JEE Main (Phase-II) 2020

Memory Based Questions & Solutions

SUBJECT

PHYSICS

Date: 02 September, 2020 (Shift-2)

Time: 3 PM to 6 PM

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1. A capacitor of $20\mu F$ is first charged up to 50 V and then disconnected from the cell. This capacitor is the connected to another capacitor of capacitance C. If common potential in steady state is 20V then find the capacitance of second capacitor C.

Ans : 30.00

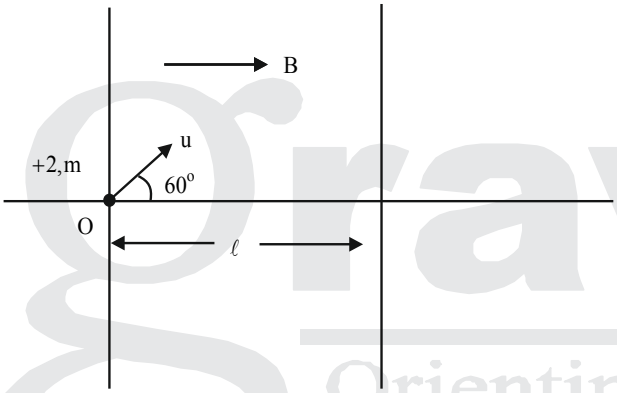
Sol : $V = \dfrac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$$20 = \frac{20\times 50 + 0}{20 + C}$$

$400 + 20C = 1000$

$C = 30\mu F$

2. A particle is projected with velocity v from point O of particle makes 10 revolutions before coming out. Find value of l *in terms of* v *m and* q.



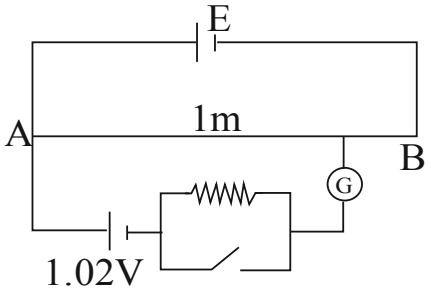
(1) $\dfrac{\pi mv}{qB}$ (2) $\dfrac{2\pi mv}{qB}$ (3) $\dfrac{20\pi mv}{qB}$ (4) $\dfrac{40\pi mv}{qB}$

Sol : $l = 10 \times$ pitch

$$= 10 \times v\cos 60^0 \times \frac{2\pi m}{qB}$$

$$l = \frac{20\pi mv}{qB}$$

3. In the given circuit of potentiometer 1.02 volt is balanced by a length of 51 cm from A. What is the potential gradient along the wire AB :



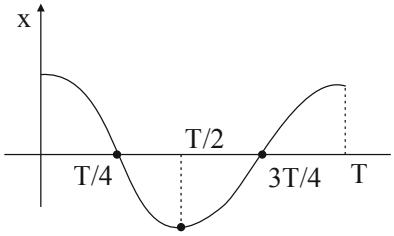
(1) 0.01 volt/cm (2*) 0.02 volt/cm (3) 0.3 volt/cm (4) 0.4 volt/com

Sol: $X = V/l$

$$x = \frac{1.02}{51}$$

$= 0.2$ volt/cm

4. Displacement time graph of a body in SHM is as shown in figure. If equilibrium position is at x = 0 then:



(1) No force acting on the particle at $\frac{T}{4}$

(2) Speed of particle is maximum at $\frac{3T}{4}$

(3*) acceleration at $\frac{T}{4}$ is maximum

(4) KE and PE is equal at $t = \frac{T}{8}$

Sol: From garph equation of SHM

$X = A\cos\omega t$

(i) at $\frac{T}{4}$ particle at mean position

$\therefore a = 0$

$F = 0$

(ii) at $\frac{3T}{4}$ particle again at mean position so velocity is maximum

(iii) at $t = \frac{T}{4}$, particle is at mean position.

