} = Blv\sin\theta$

Substitute the values as,

$$\text{Voltage difference} = \left(4\times10^{-4}\right)(20)(400)\sin 30°$$
$$= 32000\times10^{-4}\times\sin 30°$$
$$= 1.6\ \text{V}$$

38. Consider the given figure.



When a rod is inserted into the coil, then its inductance increases. Therefore, current through the bulb will decrease and also brightness decreases.

39. The expression of current in secondary coil is given by,

$$I_s = \frac{P_s}{V_s}$$

Substitute the values as,

$$I_s = \frac{12}{48}$$
$$= 0.25\ A$$

The amplitude of current is given by,

$$I_0 = I_s\sqrt{2}$$

Substitute the values as,

$$I_0 = (0.25)\sqrt{2}$$
$$= \frac{\sqrt{2}}{4}$$
$$= \frac{1}{2\sqrt{2}}A$$

40. As we know that,

$$\tan\phi = \frac{\omega L}{R}$$
$$= \frac{X_L}{R}$$

Therefore,

$$\tan\phi = \frac{1/\sqrt{3}}{1}$$
$$\phi = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$$
$$= 30°$$

Since,

$\omega t = \frac{\pi}{6}$

Therefore,

$t = \frac{\pi}{6\omega}$

$= \frac{\pi}{6(2\pi f)}$

$= \frac{1}{12f}$

Here,

$f = 50\ \text{Hz}$

So,

$t = \frac{1}{12(50)}$

$= \frac{1}{600}\ \text{s}$

41. According to electromagnetic wave property, the electric field is perpendicular to the magnetic field. The directions of electromagnetic wave propagation will perpendicular to E and B.

Then $E \times B = C$

42. In ray optics, distances are measured from the optical center of the lens or mirror. As per the Cartesian sign convention, the distances measured in the direction of incident ray are taken as positive and the distances measured in the opposite direction of incident ray are taken as negative.

43. The mirror formula is given as,

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

Substitute the values as,

$$\frac{1}{-\frac{15}{2}} = \frac{1}{-10} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{-2}{15} + \frac{1}{10}$$

$$= -\frac{1}{30}$$

$$v = -30 \text{ cm}$$

The expression of magnification is given by,

$$m = \frac{h_i}{h_o} = -\frac{v}{u}$$

Substitute the values as,

$$\frac{h_i}{10} = -\frac{(-30)}{-10}$$

$$h_i = -30$$

Therefore, the image will be magnified and inverted.

44. During scattering of light, the amount of scattering is inversely proportional to fourth power of wavelength of light as,

$$I \propto \frac{1}{\lambda^4}$$

45. The wavelength of yellow light is greater than blue light.

The expression of fringe width is given by,

$$w = \frac{D\lambda}{d}$$

$$w \propto \lambda$$

Here, wavelength is decreasing therefore, the interference fringes become narrower.

46. If c is the speed of light in air and n is the refractive index of medium, the speed of light in medium is given as,

$$v = \frac{c}{n} \qquad \ldots\ldots (1)$$

From the above equation, it is clear than the speed of light decreases when it goes from air to denser medium.

The wavelength of light depends on the velocity as,

$$\lambda = \frac{v}{f} \qquad \ldots\ldots (2)$$

The frequency of light wave in all mediums remains same. So, when light goes from air to a denser medium, its speed decreases and hence wavelength will also decrease.

