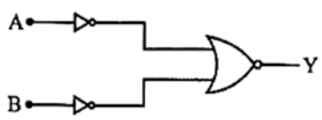
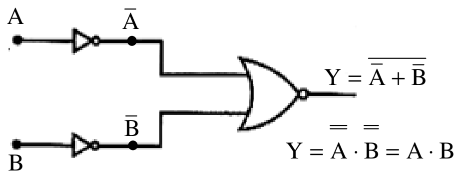
PHYSICS - CET 2022 - VERSION CODE - A-2
Solution

1. Which logic gate is represented by the following combination of logic gates?

   (A) NAND
   (B) AND
   (C) NOR
   (D) OR



   Ans (B)



2. A metallic rod of mass per unit length 0.5 kg m^{-1} is lying horizontally on a smooth inclined plane which makes an angle of 30° with the horizontal. A magnetic field of strength 0.25 T is acting on it in the vertical direction. When a current 'I' is flowing through it, the rod is not allowed to slide down. The quantity of current required to keep the rod stationary is

   (A) 5.98 A (B) 14.76 A (C) 11.32 A (D) 7.14 A

   Ans (C)

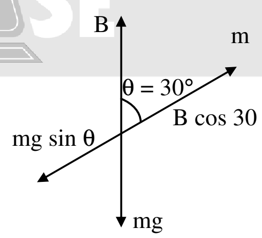
   $F = mg \sin\theta$

   $B \cos\theta \, I \, l = mg \sin\theta$

   $$I = \frac{m}{l} g \frac{\sin\theta}{B \cos\theta} = \frac{m}{l} \times \frac{g}{B} \times \tan\theta$$

   $$I = \frac{0.5 \times 9.8}{0.25} \times \frac{1}{\sqrt{3}}$$

   $I = 11.32$ A



3. A nuclear reactor delivers a power of 10^9 W, the amount of fuel consumed by the reactor in one hour is

   (A) 0.08 g (B) 0.72 g (C) 0.96 g (D) 0.04 g

   Ans (D)

   $$P = \frac{E}{t} = \frac{mc^2}{t}$$

   $$10^9 = \frac{m \times (3 \times 10^8)^2}{3600}$$

   $$m = \frac{10^9 \times 3600}{9 \times 10^{16}} = 0.04 \times 10^{-3} \text{ kg}$$

   $m = 0.04$ g

4. Which of the following radiations is deflected by electric field?

   (A) Neutrons (B) γ-rays (C) α-particles (D) X-rays

   Ans (C)

   α- particles are positively charged

5. The resistivity of a semiconductor at room temperature is in between

(A) 10^{-3} to 10^{6} Ω cm (B) 10^{6} to 10^{8} Ω cm (C) 10^{10} to 10^{12} Ω cm (D) 10^{-2} to 10^{-5} Ω cm

Ans (A)

10^{-5} Ω m – 10^{6} Ω m

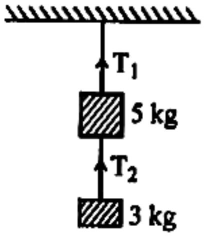
10^{-3} Ω cm – 10^{4} Ω cm

6. The forbidden energy gap for Ge crystal at 0 K is

(A) 0.71 eV (B) 2.57 eV (C) 6.57 eV (D) 0.071 eV

Ans (A)

7. Two masses of 5 kg and 3 kg are suspended with the help of massless inextensible strings as shown in figure. When whole system is going upwards with acceleration 2 m/s^2, the value of T_1 is (use $g = 9.8$ m/s^2)



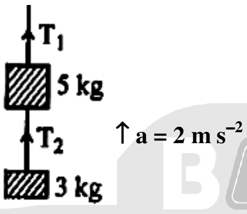
(A) 35.4 N

(B) 23.6 N

(C) 59 N

(D) 94.4 N

Ans (D)



$T_1 = m(g + a)$

$= 8\,(9.8 + 2)$

$= 8 \times 11.8$

$T_1 = 94.4$ N

8. The Vernier scale of a travelling microscope has 50 divisions which coincides with 49 main scale divisions. If each main scale division is 0.5 mm, then the least count of the microscope is

(A) 0.5 mm (B) 0.01 mm (C) 0.5 cm (D) 0.01 cm

Ans (B)

$$LC = \frac{\text{Value of 1 MSD}}{\text{Number of VSD}} = \frac{0.5}{50}\text{ mm}$$

