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PAPER-1 (B.E./B. TECH.)

2023

COMPUTER BASED TEST (CBT) Questions & Solutions

Date: 24 January, 2023 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

1. If two vectors $\vec{P} = \hat{i} + 2\hat{j} + m\hat{k}$ and $\vec{Q} = 4\hat{i} + 2\hat{j} + m\hat{k}$ are perpendicular to each other. Then, the value of m will be :
 (1) -1 (2) 2 (3) 3 (4) 1

Ans. (2)

Sol. $\vec{P} \cdot \vec{Q} = 0$

$$\Rightarrow 4 - 4m + m^2 = 0$$

$$m = 2$$

2. Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule

as a rigid rotator, the ratio, $\frac{\gamma_1}{\gamma_2}$ is :

- (1) $\frac{21}{25}$ (2) $\frac{25}{21}$ (3) $\frac{35}{27}$ (4) $\frac{27}{35}$

Ans. (2)

Sol. degree of freedom for monoatomic = 3, $r_1 = 1 + \frac{2}{3} = \frac{5}{3}$

degree of freedom for diatomic = 5, $r_2 = 1 + \frac{2}{5} = \frac{7}{5}$

$$\frac{r_1}{r_2} = \frac{5}{3} \times \frac{5}{7} = \frac{25}{21} \text{ Ans.}$$

3. Given below are two statements :

Statement I : Acceleration due to earth's gravity decreases as you go 'up' or down' from earth's surface.

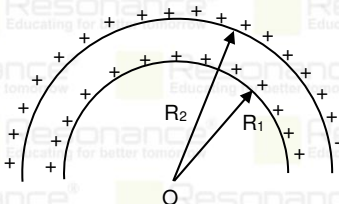
Statement II : Acceleration due to earth's gravity is same at a height 'h' and depth 'd' from earth's surface. if $h = d$.

In the light of above statements, choose the most appropriate answer from the options given below

- (1) Statement I is correct but statement II is incorrect.
 (2) Both Statement I and Statement II are incorrect
 (3) Both Statement I and II are correct.
 (4) Statement I is incorrect but statement II is correct

Ans. (1)

4. The electric potential at the centre of two concentric half rings of radii R_1 and R_2 , having same linear charge density λ is :



- (1) $\frac{2\lambda}{\epsilon_0}$ (2) $\frac{\lambda}{2\epsilon_0}$ (3) $\frac{\lambda}{4\epsilon_0}$ (4) $\frac{\lambda}{\epsilon_0}$

Ans. (2)

Sol. $V_0 = \frac{\lambda}{4\epsilon_0} + \frac{\lambda}{4\epsilon_0} = \frac{\lambda}{2\epsilon_0}$

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5. Match List I with List II

List I

- A. AM Broadcast
- B. FM Broadcast
- C. Television
- D. Satellite Communication

List II

- I. 88–108 MHz
- II. 540 – 1600 kHz
- III. 3.7 – 4.2 GHz
- IV. 54 MHz – 890 MHz

Choose the correct answer from the options given below :

(1) A–II, B–III, C–I, D–IV

(3) A–IV, B–III, C–I, D–II

(2) A–II, B–I, C–IV, D–III

(4) A–I, B–III, C–II, D–IV

Ans. (2)

6. A body of mass 200 g is tied to a spring of spring constant 12.5 N/m, while the other end of spring is fixed at point O. If the body moves about O in a circular path on a smooth horizontal surface with constant angular speed 5 rad/s. Then the ratio of extension in the spring to its natural length will be :

(1) 1 : 1

(2) 2 : 3

(3) 2 : 5

(4) 1 : 2

Ans. (2)

