1. A 100-turn closely wound circular coil of radius 5 cm has a magnetic field of 3.14×10^{-3} T at its centre. The current flowing through the coil, and the magnitude of the magnetic moment of this coil are, respectively :

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

(1) 2·5 A, 2 A m^2 ✓ (2) 2·5 A, 20 A m^2

(3) 2 A, 4 A m^2 (4) 2 A, 10 A m^2

$N = 100$

$r = .05$ m

$B = 3.14 \times 10^{-3}$ T

$B = \frac{\mu_0 N I}{2r}$

$3.14 \times 10^{-3} = \frac{4\pi \times 10^{-7} \times 100 \times I}{2 \times .05}$

$I = 2.5$ A

$M = NIA$, $A = \pi r^2$

$M = 100 \times 2.5 \times \pi r^2$

$= 2$ Amp m^2

2. Match List I with List II :

List I		List II	
A.	$E = h\nu$	I.	de Broglie wavelength
B.	Diffraction and Interference	II.	Particle nature of light
C.	$\lambda = h/p$	III.	Wave nature of light
D.	Compton effect	IV.	Energy of photon

Choose the correct answer from the options given below :

(1) A-IV, B-III, C-I, D-II ✓
(2) A-I, B-IV, C-III, D-II
(3) A-IV, B-I, C-II, D-III
(4) A-IV, B-III, C-II, D-I

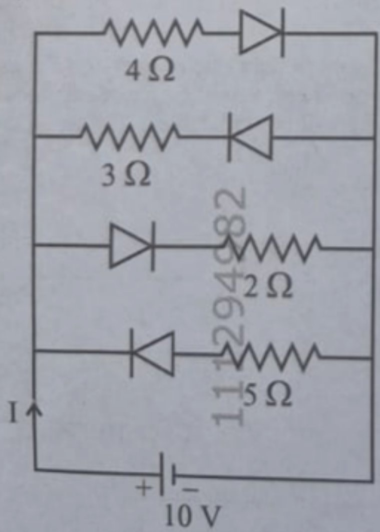
$E = h\nu$ – energy of photon

Diffraction and Interference → wave nature of light

$\lambda = \frac{h}{p}$ → debroglie wavelength

Compton effect – particle nature of light

3. The current I in the circuit shown below is :
(All diodes are ideal and identical)

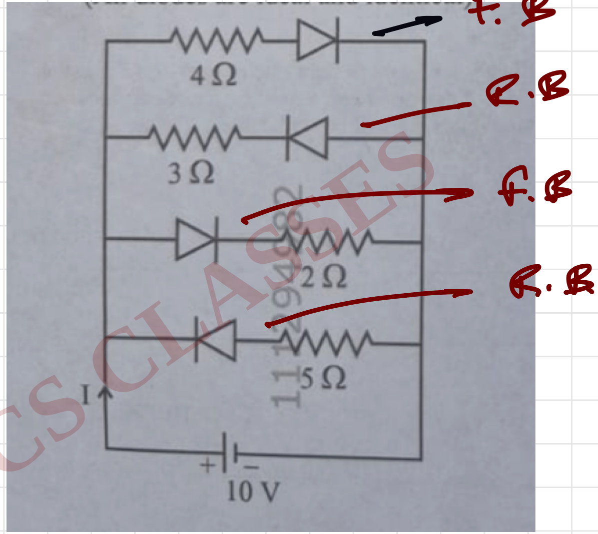


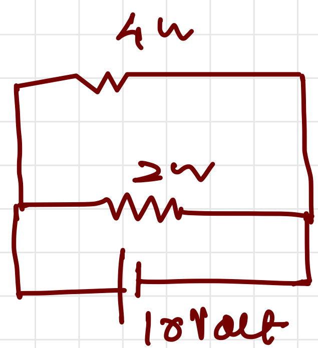
(1) $\frac{5}{3}$ A

(2) $\frac{15}{2}$ A

(3) $\frac{1}{3}$ A

(4) $\frac{5}{9}$ A





$R_{eq} = \frac{4 \times 2}{6} = \frac{4}{3}$ ohm

$I = \frac{10}{4/3} = \frac{30}{4} = \frac{15}{2}$ amp

4. The speed of light in vacuum is taken as unity. If light takes 6 min 40 s to reach the Earth from the Sun, the distance between the Sun and the Earth in new unit is :

(1) 3×10^8 (2) 3×10^{10}

(3) 400 (4) 500

$$\text{velocity} = \frac{\text{distance}}{\text{time}}$$

$$\text{distance} = \text{velocity} \times \text{time}$$

$$= 1 \times (360 + 40)$$

$$= 400$$

5. The following plots show variation of velocity (v) with time (t), of a ball thrown vertically upward, and falling back. Which of the following plots is/are correct ?

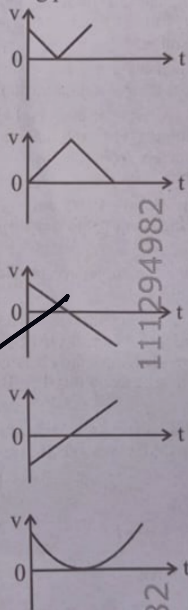
A.

B.

C.

D.

E.



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

For upward throw

→ velocity decrease linearly due to gravity

→ becomes zero at highest point

→ then negative while falling.

6. In a vernier callipers, 20 VSD coincide with 16 MSD (each division of length 1 mm). The least count of the vernier callipers is :

(1) 0·01 cm (2) 0·1 cm

(3) 0·02 cm ✓ (4) 0·2 cm

20 VSD = 16 mm

1 VSD = 0.8 mm

LC = 1 MSD − 1 VSD

= 1 − 0.8

= 0.2 mm

LC = .02 cm

7. An ac circuit contains a resistance of 1 kΩ, a capacitor of 0·1 μF and an inductor of 1 mH connected in series. The resonance frequency of the circuit is approximately :

(1) 10·1 kHz (2) 20·7 kHz

(3) 15·9 kHz ✓ (4) 13·5 kHz

$$X_L = X_C$$

$$2\pi f L = \frac{1}{2\pi f C}$$

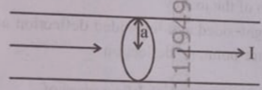
$$f = \frac{1}{2\pi\sqrt{LC}}$$

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

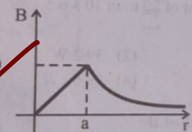
$$= \frac{1}{2\times 3.14\sqrt{1\times10^{-3}\times 0.1\times 10^{-6}}}$$

$$= 15.9 \text{ kHz}$$

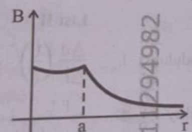
8. The figure given below shows a long straight solid wire of circular cross-section of radius 'a' carrying steady current I. The current I is uniformly distributed across its cross-section. The plot which correctly represents the variation of magnetic field (B) with distance (r) from the axis of the conductor in the region is :



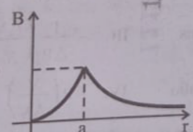
(1)



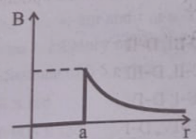
(2)



(3)



(4)



