CREATIVE NEET ACADEMY
Sapthagiri Campus, Kanangi Road, Hirgana, Karkala - 576 117
Ph: +91 96069 06466   Email : info@creativeedu.in

NEET (UG)-2025 (Code – 48)

PHYSICS

1. A parallel plate capacitor made of circular plates is being charged such that the surface charge density on its plates is increasing at a constant rate with time. The magnetic field arising due to displacement currents is:
   (1) Non-zero everywhere with maximum at the imaginary cylindrical surfaces connecting peripheries of the plates.
   (2) Zero between the plates and non-zero outside.
   (3) Zero at all places.
   (4) Constant between the plates and zero outside the plates.

   Ans: (1)

   Non-zero everywhere with maximum at the imaginary cylindrical surface connecting peripheries of the plates.

2. An electric dipole with dipole moment 5×10^{-6} Cm is aligned with the direction of a uniform electric field of magnitude 4×10^5 N/C. The dipole is then rotated through an angle of 60^0 with respect to the electric field. The change in the potential energy of the dipole is:
   (1) 1.2 J   (2) 1.5 J   (3) 0.8 J   (4) 1.0 J

   Ans: (4)

   $\Delta U = U_i - U_f$

   $= pEcos60 – (-pEcos0)$

   $= \frac{pE}{2} = \frac{5\times10^{-6}\times4\times10^5}{2} = 10 \times 10^{-1}$

   $= 1J$

3. A ball of mass 0.5 kg is dropped from a height of 40 m. The ball hits the ground and rises to a height of 10 m. The impulse imparted to the ball during its collision with the ground is (take g = 9.8 m/s^2)
   (1) 0   (2) 84 Ns   (3) 21 Ns   (4) 7 Ns

   Ans: (3)

   $I = \Delta p = mv_i - mv_f$

   $= m (\sqrt{2gh_i} + \sqrt{2gh_f})$

   $= 0.5 (\sqrt{2 \times 9.8 \times 40} + \sqrt{2 \times 9.8 \times 10}) = 21Ns$

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4. The intensity of transmitted light when a polaroid sheet, placed between two crossed polaroids at 22.5^0 from the polarization axis of one of the polaroid, is (I_0 is the intensity of polarized light after passing through the first polaroid):

(1) $\dfrac{I_0}{8}$ (2) $\dfrac{I_0}{16}$ (3) $\dfrac{I_0}{2}$ (4) $\dfrac{I_0}{4}$

Ans: (1)

Intensity from second polaroid

$I_2 = I_0 \cos^2(22.5)$

Intensity from third polaroid

$I_3 = I_0 \cos^2(22.5)\cos^2(90\text{-} 22.5)$

$\quad = I_0 \cos^2(22.5)\sin^2(22.5)$

$I = \dfrac{I_0 \sin^2(45)}{4}$

$\quad = \dfrac{I_0}{8}$

5. The kinetic energies of two similar cars A and B are 100 J and 225 J respectively. On applying breaks, car A stops after 1000 m and car B stops after 1500 m. If F_A and F_B are the forces applied by the breaks on cars A and B respectively, then the ratio F_A/F_B is

(1) $\dfrac{1}{3}$ (2) $\dfrac{1}{2}$ (3) $\dfrac{3}{2}$ (4) $\dfrac{2}{3}$

Ans: (4)

$W = \Delta K$

$F = \dfrac{\Delta K}{d}$

$\dfrac{F_A}{F_B} = \dfrac{\Delta K_A}{\Delta K_B} \times \dfrac{d_B}{d_A}$

$\quad = \dfrac{100}{225} \times \dfrac{1500}{1000} = \dfrac{2}{3}$

6. The current passing through the battery in the given circuit, is:
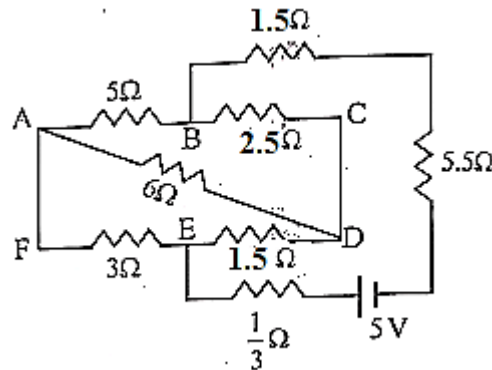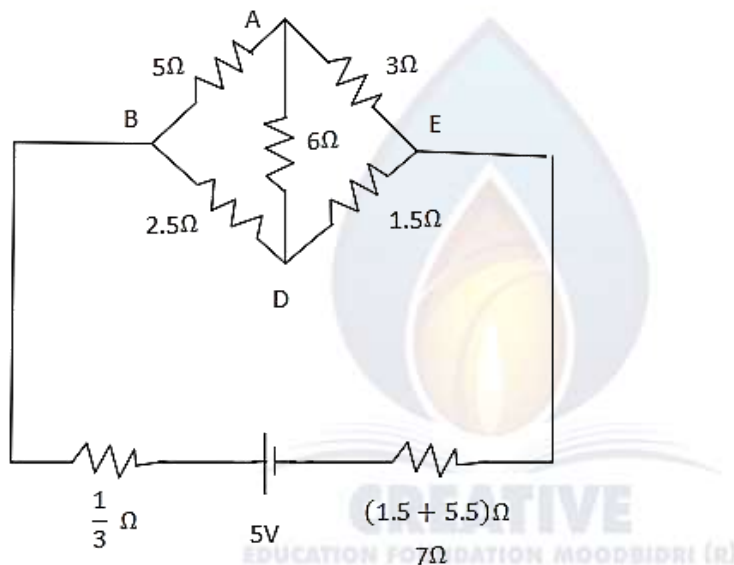

(1) 2.5 A   (2) 1.5 A   (3) 2.0 A   (4) 0.5 A

Ans: (4)

Terminals A and D are balanced

R_{eff} between B and E is $\frac{8 \times 4}{8+4} = \frac{32}{12} = \frac{8}{3}$ Ω

Total resistance $= \left(\frac{1}{3} + \frac{8}{3} + 7 \right)$

$= 10$ Ω

$I = \frac{V}{R} = \frac{5}{10} = 0.5A$

7. Three identical heat conducting rods are connected in series as shown in the figure. The rods on the sides have thermal conductivity 2K while that in the middle has thermal conductivity K. The left end of the combination is maintained at temperature 3T and the right end at T. The rods are thermally insulated from outside. In steady state, temperature at the left junction is T_1 and that at the right junction is T_2. The ratio T_1/T_2 is
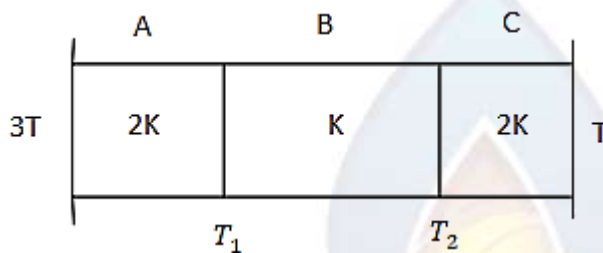