$\therefore a = 0$

(iv) KE = PE

$$\frac{1}{2}k\left(A^2 - x^2\right) = \frac{1}{2}kx^2$$

$A^2 = 2x^2$

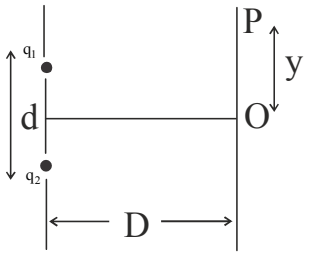
$$x = \frac{+A}{\sqrt{2}}$$

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

$$t = \frac{T}{8}$$

$\therefore$ A, B and D are correct

5. In standard YDSE when $\lambda = 700$ nm the total number of fringes between point O & P is 16. when $\lambda = 400$ nm is used instead then number of fringes between O & P is

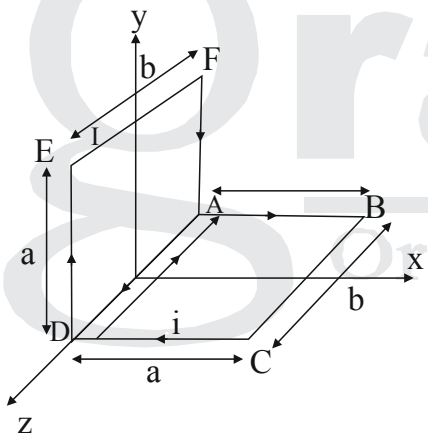


(1) 14 (2*) 28 (3) 7 (4) 12

Sol: $y = \dfrac{m_1 D\lambda_1}{d} = \dfrac{mD\lambda_2}{d}$

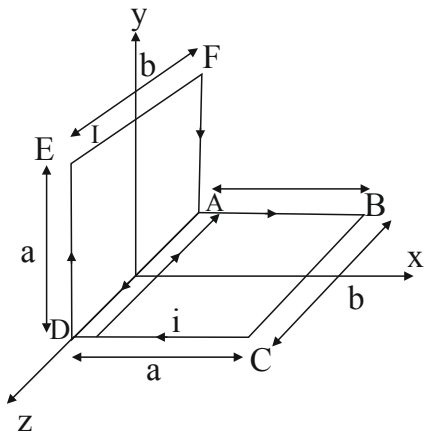
$\dfrac{m_2}{m_1} = \dfrac{\lambda_1}{\lambda_2} \Rightarrow m_2 = \dfrac{700}{400} \times 16 = 28$

6. Find magnetic dipole moment of the given loop



(1) $iab\left(\hat{i}+\hat{j}\right)$ (2*) $iab\left(-\hat{i}-\hat{j}\right)$ (3) $iab\left(\hat{i}+\hat{j}\right)$ (4) $iab+\left(\hat{j}+\hat{k}\right)$

Sol:



Loop ABCD

$\vec{M}_1 = (abi)(\hat{j})$

For loop DEFA

$\vec{M}_2 = ab(-\hat{i})$

$\vec{M} = \vec{M}_1 + \vec{M}_2 = \vec{M} = ab(-\hat{i} - \hat{j})$

7. If momentum (P) , area (A), time (T) are taken as fundamental physical quantities, then find dimensional formula of energy :

(1) $AT^{-2}P^1$ (2) $A^{1/2}T^{-1}P^2$ (3*) $A^{1/2}T^{-1}P^1$ (4) $AT^{-1/2}P^2$

Sol : Let dimension formula of energy will be

$E = A^a T^b P^c$

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

by comparison

$C = 1$ .....(1)

$2a + c = 2$ .....(2)

$b - c = -2$ .....(3)

$c = 1, a = 1/2, b = -1$

$E = A^{1/2} T^{-1}P^1$

8. $\vec{E}$ & $\vec{B}$ of an EM wave oscillate along the direction having vectors $\hat{k}$ & $\hat{i} - \hat{j}$. Find the unit vector along direction of propagation of the wave :

(1*) $\frac{\hat{i} - \hat{j}}{\sqrt{2}}$ (2) $\frac{\hat{i} + \hat{j}}{\sqrt{2}}$ (3) $\frac{\hat{j} + \hat{k}}{\sqrt{2}}$ (4) $\frac{\hat{j} - \hat{k}}{\sqrt{2}}$

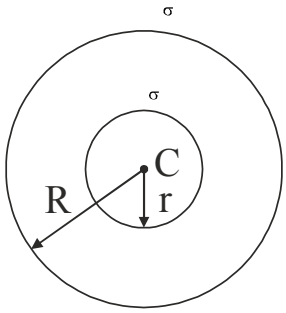
Sol : $\vec{E} \times \vec{B} \,||\, \vec{C}$

$$\hat{E} \times \hat{B} = \frac{1}{\sqrt{2}} \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ 1 & -1 & 0 \end{vmatrix} = \frac{\hat{i} - \hat{j}}{\sqrt{2}} \Rightarrow \hat{C} = \frac{\hat{i} - \hat{j}}{\sqrt{2}}$$

