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JEE
(Main)

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

2023

COMPUTER BASED TEST (CBT)
Questions & Solutions

Date: 15 April, 2023 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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PART : PHYSICS

31. The position of a particle related to time is given by $x = (5t^2 - 4t + 5)m$. The magnitude of velocity of the particle at $t = 2s$ will be:

- (1) 10 ms^{-1} (2) 06 ms^{-1} (3) 16 ms^{-1} (4) 14 ms^{-1}

NTA Ans. (3)

Reso Ans. (3)

Sol. $x(t) = 5t^2 - 4t + 5$

$$v = \frac{dx}{dt} = 10t - 4$$

$$V|_{\text{at } t=2} = 10 \times (2) - 4 = 16 \text{ m/sec.}$$

32. A flask contains Hydrogen and Argon in the ratio 2 : 1 by mass. The temperature of the mixture is 30°C . The ratio of average kinetic energy per molecule of the two gases ($K_{\text{argon}}/K_{\text{hydrogen}}$) is :
(Given: Atomic Weight of Ar = 39.9)

- (1) 1 (2) 39.9 (3) 2 (4) $\frac{399}{2}$

NTA Ans. (1)

Reso Ans. (Bonus)

Sol. $\langle KE \rangle = \frac{f}{2}KT$

$$\langle KE \rangle \text{ of } H_2 = \frac{5}{2}KT$$

$$\langle KE \rangle \text{ of Ar} = \frac{3}{2}KT$$

$$\frac{\langle KE \rangle_{H_2}}{\langle KE \rangle_{Ar}} = \frac{5}{3}$$

$$\text{Average linear KE of } H_2 = \frac{3}{2}KT$$

$$\text{Average linear KE of Ar} = \frac{3}{2}KT$$

$$\frac{\text{linear } \langle KE \rangle_{H_2}}{\text{linear } \langle KE \rangle_{Ar}} = 1$$

33. The de Broglie wavelength of an electron having kinetic energy E is λ . If the kinetic energy of electron becomes $\frac{E}{4}$, then its de-Broglie wavelength will be:

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

NTA Ans. (1)

Reso Ans. (1)

Sol. $\lambda_{db} = \frac{h}{\sqrt{2m(KE)}} \propto \frac{1}{\sqrt{KE}}$

$$KE \rightarrow \frac{1}{4} \Rightarrow \lambda_{db} \rightarrow 2 \text{ times}$$

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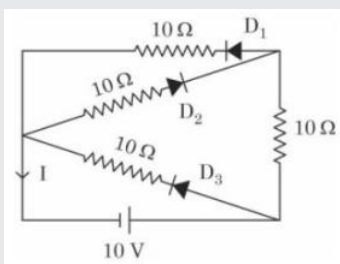
34. A single slit of width a is illuminated by a monochromatic light of wavelength 600 nm . The value of ' a ' for which first minimum appears at $\theta = 30^\circ$ on the screen will be :
 (1) $1.2 \mu\text{m}$ (2) $3 \mu\text{m}$ (3) $1.8 \mu\text{m}$ (4) $0.6 \mu\text{m}$

NTA Ans. (1)

Reso Ans. (1)

Sol. $\Delta x = d \sin \theta = \lambda$
 $d \sin 30^\circ = 600 \text{ nm}$
 $d = 1200 \text{ nm} = 1.2 \mu\text{m}$

35. In the given circuit, the current (I) through the battery will be



(1) 1.5 A

(2) 2A

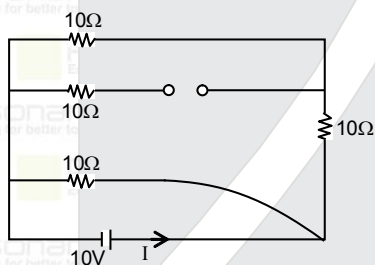
(3) 1A

(4) 2.5A

NTA Ans. (1)

Reso Ans. (1)

Sol.



$$R_{eq} = \frac{20 \times 10}{20 + 10} = \frac{200}{30} = \frac{20}{3}$$

$$I = \frac{10}{R_{eq}} = \frac{10 \times 3}{20} = 1.5 \text{ A}$$

36. Two identical particles each of mass ' m ' go round a circle of radius a under the action of their mutual gravitation attraction. The angular speed of each particle will be:

(1) $\sqrt{\frac{Gm}{8a^3}}$

(2) $\sqrt{\frac{Gm}{4a^3}}$

(3) $\sqrt{\frac{Gm}{a^3}}$

(4) $\sqrt{\frac{Gm}{2a^3}}$

NTA Ans. (2)

Reso Ans. (2)

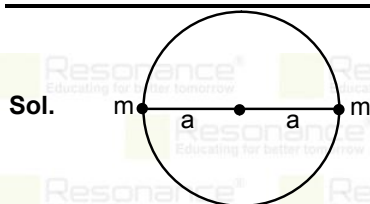
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For circular motion

$$\frac{Gm^2}{(2a)^2} = m\omega^2 a \Rightarrow \frac{Gm}{4a^3} = \omega^2 \Rightarrow \omega = \sqrt{\frac{Gm}{4a^3}}$$

37. The height of transmitting antenna is 180 m and the height of the receiving antenna is 245 m. The maximum distance between them for satisfactory communication in line of sight will be:

(given $R = 6400$ km)

- (1) 96 km (2) 56 km (3) 48 km (4) 104 km

NTA Ans. (4)

Reso Ans. (4)

Sol. $d_{\max} = \sqrt{2Rh_t} + \sqrt{2Rh_r}$

$$d_{\max} = \sqrt{2 \times 6400 \times 0.18} + \sqrt{2 \times 6400 \times 0.245}$$

$$d_{\max} = 48 + 56 = 104 \text{ km}$$

38. The half-life of a radioactive nucleus is 5 years. The fraction of the original sample that would decay in 15 years is:

- (1) $\frac{3}{4}$ (2) $\frac{1}{8}$ (3) $\frac{1}{4}$ (4) $\frac{7}{8}$

NTA Ans. (4)

Reso Ans. (4)

Sol. $N = \frac{N_0}{2^n}$

for $n = 3$

$$N = \frac{1}{8}$$

$$\text{fraction left is } 1 - \frac{1}{8} = \frac{7}{8}$$

39. A wire of length 'L' and radius 'r' is clamped rigidly at one end. When the other end of the wire is pulled by a force f, its length increases by 'l'. Another wire of same material of length '2L' and radius '2r' is pulled by a force '2f'. The increase in its length will be :

- (1) 2l (2) l (3) l/2 (4) 4l

NTA Ans. (2)






Reso Ans. (2)

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Sol. $F = \left(\frac{yA}{\ell_0}\right)x$

$$x = \frac{F\ell_0}{yA} \Rightarrow x \propto \frac{F\ell_0}{\pi r^2}$$

$$x = \frac{(2)(2)}{(2)^2} = \text{will remain same.}$$

40. The position vector of a particle related to time t is given by

$$\vec{r} = (10t \hat{i} + 15t^2 \hat{j} + 7\hat{k})\text{m}$$

The direction of net force experienced by the particle is :

- (1) Positivity y - axis (2) In $x - y$ plane (3) Positive z -axis (4) Positive $x -$ axis

NTA Ans. (1)

Reso Ans. (1)

Sol. $\vec{r} = 10t \hat{i} + 15t^2 \hat{j} + 7\hat{k}$

$$\vec{v} = \frac{d\vec{r}}{dt} = 10\hat{i} + 30t\hat{j}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = 30\hat{j}$$

$$\vec{F} = (m)\vec{a} = (m)(30\hat{j}) = \text{Along } y\text{-direction.}$$

41. In a linear Simple Harmonic Motion (SHM)

- (1) Restoring force is directly proportional to the displacement.
 (2) The acceleration and displacement are opposite in direction.
 (3) The velocity is maximum at mean position.
 (4) The acceleration is minimum at extreme points.