Inside conductor $B \propto r$

outside conductor $B \propto \frac{1}{r}$

case: $r = a < R$, $r = R$, $r = b > R$

Case-I

$r = a < R$, $\oint \vec{B} \cdot d\vec{l} = \mu_0 I'$

current enclosed is equal to I'

$B \cdot 2\pi a = \mu_0 I'$

$B = \frac{\mu_0}{2\pi} \frac{I'}{a}$

since current density is constant hence $\frac{I}{\pi R^2} = \frac{I'}{\pi a^2}$

$I' = \frac{I a^2}{R^2}$

$B = \frac{\mu_0}{2\pi} \frac{I a^2}{R^2 a}$

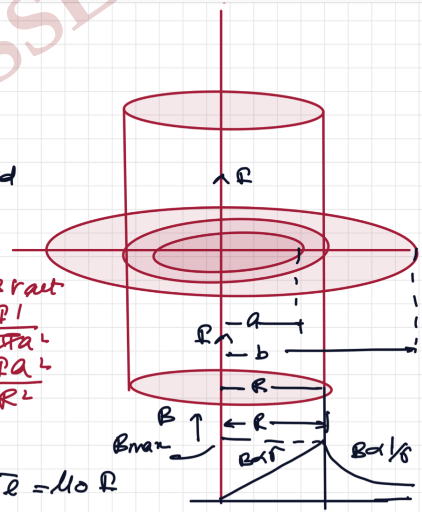
$B = \left(\frac{\mu_0}{2\pi} \frac{I}{R^2}\right)(a)$ constant

$B \propto a \propto r$

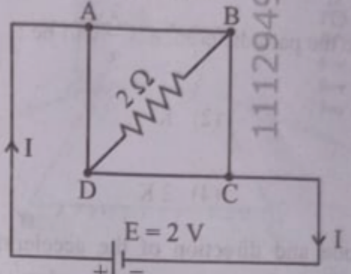
Case-2 → $r = R$ apply A.C.L $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$

current enclosed $= I$

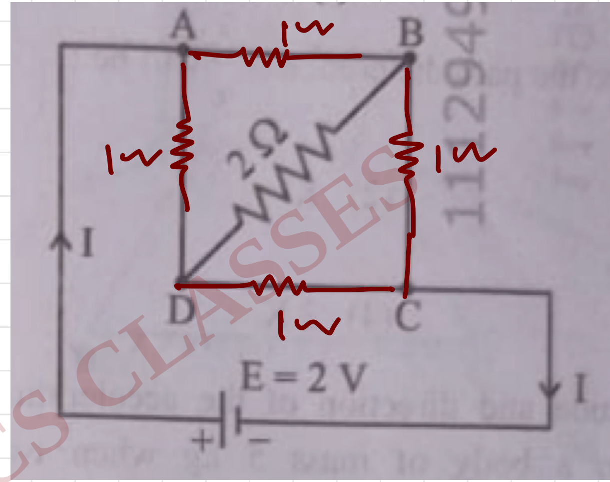
$B\, 2\pi R = \mu_0 I \Rightarrow B = \frac{\mu_0}{2\pi} \frac{I}{R} = B_{max}$

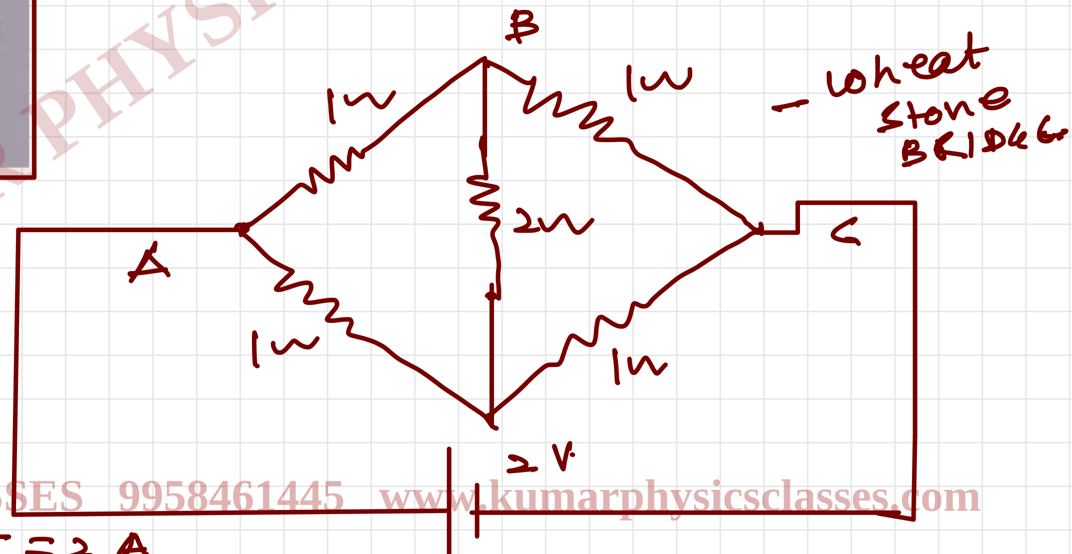


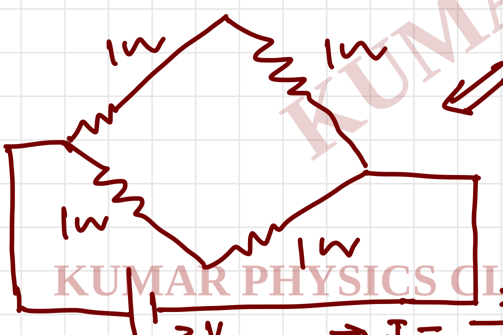
9. A uniform metallic wire having resistance 4 Ω is bent to form a square loop (ABCD) (see figure). A resistance of 2 Ω is connected between points B and D and a battery of 2 V is connected across points A and C as shown in the figure. Now the value of current (I) is :



(1) 2 A ✓
(2) 4 A
(3) 8 A
(4) 4·5 A







$\Rightarrow I = \frac{2}{1} = 2\,A$

10. An unknown nucleus has a nuclear density of $2{\cdot}29 \times 10^{17}$ kg/m^3 and mass of $19{\cdot}926 \times 10^{-27}$ kg. Its mass number A is approximately :
(Take $R_0 = 1{\cdot}2 \times 10^{-15}$ m, $4\pi = 12{\cdot}56$)

(1) 12 ✓
(2) 19
(3) 20
(4) 16

$$R = R_0 (A)^{1/3}$$

$$V = \frac{4}{3}\pi R^3$$

$$m = \rho V$$

$$= \rho \times \frac{4}{3}\pi R^3$$

$$= \rho \times \frac{4}{3}\pi \left(R_0 (A)^{1/3}\right)^3$$

$$= \rho \times \frac{4}{3}\pi R_0^3 A$$

$$19{\cdot}926 \times 10^{-27} = m = 2{\cdot}29 \times 10^{17} \times 12{\cdot}56 \times (1{\cdot}2 \times 10^{-15})^3 A$$

$$\Rightarrow A \simeq 12.$$

11. A rectangular wire loop of sides 8 cm and 3 cm with a small cut, is moving out of a region of uniform magnetic field of magnitude 0·3 T directed normal to the plane of the loop. The emf developed across the cut, if the velocity of the loop is 2 cm s^{-1}, in a direction normal to the shorter side of the loop, will be :