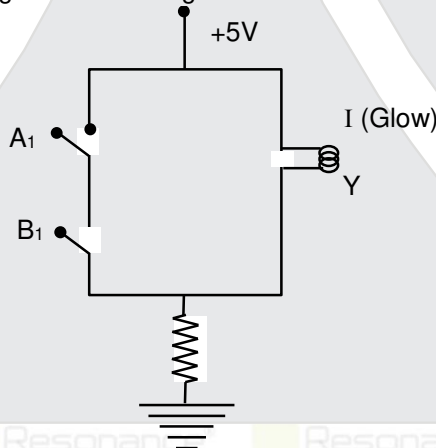
Sol. $kx = m\omega^2 (\ell + x)$

$$\frac{\ell + x}{x} = \frac{k}{m\omega^2}$$

$$\frac{\ell}{x} + 1 = \frac{12.5}{0.5 \times 25} ; \quad \frac{\ell}{x} = \frac{1}{0.2 \times 2} - 1$$

$$\frac{\ell}{x} = \frac{10}{4} - 1 = \frac{6}{4} = \frac{3}{2} ; \quad \frac{\ell}{x} = 1.5$$

7. The logic gate equivalent to the given circuit diagram is



(1) NOR

(2) NAND

(3) OR

(4) AND

Ans. (2)

Sol. Out put of the circuit
Gate will be NAND gate

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

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8. When a beam of white light is allowed to pass through convex lens parallel to principal axis, the different colours of light converge at different point on the principle axis after refraction. This is called :
 (1) Scattering (2) Chromatic aberration
 (3) Spherical aberration (4) Polariasiation

Ans. (2)

9. A photon is emitted in transition from $n = 4$ to $n = 1$ level in hydrogen atom. The corresponding wavelength fro this transition is (given, $h = 4 \times 10^{-15}$ eVs) :

- (1) 941 nm (2) 974 nm (3) 99.3 nm (4) 94.1 nm

Ans. (4)

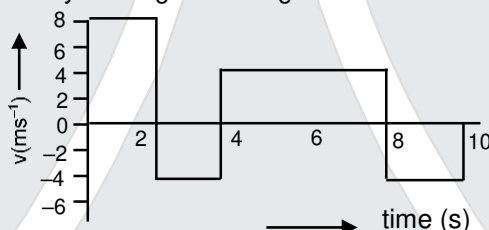
Sol. $\frac{hc}{\lambda} = 13.6z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

$$\frac{4 \times 10^{-15} \times 3 \times 10^8}{\lambda} = 13.6 \left(\frac{1}{1^2} - \frac{1}{4^2} \right)$$

$$\frac{12 \times 10^{-7}}{\lambda} = 13.6 \times \frac{15}{16}$$

$$\lambda = 94.1 \text{ nm}$$

10. The velocity time graph of a body moving in a straight line is shown in figure.



The ratio of displacement to distance travelled by the body in time 0 to 10s is :

- (1) 1 : 2 (2) 1 : 4 (3) 1 : 3 (4) 1 : 1

Ans. (3)

Sol. $|\Delta \vec{r}| = 16 - 8 + 16 - 8 = 16$

distance = $16 + 8 + 16 + 8 = 48$

Ans. $1/3$

11. A long solenoid is formed by winding 70 turns cm^{-1} . If 2.0 A current flows, then the magnetic field produced inside the solenoid is _____ ($\mu_0 = 4\pi \times 10^{-7}$ TmA $^{-1}$)

- (1) 88×10^{-4} T (2) 1232×10^{-4} T (3) 352×10^{-4} T (4) 176×10^{-4} T

Ans. (4)

Sol. $B = \mu_0 Ni$

$$= 4\pi \times 10^{-7} \times \frac{70}{10^{-2}} \times 2$$

$$= 4\pi \times 10^{-5} \times 70 \times 2$$

$$= 17.58 \times 10^{-3} \text{ T}$$

$$= 176 \times 10^{-4} \text{ T}$$

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12. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R
Assertion (A) : Steel is used in the construction of buildings and bridges.

Reason (R) : Steel is more elastic and its elastic limit is high.