LC = 0.01 mm

9. The displacement 'x' (in metre) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time 't' (in sec.) by, $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

(A) 0 m (B) 6 m (C) 2 m (D) 4 m

Ans (A)

$t = \sqrt{x} + 3$

$\sqrt{x} = t - 3 \quad x = (t-3)^2$

$$v = \frac{dx}{dt} = \frac{d}{dt}(t^2 + 9 - 6t)$$

$v = 2t - 6$

$0 = 2t - 6 \qquad t = 3$ s

$x = (3 - 3)^2 = 0$

10. Two objects are projected at an angle θ and (90° – θ), to the horizontal with the same speed. The ratio of their maximum vertical heights is

(A) tan θ : 1 (B) 1 : tan θ (C) $\tan^2\theta : 1$ (D) 1 : 1

Ans (C)

$H = \frac{u^2 \sin^2\theta}{2g}$ $H \propto \sin^2\theta$

$\frac{H_1}{H_2} = \frac{\sin^2\theta}{\sin^2(90-\theta)}$

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

$= \tan^2\theta$

$H_1 : H_2 = \tan^2\theta = 1$

11. A car is moving in a circular horizontal track of radius 10 m with a constant speed of 10 m s^{-1}. A bob is suspended from the roof of the car by a light wire of length 1.0 m. The angle made by the wire with the vertical is (in radian)

(A) $\frac{\pi}{4}$ (B) 0 (C) $\frac{\pi}{3}$ (D) $\frac{\pi}{6}$

Ans (A)

$\tan\theta = \frac{v^2}{rg}$

$\tan\theta = \frac{10^2}{10\times10} = 1$

$\theta = 45° = \frac{\pi}{4}\text{rad}$

12. A tiny spherical oil drop carrying a net charge q is balanced in still air, with a vertical uniform electric field of strength $\frac{81}{7}\pi\times10^5$ V / m. When the field is switched off, the drop is observed to fall with terminal velocity 2×10^{-3} m s^{-1}. Here g = 9.8 m/s^2, viscosity of air is 1.8×10^{-5} Ns/m^2 and the density of oil is 900 kg m^{-3}. The magnitude of 'q' is

(A) 8×10^{-19} C (B) 1.6×10^{-19} C (C) 3.2×10^{-19} C (D) 0.8×10^{-19} C

Ans (A)

qE = mg

In the absence of electric field

mg = 6 π η r v = qE

$\therefore\ r = \frac{qE}{6\pi\eta v}$

m = volume × ρ

$m = \frac{4}{3}\pi r^3\rho = \frac{qE}{g}$

$\frac{4}{3}\pi\left[\frac{qE}{6\pi\eta v}\right]^R \rho = \frac{qE}{g}$

$$q^2 = \frac{6^3 \pi^2 \eta^3 v^3 \times 3}{4 E^2 \rho g}$$

$$q^2 = \frac{6^3 \times \pi^2 \times \left(1.8\times10^{-5}\right)^3 \times \left(2\times10^{-3}\right)^3 \times 3}{4\times\left(\frac{81}{7}\pi\times10^5\right)^2 \times900\times9.8}$$

$$= \frac{6^3 \times \left(1.8\times10^{-5}\right)^3 \times \left(2\times10^{-3}\right)^3 \times3\times7}{4\times81^2\times10^{10}\times900\times9.8}$$

$q^2 = 6.4 \times 10^{-37}$

$q = 8 \times 10^{-19}$ C

13. 'Heat cannot be itself flow from a body at lower temperature to a body at higher temperature'. This statement corresponds to

(A) Conservation of momentum
(B) Conservation of mass
(C) First law of thermodynamics
(D) Second law of Thermodynamics

Ans (D)

Statement of II law of thermodynamics.