9. A Charge Q is distributed on two concentric spheres of radius r and R respectively, given that sureface charge density of both spheres is same , Find the electric potential at the centre :

(1) $KQ\left(\frac{1}{r} + \frac{1}{R}\right)$ (2) $\frac{KQ(r+R)}{(r^2+R)}$ (3) $\frac{KQrR}{r+R}$ (4) $\frac{KQ(R^2+r^2)}{(R+r)}$

Sol:



$$Q_1 = \sigma 4\pi r^2$$

$$Q_2 = \sigma 4\pi R^2$$

$$\therefore \quad Q = \sigma 4\pi\left(r^2 + R^2\right)$$

$$\therefore \quad \sigma = \frac{Q}{4\pi\left(r^2 + R^2\right)}$$

$$V_c = \frac{KQ_1}{r} + \frac{KQ_2}{R}$$

$$= \frac{K\sigma 4\pi r^2}{r} + \frac{K\sigma 4\pi R^2}{R}$$

$$= K\sigma 4\pi\left(r + R\right)$$

$$= \frac{KQ4\pi\left(r + R\right)}{4\pi\left(r^2 + R^2\right)}$$

$$= \frac{KQ\left(r + R\right)}{\left(r^2 + R^2\right)}$$

10. A capillary tube of radius 0.15 mm is dipped in a liquid of density $\rho = 667$ kg/m^3. If surface tension of liquid is $\frac{1}{20}$ Nm^{-1} then find the height of capillary rise of liquid in the tube. Given that angle of contact between liquid and capillary tube is 60^0. (g = 10 m/s^2)

(1) 0.01 m (2) 0.02 m (3) 0.04 m (4*) 0.05 m

Sol: $h = \frac{2T\cos\theta}{\rho g r}$ $\theta = 60^0$ P = 667 kg/m^3; T = 1/20 Nm^{-1}; r = 0.15 × 10^{-3}

$$= \frac{2 \times \frac{1}{20} \times \frac{1}{2}}{667 \times 10 \times 0.15 \times 10^{-3}}$$

$$= 0.05 \text{ m}$$

11. In hydrogen atom electron get deexited from $(n+1)^{th}$ state to n^{th} state, then the frequency of emitted photon is directly proportional to (n >>1)

(1) n (2) $\frac{1}{n}$ (3) $\frac{1}{n^2}$ (4*) $\frac{1}{n^3}$

Sol: $E_n = -\frac{Rhc}{n^2}$

$E_{n+1} = -\frac{Rhc}{(n+1)^2}$

$\Delta E = E_{n+1} - E_n$

$hv = Rhc\left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right]$

$v = R.c\left[\frac{(n+1)^2 - n^2}{n^2(n+1)^2}\right]$

$v = R.c\left[\frac{1+2n}{n^2(n+1)^2}\right]$

n>>1 $\Rightarrow$ $v = R.c\left[\frac{2n}{n^2 \times n^2}\right]$

$= \frac{2RC}{n^3}$

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

12. A closed box contains an ideal gas if temperature of gas increased then which among the following is correct :

(A) Mean free path reamin same (B) Mean free path decreases

(C) Relaxation time decreases (D) Relaxation time remain same

Which of the following is correct

(1) B & D (2*) A & C (3) A & D (4) B & C

Sol: As we knwon mean free path

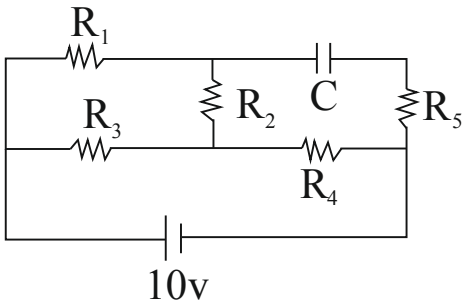
$\lambda = \frac{1}{\sqrt{2}\left(\frac{N}{V}\right)\pi d^2}$

N = no. of molecule

V = volume of container

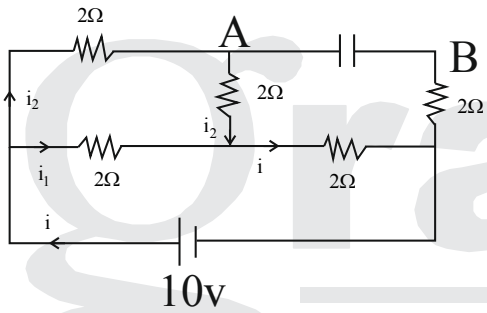
d = diameter of molecule
Velocity constant and no. of molecules are same.
So mean free path remains same
As temperature increases no. of collision increases so relaxation time decrease.