In the light of above statements, choose the most appropriate answer from the options given below

- (1) Both A and R are correct but R is the correct explanation of A
(2) Both A and R are correct and R is the correct explanation of A
(3) A is not correct but R is correct
(4) A is correct but R is not correct

Ans. (2)

13. The frequency (ν) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as $\nu = r^a \rho^b s^c$. The values of a , b and c respectively are :

- (1) $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$ (2) $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$ (3) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$ (4) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

Ans. (2)

Sol. $[r] = [c]$

$$\rho = \frac{m}{v} = ML^{-3}$$

$$S = \frac{F}{\ell} = \frac{MLT^{-2}}{L} = MT^{-2}$$

$$r = \frac{1}{T} = T^{-1}$$

$$T^{-1} = L^a [ML^{-3}]^b [MT^{-2}]^c$$

$$T^{-1} = L^{a-3b} M^{b+c} T^{-2c}$$

by comparing

$$a - 3b = 0 \quad b + c = 0 \quad +2c = +1$$

$$a - 3 \times \frac{-1}{2} = 0 \quad b = -\frac{1}{2} \quad c = \frac{1}{2}$$

$$a = \frac{3}{2}$$

14. The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by :

$$E_x = E_0 \sin(kz - \omega t)$$

$$B_y = B_0 \sin(kz - \omega t)$$

Then the correct relation between E_0 and B_0 is given by

- (1) $E_0 B_0 = \omega k$ (2) $E_0 = k B_0$ (3) $k E_0 = \omega B_0$ (4) $\omega E_0 = k B_0$

Ans. (3)

Sol. $\frac{E_0}{B_0} = \frac{\omega}{k}$

$$\Rightarrow k E_0 = \omega B_0$$

15. A cell of emf 90 V is connected across series combination of two resistors each of 100 Ω resistance. A voltmeter of resistance 400 Ω is used to measure the potential difference across each resistor. The reading of the voltmeter will be :

- (1) 45V (2) 40V (3) 80V (4) 90 V

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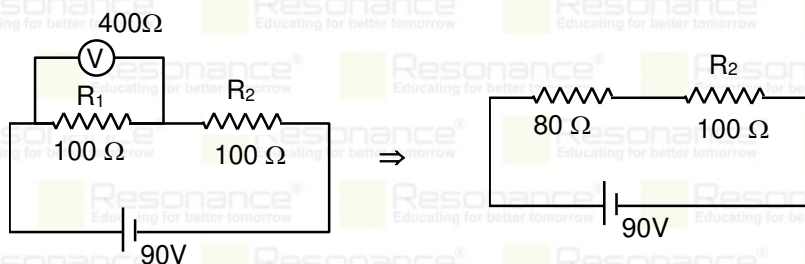
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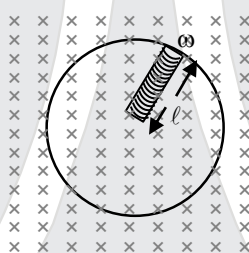
Ans. (2)

Sol.



$$V_{R1} = 90 \times \frac{80}{80 + 100} = 40V$$

16. A metallic rod of length 'L' is rotated with an angular speed of ' ω ' normal to a uniform magnetic field 'B' about an axis passing through one end of rod as shown in figure. The induced emf will be :



(1) $\frac{1}{2} B^2 L^2 \omega$

(2) $\frac{1}{4} B^2 L^2 \omega$

(3) $\frac{1}{2} B L^2 \omega$

(4) $\frac{1}{4} B^2 L \omega$

Ans. (3)

Sol.

$$\varepsilon = VB\ell$$

$$\int d\varepsilon = \int_0^L B(\omega x) dx$$

$$\varepsilon = B\omega \left[\frac{x^2}{2} \right]_0^L$$

$$\varepsilon = \frac{B\omega L^2}{2}$$

17. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.
Assertion (A) : A pendulum clock when taken a Mount Everest becomes fast.

Reason (R) : The value of g (acceration due to gravity) is less at Mount Everest than its value on the surface of earth.