$3T$ | $2K$ | K | $2K$ | T
T_1 T_2
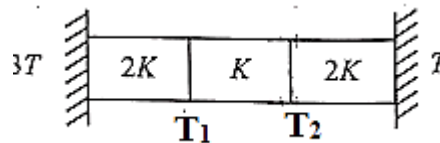
(1) $\dfrac{5}{3}$ (2) $\dfrac{5}{4}$ (3) $\dfrac{3}{2}$ (4) $\dfrac{4}{3}$

Ans: (1)

$$\frac{Q_A}{t} = \frac{Q_B}{t} = \frac{Q_C}{t}$$

$$\frac{2KA(3T - T_1)}{d} = \frac{KA(T_1 - T_2)}{d} = \frac{2KA(T_2 - T)}{d}$$

Consider,

$$\frac{2KA(3T - T_1)}{d} = \frac{2KA(T_2 - T)}{d}$$

$$3T - T_1 = T_2 - T$$

$$4T = T_1 + T_2 \quad \text{---- eqn (1)}$$

Consider,

$$\frac{2KA(3T - T_1)}{d} = \frac{KA(T_1 - T_2)}{d}$$

$$6T - 2T_1 = T_1 - T_2$$

$$3T_1 - T_2 = 6T$$

From equation (1)

$T_2 = 4T - T_1$

We get,

$3T_1 - 4T + T_1 = 6T$

$4T_1 = 10T$
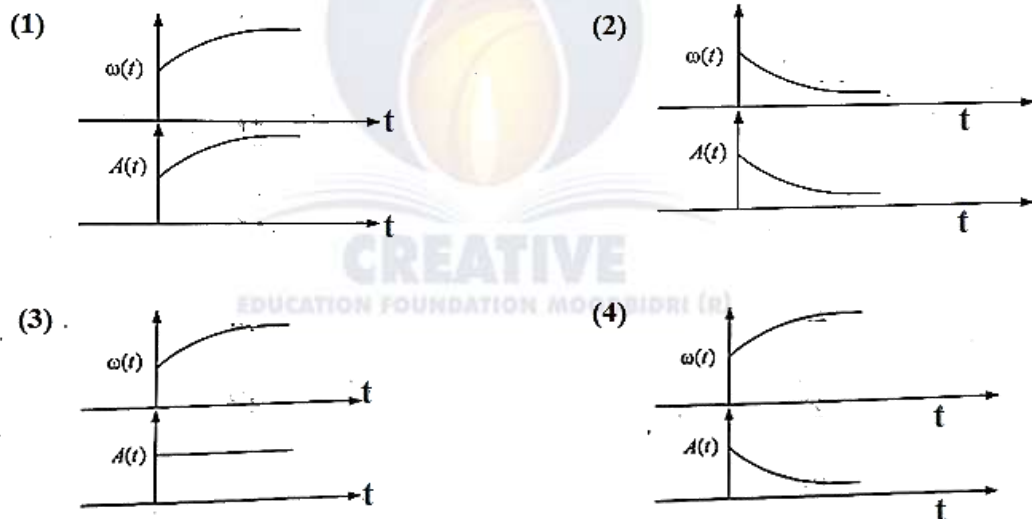
$T_1 = \dfrac{5}{2}T = 2.5T$

$T_2 = 4T - T_1$

$\quad = (4 - 2.5)T$

$T_2 = 1.5T$

$\dfrac{T_1}{T_2} = \dfrac{2.5}{1.5} = \dfrac{5}{3}$

8. In an oscillating spring mass system, a spring is connected to a box filled with sand. As the box oscillates, sand leaks slowly out of the box vertically so that the average frequency $\omega(t)$ and average amplitude A(t) of the system change with time t, which one of the following options schematically depicts these changes correctly?
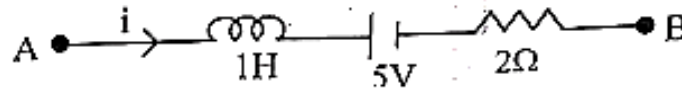

Ans: (4)

$\omega = \sqrt{\dfrac{k}{m}} \ \Rightarrow \ \omega \propto \dfrac{1}{\sqrt{(m)}}$

As m decreases, ω increases. Leaking of sand is an example of damping. Thus, the amplitude of the oscillation will decrease.
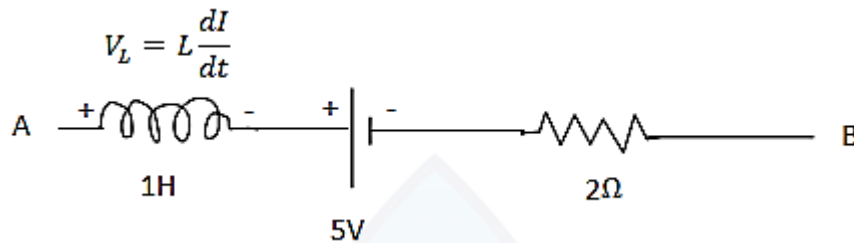
9. AB is a part of an electrical circuit (see figure). The potential difference "$V_A - V_B$", at the instant when current i = 2A and is increasing at a rate of 1 amp/second is

(1) 9 volt   (2) 10 volt   (3) 5 volt   (4) 6 volts

Ans: (2)

$$V_A - 1(1) - 5 - 4 - V_B = 0$$

$$V_A - V_B = 10V$$

10. A particle of mass m is moving around the origin with a constant force F pulling it towards the origin. If Bohr model is used to describe its motion, the radius of the nth orbit and the particle speed v in the orbit depend on as

(1) $r \propto n^{2/3}; v \propto n^{1/3}$

(2) $r \propto n^{4/3}; v \propto n^{-1/3}$

(3) $r \propto n^{1/3}; v \propto n^{1/3}$

(4) $r \propto n^{1/3}; v \propto n^{2/3}$

Ans: (1)

$$\frac{mv^2}{R} = F = \text{constatnt} \quad ---- \text{ eqn (1)}$$

As per Bohr model, angular momentum

$$L = n(\text{constant})$$

$$mvr = n(\text{constant})$$

$$vr \propto n$$

From eqn (1) $\frac{v^2}{r} = \text{constant}$

But $v \propto \frac{n}{r}$

$$\frac{n^2}{r^3} = \text{constant}$$

$r^3 \propto n^2$

$r \propto n^{\frac{2}{3}}$

Again in relation (2)

$vr \propto n$

$v\, n^{\frac{2}{3}} \propto n$

$v \propto n^{\frac{1}{3}}$

11. In some appropriate units, time (t) and position (x) relation of a moving particle is given by $t = x^2 + x$. The acceleration of the particle is

(1) $+\dfrac{2}{(x+1)^3}$
(2) $+\dfrac{2}{2x+1}$
(3) $-\dfrac{2}{(x+2)^3}$
(4) $-\dfrac{2}{(2x+1)^3}$

Ans: (4)

$t = x^2 + x$

$dt = 2xdx + dx$

$dt = (2x + 1)dx$

$\dfrac{dx}{dt} = \dfrac{1}{(2x + 1)} = V$

$acceleration, a = \dfrac{Vdv}{dx} = \dfrac{d(2x + 1)^{-1}}{dt}$

$a = \dfrac{-1}{(2x + 1)^2} (2)\dfrac{dx}{dt} = \dfrac{-2}{(2x + 1)^2}\left(\dfrac{1}{2x + 1}\right)$