14. A smooth chain of length 2 m is kept on a table such that its length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on the table is, (Take $g = 10$ m/s^2)

(A) 6.3 J
(B) 3.6 J
(C) 2.0 J
(D) 12.9 J

Ans (B)

Mass of 60 cm length, m $= 0.6\times\frac{4}{2} = 1.2$ kg

W = mgh

$= 1.2 \times 10 \times 0.3$

W = 3.6 J

15. The angular speed of motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration of the motor wheel is

(A) 4π rad/s^2
(B) 6π rad/s^2
(C) 8π rad/s^2
(D) 2π rad/s^2

Ans (A)

$$\alpha = \frac{\omega_2 - \omega_1}{t} = \frac{2\pi}{t}[f_2 - f_1]$$

$$= \frac{2\pi}{16\times60}[3120-1200]$$

$$= \frac{2\pi}{16\times60}\times1920$$

$= 4\pi$ rad s^{-2}

16. The centre of mass of an extended body on the surface of the earth and its centre of gravity
    (A) are always at the same point only for spherical bodies.
    (B) can never be at the same point.
    (C) centre of mass coincides with the centre of gravity of a body if the size of the body is negligible as compared to the size (or radius) of the earth.
    (D) are always at the same point for any size of the body.
    Ans (C)

17. A metallic rod breaks when strain produced is 0.2%. The Young's modulus of the material of the rod is 7×10^9 N/m^2. The area of cross section to support load of 10^4 N is
    (A) 7.1×10^{-6} m^2 (B) 7.1×10^{-4} m^2 (C) 7.1×10^{-2} m^2 (D) 7.1×10^{-8} m^2
    Ans (B)
    $$\text{Maximum stress} = \frac{0.2}{100} \times 7 \times 10^9 = 1.4 \times 10^7 \text{ N}$$
    Force = Stress × Area
    $10^4 = 1.4 \times 10^7 \times A$
    $A = 7.1 \times 10^{-4}$ m^2

18. A charged particle of mass 'm' and charge 'q' is released from rest in an uniform electric field $\vec{E}$. Neglecting the effect of gravity, the kinetic energy of the charged particle after 't' second is
    (A) $\frac{Eq^2m}{2t^2}$ (B) $\frac{Eqm}{t}$ (C) $\frac{E^2q^2t^2}{2m}$ (D) $\frac{2E^2t^2}{mq}$
    Ans (C)
    $v = u + at$
    $v = at$ (u = 0)
    $$v = \frac{qE}{m}t$$
    $$K = \frac{1}{2}mv^2$$
    $$= \frac{1}{2}m\frac{q^2E^2}{m^2}t^2$$
    $$K = \frac{q^2E^2t^2}{2m}$$

19. The electric field and the potential of an electric dipole vary with distance r as
    (A) $\frac{1}{r^2}$ and $\frac{1}{r}$ (B) $\frac{1}{r^2}$ and $\frac{1}{r^3}$ (C) $\frac{1}{r^3}$ and $\frac{1}{r^2}$ (D) $\frac{1}{r}$ and $\frac{1}{r^2}$
    Ans (C)
    $$E \alpha \frac{1}{r^3}$$
    $$V \alpha \frac{1}{r^2}$$

20. The displacement of a particle executing SHM is given by $X = 3\sin\left[2\pi t + \frac{\pi}{4}\right]$ where 'x' is in metres and 't' is in seconds. The amplitude and maximum speed of the particle is

(A) 3 m, 4 π m s^{-1} (B) 3 m, 6 π m s^{-1} (C) 3 m, 8 π m s^{-1} (D) 3 m, 2 π m s^{-1}

Ans (B)

$x = 3\sin\left[2\pi t + \frac{\pi}{4}\right]$

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

$A = 3$ m, $\omega = 2\pi$ rad s^{-1}

$v_{max} = \omega A$

$= 2\,\pi \times 3$

$v_{max} = 6\,\pi$ m s^{-1}

21. Electrical as well as gravitational affects can be thought to be caused by fields. Which of the following is true for an electrical or gravitational field?

(A) Gravitational or Electric field does not exist in the space around an object.

(B) Fields are useful for understanding forces acting through a distance.

(C) There is no way to verify the existence of a force field since it is just a concept.

(D) The field concept is often used to describe contact forces.

Ans (B)

In physics, concept of field is a model used to explain the influence of a massive body or charged particle extends into space around itself, producing a force on another massive body or charged body placed in space.

22. Four charges +q, +2q, +q and −2q are placed at the corners of a square ABCD respectively. The force on a unit positive charge kept at the centre 'O' is

(A) along the diagonal BD (B) along the diagonal AC

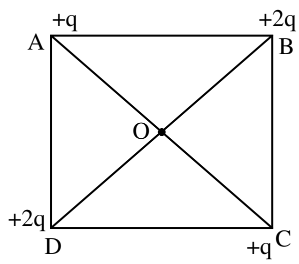
(C) perpendicular to AD (D) zero

Ans (A)

F_{AO} and F_{OC} will be equal in magnitude and opposite in direction. Hence, they cancel out.