- (1) Both A and R are correct but R is Not the correct explanation of A
(2) Both A and R are correct and R is the correct explanation of A.
(3) A is not correct but R is correct
(4) A is correct but R is not correct

Ans. (3)

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18. If the distance of the earth from Sun is 1.5×10^6 km. Then the distance of an imaginary planet from Sun, if its period of revolution is 2.83 years is :

(1) 6×10^6 km (2) 3×10^6 km (3) 6×10^7 km (4) 3×10^7 km

Ans. (2)

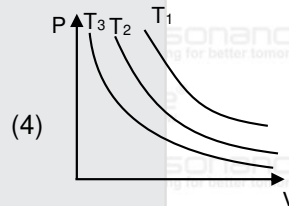
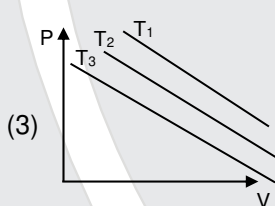
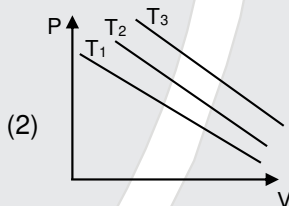
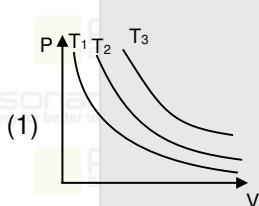
Sol. Distance from sun to earth
 $= 1.5 \times 10^6$ m
 $T_{\text{planet}} = 2.8$ earth year
 Distance of planet from sun.

$$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3}$$

$$\left(\frac{365}{2.8 \times 365}\right)^2 = \left(\frac{1.5 \times 10^6}{R_2}\right)^3 ; R_2^3 = (1.5)^3 \times 10^{18} \times (2.8)^2$$

$$R_2 \approx 3 \times 10^6 \text{ m}$$

19. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperature ; $T_3 > T_2 > T_1$ as :



Ans. (1)

Sol. $PV = nRT$
 at constant temperature
 $P \propto 1/V \Rightarrow$ curved graph between P & V
 $\Rightarrow$ as $V \uparrow$ is, $P \downarrow$ is.

$$\text{at temperature } P_1 = \frac{nRT_1}{V}$$

at temperature T_2

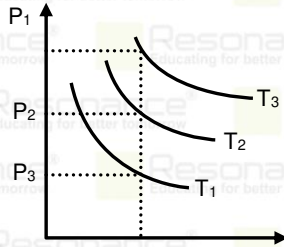
$$P_2 = \frac{nRT_2}{V}$$

at temperature T_3

$$P_3 = \frac{nRT_3}{V}$$

as $T_1 < T_2 < T_3$

$\Rightarrow P_1 < P_2 < P_3$ for particular volume V



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20. An α – particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their de-Broglie wavelength :

(1) $\lambda_a > \lambda_p < \lambda_e$

(2) $\lambda_a < \lambda_p < \lambda_e$

(3) $\lambda_a = \lambda_p = \lambda_e$

(4) $\lambda_a > \lambda_p < \lambda_e$

Ans. (2)

Sol. $P = \sqrt{2m(KE)}$

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

Hence $\lambda \propto \frac{1}{\sqrt{m}}$

$$\lambda_e > \lambda_p > \lambda_a$$

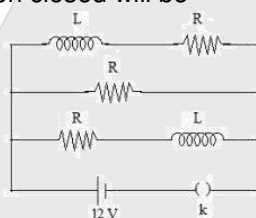
21. If copper wire is stretched to increase its length by 20%. The percentage increase in resistance of the wire is%

Ans. 44

Sol. $\frac{R_1}{R_2} = \left(\frac{l_1}{l_2}\right)^2 = \left(\frac{5}{6}\right)^2 = \frac{25}{36}$

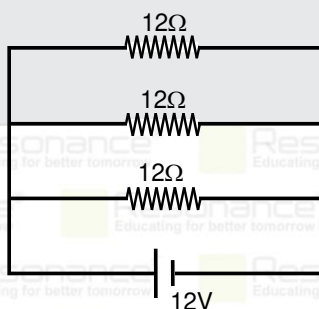
$$\% \text{ change in resistance} = \frac{36 - 25}{25} \times 100 = 44\%$$

22. Three identical resistors with resistance $R = 12\Omega$ and two identical inductors with self inductance $L = 5 \text{ mH}$ are connected to an ideal battery with emf of 12 V as shown in figure. The current through the battery long after the switch has been closed will be _____ A.