(1) $1{\cdot}8 \times 10^{-4}$ volt
(2) $1{\cdot}2 \times 10^{-4}$ volt
(3) $1{\cdot}3 \times 10^{-4}$ volt
(4) $4{\cdot}8 \times 10^{-4}$ volt ✓

$B = .03\ T$

$v = 2\ cm/sec$

$= .02\ m/sec$

$l = .08\ m$

$e = B l v$

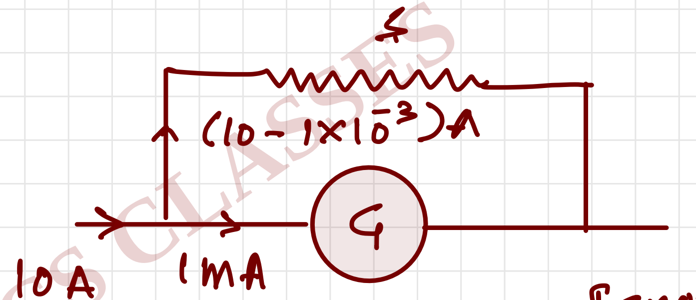
$= (0.3)(0.02)(.08)$

$= 4.8 \times 10^{-4}$ volt

12. A galvanometer of resistance 100 Ω gives full scale deflection for a current of 1 mA. It is converted into an ammeter of range 0 – 10 A. The shunt required is :

(1) 0·01 Ω ✓ (2) 0·10 Ω

(3) 0·001 Ω (4) 1·0 Ω



$$1\times10^{-3}\,G = (10 - 1\times10^{-3})\,S$$ Ignore (very small)

$$S = \frac{1\times10^{-2}(G)}{10}$$

$$= \frac{1\times10^{-3}\times100}{10} = 10^{-2}\ \text{ohm}$$

$$= .01\ \Omega$$

13. In Young's double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the screen where the path difference is λ, is K units. The intensity of light at a point where the path difference is $\frac{\lambda}{3}$ will be :

(1) $\frac{K}{4}$ ✓

(2) K

(3) $\frac{K}{2}$

(4) 2 K

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

$$\Delta\phi_1 = \frac{2\pi}{\lambda}(\lambda) = 2\pi = 360^\circ$$

$$\Delta\phi_2 = \frac{2\pi}{\lambda}\cdot\frac{\lambda}{3} = \frac{2\times 180}{3} = 120^\circ$$

$$K = a^2 + a^2 + 2a^2\cos 2\pi$$

$$K = 4a^2$$

$$K' = a^2 + a^2 + 2a^2\cos 120^\circ$$

$$K' = a^2 + a^2 + 2a^2\left(-\frac{1}{2}\right) = a^2$$

$$\frac{K}{K'} = \frac{4a^2}{a^2} \Rightarrow K' = \frac{K}{4}$$

14. The magnitude and direction of the acceleration produced in a body of mass 5 kg when two mutually perpendicular forces 8 N and 6 N act on it, are respectively :

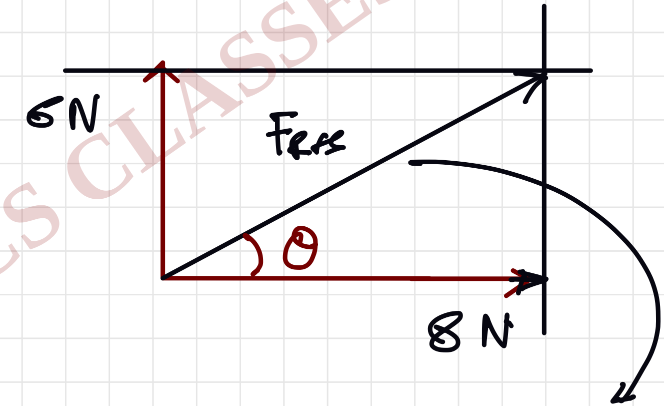
(1) $2\ m\ s^{-2}$; $\tan^{-1}(3/4)$ with 6 N force

(2) $2\ m\ s^{-2}$; $\tan^{-1}(4/3)$ with 8 N force

(3) $2\ m\ s^{-2}$; $\tan^{-1}(3/4)$ with 8 N force ✓

(4) $20\ m\ s^{-2}$; $\tan^{-1}(4/3)$ with 8 N force

$m = 5\ kg$



$F_{res} = m(a)$

$a = \frac{F_{res}}{5} = \frac{10}{5} = 2\ m\ s^{-2}$

$F_{res} = \sqrt{(8)^2 + (6)^2}$

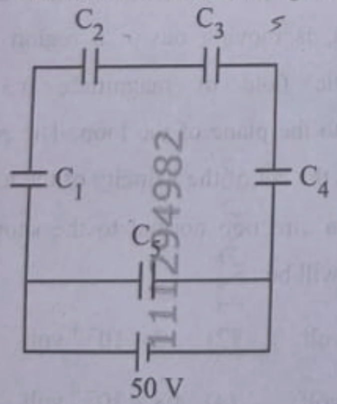
$\sqrt{64 + 36}$

$\sqrt{100} = 10\ N$

$\tan\theta = \frac{6^3}{8_4} = \frac{3}{4}$

$\theta = \tan^{-1}(3/4)$

15. Five capacitors of capacitances $C_1 = C_2 = C_3 = C_4 = 10\ \mu F$ and $C_5 = 2{\cdot}5\ \mu F$ are connected as shown, along with a battery of 50 V.



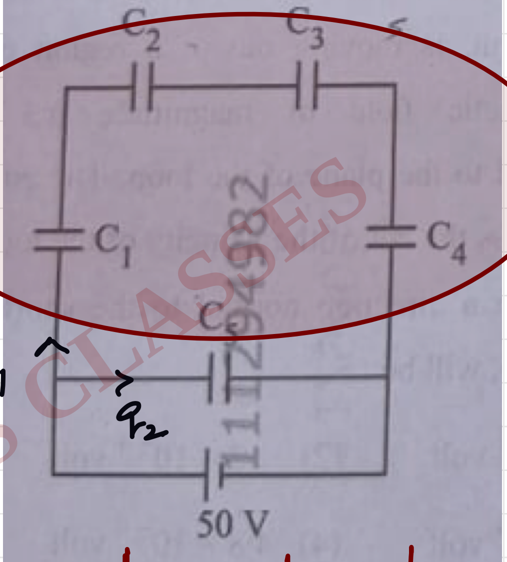
The equivalent capacitance and the charges on each capacitor respectively are :

(1) 5 μF, 125 μC on all capacitors ✓

(2) 5 μF, 250 μC on all capacitors

(3) 4 μF, 250 μC on C_1 to C_4 and 125 μC on C_5

(4) 5 μF, 125 μC on C_1 to C_4 and 25 μC on C_5



$$\frac{1}{C_{series}} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = \frac{4}{10}$$