$F_{BO} \rightarrow$ towards D

$F_{OD} \rightarrow$ towards D



23. An electric dipole with dipole moment 4×10^{-9} C m is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^{4} NC^{-1}, the magnitude of the torque acting on the dipole is

(A) $\sqrt{3} \times 10^{-4}$ N m (B) 10^{-5} N m (C) 10×10^{-3} N m (D) 10^{-4} N m

Ans (D)

$p = 4 \times 10^{-9}$ cm ; $\theta = 30°$; $E = 5 \times 10^{4}$ N C^{-1}

$\tau = pE\sin\theta \Rightarrow \tau = 4 \times 10^{-9} \times 5 \times 10^{4} \times \sin 30°$

$\tau = 20 \times 10^{-5} \times \frac{1}{2} = 10^{-4}$ Nm

24. Ten identical cells each of potential 'E' and internal resistance 'r', are connected in series to form a closed circuit. An ideal voltmeter connected across three cells, will read

(A) 3 E (B) 13 E (C) 7 E (D) 10 E

Ans (A)

Total emf = 10 E

Total internal resistance = 10 r

Current in the circuit $= \frac{10\,E}{10\,r} = \frac{E}{r}$

Potential difference a cross 3 cells = I × 3r

$$V = \frac{E}{r} \times 3r$$

$$V = 3\ E$$

25. In an atom electrons revolve around the nucleus along a path of radius 0.72 Å making 9.4×10^{18} revolutions per second. The equivalent current is [given $e = 1.6 \times 10^{-19}$ C]

(A) 1.5 A (B) 1.4 A (C) 1.8 A (D) 1.2 A

Ans (A)

$$I = \frac{e}{T} = ef = 1.6\times10^{-19}\times9.4\times10^{18} = 1.504\,A$$

26. When a metal conductor connected to left gap of a meter bridge is heated, the balancing point

(A) shifts towards left (B) remains unchanged

(C) shifts to the center (D) shifts towards right

Ans (D)

When the metal conductor is heated its resistance increases and hence the balancing point will shift towards right

27. Two tiny spheres carrying charges 1.8 μC and 2.8 μC are located at 40 cm apart. The potential at the mid-point of the line joining the two charge is

(A) 2.1×10^5 V (B) 4.3×10^4 V (C) 3.6×10^5 V (D) 3.8×10^4 V

Ans (A)

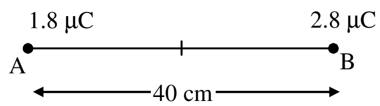
At C, $V = V_1 + V_2$

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_1} + \frac{q_2}{r_2}\right]$$

$$V = 9\times10^9\left[\frac{1.8\times10^{-6}}{20\times10^{-2}} + \frac{2.8\times10^{-6}}{20\times10^{-2}}\right]$$

$$V = \frac{9\times10^9\times(1.8+2.8)\times10^{-6}}{20\times10^{-2}}$$

$$V = 2.07\times10^5\ V$$



28. A parallel plate capacitor is charged by connecting a 2 V battery across it. It is then disconnected from the battery and a glass slab is introduced between plates. Which of the following pairs of quantities decrease?

(A) Potential difference and energy stored. (B) Energy stored and capacitance.

(C) Capacitance and charge. (D) Charge and potential difference.

Ans (A)

When battery is disconnected, charge remains constant.

On introducing glass slab, capacity increases.

Hence, potential difference and energy stored decreases.

29. A charged particle is moving in an electric field of 3×10^{-10} V m^{-1} with mobility 2.5×10^{6} m^2/v/s, its drift velocity is

(A) 8.33×10^{-4} m/s (B) 2.5×10^{4} m/s (C) 1.2×10^{-4} m/s (D) 7.5×10^{-4} m/s

Ans (D)

$E = 3 \times 10^{-10}$ V m^{-1}

$\mu = 2.5 \times 10^{6}$ m^2/v/s

$$\mu = \frac{v_d}{E} \Rightarrow v_d = \mu E = 3\times10^{-10}\times2.5\times10^{6}$$

$$v_d = 7.5 \times 10^{-4} \text{ m s}^{-1}$$

30. Wire bound resistors are made by

(A) winding the wires of an alloy of Si, Tu, Fe

(B) winding the wires of an alloy of Ge, Au, Ga

(C) winding the wires of an alloy of manganin, constantan, nichrome

(D) winding the wires of an alloy of Cu, Al, Ag

Ans (C)