$a = \dfrac{-2}{(2x + 1)^3}$

12. A model for quantized motion of an electron in a uniform magnetic field B states that the flux passing through the orbit of the electron in n(h/e) where n is an integer, h is Planck's constant and e is the magnitude of electron's charge. According to the model, the magnetic moment of an electron in its lowest energy state will be (m is the mass of the electron)

(1) $\dfrac{heB}{\pi m}$
(2) $\dfrac{heB}{2\pi m}$
(3) $\dfrac{he}{\pi m}$
(4) $\dfrac{he}{2\pi m}$

Ans: (4)

Given, $B\left(\pi r^{2}\right)=n\left(\dfrac{h}{e}\right)$

$Magnetic\ moment = i\left(\pi r^{2}\right)$

$$=\left(ef\right)\left(\pi r^{2}\right)$$

$$=e\dfrac{\omega}{2\pi}\left(\pi r^{2}\right)$$

$$=\dfrac{e}{2}\left(\omega\right)\left(r^{2}\right)$$

$$=\dfrac{e}{2}\left(\dfrac{eB}{m}\right)\left(\dfrac{h}{eB\pi}\right)=\dfrac{eh}{2\pi m}$$

13. A microscope has an objective of focal length 2 cm, eyepiece of focal length 4 cm and the tube length of 40 cm. If the distance of distinct vision of eye is 25 cm, the magnification in the microscope is
(1) 150   (2) 250   (3) 100   (4) 125

Ans: (4)

Magnification of microscope $m = m_o m_e$

$$m_o = \dfrac{L}{f_o} = \dfrac{40}{2} = 20$$

$$m_e = \dfrac{D}{f_e} = 6.25$$

$$m = 20(6.25) = 125$$

14. There are two inclined surfaces of equal length (L) and same angle of inclination 45^0 with the horizontal. One of them is rough and the other is perfectly smooth. A given body takes 2 times as much time to slide down on rough surface that on the smooth surface. The coefficient of kinetic friction $\left(\mu_k\right)$ between the object and the rough surface is close to
(1) 0.5   (2) 0.75   (3) 0.25   (4) 0.40
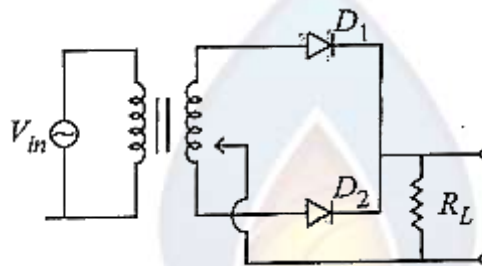
Ans: (2)

$$t_r = 2t_s$$

$$s = \dfrac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

$$\sqrt{\frac{2s}{g(\sin 45 - \mu \cos 45)}} = 2\sqrt{\frac{2s}{g \sin 45}}$$

$$\frac{\sqrt{2}}{1 - \mu} = 4(\sqrt{2})$$

$$\mu = \frac{3}{4} = 0.75$$

15. A full wave rectifier circuit with diode (D_1) and (D_2) is shown in the figure. If input supply voltage V_{in} = 220 sin(100πt) volt, then at t = 15 m sec

    (1) D_1 and D_2 both are forward biased
    (2) D_1 and D_2 both are reverse biased
    (3) D_1 is forward biased, D_2 is reverse biased
    (4) D_1 is reverse biased, D_2 is forward biased

    Ans: (3 & 4)
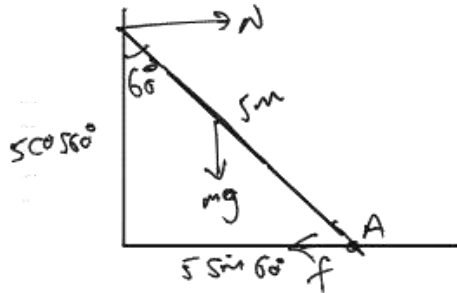
    V= 220 $\sin(100\pi \times 15 \times 10^{-3})$

    V = 220 $\sin(\frac{3\pi}{2})$ = $-220V$

    So, option (3) and (4) both are possible.

16. A uniform rod of mass 20 kg and length 5 m leans against a smooth vertical wall making an angle of 60^0 with it. The other end rests on a rough horizontal floor. The friction force that the floor exerts on the rod is (take g = 10 m/s²)
    (1) 200 N   (2) $200\sqrt{3}N$ (3) 100 N   (4) $100\sqrt{3}N$

    Ans: (4)

Consider normal force by the wall is 'N'

According rotational equilibrium about point A is

$$N \times 5 \times \cos 60^0 = mg \times \frac{5}{2} \times \sin 60^0$$

$$N = \frac{mg \tan 60^0}{2}$$

$$N = \frac{20 \times 10 \times \sqrt{3}}{2} = 100\sqrt{3}N$$

In horizontal direction f = N

$$f = 100\sqrt{3}N$$

17. Two identical charged conducting spheres A and B have their centres separated by a certain distance, charge on each sphere is q and the force of repulsion between them is F. A third identical uncharged conducting sphere is brought in contact with sphere A first and then with B and finally removed from both. New force of repulsion between spheres A and B (Radii of A and B are negligible compared to the distance pf separation so that for calculating force between them they can be consider as point charges) is best given as:
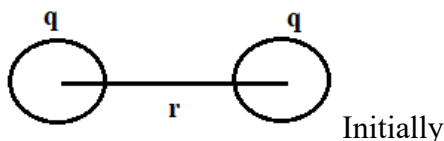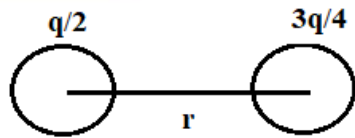
(1) $\frac{F}{2}$ (2) $\frac{3F}{8}$ (3) $\frac{3F}{5}$ (4) $\frac{2F}{3}$

Ans (2)

Initially

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

Finally

$$F' = \frac{k\left(\dfrac{q}{2}\right)\left(\dfrac{3q}{4}\right)}{r^2} = \frac{3kq^2}{8r^2}$$

$$F' = \frac{3}{8}F$$

18. Two cities X and Y are connected by a regular bus service with a bus leaving in either direction every T min. A girl is driving scooty with a speed of 60 km/h in the direction X to Y notices that a bus goes past her every 30 minutes in the direction of her motion, and every 10 minutes in the opposite direction. Choose the correct option for the period T of the bus service and the speed (assumed constant) of the buses.
(1) 10 min, 90 km/h   (2) 15 min, 120 km/h
(3) 9 min, 40 km/h   (4) 25 min, 100 km/h

Ans: (2)

Speed of girl $V_g = 60$ kw/h

Speed of buses is 'V'

The relative sped of bus which is moving X to Y is V – 60

The relative speed of bus which is moving Y to X is V + 60

Distance between X and Y is D = V × T

For bus X to Y is D = $(V – 60)\left(\dfrac{1}{2}\right)$

For bus Y to X is $D = (V + 60)\left(\dfrac{1}{6}\right)$

i.e., $(V - 60)\left(\dfrac{1}{2}\right) = (V + 60)\left(\dfrac{1}{6}\right)$

$3V - 180 = V + 60$
$2V = 240$
$V = 120 km/h$

Distance $D = \dfrac{(120 - 60)}{2} = 30 km$

Then $30 = 120(T) \Rightarrow T = \dfrac{1}{4} hr$

19. A container gas two chambers of volumes $V_1 = 2$ liters and $V_2 = 3$ liters separated by a partition made of a thermal insulator. The chambers contain $n_1 = 5$ and $n_2 = 4$ moles of ideal gas at pressures $p_1 = 1$ atm and $p_2 = 2$ atm, respectively. When the piston is removed, the mixture attains an equilibrium pressure of:
    (1) 1.4 atm   (2) 1.8 atm   (3) 1.3 atm   (4) 1.6 atm