Choose the correct answer from the options given below:

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

NTA Ans. (1)

Reso Ans. (1)

Sol. (A) For SHM $F_{\text{net}} \propto -x$

(B) $a \propto -x$

(C) At mean position, V is maximum






(D) At the extreme position, $|F|_{\text{max}} \Rightarrow |a|_{\text{max}}$

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42. Match List I with List II of Electromagnetic waves with corresponding wavelength range:

- | | | |
|-----------------|-------|----------------------|
| (A) Microwave | (I) | 400 nm to 1 nm |
| (B) Ultraviolet | (II) | 1 nm to 10^{-3} nm |
| (C) X-Ray | (III) | 1 mm to 700 nm |
| (4) Infra-red | (IV) | 0.1 m to 1 mm |

Choose the correct answer from the options given below:

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

NTA Ans. (3)

Reso Ans. (3)

- Sol. (A) Microwave $\Rightarrow \lambda \in (1 \text{ mm} \leftrightarrow 0.1 \text{ m})$
(B) UV tavoilet $\Rightarrow \lambda \in (400 \text{ nm} \leftrightarrow 1 \text{ nm})$
(C) X-ray $\Rightarrow \lambda \in (1 \text{ nm} \leftrightarrow 1 \text{ pm})$
(D) Infra-red $\lambda \in (1 \text{ mm} \leftrightarrow 700 \text{ nm})$

43. The electric field due to a short electric dipole at a large distance (r) from centre of dipole on the equatorial plane varies with distance as :

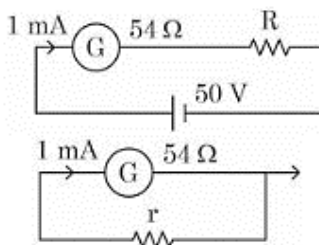
- (1) $\frac{1}{r}$
- (2) r
- (3) $\frac{1}{r^2}$
- (4) $\frac{1}{r^3}$

NTA Ans. (4)

Reso Ans. (4)

- Sol. $E_{\text{dipole}} \propto \frac{1}{r^3}$

44. For designing a voltmeter of range 50 V and an ammeter of range 10 mA using a galvanometer which has a coil of resistance 54Ω showing a full scale deflection for 1 mA as in figure.



- (A) for voltmeter $R \approx 50 \text{ k}\Omega$
- (B) for ammeter $r \approx 0.2 \Omega$
- (C) for ammeter $r = 6 \Omega$
- (D) for voltmeter $R = 5 \text{ k}\Omega$
- (E) for voltmeter $R = 500 \Omega$

Choose the correct answer from the options given below:

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

NTA Ans. (4)

Reso Ans. (4)

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Sol. For voltmeter $(\Delta V)_{\max} = (i_g)_{\max} (R + R_g)$
 $50 = (1 \times 10^{-3}) (R + 54) \Rightarrow R = 50 \text{ K}\Omega - 54$
 $R \approx 50 \text{ K}\Omega$
 For Ammeter $i_g R_g = (i - i_g) (s)$

$$(i)_{\max} = \left(\frac{R_g + s}{s} \right) (i_g)_{\max}$$

$$10 \times 10^{-3} = \frac{54 + (s)}{(s)} \times 1 \times 10^{-3}$$

$$10s = 54 + s$$

$$9s = 54$$

$$s = 6 \Omega$$

45. The speed of a wave produced in water is given by $v = \lambda^a g^b \rho^c$. Where λ , g and ρ are wavelength of wave, acceleration due to gravity and density of water respectively. The values of a , b and c respectively, are :

- (1) 1, -1, 0 (2) $\frac{1}{2}, \frac{1}{2}, 0$ (3) 1, 1, 0 (4) $\frac{1}{2}, 0, \frac{1}{2}$

NTA Ans. (2)

Reso Ans. (2)

Sol. $M^0 L^1 T^{-1} = L^a L^b T^{-2b} M^c L^{-3c}$
 $M^0 L^1 T^{-1} = M^c T^{-2b} L^{a+b-3c}$
 $C = 0$
 $b = \pm 1/2$
 $a + \frac{1}{2} + 0 = 1$
 $a = \frac{1}{2}$
 $V = \lambda^{1/2} g^{1/2} \rho^0$

46. A body is released from a height equal to the radius R of the earth. The velocity of the body when it strikes the surface of the earth will be :

(Given g = acceleration due to gravity on the earth)