13. $R_1 = R_2 = R_3 = R_4 = 2\,\Omega$. When steady state is reached find the voltage across capacitor :



(1) 0 V (2) 2 V (3) 4 V (4*) 8 V

Sol :



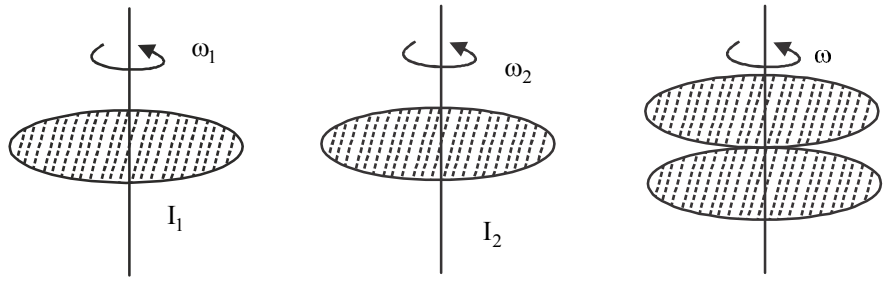
$$i = \frac{10}{\frac{4}{3}+2} = \frac{10\times 3}{10} = 3\ \text{Amp}$$

$i_1 = 2A$ & $i_2 = 1$ A

$V_{AB} = 1 \times 2 + 3 \times 2 = 8$ V

14. Two discs having moment of inertia I_1 and I_2 respectively and angular velocities ω_1 & ω_2 are placed coaxially find total kinetic energy when they rotates with same angular velocity (or when slipping stops)
$I_1 = 0.10$ (kg-m^2); $I_2 = 0.20$ (kg-m^2)
$\omega_1 = 10$ Rad/sec; $\omega_2 = 5$ Rad/sec
(1) 0 J (2) 5 J (3) 10 J (4*) 20/3 J

Sol:



$$\omega = \frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2} = \frac{20}{3}$$

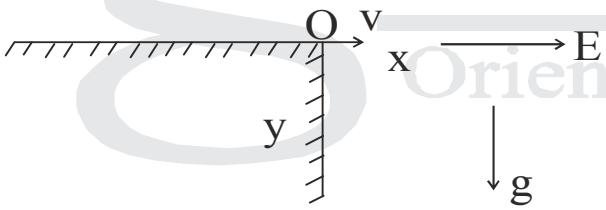
Final K.E.

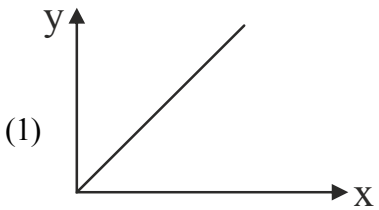
$$K_f = \frac{1}{2}I_1\omega^2 + \frac{1}{2}I_2\omega^2$$

$$= \frac{1}{2}(0.1+0.2)\times\left(\frac{20}{3}\right)^2$$

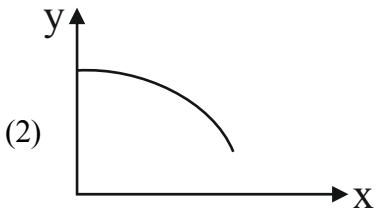
$$= k_f = \frac{20}{3}$$

15. A particle having positive charge q and mass m is projected horizontally from point O. Choose correct option.



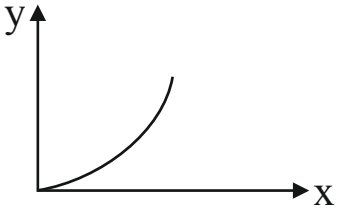


(1)

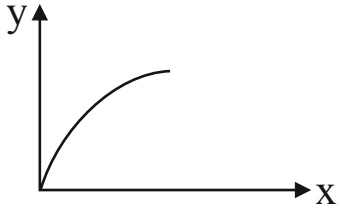


(2)

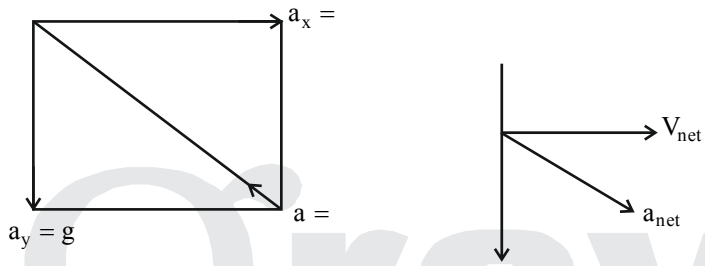
(3*)



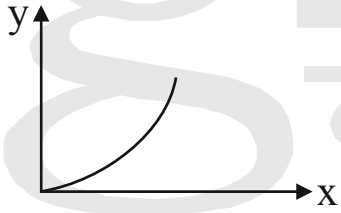
(4)



SOl:



Net acceleration of particle is constant therefore path is parabola



16. Acceleration due to gravity is same at a height h from surface and at the depth h from the surface, then find the value of h.