31. A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with a resistance 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the resistance in series should be

(A) 5550 Ω (B) 5050 Ω (C) 4450 Ω (D) 6050 Ω

Ans (C)

R_{total} = 50 Ω + 2950 Ω = 3000 Ω

$$\text{Current } I = \frac{3}{3000} = 1\times10^{-3} A = 1 \text{ mA}$$

$$I' = \frac{1 \text{ mA}}{30}\times 20 = \frac{2}{3} \text{ mA}$$

$$3 \text{ V} = 3000\ \Omega\times1 \text{ mA} = x\times\frac{2}{3} \text{ mA}$$

$$x = 3000\times1\times\frac{3}{2}$$

$$= 4500\ \Omega$$

Resistance to be added = 4500 Ω – 50 Ω

= 4450 Ω

32. A circular coil of wire of radius ‘r’ has ‘n’ turns and carries a current ‘I’. The magnetic induction ‘B’ at a point on the axis of the coil at a distance $\sqrt{3}$ r from its centre is

(A) $\frac{\mu_0 nI}{8r}$ (B) $\frac{\mu_0 nI}{16r}$ (C) $\frac{\mu_0 nI}{4r}$ (D) $\frac{\mu_0 nI}{32r}$

Ans (B)

$$B = \frac{\mu_0 n I a^2}{2\left(a^2 + x^2\right)^{3/2}}$$

$$= \frac{\mu_0 n I r^2}{2\left(r^2 + 3r^2\right)^{3/2}}$$

$$= \frac{\mu_0 n I r^2}{2\left(4r^2\right)^{3/2}} = \frac{\mu_0 n I r^2}{2 \times 8 \times r^3} = \frac{\mu_0 n I}{16r}$$

33. If voltage across a bulb rated 220 V, 100 W drops by 2.5 % of its rated value, the percentage of the rated value by which the power would decrease is

(A) 2.5 % (B) 5 % (C) 10 % (D) 20 %

Ans (B)

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

$$\frac{\Delta P}{P} = 2\frac{\Delta V}{V}$$

% decrease in power $= \frac{\Delta P}{P} \times 100$

$= \frac{2\Delta V}{V} \times 100$

$= 2 \times 2.5\ \% = 5\ \%$

34. A wire of a certain material is stretched slowly by 10 %. Its new resistance and specific resistance becomes respectively

(A) 1.2 times, 1.1 times (B) 1.21 times, same

(C) both remains the same (D) 1.1 times, 1.1 times

Ans (B)

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

$$l' = l + \frac{10}{100} l$$

$$l' = \frac{110}{100} l$$

$$\frac{l'}{l} = \frac{11}{10}$$

Volume remains constant

$$A l = A' l'$$

$$\frac{l'}{l} = \frac{A}{A'}$$

$$A' = \frac{10}{11} A$$

$$R' = \rho \frac{\left(\frac{11}{10}\right) l}{\frac{10}{11} A}$$

$$R' = \frac{\rho l}{A}\left(\frac{11}{10}\right)^2$$

$R' = 1.21\ R$

Specific resistance remains the same.

35. A proton moves with a velocity of $5\times10^{6}\ \hat{j}$ m s^{-1} through the uniform electric field, $\vec{E}=4\times10^{6}\left[2\hat{i}+0.2\hat{j}+0.1\hat{k}\right]$V m^{-1} and the uniform magnetic field $\vec{B}=0.2\left[\hat{i}+0.2\hat{j}+\hat{k}\right]$T . The approximate net force acting on the proton is

(A) 25×10^{-13} N (B) 2.2×10^{-13} N (C) 20×10^{-13} N (D) 5×10^{-13} N

Ans (C)

$\vec{F}=q\left(\vec{E}+\left(\vec{v}\times\vec{B}\right)\right)$

$F=14.4\times10^{-13}$ N

36. A solenoid of length 50 cm having 100 turns carries a current of 2.5 A. The magnetic field at one end of the solenoid is

(A) 6.28×10^{-4} T (B) 1.57×10^{-4} T (C) 9.42×10^{-4} T (D) 3.14×10^{-4} T

Ans (D)

$n=\frac{N}{l}=\frac{100}{0.50}=\frac{100}{50\times10^{-2}}\Rightarrow 200$ turns m^{-1}