    Ans: (4)

If piston was removed gases will mixed without any loss of energy

$P(V_1 + V_2) = P_1 V_1 + P_2 V_2$

$P = \dfrac{1 \times 2 + 2 \times 3}{2 + 3} = \dfrac{8}{5} = 1.6 atm$

20. De-Broglie wavelength of an electron orbiting in the $n = 2$ state of hydrogen atom is close to (Given Bohr radius = 0.052 nm)
    (1) 1.67 nm   (2) 2.67 nm   (3) 0.067 nm   (4) 0.67 nm

    Ans: (4)

Energy $E = \dfrac{-13.6^2}{n^2} eV \ (z = -1, n = 2)$

$E = -3.4 \ eV$

$E = -3.4 \times 1.6 \times 10^{-19} J = 5.44 \times 10^{-19} J$

$\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mK.E}} = \dfrac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 5.44 \times 10^{-19}}}$

$\lambda = 0.67 nm$

21. To an ac power supply of 220 V at 50 Hz, a resistor of $20\,\Omega$, a capacitor of reactance $25\ \Omega$ and an inductor of reactance $45\,\Omega$ are connected in series. The corresponding current in the circuits and the phase angle between the current and the voltage is, respectively

(1) 15.6 A and 30^0 (2) 15.6 A and 45^0 (3) 7.8 A and 30^0 (4) 7.8 A and 45^0

Ans: (4)

$$I = \frac{V}{Z}$$
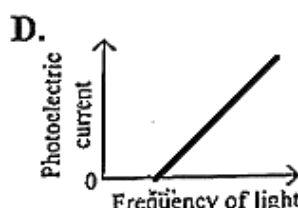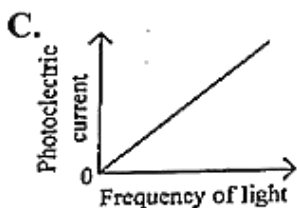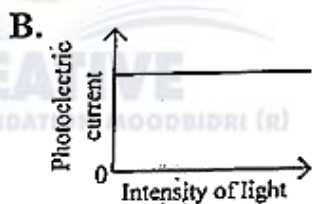
$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{20^2 + (20)^2}$$

$$Z = 20\sqrt{2}$$

$$I = \frac{220}{20\sqrt{2}} = \frac{11}{\sqrt{2}} = 7.8A$$

Phase angle $\emptyset = \tan^{-1}\frac{X_L - X_C}{R}$

$$\emptyset = \tan^{-1}\frac{20}{20} = 45^0$$

22. Which of the following options represent the variation of photoelectric current with property of light shown on the x-axis?

(1) A and D   (2) B and D   (3) A only   (4) A and C

Ans: (3) Photoelectric current is directly proportional to intensity of light.

23. A pipe open at both ends has a fundamental frequency f in air. The pipe is no dipped vertically in a water drum to half of its length. The fundamental frequency of the air column is now equal to

(1) $\dfrac{3f}{2}$ (2) 2f (3) $\dfrac{f}{2}$ (4) f

Ans: (4)

$f = \dfrac{v}{2l}$ (open pipe)

$f^1 = \dfrac{v}{4\dfrac{l}{2}} = \dfrac{v}{2l}$ (closed pipe)

$f^1 = f$

24. Two identical point masses P and Q, suspended from two separate massless springs of spring constants k_1 and k_2, respectively, oscillate vertically. If their maximum speed are the same, the ratio (A_Q/A_P) of the amplitude A_Q of mass Q to the amplitude A_P of mass P is:

(1) $\sqrt{\dfrac{k_2}{k_1}}$ (2) $\sqrt{\dfrac{k_1}{k_2}}$ (3) $\dfrac{k_2}{k_1}$ (4) $\dfrac{k_1}{k_2}$
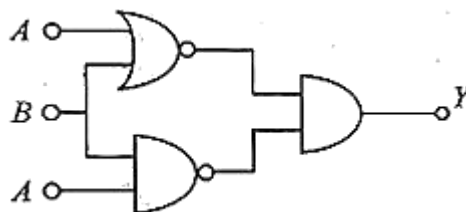
Ans: (2)

$V_{max} = A\omega$

$V_{max} = A\sqrt{\dfrac{k}{m}}$

$A_P\sqrt{\dfrac{K_1}{m}} = A_Q\sqrt{\dfrac{K_2}{m}}$

$\sqrt{\dfrac{K_1}{K_2}} = \dfrac{A_Q}{A_P}$

25. The output (Y) of the given logic implementation is similar to the output of an/a _____ gate.

(1) OR (2) NOR (3) AND (4) NAND

Ans: (2)

Here $Y = \left(\overline{A+B}\right).\left(\overline{A.B}\right)$

A	B	$\overline{A+B}$	$\overline{A.B}$	$\left(\overline{A+B}\right).\left(\overline{A.B}\right)$
0	0	1	1	1
0	1	0	1	0
1	0	0	1	0
1	1	0	0	0

26. An oxygen cylinder of volume 30 litre has 18.20 moles of oxygen. After some oxygen is withdrawn from the cylinder, its gauge pressure drops to 11 atmospheric pressure at temperature 27^0C. The mass of the oxygen withdrawn from the cylinder is nearly equal to: [Given, $R = \dfrac{100}{12} Jmol^{-1}K^{-1}$ and molecular mass of $O_2 = 32$,

1atm pressure $= 1.01 \times 10^5 N/m$]

(1) 0.116 kg   (2) 0.156 kg   (3) 0.125 kg   (4) 0.144 kg

Ans: (1)

$PV = nRT$

$12 \times 1.01 \times 10^5 \times 30 \times 10^{-3} = n_f \times \frac{100}{12} \times 300$

$[T = 27 + 273K = 300K]$

$n_f = 14.54 moles$

Mass withdrawn $= \left(n_i - n_f\right)M_0$

$\qquad = (18.20 - 14.54) \times 32 \times 10^{-3}$
$\qquad = 0.117 kg$

27. In a certain camera, a combination of four similar convex lenses are arranged axially in contact. Then the power of the combination and the total magnification in comparison to the power (p) and magnification (m) for each lens will be, respectively

(1) 4 p and m^4 (2) p^4 and m^4 (3) 4p and 4m   (4) p^4 and 4m

Ans: (1)

For combination of thin lenses,

$P_{net} = P_1 + P_2 + P_3 + P_4 = P + P + P + P = 4P$

and net magnification,

$$m_{net} = m_1 + m_2 + m_3 + m_4 = m + m + m + m = m^4$$

28. Two gases A and B filled at the same pressure in separate cylinders with movable pistons of radius r_A and r_B, respectively. On supplying an equal amount of heat to both the systems reversibly under constant pressure, the pistons of gas A and B are displaced by 16 cm and 9 cm, respectively. If the change in their internal energy is the same, then the ratio r_A / r_B is equal to