(1) $\left(\sqrt{5}-1\right)\frac{R}{2}$ (2*) $\frac{\sqrt{5}R}{2}-1$ (3) $\frac{R}{\sqrt{2}}$ (4) $\frac{\sqrt{5}R+R}{2}$

Sol: $\frac{GM}{\left(R+h\right)^2}=\frac{GM}{R^3}\left(R-h\right)$

$R^3=\left(R+h\right)^2\left(R-h\right)$

$=\left(R^2+h^2+2hR\right)\left(R-h\right)$

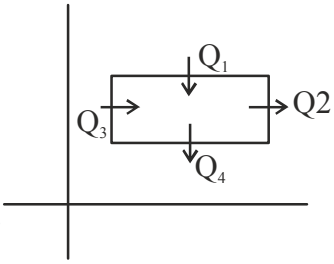
$R^3=R^3+h^2R-R^2h-R^2h-h^3-2h^2R$

$$h = \frac{-R \pm \sqrt{R^2 + 4(1)R^2}}{2}$$

$$= \frac{-R + \sqrt{4}R}{2}$$

$$= \frac{\left(\sqrt{5}-1\right)}{2}R$$

17. Efficiency of a cyclic process is 50% if heat $Q_1 = 1915$ J, $Q_2 = 40$ J, $Q_3 = 125$ J, then Q_4 is unknown then find the value of Q_4.



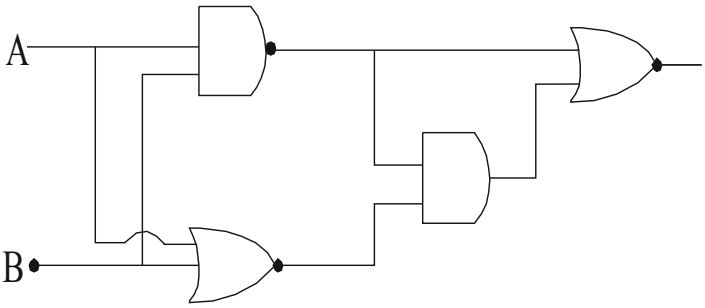
(1) 1080 (2*) -980 J (3) -1080 (4) -1280 J

Sol: $\eta = \frac{W}{\sum Q_+} = \frac{Q_1 + Q_2 + Q_3 + Q_4}{Q_1 + Q_3} = 0.5$

$$\Rightarrow \frac{1915 - 40 + 125 + Q_4}{1915 + 125} = 0.5$$

$\Rightarrow Q_4 = -980$ J

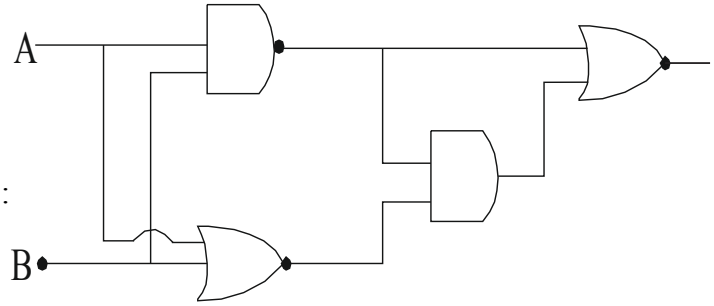
18.



(A, B) is (0, 0), (0, 1), (1, 0), (1, 1) then out put at x will be

(1*) (0, 0, 1, 0) (2) (1, 1, 1, 0) (3) (1, 0, 1, 0) (4) (1, 1,1 ,1)

Sol:



$\therefore$ optin (1) is the Answer

A	B	$\overline{A.B}$	$\overline{A+B}$	$P=\left(\overline{A.B}\right).\left(\overline{A+B}\right)$	$Q=P+\left(\overline{A.B}\right)$	$\overline{Q}=X$
1	0	1	0	0	1	0
0	1	1	0	0	1	0
1	1	0	0	0	0	1
0	0	1	1	1	1	0

19. Given impedance Z of a L-R circuit is $100\,\Omega$ and phase difference between source voltage and source current is 45^0, if frequency of source is 1000 Hz. Find inductance of coil.