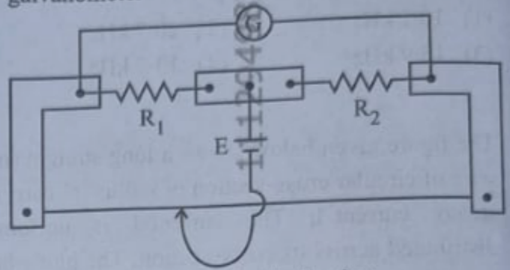
$$C_{series} = \frac{10}{4} = \frac{5}{2} = 2{\cdot}5\ \mu F$$

$$C_{eq} = 2{\cdot}5\ \mu F + 2{\cdot}5\ \mu F = 5\ \mu F$$

$$q_1 = (C_{series})(50) = \frac{25 \times 50}{10} = 125\ \mu C$$

$$q_2 = C_5 \times 50 = 2{\cdot}5 \times 50 = 125\ \mu C$$

16. In a metre bridge experiment (see figure), the positions of the cell, E, and galvanometer, G, are interchanged. We shall observe in the galvanometer :



(1) Only the right-sided deflection
(2) Only the left-sided deflection
(3) There will be no deflection irrespective of the position of the jockey
(4) Both right-sided and left-sided deflection and at balance point, no deflection

when cell and galvanometer are interchanged
balance condition does not change $I_g = 0$

17. The power of a crane, which lifts a mass of 1000 kg to a height of 20 m in 10 s is : ($g = 9{\cdot}8\ m/s^2$)

(1) 19·6 W ✓
(2) 39·2 W
(3) 39·2 kW
(4) 19·6 kW

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

$$\text{work} = mgh$$

$$= 1000 \times 9.8 \times 20$$

$$\text{Power} = \frac{1000 \times 9.8 \times 20}{10}$$

$$= 19.6\ \text{kW}$$

18. Match List I with List II :

List I		List II	
A.	Young's Modulus	I.	$\frac{\Delta d}{\Delta L}\left(\frac{L}{d}\right)$
B.	Compressibility	II.	$\frac{FL}{A(\Delta L)}$
C.	Bulk Modulus	III.	$-\frac{1}{\Delta P}\left(\frac{\Delta V}{V}\right)$
D.	Poisson's Ratio	IV.	$-P\left(\frac{V}{\Delta V}\right)$

Choose the **correct** answer from the options given below :

(1) A-I, B-IV, C-III, D-II

(2) A-IV, B-I, C-II, D-III

(3) A-III, B-II, C-I, D-IV

(4) A-II, B-III, C-IV, D-I ✓

$$YM = \frac{F\,l}{A\,\Delta l}$$

$$\text{Compressibility} = -\frac{1}{V}\frac{\Delta V}{\Delta P}$$

$$\text{Bulk modulus} = -\frac{P}{(\Delta V/V)}$$

$$\text{Poissons ration} = \frac{-\Delta d/d}{\Delta l/l}$$

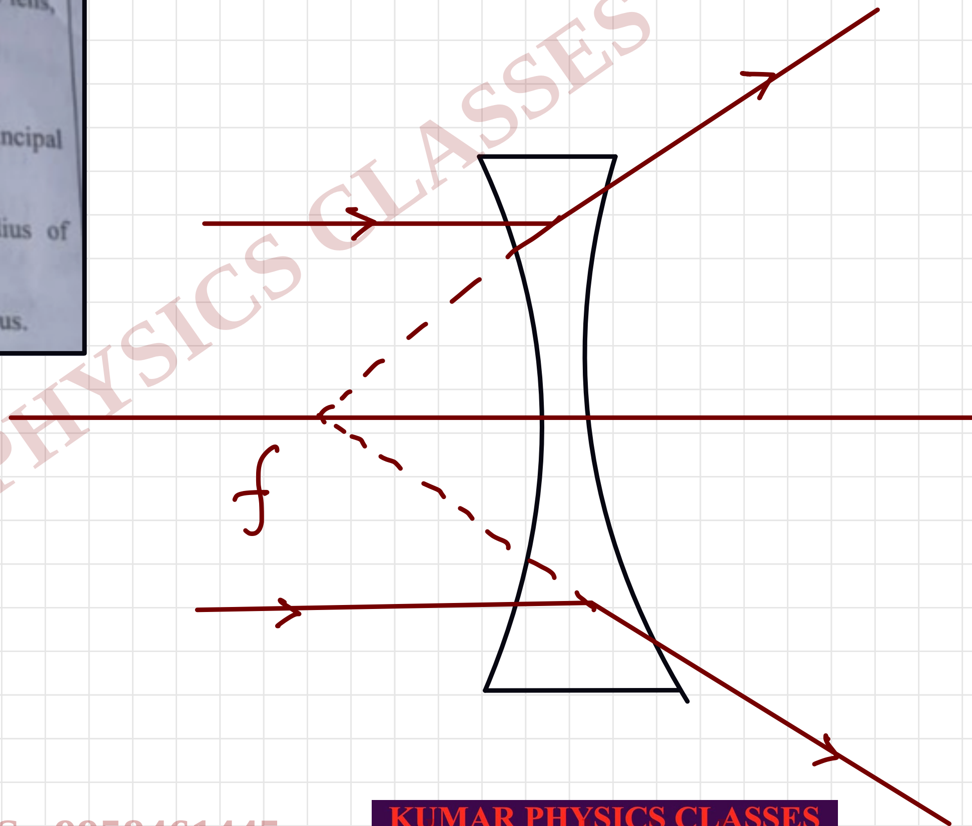
19. In a concave lens, a ray of light emanating from the object parallel to the principal axis of the lens, after refraction :

(1) emerges parallel to the principal axis.

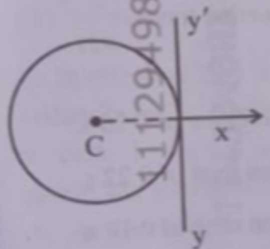
(2) appears to diverge from the first principal focus.

(3) passes through 2F, which is the radius of curvature of the lens.

(4) passes through the second principal focus.



20. A thin wire of length 'L' and linear mass density 'm' is bent into a circular ring (in x-y plane) with centre 'C' as shown in figure. The moment of inertia of the ring about an axis yy' will be :



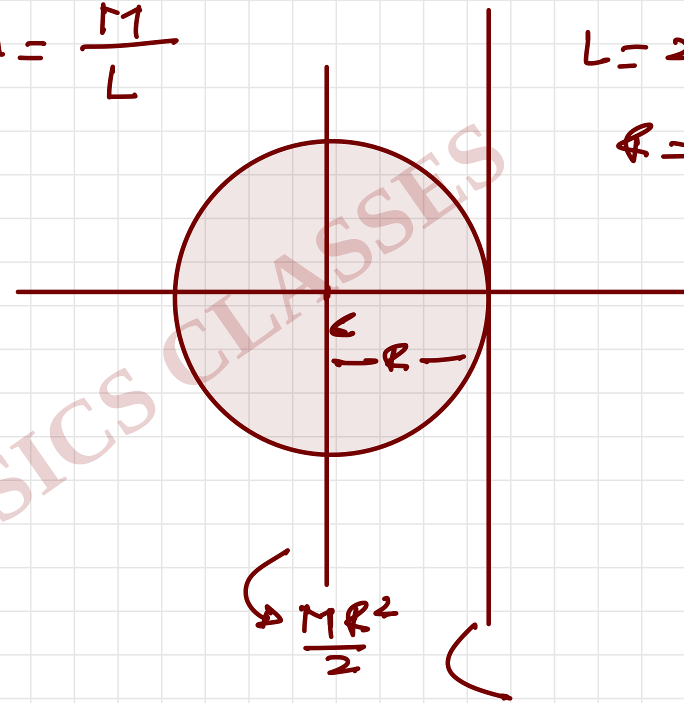
(1) $\frac{3\,mL^3}{8\pi^2}$ ✓ (2) $\frac{3\,mL^3}{8\pi}$

