JEE Main (Phase-II) 2020

Memory Based Questions & Solutions

SUBJECT

PHYSICS

Date: 03 September, 2020 (Shift-2)

Time: 3 PM to 6 PM

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1. Dimension of solar constant is:

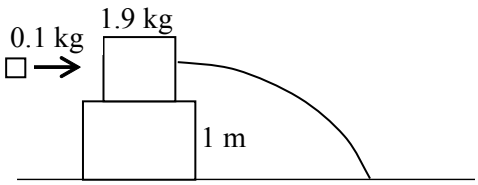
(1) $M^1L^0T^{-3}$ (2) $M^1L^1T^{-3}$ (3) $M^0L^0T^3$ (4) $M^1L^2T^{-3}$

Ans. **(1)**

Sol. Solar constant $= \dfrac{\text{Energy}}{\text{Time Area}}$

$= \dfrac{M^1L^2T^{-2}}{TL^2} = M^1L^0T^{-3}$

2. In the given diagram a 0.1 kg bullet moving with speed 20 m/sec strikes 1.9 kg mass and get embedded in it. Find the kinetic energy of the mass with which it will strikes the ground .



(1) 11 J (2) 21 J (3) 25 J (4) 30 J

Ans. **(2)**

Sol. Conservation of linear momentum

$0.1 \times 20 = (0.1 + 1.9) \times v$

$v = 1 \text{ m/s}$

Using work energy theorem

$W_g = \Delta k$

$2 \times g \times 1 = k_f - \dfrac{1}{2} \times 2 \times 1^2$

$\therefore\ k_f = 21 \text{ J}$

3. A mass m is moving in SHM on a line with amplitude A and frequency f in a spring-mass system. Suddenly half of the mass comes to rest just at the moment, when it crosses mean position, then the new amplitude becomes λA, then λ will be

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

Ans. **(3)**

Sol. As the external force is absent, by conservation of linear momentum

$m_1u_1 = m_fv_f$

$m.A\omega = \dfrac{m}{2}A'\omega'$

$m.A\sqrt{\dfrac{k}{m}} = \dfrac{m}{2}A'\sqrt{\dfrac{k}{m/2}}$

$A = \dfrac{1}{2}\sqrt{2}A'$

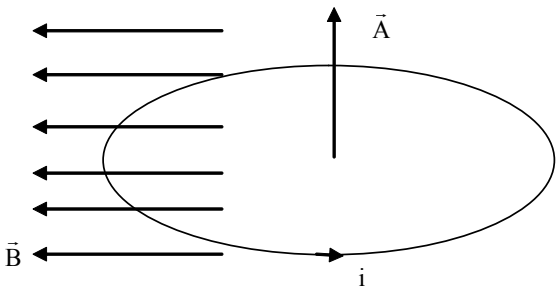
$A' = \sqrt{2}A$

4. A loop of area 'S' m^2 and N turns carrying current 'i' is placed in a uniform magnetic field 'B' with its plane parallel to $\vec{B}$. If torque 'τ' is experienced by loop due to magnetic field, find $|\vec{B}|$

(1) $\frac{\tau}{NiS}$ (2) $\frac{N\tau}{iS}$ (3) $\frac{i\tau}{NS}$ (4) $\frac{S\tau}{Ni}$

Ans. **(1)**

Sol.