(1) $25\sqrt{2}$ mH (2) $\frac{50\sqrt{2}}{\pi}mH$ (3*) $\frac{25\sqrt{2}}{\pi}mH$ (4) $\frac{20\sqrt{2}}{\pi}mH$

Sol: $\tan\theta=\frac{x_L}{R}=\tan 45^0$

$x_L=R$

$=100=\sqrt{x_L^2+R^2}$

$100=\sqrt{R^2+R^2}$

$R=50\sqrt{2}$

$\therefore X_L=50\sqrt{2}$

$L\omega=50\sqrt{2}$

$L=\frac{50\sqrt{2}}{2\pi\times1000}=\frac{25\sqrt{2}}{\pi}mH$

20. Given that a rod when heated from 0 to 10^0C its length is changed by 0.02%, by what % does its density?

(1) 0.2 (2) 0.04 (3*) 0.06 (4) 0.08

Sol: $\Delta l=l\alpha\Delta t$

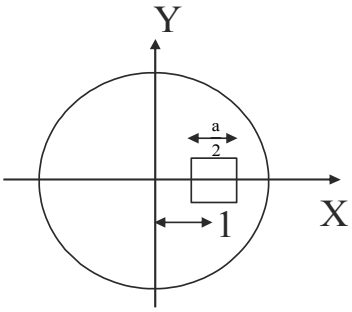
$\alpha=\frac{\Delta l}{l\Delta T}=\frac{0.02}{100\times10}$; $\alpha=2\times10^{-5}$

$\eta=3a=6\times10^{-5}$

$$\frac{\Delta V}{V} = 4 \times \Delta T \; ; \; \frac{\Delta V}{V} \times 100 = \left(6 \times 10^{-5} \times 10 \times 100\right) = 6 \times 10^{-2}$$

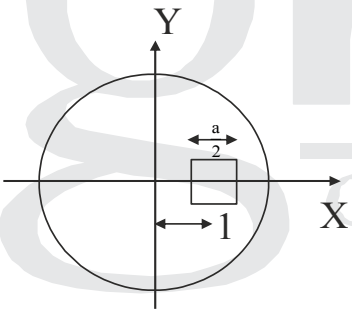
Volume increase by 0.06% therefore density decrease by 0.06%

21. A square of side $\frac{a}{2}$ is removed from a disc having radius a. Find position of centre of mass of remaining portion.



(1) $x = \frac{-2a}{\pi}$ (2*) $\frac{-a}{8\pi - 2}$ (3) $\frac{-4a}{3\pi}$ (4) $\frac{-a}{3\pi - 4}$

Sol:



$$X_a = \frac{A.x - Ax1}{A - A_1} = \frac{\pi a^2 \times 0 - \frac{a^2}{4} \times \frac{a}{2}}{\pi a^2 - \frac{a^2}{4}}$$

$$= \frac{-a^3/8}{\left(\pi - \frac{1}{4}\right)a^2} = \frac{-a}{2(4\pi - 1)} = \frac{-a}{8\pi - 2}$$

22. Young modulus of a string of length 1 m and density 900 kg/m^3 is 9×10^9 N/m^2. Find minimum resonant frequency (in Hz) can be produced in the string if strain in the string is 4.9×10^{-4}.

Ans : 35.00 Hz

Sol : Fundamental frequency in the string

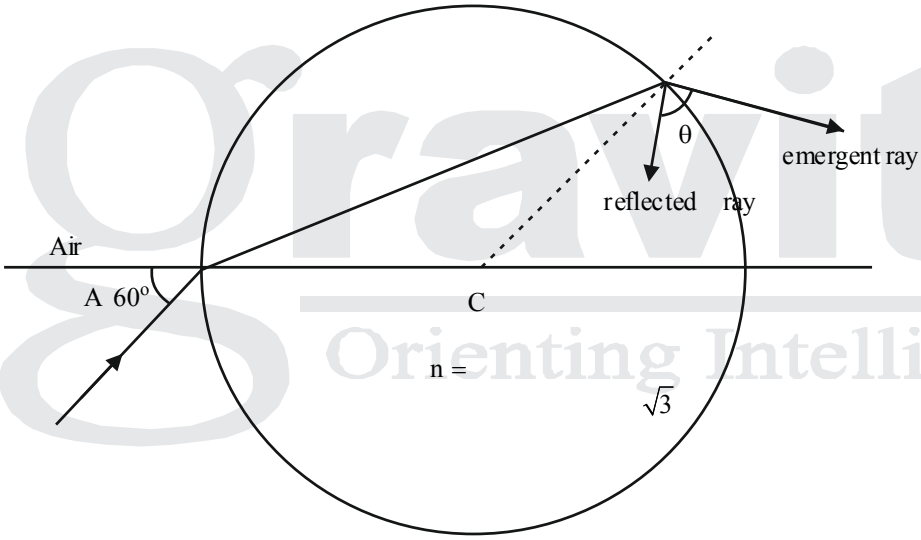
$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}} = \frac{1}{2l}\frac{\sqrt{Y\Delta l}}{\rho l}$$