- (1) $\sqrt{4gR}$ (2) $\sqrt{\frac{gR}{2}}$ (3) $\sqrt{2gR}$ (4) \sqrt{gR}

NTA Ans. (4)

Reso Ans. (4)

Sol. $\frac{GMm}{R+h} = \frac{1}{2} mv^2 - \frac{GMm}{R}$
 $h = R$
 $\frac{1}{2} mv^2 = \frac{GMm}{R} - \frac{GMm}{2R}$
 $\frac{1}{2} mv^2 = \frac{GMm}{2R}$
 $v = \sqrt{\frac{GM}{R}} = \sqrt{\frac{gR^2}{R}} = \sqrt{gR}$

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47. Given below are two statements:

Statement I : The equivalent resistance of resistors in a series combination is smaller than least resistance used in the combination.

Statement II : The resistivity of the material is independent of temperature.

In the light of the above statements, choose the correct answer from the options given below :

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are false
- (3) Statement I is true but Statement II is false
- (4) Both Statement I and Statement II are true

NTA Ans. (2)

Reso Ans. (2)

Sol. $R_a = R_1 + R_2 + R_3 = \text{greater than each resistance}$

$$\rho = \rho_0(1 + \alpha_R \Delta T)$$

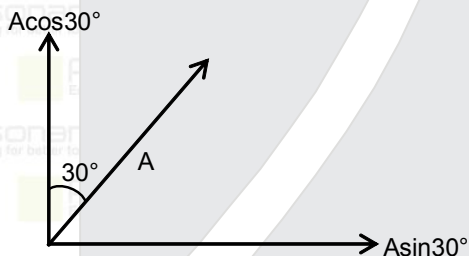
48. A vector in x – y plane makes an angle of 30° with y-axis. The magnitude of y-component of vector is $2\sqrt{3}$, The magnitude of x-component of the vector will be:

- (1) 6
- (2) 1
- (3) $\sqrt{3}$
- (4) 2

NTA Ans. (4)

Reso Ans. (4)

Sol.



$$A \cos 30^\circ = 2\sqrt{3} \Rightarrow A = 4$$

$$x - \text{Component} = A \sin 30^\circ = 4 \times \frac{1}{2} = 2$$

49. A 12 V battery connected to a coil of resistance 6Ω through a switch, drives a constant current in the circuit. The switch is opened in 1 ms. The emf induced across the coil is 20 V. The inductance of the coil is :

- (1) 8 mH
- (2) 10 mH
- (3) 5 mH
- (4) 12 mH

NTA Ans. (2)

Reso Ans. (2)

Sol. Initially $i = \frac{\varepsilon}{R} = \frac{12}{6} = 2$ Amp

Finally $i = 0$

$$\langle \text{emf} \rangle = L \frac{\Delta i}{\Delta t}$$






$$20 = (L) \frac{2-0}{1 \times 10^{-3}} \Rightarrow L = 10 \text{ mH}$$

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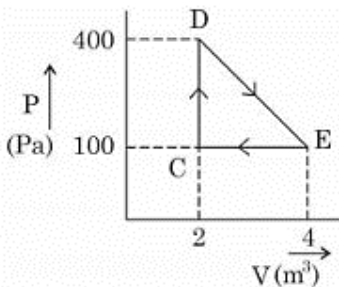
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50. A thermodynamics system is taken through cyclic process. The total work done in the process is :



(1) 300 J

(2) Zero

(3) 200 J

(4) 100 J

NTA Ans. (1)

Reso Ans. (1)

Sol. $W = \text{Area under P-V graph}$

$$= \frac{1}{2} \times 2 \times 300 = 300 \text{ J}$$

51. The refractive index of a transparent liquid filled in an equilateral hollow prism is $\sqrt{2}$. The angle of minimum deviation for the liquid will be _____.

NTA Ans. 30.00

Reso Ans. 30.00

Sol.
$$h = \frac{\sin\left(\frac{\delta_{\min} + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\sqrt{2} = \frac{\sin\left(\frac{\delta_{\min} + 60}{2}\right)}{\sin\left(\frac{60}{2}\right)} \Rightarrow \delta_{\min} = 30^\circ$$

52. A 20 cm long metallic rod is rotated with 210 rpm about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field 0.2T parallel to the axis exists everywhere. The emf developed between the centre and the ring is _____ mV.