(3) $\frac{3\,mL^2}{8\pi^2}$ (4) $\frac{3\,mL^2}{8\pi}$

$m = \frac{M}{L}$

$L = 2\pi R$

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



$I = \frac{MR^2}{2} + MR^2$

$I = \frac{3}{2} M R^2$

$= \frac{3}{2} m (L) \left(\frac{L}{2\pi}\right)^2$

$= \frac{3}{2} m L \cdot \frac{L^2}{4\pi^2} = \frac{3\,mL^3}{8\pi^2}$

21. Each side of a metallic cube of mass 5·580 kg is measured to be 9·0 cm. Keeping the significant figures in view, the density of the material of the cube can be best expressed as $X \times 10^3$ kg m^{-3}, where the value of X is :

(1) 7·654
(2) 7·7 ✓
(3) 7·65
(4) 7·6

$m = 5.580$ kg

$a = 9.0$ cm $= .090$ m

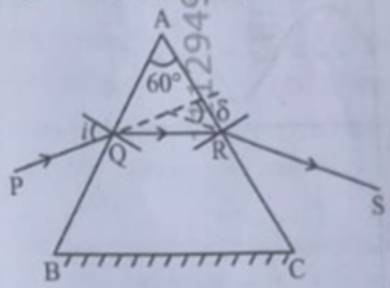
$a^3 = (0.09)^3$

$= 7.29 \times 10^{-4}$ m^3

$\rho = \dfrac{5.580}{7.29 \times 10^{-4}} \simeq 7654$ kg/m^3

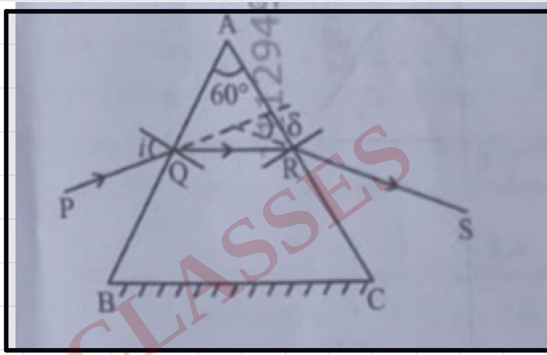
$\rho = 7.7 \times 10^3$ kg/m^3

A ray of monochromatic light is passing through an equilateral prism (ABC) as shown in the figure. The refracted ray (QR) is parallel to its base (BC) and the angle of incidence (i) is 50°. Then the angle of deviation (δ) is :



(1) 40° ✓ (2) 45°

(3) 55° (4) 35°



$A = 60^\circ$

$r_1 = r_2 = A/2 = 30^\circ$

$i = 50^\circ$

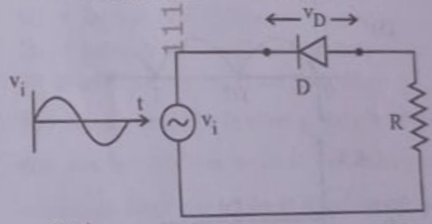
$\delta = i + e - A$

$\delta = 2i - A$

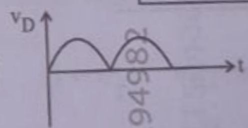
$= 2(50) - 60$

$= 40^\circ$

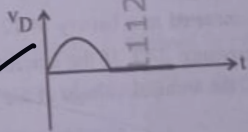
24. In the circuit shown below, the voltage appearing across the diode D will be of the form :



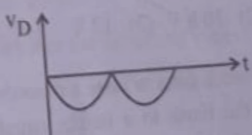
(1)



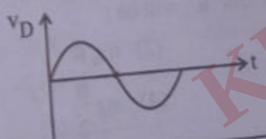
(2)

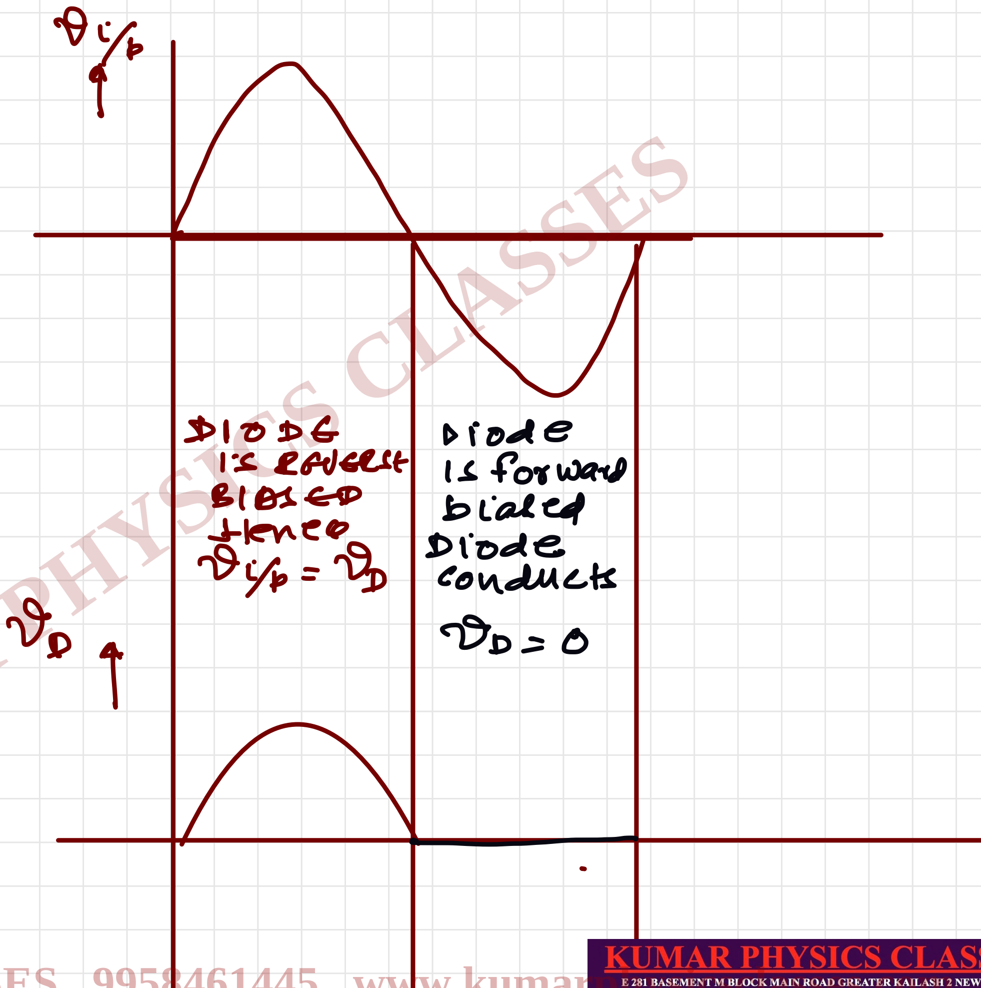


(3)