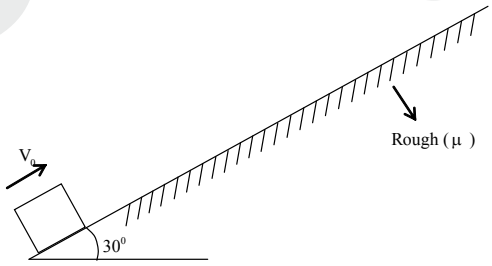


$$\tau = |\vec{M} \times \vec{B}| = NiAB\sin(90^0)$$

$$= Ni\ S\ B$$

$$\Rightarrow \quad B = \frac{\tau}{NiS}$$

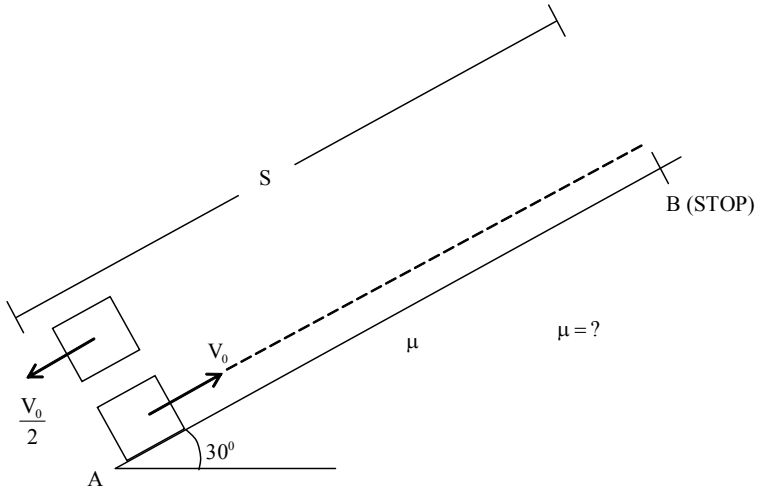
5. A block starts going up a rough inclined plane with speed V_0 as shown in figure. After some time it reaches to starting point again, with a speed $\frac{V_0}{2}$. Find coefficient of friction 'μ'. (Given g = 10 m/s^2.)



(1) 0.15 (2) 0.35 (3) 0.75 (4) 0.80

Ans. **(2)**

Sol.



A to B

$$a_1 = g\sin 30^0 + \mu g\cos 30^0$$

$$= \frac{g}{2} + \frac{\mu g\sqrt{3}}{2} \; ; \; g = 10 \text{ m/s}^2$$

$$V_0^2 - 2a_1(s) = 0$$

$$s = \frac{V_0^2}{a_1} \qquad .....(i)$$

B to A

$$a_2 = \frac{g}{2} - \frac{\mu\sqrt{3}}{2}g$$

$$\left(\frac{V_0}{2}\right)^2 = 2a_2(s)$$

$$s = \frac{V_0^2}{4a_2} \qquad .....(ii)$$

From equation (i) and (ii)

$$\frac{V_0^2}{a_1} = \frac{V_0^2}{4a_2}$$

$$\Rightarrow a_1 = 4a_2$$

$$\Rightarrow 5 + 5\sqrt{3}\mu = 4\left(5 - 5\sqrt{3}\mu\right)$$

$$\Rightarrow 5 + 5\sqrt{3}\mu = 20 - 20\sqrt{3}\mu \Rightarrow 25\sqrt{3}\mu = 15 \Rightarrow \mu = \frac{\sqrt{3}}{5} = 0.35$$

6. An ideal gas is heated by 160 J at constant pressure, its temperature rises by 50^0C and if 240 J of heat is supplied at constant volume, temperature rises by 100^0C, then its degree of freedom should be:
(1) 3 (2) 5 (3) 6 (4) 7

Ans. **(3)**

Sol. At constant pressure:

$$\Delta Q = nC_P\Delta T$$

$\Rightarrow \quad 160 = nC_P.50 \quad .....(1)$

At constant volume

$$\Delta Q = nC_V\Delta T$$

$\Rightarrow \quad 240 = nC_V.100 \quad .....(2)$

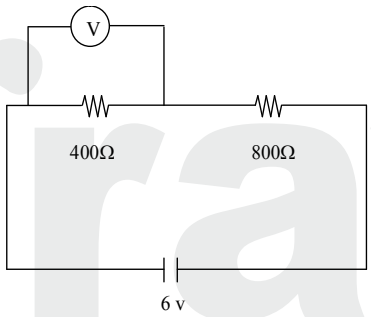
Equation (1) divided by (2)

$$\frac{160}{240} = \frac{C_P}{C_V}\cdot\frac{50}{100}$$

$$\frac{C_P}{C_V} = \frac{4}{3} = 1+\frac{2}{f}$$

$$f = 6$$

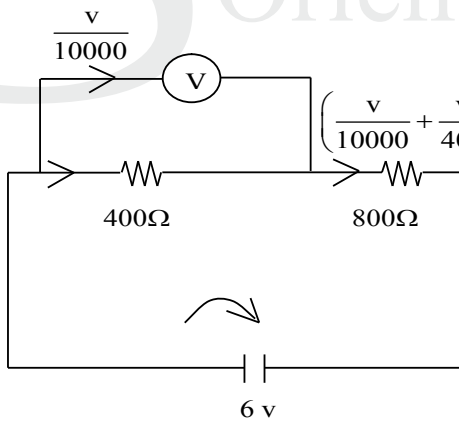
7. In the given diagram resistance of voltmeter is 10 kΩ. Find reading of the voltmeter.