Ans. 3

Sol. at $t \rightarrow \infty$ inductor behaves as a closed circuit



all resistors connected in parallel with battery

$$R_{eq} = \frac{R}{3} = \frac{12}{3} = 4\Omega$$

$$\text{current from battery is equal to } i = \frac{V}{R_{eq}} = \frac{12}{4} = 3 \text{ A}$$

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23. A spherical ball of radius 1mm density 10.5 g/cc is dropped in glycerine of coefficient of viscosity 9.8 poise and density 1.5 g/cc. Viscous force on the ball when it attains constant velocity is 3696×10^{-x} N.

The value of x is (Given, $g = 9.8 \text{ m/s}^2$ and $\pi = \frac{22}{7}$)

Ans. 7

Sol.
$$v = \frac{2gr^2(d_1 - d_2)}{9\eta} = \frac{2 \times 9.8 \times 10^{-6}(10.5 - 1.5)10^3}{9 \times 98} = 2 \times 10^{-4} \text{ m/s}$$

$$F = 6\pi\eta rv$$

$$= 6 \times \frac{22}{7} \times 98 \times 10^{-3} \times 2 \times 10^{-4} = 3696 \times 10^{-7} \text{ N}$$

24. A body of mass 1kg begins to move under the action of a time dependent force $\vec{F} = (t\hat{i} + 3t^2\hat{j})\text{N}$, where $\hat{i}$ and $\hat{j}$ are the unit vectors along x and y axis. The power developed by above force, at the time $t = 2\text{s}$, will be _____W.

Ans. 100

Sol. $t = 0$

$$\vec{a} = t\hat{i} + 3t^2\hat{j}$$

$$d\vec{v} = \frac{t^2}{2}\hat{i} + t^3\hat{j} ; \quad \vec{v} = \frac{t^2}{2}\hat{i} + t^3\hat{j}$$

$$P = \vec{F} \cdot \vec{v} = (t\hat{i} + 3t^2\hat{j}) \cdot \left(\frac{t^2}{2}\hat{i} + t^3\hat{j} \right) = \left[\frac{t^3}{2} + 3t^5 \right]$$

$$\text{at } t = 2 \text{ P} = \frac{8^4}{2} + 3 \times 32 = 100 \text{ watt.}$$

25. A mass m attached to free end of a spring executes SHM with a period of 1s. If the mass is increased by 3 kg and period of oscillation increases by one second, the value of mass m is ____ kg.

Ans. 1

Sol. Using, $T = 2\pi\sqrt{\frac{m}{k}}$

$$\frac{T_1}{T_2} = \frac{1}{2} = \frac{2\pi\sqrt{\frac{m_1}{k}}}{2\pi\sqrt{\frac{m_2}{k}}}$$

$$\frac{m_1}{m_2} = \left(\frac{1}{2} \right)^2 = \frac{1}{4}$$

$$\frac{m_1}{m_1 + 3} = \frac{1}{4}$$

$$m_1 = 1 \text{ kg}$$

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26. The energy released per fission of nucleus of ^{240}X is 200 MeV. The energy released if all the atoms in 120 g of pure ^{240}X undergo fission is $\quad \times 10^{25}$ MeV. (Given $N_A = 6 \times 10^{23}$)

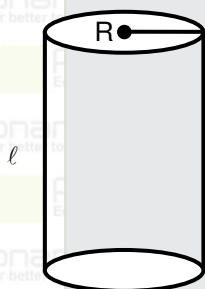
Ans. 6

Sol. no. of atoms = $\frac{120}{200} \times 6 \times 10^{23} = 3 \times 10^{23}$
Total energy released = $3 \times 10^{23} \times 200$ MeV
 $= 6 \times 10^{25}$ MeV

27. A uniform solid cylinder with radius R and length L has moment of inertia I_1 , about the axis of the cylinder. A concentric solid cylinder of radius $R' = R/2$ and length $L' = L/2$ is carved out of the original cylinder. If I_2 is the moment of the inertia of the carved out portion of the cylinder then I_1/I_2 (Both I_1 and I_2 are about the axis of the cylinder)