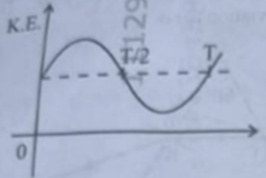
(4)



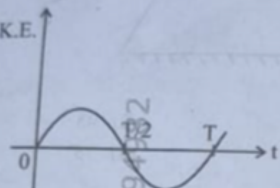


25. For a simple pendulum, having time period T, the variation of kinetic energy (K.E.) with time (t) is represented by :

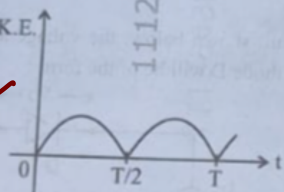
(1)



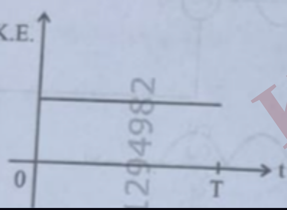
(2)



(3) ✓



(4)



$KE = \frac{1}{2} m v^2$

$v = a\omega \cos \omega t$

$KE = \frac{1}{2} m a^2 \omega^2 \cos^2 \omega t$

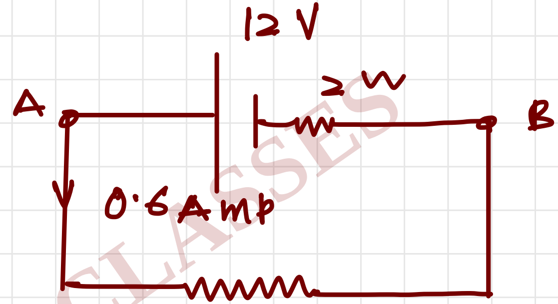
↓

All +ve

Hence possible option (3)

26. A resistor is connected to a battery of 12 V emf and internal resistance 2 Ω. If the current in the circuit is 0·6 A, the terminal voltage of the battery is :

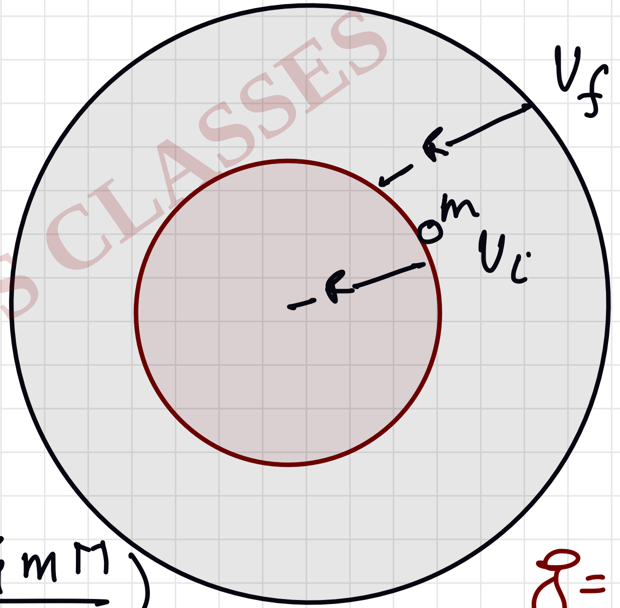
(1) 10 V (2) 10·8 V ✓ (3) 12 V (4) 1·2 V



$$V_{AB} = 12 - 2(0.6)$$
$$= 12 - 1.2$$
$$= 10.8 \text{ volt}$$

27. The amount of work done to raise a mass 'm' from the surface of the Earth to a height equal to the radius of the Earth 'R', will be :

(1) 2 mg R
(2) mg R
(3) mg $\frac{R}{4}$
(4) mg $\frac{R}{2}$ ✓



$$V_f = -\frac{GmM}{2R}$$

$$V_i = -\frac{GmM}{R}$$

$$V_f - V_i = -\frac{GmM}{2R} - \left(-\frac{GmM}{R}\right)$$

$$= -\frac{GmM}{2R} + \frac{GmM}{R} = \frac{GmM}{R}\left(-\tfrac{1}{2}+1\right)$$

$$= \frac{GMm}{R}\left(\tfrac{1}{2}\right) = \frac{gR^2 m}{2R} = \frac{mgR}{2}$$

$$g = \frac{GM}{R^2}$$

$$GM = gR^2.$$

28. An electric heater supplies heat to a system at a rate of 100 W. If the system performs work at a rate of 75 J/s, then the rate at which internal energy increases will be :

(1) 125 W (2) 100 W

(3) 25 W ✓ (4) 75 W

$\Delta Q = \Delta U + \Delta W$

$100 = \Delta U + 75$

$\Delta U = 25\ W$

30. When a ruler falls vertically, 5 different persons catch it with different reaction times.

($g = 9{\cdot}8 \text{ m s}^{-2}$)

A. Person A has reaction time of 0·20 s.

B. Person B has reaction time of 0·22 s.

C. Person C has reaction time of 0·18 s.

D. Person D has reaction time of 0·19 s.

E. Person E has reaction time of 0·21 s.

What is the **correct** order of the distance travelled by the ruler for each person ?

(1) C > D > A > B > E

(2) C > D > A > E > B

(3) B > E > A > C > D

(4) B > E > A > D > C ✓

$$h = \frac{1}{2} g t^2$$

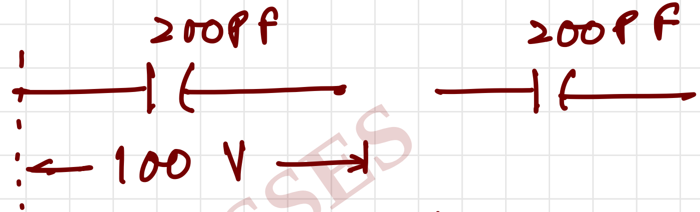
$$h \propto t^2$$

B (0·22 sec) > E (0·21 s) > A (0·20 s) > D (0·19 s) > C (0·18 s)

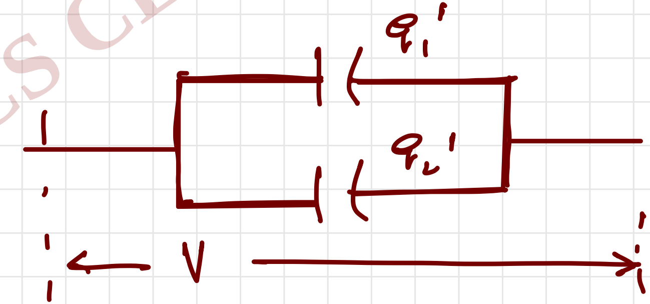
$$h_B > h_E > h_A > h_D > h_C$$

31. Consider two uncharged capacitors of equal capacitance 200 pF. One of them is charged by a 100 V supply and disconnected. Now this capacitor is connected to the uncharged capacitor. The amount of electrostatic energy lost in the process is :