$B=\mu_0 nI$

$=4\pi\times10^{-7}\times200\times2.5$

$=6.28\times10^{-4}$ T

$B_{end}=\frac{\mu_0 nI}{2}$

$=\frac{6.28\times10^{-4}}{2}$

$=3.14\times10^{-4}$ T

37. An alternating current is given by $i=i_1\sin\omega t+i_2\cos\omega t$. The r.m.s. current is given by

(A) $\frac{i_1-i_2}{\sqrt{2}}$ (B) $\sqrt{\frac{i_1^2+i_2^2}{2}}$ (C) $\sqrt{\frac{i_1^2+i_2^2}{\sqrt{2}}}$ (D) $\frac{i_1+i_2}{\sqrt{2}}$

Ans (B)

$i_{rms}=\frac{i}{\sqrt{2}}$

$i_{rms}=\frac{\sqrt{i_1^2+i_2^2}}{\sqrt{2}}$

$i_{rms}=\sqrt{\frac{i_1^2+i_2^2}{2}}$

38. Which of the following statements proves that Earth has a magnetic field?

(A) Earth is a planet rotating about the North South axis.

(B) Earth is surrounded by ionosphere.

(C) A large quantity of iron-ore is found in the Earth.

(D) The intensity of cosmic rays stream of charged particles is more at the poles than at the equator.

Ans (D)

39. A long solenoid has 500 turns, when a current of 2 A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb, then self induction of the solenoid is

(A) 2.5 henry (B) 2.0 henry (C) 1.0 henry (D) 4.0 henry

Ans (C)

$\phi = 500 \times 4 \times 10^{-3} = 2$ Wb

$\phi = LI$

$L = \frac{\phi}{I}$

$L = \frac{2}{2}$

L = 1 H

40. A fully charged capacitor 'C' with initial charge 'q_0' is connected to a coil of self inductance 'L' at t = 0. The time at which the energy is stored equally between the electric and the magnetic field is

(A) $\sqrt{LC}$ (B) $\pi\sqrt{LC}$ (C) $\frac{\pi}{4}\sqrt{LC}$ (D) $2\pi\sqrt{LC}$

Ans (C)

$q = q_0 \cos \omega t$ …(1) $U = \frac{1}{2}\left(\frac{q_0^2}{2C}\right)$ $q = \frac{q_0}{\sqrt{2}}$

$\frac{q_0}{\sqrt{2}} = q_0 \cos \omega t$

$\cos \omega t = \frac{1}{\sqrt{2}}$

$f = \frac{1}{2\pi\sqrt{LC}}$

$\omega = \frac{1}{\sqrt{LC}}$

$\omega t = \frac{\pi}{4}$, $t = \frac{\pi}{4\omega} = \frac{\pi}{4}\sqrt{LC}$

41. A magnetic field of flux density 1.0 Wb m^{-2} acts normal to a 80 turn coil of 0.01 m^2 area. If this coil is removed from the field in 0.2 second, the emf induced in it is

(A) 8 V (B) 0.8 V (C) 5 V (D) 4 V

Ans (D)

$E = \frac{-d\phi}{dt}$

$|E| = NA\frac{dB}{dt} = 80 \times 10^{-2} \times \frac{1}{0.2} = 4$ V

42. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to $\frac{3}{4}$ of the angle of the prism. The angle of deviation is

(A) 39° (B) 20° (C) 30° (D) 45°

Ans (C)

$i_1 = i_2 = i = \frac{3}{4}A$ $d = i_1 + i_2 - A$

$= 2\left(\frac{3}{4}A\right) - A = A\left(\frac{6-4}{4}\right) = \frac{A}{2} = 30°$

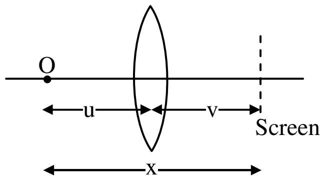
43. A convex lens of focal length 'f' is placed somewhere in between an object and a screen. The distance between the object and the screen is 'x'. If the numerical value of the magnification produced by the lens is 'm', then the focal length of the lens is

(A) $\frac{mx}{(m-1)^2}$ (B) $\frac{(m+1)^2 x}{m}$ (C) $\frac{(m-1)^2 x}{m}$ (D) $\frac{mx}{(m+1)^2}$

Ans (D)