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

   Ans: (4)

   At constant pressure,

   $$\Delta Q = nC_P\Delta T = nC_V\Delta T + nR\Delta T$$

   Now, $\Delta Q_A = \Delta Q_B$ and $\Delta U_A = \Delta U_B$

   $$\Delta U_A + W_A = \Delta U_B + W_B$$

   $$W_A = W_B$$

   $$P(\Delta V_A) = P(\Delta V_B)$$

   $$16 \times 10^{-2} \times \pi r_A{}^2 = 9 \times 10^{-2} \times \pi r_B{}^2$$
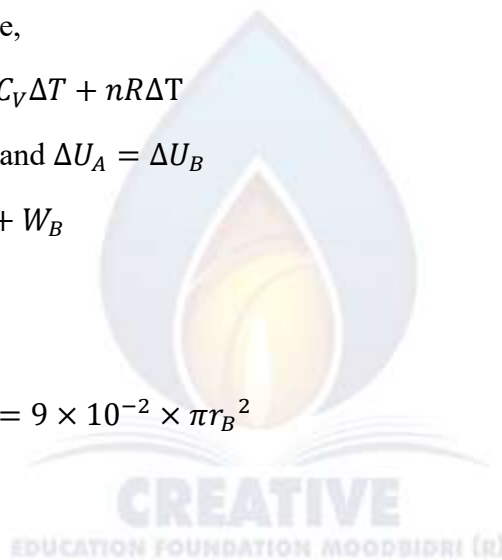
   $$4r_A = 3r_B$$

   $$\frac{r_A}{r_B} = \frac{3}{4}$$

29. A balloon is made of a material of surface tension S and its inflation outlet (from where gas is filled in it) has small area A. It is filled with a gas of density ρ and takes a spherical shape of radius R. When the gas is allowed to flow freely out of it, its radius r changes from R to 0 (zero) in time T. If the speed v(r) of gas coming out of the balloon depends on r as r^a and $T \propto S^{\alpha} A^{\beta} \rho^{\gamma} R^{\delta}$ then

   (1) $a = -\dfrac{1}{2}, \alpha = -\dfrac{1}{2}, \beta = -\dfrac{1}{2}, \gamma = \dfrac{1}{2}, \delta = \dfrac{7}{2}$

   (2) $a = -\dfrac{1}{2}, \alpha = \dfrac{1}{2}, \beta = -\dfrac{1}{2}, \gamma = \dfrac{1}{2}, \delta = \dfrac{7}{2}$

(3) $a = \dfrac{1}{2}, \alpha = \dfrac{1}{2}, \beta = -1, \gamma = +1, \delta = \dfrac{3}{2}$

(4) $a = -\dfrac{1}{2}, \alpha = -\dfrac{1}{2}, \beta = -1, \gamma = -\dfrac{1}{2}, \delta = \dfrac{5}{2}$

Ans: (1)

Dimensional analysis,

$[T] = [S]^{\alpha}[A]^{\beta}[\rho]^{\gamma}[R]^{\delta}$

$[T] = [MT^{-2}]^{\alpha}[L^2]^{\beta}[ML^{-3}]^{\gamma}[L]^{\delta}$

$[T] = [M^{\alpha+\beta}L^{2\beta-3\gamma+\delta}T^{-2\alpha}]$

Comparing,

$-2\alpha = 1$

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

$\alpha + \gamma = 0$

$\gamma = -\alpha = \dfrac{1}{2}$

$2\beta - 3\gamma + \delta = 0$

$2\beta + \gamma = 3\gamma = \dfrac{3}{2}$

Rate of reduction in size is equal to volume of gas escaped.
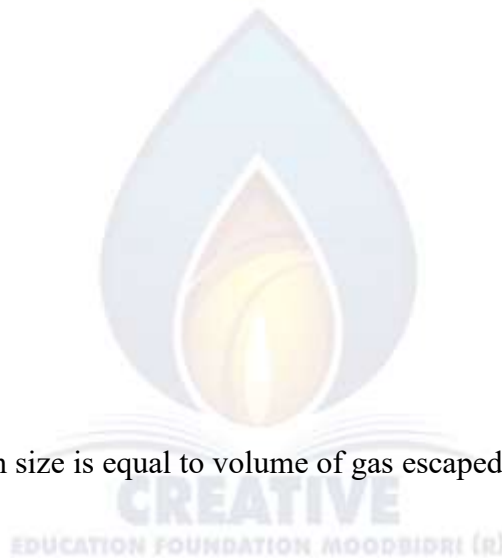
So, $-\dfrac{dV}{dt} = Av(r)$

$\Rightarrow -\dfrac{d}{dt}\left(\dfrac{4}{3}\pi r^3\right) = Av(r)$

$\Rightarrow -\dfrac{4}{3}r.3r^2\dfrac{dr}{dt} = Av(r) \Rightarrow \left|\dfrac{dr}{dt}\right| = \dfrac{Av}{4\pi r^2}$

Gas flows due to pressure difference between in and out.

So, $F = \dfrac{2s}{r} \times A$
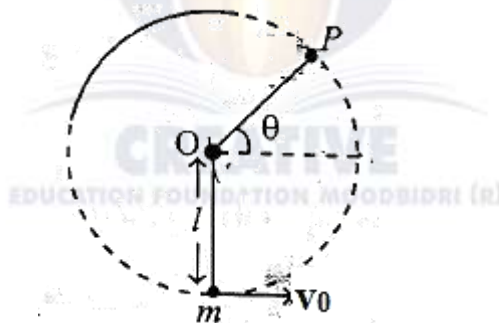
$\Rightarrow v\dfrac{dm}{dt} = \dfrac{2s}{r}A$

$$\Rightarrow v\frac{d}{dt}\left(\rho\frac{4}{3}\pi r^3\right)=\frac{4s}{r}A$$

$$\Rightarrow v\rho\times\frac{4}{3}r\frac{d\left(r^3\right)}{dt}=\frac{4s}{r}A$$

$$\Rightarrow v\rho\times\frac{4}{3}r\times 3r^2\frac{dr}{dt}=\frac{4s}{r}A$$

$$\Rightarrow v\rho\times\frac{4}{3}\pi r^2\times\left(\frac{Av}{4\pi r^2}\right)=\frac{4s}{r}A$$

[Replacing value of $\left|\dfrac{dr}{dt}\right|$]

$$\Rightarrow \rho Av^2=\frac{4s}{r}A$$

$$\Rightarrow v^2=4s$$

$$\Rightarrow v\propto\frac{1}{\sqrt{r}}\Rightarrow v\propto r^{-\frac{1}{2}}$$

30. A bob of heavy mass m is suspended by a light string of length l. The bob is given a horizontal velocity v_0 as shown in the figure. If the string gets slack at some point P making an angle θ from the horizontal the ratio of the speed v of the bob at point P to its initial speed v_0 is
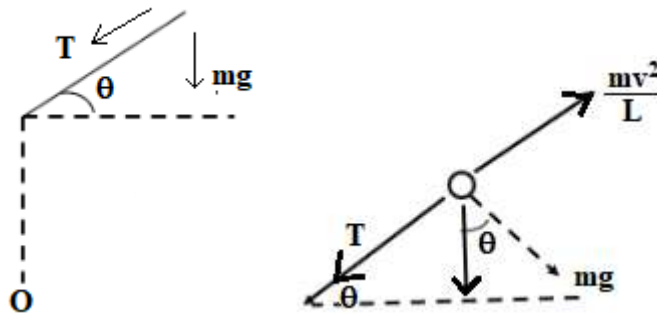