(1) $1\cdot0 \times 10^{-6}$ J
(2) $0\cdot5 \times 10^{-6}$ J ✓
(3) $0\cdot5$ J
(4) $1\cdot0$ J



$q_1 = (100)(200\times10^{-12})\,c \qquad q_2 = 0$



$q_1 + q_2 = q_1' + q_2'$

$100 \times 200 \times 10^{-12} = (C_1 + C_2)V$

$= (400 \times 10^{-12})V$

V = 50 Volt

$U_i = \frac{1}{2}(200\times10^{-12})(100)^2$

$U_f = \frac{1}{2}(400\times10^{-12})(50)^2$

$U_f - U_i = \frac{1}{2}\times10^{-12}\left[(400)(2500) - 200\times(10000)\right]$

$= \frac{1}{2}\times10^{-12}\times200\left[2\times2500 - 10000\right]$

$= \frac{1}{2}\times10^{-12}\times200\times\left[-5000\right] = -5\times10^{-5}\,J = 0.5\times10^{-5}$

32. Savitha, a XI standard student, while conducting an experiment to determine the effective length of a simple pendulum L, notes down the data of time taken to complete 30 oscillations as 60 s and hence calculates the length of the simple pendulum as :

(Take $\pi^2 = 9.8$ and $g = 9.8\ m/s^2$)

(1) 2 m (2) 0.75 m

(3) 1.5 m (4) 1 m

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

$T^2 = 4\pi^2 \frac{l}{g}$

$l = \frac{T^2 g}{4\pi^2}$

$T = \frac{60}{30} = 2\,sec$

$= \frac{(2)^2 \times 9.8}{4 \times 9.8}$

$= 1\ m$

33. The peak value of an alternating current is 5 A and frequency is 60 Hz. How long will the current, starting from zero, take to reach the peak value ?

(1) $\frac{1}{240}$ s ✓
(2) $\frac{1}{30}$ s
(3) $\frac{1}{120}$ s
(4) $\frac{1}{60}$ s

$I = I_0 \sin \omega t$

$I = I_0$

$I_0 = I_0 \sin \omega t$

$\sin \pi/2 = \sin \omega t$

$\frac{\pi}{2} = \omega t = 2\pi f t$

$t = \frac{1}{4f} = \frac{1}{4 \times 60}$

$= \frac{1}{240}$ sec

34. In interference and diffraction, the light energy is redistributed. If it reduces in one region, producing a dark fringe, it increases in another region, producing a bright fringe.

A. As there is no gain or loss of energy, these phenomena are consistent with the principle of conservation of energy.

B. Diffraction and interference are characteristics exhibited only by light waves.

Choose the **correct** answer from the options given below :

(1) A is true, but B is false ✓

(2) A is true and B is also true

(3) A is false, but B is true

(4) Both A and B are false

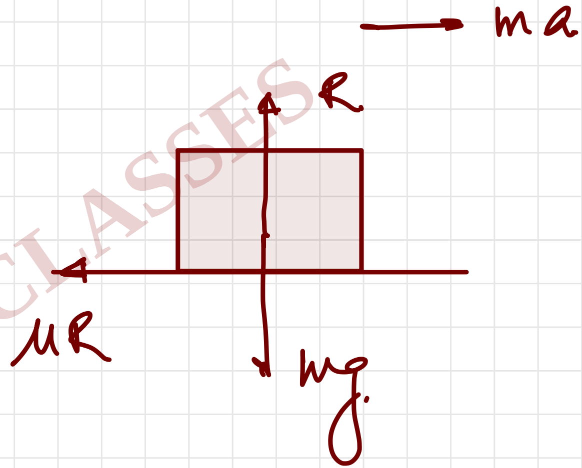
...15 kg is kept on the floor of a

Interference and diffraction are the wave phenomenon. They involve the superposition of wave, leading to the distribution of energy

(4) Both A and B are false

35. A box of mass 15 kg is kept on the floor of a stationary trolley. The coefficient of static friction between the box and the trolley is 0·12. Keeping the box in stationary state over the trolley, the maximum acceleration with which the trolley can be moved horizontally in m s^{-2} is : ($g = 10\ m/s^2$)

(1) 1·5
(2) 1·8
(3) 2·1
(4) 1·2 ✓



$\mu m g > m a$

$\frac{(0.12) \times 10}{100} > a$

$1.2 > a$ (a_{max})

36. The sum of kinetic energy and potential energy of a simple pendulum bob is 0·02 joule. The speed of the simple pendulum bob at equilibrium position is approximately :

(Consider mass of the bob = 20 g)

(1) 1·41 m/s ✓
(2) 14·1 m/s
(3) 0·2 m/s
(4) 2·0 m/s

$$\frac{1}{2} m \omega^2 a^2 = .02$$

$$\frac{1}{2} m (v_{max})^2 = .02$$

$$(v_{max})^2 = \frac{.02 \times 2}{20 \times 10^{-3}} \times 100$$

$$v_{max} = \sqrt{2}$$

$$= 1.41 \text{ m/sec}$$

37. Four statements are given (A is mass number) :

T A. The volume of a nucleus is proportional to $A^{1/3}$.

F B. The volume of a nucleus is proportional to A.

F C. The difference in mass of an atom and its nucleus is called the mass defect.

T D. The difference in mass of a nucleus and its constituents is called the mass defect.

Choose the **correct** answer from the options given below :

(1) B and D are true, but A and C are false

(2) A and D are true, but B and C are false ✓

(3) A and C are true, but B and D are false

(4) B and C are true, but A and D are false

$$R = R_0 (A)^{1/3}$$

$$V = \frac{4}{3}\pi R^3$$

$$= \frac{4}{3}\pi \left[R_0 (A)^{1/3}\right]^3$$

$$= \frac{4}{3}\pi R_0^3 A$$

$\frac{4}{3}\pi R_0^3$ → constant

$$V \propto A$$

38. The angular speed of a flywheel is increased from 600 rpm to 1200 rpm in 10 s. The number of revolutions completed by the flywheel during this time is :

(1) 600 (2) 900

(3) 300 (4) 150 ✓

$\omega^2 = \omega_0^2 + 2\alpha(\theta)$

$\omega = \omega_0 + \alpha t$

$2\pi \times \frac{1200}{60} = 2\pi \times \frac{600}{60} + \alpha \times 10$

$\frac{2\pi}{60}(1200 - 600) = \alpha \times 10$

$\frac{2\pi \times 600}{60} = \alpha \times 10$

$\alpha = 2\pi$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$\frac{\omega^2 - \omega_0^2}{2\alpha} = \theta$

$\frac{\left(\frac{2\pi \times 1200}{60}\right)^2 - \left(\frac{2\pi \times 600}{60}\right)^2}{2(2\pi)} = \theta$

$\frac{(2\pi)^2\left[(20)^2 - (10)^2\right]}{4\pi} = \theta \Rightarrow \frac{4\pi^2 (30)(10)}{4\pi} = \theta$