$$f = \frac{1}{2l}\sqrt{\frac{T\Delta l}{\rho l}} \qquad \left(\frac{\Delta l}{l} = 4.9 \times 10^{-4}\right)$$

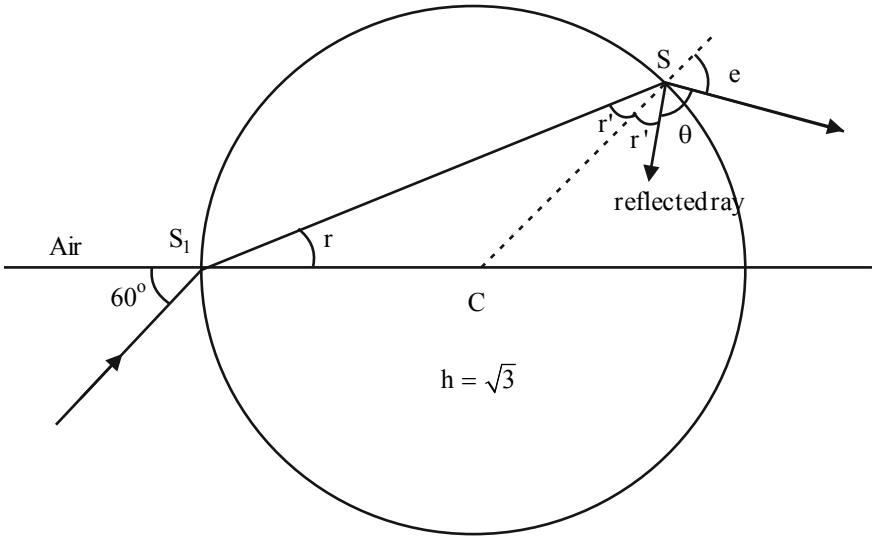
$$= \frac{1}{2\times 1}\sqrt{\frac{9\times 10^{9}\times 4.9\times 10^{-4}}{100}}$$

$$\frac{1}{2}\times 70 = 35Hz$$

23. Light incident on a sphere of refreactive index $\sqrt{3}$ placed in a air as shown in figure. At the second surface the gets partially reflected and refracted as shown. Find the angle (θ) in degree between emergent ray and reflected ray at the second surface.



Sol :



$$\theta = 90^{0}$$

Apply Snell's law at S_1

$1\sin 60^0 = \sqrt{3}\sin r$

$\sin r = \frac{1}{2}$

$r = 30^0$

from geometry

$r' = 30^0$

Again apply snell's law on S_2

$\sqrt{3}\sin r' = 1\sin e$

$\frac{\sqrt{3}}{2} = \sin e$

$\therefore e = 60^0$

from geometry

$r' + \theta + e = 180^0$

$\theta = 90^0$

Gravity
Orienting Intelligence

JEE Main - 2020

Best Result in U.P.