(1) $\left(\dfrac{\cos\theta}{2+3\sin\theta}\right)^{\frac{1}{2}}$ (2) $\left(\dfrac{\sin\theta}{2+3\sin\theta}\right)^{\frac{1}{2}}$ (3) $\left(\sin\theta\right)^{\frac{1}{2}}$ (4) $\left(\dfrac{1}{2+3\sin\theta}\right)^{\frac{1}{2}}$
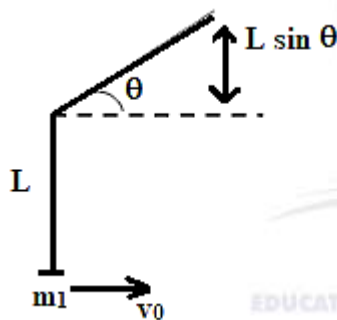
Ans: (2)

If string is slack T= 0

F.B.D:

Along radius,

$$T + mg\sin\theta = \frac{mv^2}{L}$$

$$mg\sin\theta = \frac{mv^2}{L}$$

$$v^2 = gL\sin\theta$$

Applying energy conservation,

$$\frac{1}{2}mv_0{}^2 = mg\{L + L\sin\theta\} + \frac{1}{2}mv^2$$

$$v_0{}^2 = 2gl(1 + \sin\theta) + v^2$$

$$v_0{}^2 = 2gl(1 + \sin\theta) + gL\sin\theta$$

$$v_0{}^2 = gl(2 + 2\sin\theta + \sin\theta)$$

$$v_0{}^2 = gl(2 + 3\sin\theta)$$

So, $\frac{v}{v_0} = \sqrt{\frac{v^2}{v_0{}^2}} = \sqrt{\frac{gL\sin\theta}{gl(2+3\sin\theta)}} = \left(\frac{\sin\theta}{(2+3\sin\theta)}\right)^{\frac{1}{2}}$

CREATIVE NEET ACADEMY
Sapthagiri Campus, Kanangi Road, Hirgana, Karkala - 576 117
Ph: +91 96069 06466   Email : info@creativeedu.in

NEET (UG)-2025 (Code – 48)

31. A physical quantity P is related to four observations a, b, c and d as follows:
$P = a^3b^2 / c\sqrt{d}$. The percentage errors of measurement in a, b, c and d are 1%, 3%, 2% and 4% respectively. The percentage error in the quantity P is
(1) 13%   (2) 15%   (3) 10%   (4) 2%

Ans: (1)

$$P = \frac{a^3b^2}{c\sqrt{d}}$$

$$\frac{\Delta P}{P} \times 100 = 3(\frac{\Delta a}{a} \times 100) + 2 (\frac{\Delta b}{b} \times 100) + 1(\frac{\Delta b}{b} \times 100) + \frac{1}{2} (\frac{\Delta b}{b} \times 100)$$

$$= 3 (1\%) + 2 (3\%) + 1(2\%) + \frac{1}{2}(4\%)$$

$$= 3\% + 6\% + 2\% + 2\%$$

$$= 13\%$$

32. The Sun rotates around its centre once in 27 days. What will be the period of revolution if the Sun were to expand to twice its present radius without any external influence? Assume the Sun to be a sphere of uniform density.
(1) 115 days   (2) 108 days   (3) 100 days   (4) 105 days

Ans: (2)

$I\omega$ = Constant

$$\Rightarrow I_1\omega_1 = I_2\omega_2$$

$$\Rightarrow \frac{2}{5}MR^2 \times \frac{2\pi}{T_1} = \frac{2}{5}\pi(2R)^2 \times \frac{2\pi}{T_2}$$

$$\Rightarrow \frac{1}{27} = \frac{4}{T_2}$$

$$\Rightarrow T_2 = 108 days$$

33. The radius of Martian orbit around the Sun is about 4 times the radius of the orbit of Mercury. The Martian year is 687 Earth days. Then which of the following is the length of 1 year on Mercury?
(1) 172 earth days   (2) 124 earth days   (3) 88 earth days   (4) 225 earth days

Ans: (3)

$r_{Mars} = 4r_{mercury}$

$T^2 \alpha R^3$

$$\frac{T_{Mars}}{T_{Mercury}} = \left(\frac{R_{Mars}}{R_{Mercury}}\right)^{\frac{3}{2}}$$

$$\frac{687}{T_{mercury}} = \left(\frac{4R_{Mercury}}{R_{Mercury}}\right)^{\frac{3}{2}}$$

$$T_{mercury} = \frac{687}{4^{3/2}}$$

$$= \frac{687}{8}$$

$$= 85.875$$

$$\cong 88 \text{ earth days}$$

34. A wire resistance R is cut into 8 equal pieces. From these pieces two equivalent resistances are made by adding four of these together in parallel. Then these two sets are added in series. The net effective resistance of the combination is

(1) $\dfrac{R}{16}$ (2) $\dfrac{R}{8}$ (3) $\dfrac{R}{64}$ (4) $\dfrac{R}{32}$

Ans: (1)

$R_{each} = \dfrac{R}{8}$

35. A photon and an electron (mass m) have the same energy E. The ratio $\left(\lambda_{photon} / \lambda_{electron}\right)$ of their de Broglie wavelengths is: (c is the speed of light)

(1) $c\sqrt{\dfrac{2m}{E}}$ (2) $\dfrac{1}{c}\sqrt{E/2m}$ (3) $\sqrt{E/2m}$ (4) $c\sqrt{2mE}$

Ans: (1)

$\lambda_e = \dfrac{h}{p} = \dfrac{h}{mv}$ ------------ (1)
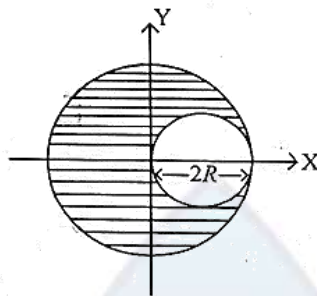
$\lambda_{photon} = \dfrac{hC}{p}$ ----------- (2)

$$E = \frac{p^2}{2m}, p = \sqrt{2mE}$$

$$\Rightarrow \frac{\lambda_{photon}}{\lambda_e} = \frac{hc}{E} \times \frac{p}{h}$$

$$= \frac{C}{E}\sqrt{2mE} = C\sqrt{\frac{2m}{E}}$$

36. A sphere of radius R is cut from a larger solid sphere of radius 2R as shown in the figure. The ratio of the moment of inertia of the smaller sphere to that of the rest part of the sphere about the Y-axis is

(1) $\frac{7}{57}$ (2) $\frac{7}{64}$ (3) $\frac{7}{8}$ (4) $\frac{7}{40}$

Ans: (1)