_____ mV.

Take $\pi = \frac{22}{7}$

NTA Ans. 88.00

Reso Ans. 88.00

Sol.
$$\text{emf} = \frac{B\omega\ell^2}{2} = \frac{(0.2)\left(\frac{210 \times 2\pi}{60}\right)(0.2)^2}{2}$$

emf = 88 m volt

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53. An electron in a hydrogen atom revolves around its nucleus with speed of $6.76 \times 10^6 \text{ ms}^{-1}$ in an orbit of radius 0.52 \AA . The magnetic field produced at the nucleus of the hydrogen atom is _____ T.

NTA Ans. 40.00

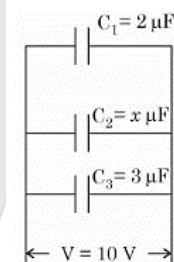
Reso Ans. 40.00

Sol. $B = \frac{\mu_0 qv \sin \theta}{4\pi r^2}$

$$B = \frac{(10^{-7})(1.6 \times 10^{-19})(6.76 \times 10^6) \sin 90^\circ}{(0.52 \times 10^{-10})^2}$$

$$B = 40 \text{ T}$$

54. In the given figure the total charge stored in the combination of capacitors is $100 \mu\text{C}$. The value of 'x' is _____.



NTA Ans. 05.00

Reso Ans. 05.00

Sol. $C_{eq} = 3 + 2 + x = 5 + x$

$$Q = C_{eq}V = (5 + x) 10 = 100$$

$$\Rightarrow 5 + x = 10$$

$$\Rightarrow x = 5$$

55. A solid sphere and a solid cylinder of same mass and radius are rolling on a horizontal surface without slipping. The ratio of their radius of gyration respectively ($k_{sph} : k_{cyl}$) is $2 : \sqrt{x}$. The value of x is _____.

NTA Ans. 05.00

Reso Ans. 05.00

Sol. For solid sphere $I_{cm} = \frac{2}{5}MR^2 = MR_{eq}^2$

$$R_{eq} = \sqrt{\frac{2}{5}} R$$

For solid cylinder $I_{cm} = \frac{MR^2}{2} = MR_{eq}^2$

$$R_{eq} = \frac{1}{\sqrt{2}} R \Rightarrow \frac{(R_{eq})_{sphere}}{(R_{eq})_{cylinder}} = \frac{\sqrt{\frac{2}{5}}}{\frac{1}{\sqrt{2}}} = \frac{2}{\sqrt{5}}$$

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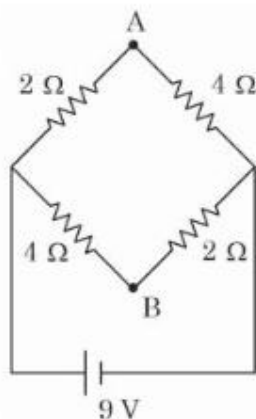
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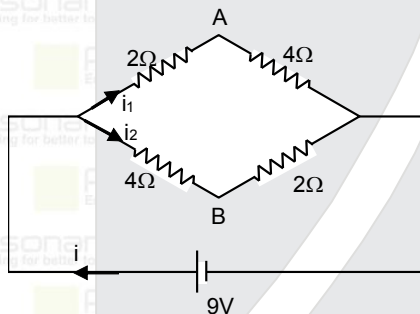
56. A network of four resistances is connected to 9V battery, as shown in figure. The magnitude of voltage difference between the points A and B is _____ V.