Ans. 32

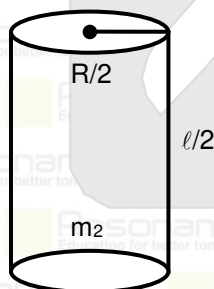
Sol. Thus $\frac{I_1}{I_2} = 32$



MOI of solid cylinder

$$I_1 = \frac{1}{2} m R^2$$

$$\text{density} = \rho = \frac{m}{V} = \frac{m}{\pi R^2 \ell}$$



$$I_2 = \frac{m_2 (R/2)^2}{2}$$

$$I_2 = \frac{1}{2} \frac{m}{\pi R^2 \ell} \times \pi \left(\frac{R}{2}\right)^2 \left(\frac{\ell}{2}\right) \left(\frac{R}{2}\right)^2 \text{ where, } m_2 = \frac{m}{\pi R^2 \ell} \times \pi \left(\frac{R}{2}\right)^2 \frac{\ell}{2}$$

$$I_2 = \frac{1}{2} \frac{m R^2}{32} \Rightarrow \frac{I_1}{I_2} = \frac{\frac{1}{2} m R^2}{\frac{1}{2} \frac{m R^2}{32}} = \frac{32}{1}$$

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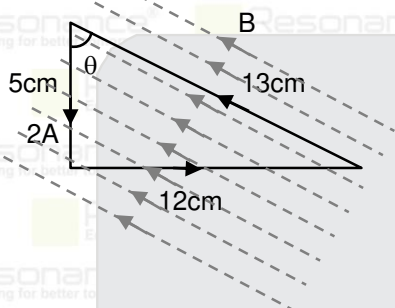
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28. A single turn current loop in the shape of a right angle triangle with sides 5 cm, 12 cm, 13 cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75 T whose direction is parallel to the current in the 13 cm side of the loop. The magnitude of the magnetic force on the 5 cm side will be $\frac{x}{130}$ N, the value of x is _____.

Ans. 9

Sol.



$$F_{5\text{cm}} = iBl \sin \theta$$

$$= 2 \times 0.75 \times \frac{5}{100} \times \frac{12}{13} = \frac{9}{130} \text{ N}$$

29. A parallel plate capacitor with air between the plate has a capacitance of 15pF. the separation between the plate becomes twice and the space between them is filled with a medium of dielectric constant 3.5. Then the capacitance becomes $\frac{x}{4}$ pF. The value of x is _____

Ans. 105

Sol.

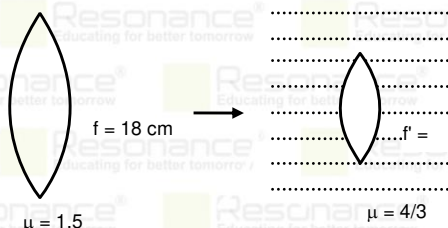
$$C = 15\text{pF} = \frac{\epsilon_0 A}{d}$$

$$C' = \frac{k\epsilon_0 A}{2d} = \frac{3.5}{2} C = \frac{105}{4} \text{ pF}$$

30. A convex lens of refractive index 1.5 and focal length 18 cm in air is immersed in water. The change in focal length of the lens will be _____ cm. (Given refractive index of water = 4/3)

Ans. 54

Sol.



$$\frac{1}{f} = \left(\frac{\mu_l}{\mu_s} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{18} = \left(\frac{3}{2} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

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$$\left(\frac{1}{R_1} - \frac{1}{R_2} \right) = \frac{1}{9} \quad \dots\dots(1)$$

$$\frac{1}{f'} = \left(\frac{\mu_\ell}{\mu_s} - 1 \right) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\left[\left(\frac{1}{R_1} - \frac{1}{R_2} \right) \text{ from equation (1)} \right]$$

$$\frac{1}{f_1} = \left(\frac{3/2}{4/3} - 1 \right) \left(\frac{1}{9} \right)$$

$$\frac{1}{f_1} = \frac{1}{8} \times \frac{1}{9}$$

$$f' = 72 \text{ cm}$$

$$\Delta f = 72 - 18 = 54$$

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