$R \rightarrow M$

$2R \rightarrow 8M \ [M \propto R^3]$

Smaller, $I_1 = \frac{2}{5}MR^2 + MR^2 = \frac{7}{5}MR^2$

Remaining part, $I_2 = \frac{2}{5}(8M)(2R)^2 - \frac{7}{5}MR^2$

$$\Rightarrow I_2 = \frac{(64-7)}{5}MR^2 = \frac{57}{5}MR^2$$

$$\therefore \frac{I_1}{I_2} = \frac{7}{57}$$

37. An electron (mass 9×10^{-31} kg and charge $1.6 \times 10^{-19} C$) moving with speed c/100 (c= speed of light) is injected into a magnetic field B of magnitude 9×10^{-4} T perpendicular to its direction of motion. We wish to apply an uniform electric filed $\vec{E}$ together with the magnetic field so that the electron does not deflect from its path. Then (speed of light $c = 3 \times 10^8 ms^{-1}$)

(1) $\vec{E}$ is parallel to $\vec{B}$ and its magnitude is $27 \times 10^2 Vm^{-1}$

(2) $\vec{E}$ is parallel to $\vec{B}$ and its magnitude is $27 \times 10^4 Vm^{-1}$

(3) $\vec{E}$ is perpendicular to $\vec{B}$ and its magnitude is $27 \times 10^4 Vm^{-1}$

(4) $\vec{E}$ is perpendicular to $\vec{B}$ and its magnitude is $27 \times 10^2 Vm^{-1}$

Ans: (4)

$F_E = -F_B$

$\Rightarrow q\vec{E} = -(\vec{v} \times \vec{B})$

$\quad |\vec{E}| = vB \sin 90° = \frac{c}{100} \times 9 \times 10^{-4} T \times 1$

$\quad\quad = \frac{3 \times 10^8 \times 9 \times 10^{-4}}{100} \frac{V}{m}$

$\quad\quad = 27 \times 10^2 \frac{V}{m}$, Perpendicular

38. The electric field in a plane electromagnetic wave is given by

$E_z = 60\cos(5x + 1.5 \times 10^9 t) V/m$

Then expression for the corresponding magnetic field is (here subscripts denote the direction of the field) :

(1) $B_z = 60\cos(5x + 1.5 \times 10^9 t)T$ (2) $B_y = 60\sin(5x + 1.5 \times 10^9 t)T$

(3) $B_y = 2 \times 10^{-7}\cos(5x + 1.5 \times 10^9 t)T$ (4) $B_x = 2 \times 10^{-7}\cos(5x + 1.5 \times 10^9 t)T$

Ans: (3)

$B_0 = \dfrac{E_0}{c} = \dfrac{60}{3 \times 10^8} = 2 \times 10^{-7} T$

$B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t) T$

$\vec{B}$ is perpendicular to both $\vec{E}$ and propagation (x), so along y direction.

39. A body weights 48 N on the surface of the earth. The gravitational force experienced by the body due to the earth at a height equal to one-third the radius of the earth from its surface is

(1) 32 N   (2) 36 N   (3) 16 N   (4) 27 N

Ans: (4)

$g_h = \dfrac{gR^2}{(R+h)^2} = \dfrac{gR^2}{\left(R + \dfrac{R}{3}\right)^2}$

$$\Rightarrow g_h = g\,\frac{9}{16}$$

$$mg = 48\,N$$

$$mg_h = mg\,\frac{9}{16} = 48 \times \frac{9}{16} = 27\,N$$

40. An unpolarized light beam traveling in air is incident on a medium of refractive index 1.73 at Brewster's angle. Then

    (1) Both reflected and transmitted light are perfectly polarized with angles of reflection and refraction close to 60^0 and 30^0, respectively.

    (2) Transmitted light is completely polarized with angle of refraction close to 30^0

    (3) Reflected light is completely polarized and the angle reflection is close to 60^0

    (4) Reflected light is partially polarized and the angle of reflection is close to 30^0

    Ans: (3)

    $$\theta_P = tan^{-1}(\mu) = tan^{-1}(1.73)$$

    $$\Rightarrow \theta_P = tan^{-1}\left(\sqrt{3}\right) = 60°$$

    i.e, i = 60° (θ_P is i)

    $$\Rightarrow \mu = \frac{sin\,60°}{sin\,r} = \sqrt{3}$$

    $$\Rightarrow r = 30°$$

    Angle of polarization $= i = 60°$

    Reflected light only polarize.

41. A constant voltage of 50 V is maintained between the points A and B of the circuit shown in the figure. The current through the branch CD of the circuit is
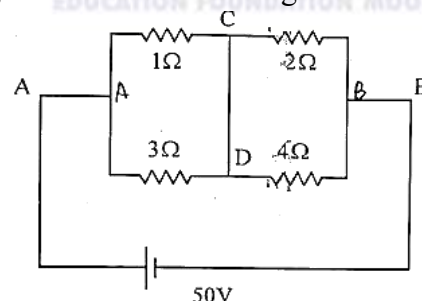
    (1) 2.5A   (2) 3.0 A   (3) 1.5 A   (4) 2.0 A
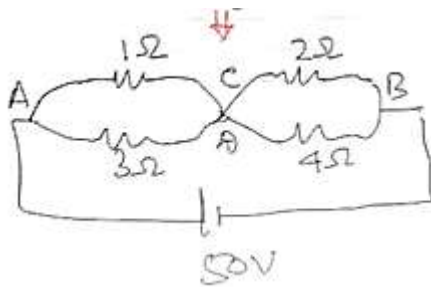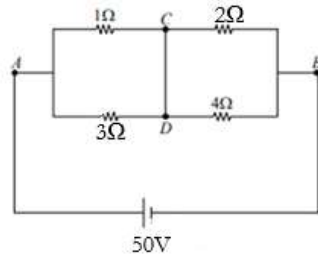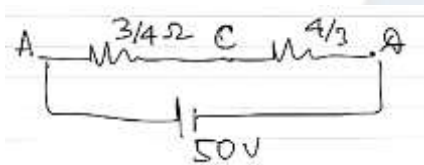
    Ans: (4)

Equivalent between AC

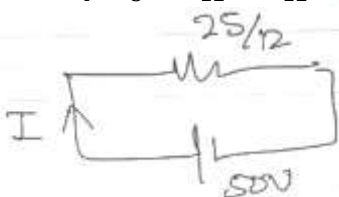$$E_{eq} = \frac{1 \times 3}{1+3} = \frac{3}{4}\,\Omega$$