NTA Ans. 03.00

Reso Ans. 03.00

Sol.



$$i = \frac{9}{3} = 3A$$

$$i_1 = i_2 = \frac{i}{2} = 1.5 A$$

$$V_A - V_B = 4i_2 - 2i_1 = 4 \times 1.5 - 2 \times 1.5 = 6 - 3$$

$$V_A - V_B = 3$$

57. The fundamental frequency of vibration of a string stretched between two rigid support is 50 Hz. The mass of the string is 18 g and its linear mass density is 20 g/m. The speed of the transverse waves so produced in the string is _____ ms^{-1}

NTA Ans. 90.00

Reso Ans. 90.00

Sol. $\mu = \frac{m}{l} \Rightarrow 20 = \frac{18}{l}$

$$\Rightarrow l = \frac{18}{20} = \frac{9}{10} = 0.9m$$






$$f = \frac{v}{2l} \Rightarrow v = 2fl = 2 \times 50 \times 0.9 = 90 m/s$$

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58. A block of mass 10 kg is moving along x-axis under the action of force $F = 5x$ N. The work done by the force in moving the block from $x = 2$ m to 4m will be _____ J.

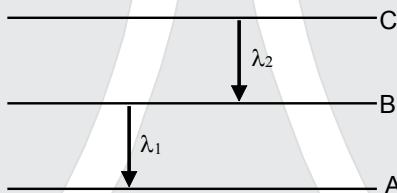
NTA Ans. 30.00

Reso Ans. 30.00

Sol. $w = \int F dx = \int_2^4 5x dx = 5 \int_2^4 x dx$

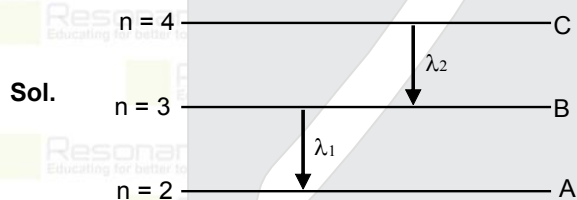
$$w = \frac{5}{2} [4^2 - 2^2] = \frac{5}{2} [16 - 4] \Rightarrow w = 5/2 \times 12 = 30 \text{ J}$$

59. As per given figure A, B and C are the first, second and third excited energy levels of hydrogen atom respectively. If the ratio of the two wavelengths (i.e. $\frac{\lambda_1}{\lambda_2}$) is $\frac{7}{4n}$, then the value of n will be _____.



NTA Ans. 05.00

Reso Ans. 05.00



$$\frac{1}{\lambda_1} = R \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

$$\Rightarrow \frac{1}{\lambda_1} = R \left(\frac{1}{4} - \frac{1}{9} \right) \Rightarrow \frac{1}{\lambda_1} = R \left(\frac{9-4}{36} \right) \Rightarrow \lambda_1 = \frac{36}{5R}$$

$$\& \frac{1}{\lambda_2} = R \left(\frac{1}{3^2} - \frac{1}{4^2} \right) = R \left(\frac{1}{9} - \frac{1}{16} \right) \Rightarrow \frac{1}{\lambda_2} = R \left(\frac{16-9}{144} \right) \Rightarrow \lambda_2 = \frac{144}{7R}$$

$$\text{So } \frac{\lambda_1}{\lambda_2} = \frac{36}{5R} \times \frac{7R}{144} = \frac{7}{20}$$

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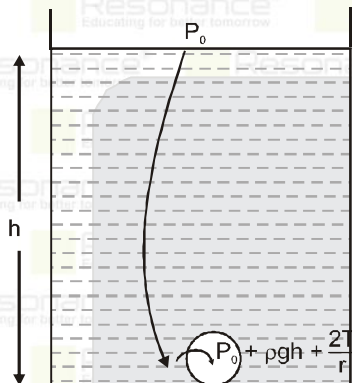
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60. There is an air bubble of radius 1.0 mm in a liquid of surface tension 0.0075 Nm^{-1} and density 1000 kg m^{-3} at a depth of 10 cm below the free surface. The amount by which the pressure inside the bubble is greater than the atmospheric pressure is _____ Pa ($g = 10 \text{ ms}^{-2}$)

NTA Ans. 1150

Reso Ans. 1150

Sol.



$$P_0 + \rho gh$$

$$P_{in} = P_0 + \rho gh + \frac{2T}{r}$$

$$\Delta P = \rho gh + \frac{2T}{r}$$

$$\Delta P = (10^3)(10)(0.1) + \frac{2 \times 0.075}{10^{-3}}$$






$$\Delta P = 1150 \text{ Pa}$$

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