$u + v = x$

$m = \frac{v}{u} \Rightarrow v = mu$



$u + v = x$

$u + mu = x$

$(1 + m)\, u = x$

$u = \frac{x}{m+1}$

$v = \frac{mx}{m+1}$

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

$\frac{1}{f} = \frac{1}{\left(\frac{mx}{m+1}\right)} + \frac{1}{\left(\frac{x}{m+1}\right)}$

$\frac{1}{f} = \frac{m+1}{mx} + \frac{(m+1)}{x}$

$\frac{1}{f} = (m+1)\left(\frac{x+mx}{mx^2}\right) = \frac{(m+1)(m+1)}{mx}$

$f = \frac{mx}{(m+1)^2}$

44. A series resonant ac circuit contains a capacitance 10^{-6} F and an inductor of 10^{-4} H. The frequency of electrical oscillations will be

(A) 10 Hz (B) $\frac{10^5}{2\pi}$Hz (C) $\frac{10}{2\pi}$Hz (D) 10^5 Hz

Ans (B)

$C = 10^{-6}$ F

$L = 10^{-4}$ H

$f = \frac{1}{2\pi\sqrt{LC}} = \frac{10^5}{2\pi}$Hz

45. In a series LCR circuit R = 300 Ω, L = 0.9 H, C = 2.0 μF and w = 1000 rad/sec., then impedance of the circuit is

(A) 900 Ω (B) 500 Ω (C) 400 Ω (D) 1300 Ω

Ans (B)

$x_L = \omega L = 1000 \times 0.9 = 900\ \Omega$

$$x_C = \frac{1}{\omega C} = \frac{1}{10^3 \times 2 \times 10^{-6}} = 500\ \Omega$$

$$z = \sqrt{R^2 + (X_L - X_C)^2},\ = \sqrt{(300)^2 + (400)^2}\ = 500\ \Omega$$

46. Which of the following radiations of electromagnetic waves has the highest wavelength?
(A) UV-rays (B) IR-rays (C) Microwaves (D) X-rays
Ans (C)

47. The power of a equi-concave lens is –4.5 D and is made of a material of R.I. 1.6, the radii of curvature of the lens is
(A) +36.6 cm (B) –2.66 cm (C) 115.44 cm (D) –26.6 cm
Ans (D)
$P = -4.5\ D$

$$\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$-4.5 = 0.6 \times \frac{2}{R}$$

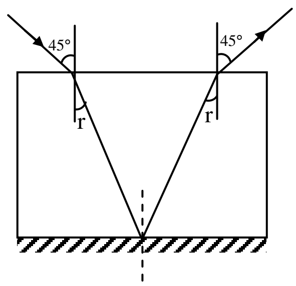
$$R = -\frac{1.2}{4.5} = -0.2666 = -26.66\ \text{cm}$$

48. In case of Fraunhoffer diffraction at a single slit the diffraction pattern on the screen is correct for which of the following statements?
(A) Central bright band having alternate dark and bright bands of decreasing intensity on either side.
(B) Central dark band having uniform brightness on either side.
(C) Central bright band having dark bands on either side.
(D) Central dark band having alternate dark and bright bands of decreasing intensity on either side.
Ans (A)

49. When a Compact Disc (CD) is illuminated by small source of white light coloured bands are observed. This is due to
(A) Diffraction (B) Interference (C) Reflection (D) Scattering
Ans (A)

50. Consider a glass slab which is silvered at one side and the other side is transparent. Given the refractive index of the glass slab to be 1.5. If a ray of light is incident at an angle of 45° on the transparent side, the deviation of the ray of light from its initial path, when it comes out of the slab is
(A) 180° (B) 120° (C) 45° (D) 90°
Ans (D)

Angle between incident ray and emergent ray = 90°.



51. Focal length of a convex lens will be maximum for

(A) Yellow light (B) Green light (C) Red light (D) Blue light

Ans (C)

Red light f < λ

52. For light diverging from a finite point source

(A) the intensity decreases in proportion to the distance squared.

(B) the wave front is parabolic.

(C) the intensity at the wave front does not depend on the distance.