47. As per Malus law,

$$I = I_0 \cos^2 \theta$$

Here,

$$I = \frac{I_0}{2}$$

Therefore,

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

$$\cos^2\theta = \frac{1}{2}$$

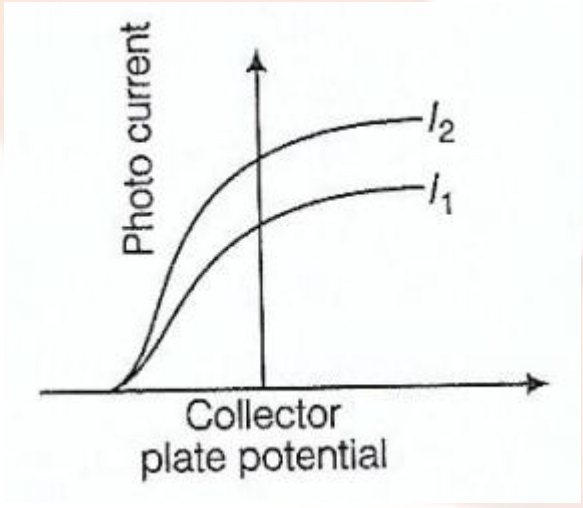
$$\cos\theta = \frac{1}{\sqrt{2}}$$

$$\theta = 45°$$

48. The value of photo current depends on the intensity of incident light. Hence, when the intensity of incident light increases, then the value of photo current is increases.

$\text{intensity of light} \propto \text{photo current}$

Consider the following graph.



From graph,

$I_1 < I_2$

49. The expression of de-Broglie wavelength is given by,

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

$$= \frac{h}{m\sqrt{2gh}}$$

Therefore,

$$\lambda \propto H^{-1/2}$$

50. Rutherford was credited with the discovery of nucleus at the centre of atom based on his α-scattering experiment observations.

51. The expression of energy is given by,

$$E_n = \frac{13.6}{n^2}$$

The required energy is calculated as,

$$E = E_2 - E_4$$

$$= \frac{13.6}{(2)^2} - \frac{13.6}{(4)^2}$$

$$= \frac{13.6 \times 4 - 13.6}{16}$$

$$= +2.55$$

52. In a nuclear reactor, the function of moderator is to decrease speed of neutron.

53. Consider the following reaction.

$$^{238}_{92}U \xrightarrow{\alpha} {}^{234}_{90}U \xrightarrow{\beta^{-1}} {}^{234}_{91}U \xrightarrow{\beta^{-1}} {}^{234}_{92}U$$

Therefore, the number of α particle are 1 and number of β particles are 2.

54. The binding energy is calculated as,

$$\text{Binding energy} = 0.03 \times 931$$

$$= 27.93$$

Calculate the per nucleon binding energy as,

$$\text{Per nucleon binding energy} = \frac{27.93}{4}$$

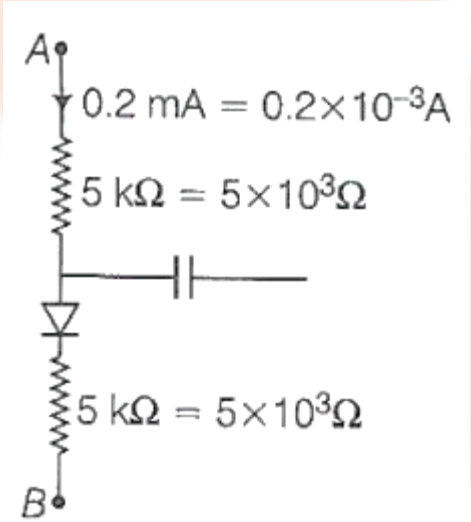
$$= 6.9825$$

55. The energy of germanium is less than 3eV.

56. Zener diode exhibits a constant voltage when it works in reverse biased condition. So, It is used as a voltage regulator.

57. In transistor, base is sandwiched between moderate sized emitter and collector. The emitter is made heavily doped to supplies a large number of majority charge carriers for the current flow across the transistor.

58. Consider the following figure.



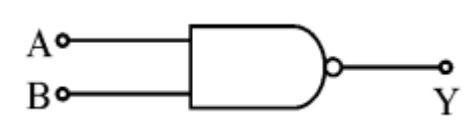
The voltage drop across $5\,k\Omega$ is given by,

$$V = 0.2 \times 10^{-3} \times 5 \times 10^{3}$$
$$= 1.0\ V$$

Apply the Kirchoff's Voltage Law as follows,

$$V_{AB} = 1 + 0.2 + 1$$
$$= 2.2\ V$$

59. NAND gate is universal gate.



60. The figure below shows the block diagram of a communication system.