Equivalent between CB

$$E_{eq} = \frac{2 \times 4}{6} = \frac{4}{3}\,\Omega$$

Overall Equivalent Resistance

$$E_{eq} = \frac{3}{4} + \frac{4}{3} = \frac{9+16}{12} = \frac{25}{12}\Omega$$

Current in the main circuit

$$I = \frac{V}{R_{eq}} = \frac{50}{25} \times 12$$

$$= 24\ A$$

Voltage across AC and CD

$$V_{AC} = 24 \times \frac{3}{4} = 18V$$

$$V_{CD} = 24 \times \frac{4}{3} = 32V$$

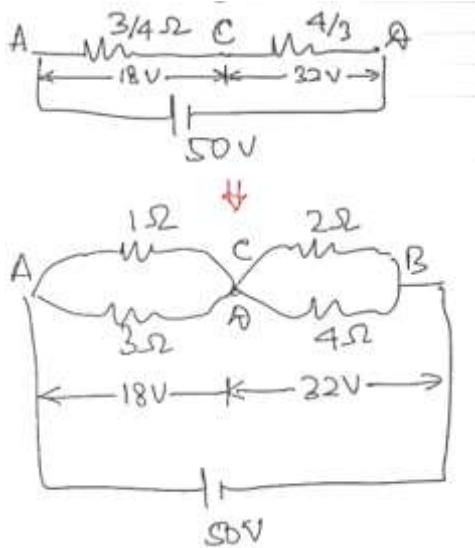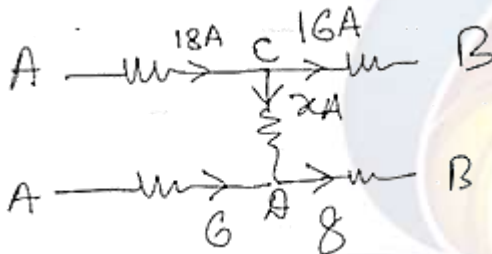$$I_{AC} = \frac{18}{1} = 18A \quad I_{AD} = \frac{18}{3} = 6A$$
$$I_{CB} = \frac{32}{2} = 16A \quad I_{DB} = \frac{32}{4} = 8A$$

Applying Junction Rule at C

$$\sum I = 0$$
$$\Rightarrow 18 - 16 - x = 0$$
$$\therefore x = 2A$$

42. The plates of a parallel plate capacitor are separated by d. Two slabs of different dielectric constant K_1 and K_2 with thickness $\frac{3}{8}d$ and $\frac{d}{2}$ respectively are inserted in the capacitor. Due to this, the capacitance becomes two times larger than when there is nothing between the plates.

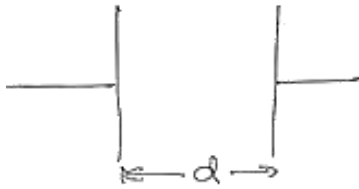If $K_1 = 1.25\ K_2$, the values of K_1 is

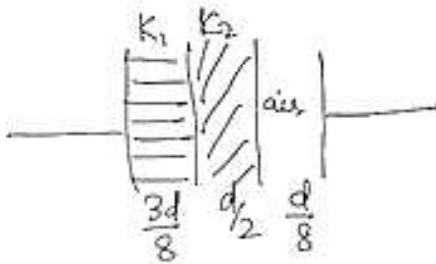(1) 1.60   (2) 1.33   (3) 2.66   (4) 2.33

Ans: (3)

Case 1,

$$C_{eq} = \frac{\varepsilon_0 A}{d}$$

Case 2,

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

$$\frac{1}{C_{eq}} = \frac{3d}{8K_1\varepsilon_0 A} + \frac{d}{2K_2\varepsilon_0 A} + \frac{d}{8\varepsilon_0 A}$$

$$\frac{1}{C_{eq}} = \frac{3d}{8K_1\varepsilon_0 A} + \frac{1.25d}{2K_1\varepsilon_0 A} + \frac{d}{8\varepsilon_0 A}$$

According to question,

$$C_{eq}^1 = 2C_{eq}$$

$$\frac{1}{2C_{eq}} = \frac{3d}{8K_1\varepsilon_0 A} + \frac{1.25d}{2K_1\varepsilon_0 A} + \frac{1}{8C_{eq}}$$

$$\frac{1}{2C_{eq}} - \frac{1}{8C_{eq}} = \frac{8d}{8K_1\varepsilon_0 A}$$

$$\frac{3d}{8\varepsilon_0 A} = \frac{d}{K_1\varepsilon_0 A}$$

$$K_1 = \frac{8}{3}$$

43. Consider the diameter of a spherical object being measured with the help of Vernier callipers. Suppose its 10 Vernier Scale Divisions (V.S.D.) are equal to its 9 Main Scale Divisions (M.S.D). The least division in the M.S. is 0.1 cm and the zero of V.S. is at x=0.1 cm when the jaws of Vernier callipers are closed. If the main scale reading for the diameter is M= 5 cm and the number of coinciding Vernier division is 8, the measured diameter after zero error correction, is

(1) 4.98 cm   (2) 5.00 cm   (3) 5.18 cm   (4) 5.08 cm

Ans: (1)

10VSD= 9MSD

$1VSD = \frac{9}{10}MSD$

L.C = 1MSD−1VSD

$= \left(1 - \frac{9}{10}\right)MSD$

$= \frac{1}{10}MSD$

= 0.1×0.1 cm

=0.01cm

Observed value = MSR+(CVD×LC)

= 5+(8×0.01)

= 5.08cm

Actual value = Observed value – ZE

= 5.08 cm – 0.1 cm

Actual value = 4.98 cm

44. A 2-amp current is flowing through two different small circular copper coils having radii ratio 1: 2. The ratio of their respective magnetic moments will be
   (1) 2:1   (2) 4:1   (3) 1:4   (4) 1:2

   Ans: (3)

   $M = IA = I\pi r^2$
   $M \propto r^2$
   $\frac{M_1}{M_2} = \frac{(1)^2}{(2)^2} = \frac{1}{4}$

45. Consider a water tank shown in the figure. It has one wall at x=L and can be taken to the very wide in the z direction. When filled with a liquid of surface tension S and density ρ, the liquid surface makes angle $\theta_0 \left(\theta_0 \ll 1\right)$ with the x-axis at x=L. if y(x) is the height of the surface then the equation for y(x) is
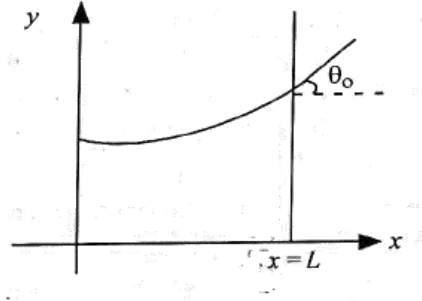
(take $\theta(x) = \sin\theta(x) = \tan\theta(x) = \dfrac{dy}{dx}$, g is the acceleration due to gravity)

(1) $\dfrac{d^2 y}{dx^2} = \sqrt{\dfrac{\rho g}{S}}$ (2) $\dfrac{dy}{dx} = \sqrt{\dfrac{\rho g}{S}}\,x$ (3) $\dfrac{d^2 y}{dx^2} = \dfrac{\rho g}{S}\,x$ (4) $\dfrac{d^2 y}{dx^2} = \dfrac{\rho g}{S}\,y$

Ans: (4)

Pressure difference across the liquid surface is due to surface tension and curvature

$$\Delta P = \frac{S}{R}$$

For small slopes, the curvature can be approximated as,

$$\frac{1}{R} = \frac{d^2 y}{dx^2}$$

Therefore, the pressure difference can be written as

$$\Delta P = S\frac{d^2 y}{dx^2} \quad \text{------(1)}$$

The pressure difference is also given by due to depth

$$\Delta P = \rho g y \text{-----(2)}$$

From equation (1) and (2)

$$S\frac{d^2 y}{dx^2} = \rho g y$$

$$\frac{d^2 y}{dx^2} = \frac{\rho g}{S} y$$

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DEPARTMENT OF PHYSICS

CREATIVE EDUCATION FOUNDATION MOODBIDRI (R)

Website   : www.creativeedu.in

Phone No.   : 9019844492