(D) the wave front is cylindrical

Ans (A)

$I \propto \frac{1}{r^2}$

53. The fringe width for red colour as compared to that for violet colour is approximately

(A) Double (B) 4 times (C) 8 times (D) 3 times

Ans (A)

$\lambda_R \approx 8000$ Å and $\lambda_V \approx 4000$ Å

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

$\beta \propto \lambda$

$\beta_{red} = 2\ \beta_{violet}$

54. In accordance with the Bohr's model, the quantum number that characterises the Earth's revolution around the Sun in an orbit of radius 1.5×10^{11} m with orbital speed 3×10^4 m s^{-1} is

[given mass of Earth = 6×10^{24} kg]

(A) 2.57×10^{38} (B) 8.57×10^{64} (C) 2.57×10^{74} (D) 5.98×10^{86}

Ans (C)

According to Bohr atomic model

$mvr = \frac{nh}{2\pi}$

$n = \frac{m2\pi vr}{h} = \frac{(6\times10^{24})(2)(3.14)(3\times10^{4})\times1.5\times10^{11}}{6.626\times10^{-34}}$

$n = 2.57 \times 10^{74}$

55. If an electron is revolving in its Bohr orbit having Bohr radius of 0.529 Å, then the radius of third orbit is

(A) 4496 Å (B) 4.761 Å (C) 5125 nm (D) 4234 nm

Ans (B)

As $r_n = n^2 a_0$

$a_0 = 0.53$ Å

n = 3

$r_n = (3)^2\ a_0 = 9 \times 0.53$ Å

$r_n = 4.761$ Å

56. Binding energy of a Nitrogen nucleus $\left[{}^{14}_{7}\text{N}\right]$, given $m\left[{}^{14}_{7}\text{N}\right] = 14.00307\,u$

(A) 85 MeV (B) 206.5 MeV (C) 78 MeV (D) 104.7 MeV

Ans (D)

Mass defect

$\Delta m = (7\ m_H + 7\ m_n) - M_N$

$= [(7 \times 1.00783) + (7 \times 1.00807)] - 14.00307$

$= 0.11243$ amu

B.E. $= \Delta m \times 931.5$ MeV $= 0.11243 \times 931.5$ MeV

$= 104.67$ MeV

57. In a photo electric experiment, if both the intensity and frequency of the incident light are doubled, then the saturation photo electric current

(A) is halved (B) is doubled

(C) becomes four times (D) remains constant

Ans (B)

The saturation photoelectric current photoelectric current is directly proportional to the intensity of incident radiation but it is independent of frequency of light. As intensity and frequency are doubled photoelectric current is also doubled

58. The kinetic energy of the photoelectrons increases by 0.52 eV when the wavelength of incident light is changed from 500 nm to another wavelength which is approximately

(A) 400 nm (B) 1250 nm (C) 1000 nm (D) 700 nm

Ans (A)

$\Delta K = 0.52$ eV, $\lambda = 500$ nm, $\lambda_2 = ?$

$$K_1 = \frac{hc}{\lambda_1} - \phi$$

$$K_2 = \frac{hc}{\lambda_2} - \phi$$

$$K_1 - K_2 = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$-\Delta K = hc\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$-0.52\ \text{eV} = 1242\ \text{eVnm}\ \left(\frac{1}{1500\ \text{nm}} - \frac{1}{\lambda_2}\right)$$

$$\frac{-0.52}{1.242} = \frac{1}{500} - \frac{1}{\lambda_2}$$

$$\frac{1}{\lambda_2} = \frac{1}{500} + \frac{0.52}{1.242}$$

$\lambda_2 = 413$ nm ≈ 400 nm

59. The de-Broglie wavelength of a particle of kinetic energy 'K' is λ; the wavelength of the particle, if its kinetic energy is $\frac{K}{4}$ is

(A) 2 λ (B) $\frac{\lambda}{2}$ (C) 4 λ (D) λ

Ans (A)

$$\lambda = \frac{h}{\sqrt{2mK}}$$

$$\lambda^1 = \frac{h}{\sqrt{2m\frac{k}{4}}} = 2\lambda$$

$\lambda^1 = 2\lambda$

60. The radius of hydrogen atom in the ground state is 0.53 Å. After collision with an electron, it is found to have a radius of 2.12 Å, the principal quantum number 'n' of the final state of the atom is

(A) n = 2 (B) n = 3 (C) n = 4 (D) n = 1

Ans (A)

$$\frac{r_1}{r_2} = \frac{n_1^2}{n_2^2}$$

$$\frac{1}{n_2^2} = \frac{5.3\times10^{-11}}{21.2\times10^{-11}}$$

$n_2^2 = 4$

$n_2 = 2$

* * *