Aditya Pandey

Percentile

99.936

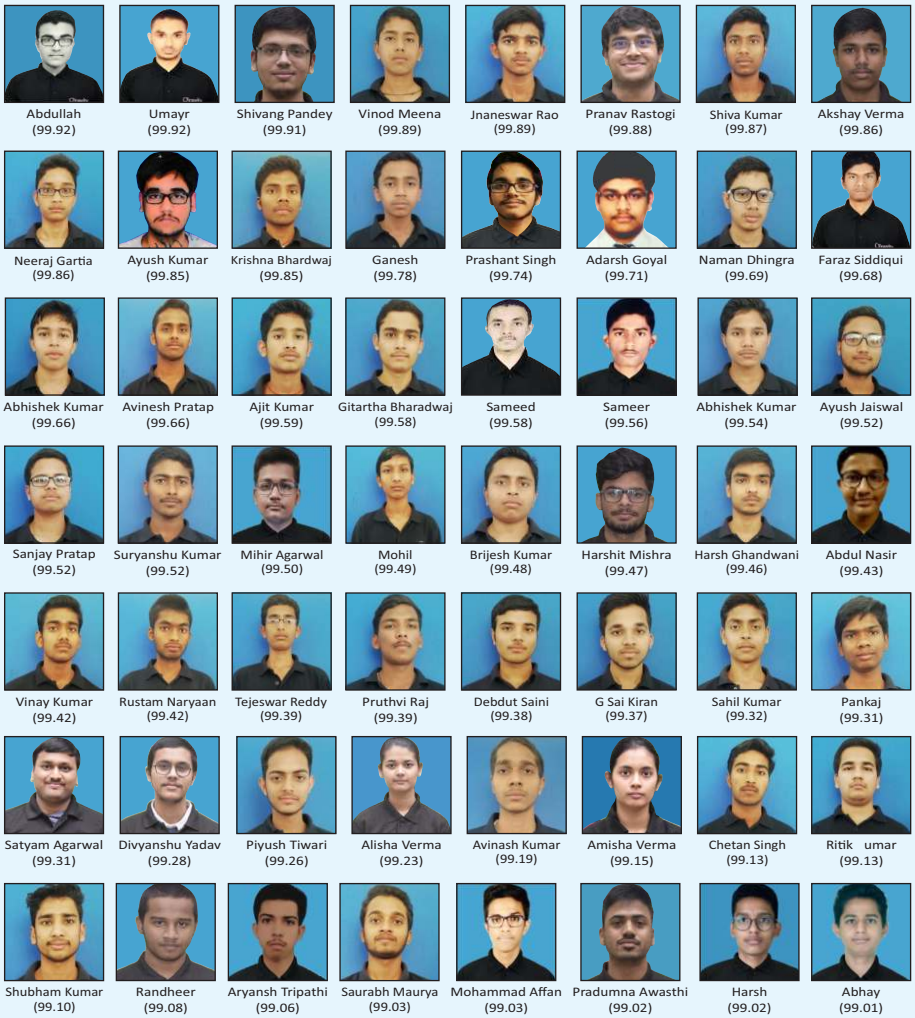
City Topper

Application No. 200310320565
DOB - 23-12-2002

65 Students Above 99 Percentile

145 Students Above 98 Percentile

208 Students Above 97 Percentile



SCHOOL INTEGRATED PROGRAM (SIP)

Tradition of Gravity Continues,
Once Again Historical Result,
100% Students Cracked
JEE Main
(Based on Last Yr Cut off)

2020

80 Out of 80
Cracked JEE Main

We had three Batches
of 55, 15 and 10.

Many Top Ranks are
from these Batches

2019

79 Out of 80 in JEE Main	50 Out of 79 in JEE Adv.

2018

83 Out of 85 in JEE Main	62 Out of 83 in JEE Adv.

2017

80 Out of 85 in JEE Main	63 Out of 80 in JEE Adv.

2016

39 Out of 40 in JEE Main	31 Out of 39 in JEE Adv.

Selections Engineering 2019

gravity
Orienting Intelligence

194 AIR (General)

Tarun

337 AIR (General)

Aniket Agarwal

494 AIR (General)

Shubh Sahu

497 AIR (General)

Shlok Nemani

50 out of 79 Cracked JEE Advanced from SIP (School Integrated Program)

4 Ranks under 500 (General Category) | 2 Ranks under 10 (Reserved Category)

126 Selections in JEE Advanced | 61 Students above 99 Percentile in JEE Main 2019

Sanjana

AIR - 3*

Akash

AIR - 4*

Priyanka

AIR - 68*

Bibek Lakra

AIR - 150*

Neha Raj

AIR - 177*

Arindam

AIR - 809 (General EWS)

Priyam

AIR - 1378 (General)

Mihir Chawla

AIR - 2237 (General)

Madhur Kumar

AIR - 2382 (General)

Manish Kumar

AIR - 2388 (General)

Saumya Raj

AIR - 2656 (General)

Raghav

AIR - 2659 (General)

Ritveek

AIR - 2709 (General)

Vanshaj

AIR - 2787 (General)

Subir Gupta

AIR - 2881 (General)

Aryan Rastogi

AIR - 3167 (General)

Devansh

AIR - 3600 (General)

Abhisht Bose

AIR - 3784 (General)