$\theta = 300\pi$

No of Revolutions $= \frac{300\pi}{2\pi} = 150$

39. A submarine is designed to withstand an absolute pressure of 100 atm. How deep can it go below the water surface?

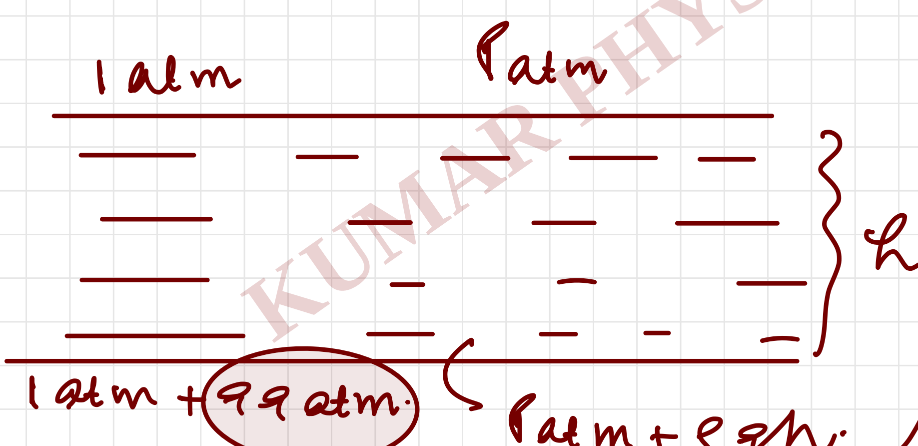
(Consider the density of water = 1000 kg m^{-3}, 1 atm = 1×10^5 Pa and gravitational acceleration g = 10 m/s^2)

(1) 9900 m
(2) 99 m
(3) 9000 m
(4) 990 m ✓

$$P = \rho g h$$

$$99 \times 1 \times 10^5 = 1000 \times 10 \times h$$

$$h = 990 \text{ m}$$



Net pressure can only by 99 atm

40. Match List I with List II :

List I (Electromagnetic wave)		List II (Production)	
A.	Microwave	I.	Electrons in atoms emit light when they move from a higher energy level to a lower energy level
B.	Visible light	II.	Radioactive decay of nucleus
C.	Gamma rays	III.	Vibration of atoms and molecules
D.	Infra-red rays	IV.	Klystron valve or magnetron valve

Choose the correct answer from the options given below :

(1) A-III, B-I, C-II, D-IV
(2) A-III, B-IV, C-I, D-II
(3) A-IV, B-III, C-II, D-I
(4) A-IV, B-I, C-II, D-III

→ **Microwaves are produced by several vacuum tubes such as klystrons, magnetrons, or Gunn diodes.**

→ **Visible light is emitted when electrons in an atom drop from a higher energy level to a lower one.**

→ **Gamma rays originate from transitions within the nucleus during radioactive decay.**

→ **Infrared rays are often called heat waves because they are produced by the thermal vibrations of atoms and molecules.**

41. Which of the following statements are correct ?

A. Inside a conductor, the electrostatic field is zero.

B. Electric field at the surface of a charged conductor does not depend on its surface charge density.

C. The interior of a charged conductor can have no excess charge in the static situation.

D. At the surface of a charged conductor, the electrostatic field must be normal to the surface at every point.

E. The electrostatic potential is zero everywhere inside a charged conductor.

Choose the correct answer from the options given below :

(1) C, D and E only

(2) A, B and D only

(3) A, C and D only

(4) A, C and E only

Always remember that inside a conductor, the electric field is zero and the net charge within the conductor is zero, while the potential remains constant throughout. The potential is zero only if the conductor is grounded.

42. For a metal of work function 6·6 eV, which of the following wavelengths of incident radiation does *not* give rise to the photoelectric effect ? (Take Planck's constant as $6{\cdot}6 \times 10^{-34}$ J s)

(1) 200 nm (2) 150 nm
(3) 100 nm (4) 50 nm

$E = \frac{hc}{\lambda}$

$E(eV) = \frac{1240}{\lambda(nm)}$

$E = \frac{1240}{200} = 6.2\,eV$

$E = \frac{1240}{150} = 8.27\,eV$

$E = \frac{1240}{100} = 12.4\,eV$

$E = \frac{1240}{50} = 24.8\,eV$

6.2 eV is less than 6.6 eV hence no electron will be emitted.

43. In the first excited state of hydrogen atom, the energy of its electron is -3.4 eV. The radius distance of the electron from the hydrogen nucleus in this case is approximately :

(Take $1\text{ eV} = 1.6 \times 10^{-19}$ J, $e = 1.6 \times 10^{-19}$ C and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \text{N m}^2/\text{C}^2$)

(1) 2.1×10^{-8} m
(2) 2.1×10^{-11} m
(3) 2.1×10^{-9} m
(4) 2.1×10^{-10} m ✓

$$E = -\frac{13.6\,Z}{n^2}\ \text{eV}$$

$$-3.4 = -\frac{13.6\,(1)}{n^2}$$

$$n^2 = \frac{13.6}{3.4} = 4$$

$$n = 2$$

$$r = 0.529\ \text{Å}\ n^2$$

$$= 0.529 \times (2)^2\ \text{Å}$$

$$= 0.529 \times 4\ \text{Å}$$

$$= 2.116 \times 10^{-10}\ \text{m}$$

44. Two statements are given below :

A. When the forward bias voltage across a p-n junction diode increases above a certain threshold voltage, the diode current increases significantly.

B. This current is called reverse saturation current.

Choose the correct answer from the options given below :

(1) Both Statements A and B are false

(2) Statement A is true, but Statement B is false

(3) Both Statements A and B are true

(4) Statement A is false, but Statement B is true

A diode is ideally considered a device that offers negligible resistance when forward biased and extremely high (practically infinite) resistance when reverse biased. However, in real conditions, a PN junction diode does not behave perfectly and shows different characteristics under forward and reverse bias.

When a diode is forward biased, the current that flows is called the forward current. Under reverse bias, the small current that flows is known as the reverse (or reverse saturation) current.

The forward current is typically measured in milliamperes (mA), whereas the reverse saturation current is much smaller and is usually measured in microamperes (µA) or nanoamperes (nA).

In terms of charge carriers, the forward current is mainly due to the motion of majority carriers, while the reverse saturation current is due to minority carriers.

In summary, under forward bias a diode offers very low resistance and allows significant current flow, while under reverse bias it offers very high resistance and allows only a very small leakage current.

45. A flask contains argon and chlorine in the ratio of 2 : 1 by mass. The temperature of the mixture is 27°C. The ratio of root mean square speed of the molecules of the two gases $\left(\frac{v_{rms}^{Ar}}{v_{rms}^{Cl}}\right)$ is :

(Atomic mass of argon = 40·0 u and molecular mass of chlorine = 70·0 u)

(1) $\frac{\sqrt{7}}{2}$ ✓

(2) $\frac{7}{2}$

(3) $\frac{7}{4}$

(4) $\frac{2}{\sqrt{7}}$

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{v_{rms}(Ar)}{v_{rms}(Cl_2)} = \sqrt{\frac{M(Cl_2)}{M(Ar)}}$$

$$= \sqrt{\frac{70}{40}} = \frac{\sqrt{7}}{2}$$