(1) 4 v (2) 3.23 v (3) 1.95 v (4) 1.26 v

Ans. (3)

Sol.



Let voltmeter reading is v

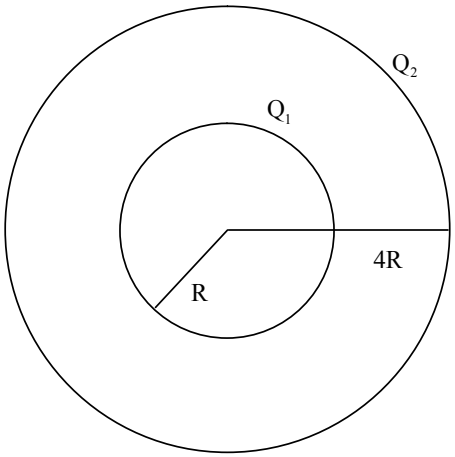
$$\frac{v}{400}\times 400 + \left(\frac{v}{10000}+\frac{v}{400}\right)800 = 6$$

$$\Rightarrow \quad v + \frac{8v}{100} + 2v = 6$$

$$\frac{77v}{25} = 6$$

$$v = \frac{150}{77} = 1.95 \text{ v}$$

8. In the given figure, there are two concentric spherical shells, find potential difference between the spheres



(1) $\frac{3}{8\pi\in_0}\cdot\frac{Q_1}{R}$ (2) $\frac{3}{16\pi\in_0}\cdot\frac{Q_2}{R}$ (3) $\frac{3}{4\pi\in_0}\cdot\frac{Q_1}{R}$ (4) $\frac{3}{16\pi\in_0}\cdot\frac{Q_1}{R}$

Ans. **(4)**

Sol. $V_{inner}=\frac{KQ_1}{R}+\frac{KQ_2}{4R}$

$V_{outer}=\frac{KQ_1}{4R}+\frac{KQ_2}{4R}$

Potential difference

$\Delta V=V_{inner}-V_{outer}$

$=\frac{3}{4}\cdot\frac{KQ_1}{R}=\frac{3}{16\pi\in_0}\cdot\frac{Q_1}{R}$

9. A body cools from 50^{0}C to 40^{0}C in 5 minutes in surrounding temperature 20^{0}C. Find temperature of body in next 5 minutes.

(1) 13.3^{0}C (2) 23.3^{0}C (3) 43.3^{0}C (4) 33.3^{0}C

Ans. **(4)**

Sol. Using Newton's Law of cooling

$\frac{50-40}{5}=K\left(\frac{50+40}{2}-20\right)$ .....(i)

Next 5 Min.

$\frac{40-\theta}{5}=K\left(\frac{40+\theta}{2}-20\right)$ .....(ii)

Dividing (ii) / (i)

$\frac{40-\theta}{10}=\frac{40+\theta-40}{50+40-40}=\frac{\theta}{50}$

$40-\theta=\frac{\theta}{5}$

$200-5\theta=\theta$

$\therefore\ \theta=\frac{200}{6}=33.3^0C$

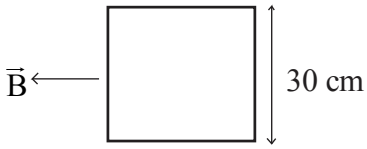
10. A square wire loop of side 30 cm & wire cross section having diameter 4 mm is placed perpendicular to a magnetic field changing at the rate 0.2 T/s. Find induced current in the wire loop.

(**Given:** Resistivity of wire material is $1.23\times10^{-8}\ \Omega m$)

(1) 15.3 A (2) 33.4 A (3) 1.53 A (4) 153 A

Ans. **(1)**

Sol.



$$R_{wire}=\frac{\rho\ell}{A}=\frac{1.23\times10^{-8}\times1.2}{\pi\times4\times10^{-6}}$$

$$=1.175\times10^{-3}$$

$$\phi=BA\ ;\ |e|=\frac{d\phi}{dt}=\frac{dB}{dt}(A)=9\times10^{-2}\times0.2=18\times10^{-3}$$

$$i=\frac{e}{R}=\frac{18\times10^{-3}}{1.175\times10^{-3}}=15.3$$

11. Electric field of an electromagnetic wave is $\vec{E}=E_0\cos(\omega t-kx)j$. The equation of corresponding magnetic field at t = 0 should be:

(1) $\vec{B}=E_0\sqrt{\mu_0\in_0}\cos kx\ \hat{k}$ (2) $\vec{B}=\frac{E_0}{\sqrt{\mu_0\in_0}}\cos kx\ \hat{k}$

(3) $\vec{B}=E_0\sqrt{\mu_0\in_0}\cos kx\ (-\hat{k})$ (4) $\vec{B}=\frac{E_0}{\sqrt{\mu_0\in_0}}\cos kx\ (-\hat{k})$

Ans. **(1)**

Sol. $$B_0=\frac{E_0}{C}=\frac{E_0}{1/\sqrt{\mu_0\in_0}}=E_0\sqrt{\mu_0\in_0}$$

As the light is propagating in x direction

& $\hat{E}\times\hat{B}\|\hat{C}$

$\therefore$ $\vec{B}$ should be in $\hat{k}$ direction, hence option (1) is correct

12. Given two points sources having same power of 200W. One source is emitting photons of $\lambda_1=500$ nm and other emitting X-ray photons of $\lambda_2=1$ nm. Find ratio of photon density from both the sources?

(1) 200 (2) 500 (3) 250 (4) 0.4

Ans. **(2)**

Sol. P – Power of source

$$P=n\frac{hc}{\lambda}\ ;\ n=\text{no. of photons emitted/s}$$

$$\Rightarrow\quad n\propto\lambda\quad\Rightarrow\quad\frac{n_1}{n_2}=\frac{\lambda_1}{\lambda_2}=500$$

13. A spherical mirror forms image of a point object, placed at principle axis at a distance 10 cm, at distance 30 cm from the mirror. If object start moving with velocity 9 cm/sec. Find initial velocity of image.

(1) -81 cm/sec (2) -40 cm/sec (3) $+81$ cm/sec (4) $+40$ cm/sec

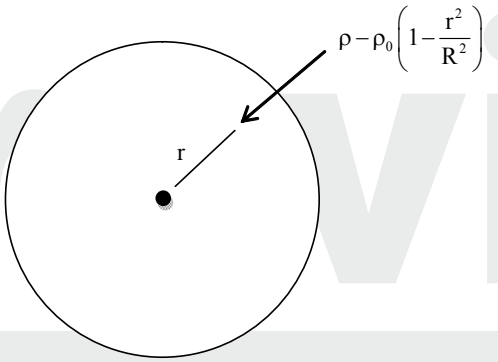
Ans. **(1)**

Sol. Velocity of image

$$v_i = -\frac{v^2}{u^2} \times v_0$$

$$= -\frac{30^2}{10^2}(9) = -81$$

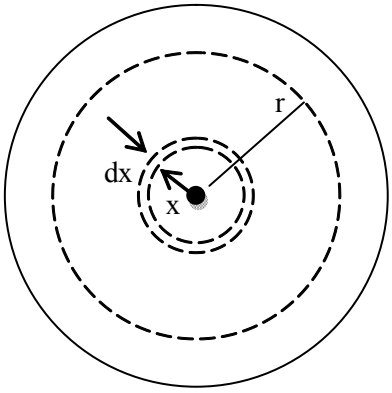
14. Mass density of a sphere having radius R varies as $\rho = \rho_0\left(1-\frac{r^2}{R^2}\right)$. Find maximum magnitude of gravitational field.



(1) $\frac{4}{3}\pi G\rho_0 R$ (2) $\frac{2\sqrt{3}}{5}\pi G\rho_0 R$ (3) $\frac{8\sqrt{5}}{27}\pi G\rho_0 R$ (4) $\frac{2\sqrt{5}}{27}\pi G\rho_0 R$

Ans. **(3)**

Sol.



$$dm = \rho \times 4\pi x^2 dx$$

$$= \rho\left(1-\frac{x^2}{r^2}\right) \times 4\pi x^2 dx$$

$$m = 4\pi\rho\int_0^r \left(x^2 - \frac{x^4}{R^2}\right)dx$$

$$m = 4\pi\rho_0\left|\frac{r^3}{3} - \frac{r^5}{5R^2}\right|$$

$$E = \frac{Gm}{r^2}$$

$$= \frac{G}{r^2} \times 4\pi\rho_0\left(\frac{r^3}{3} - \frac{r^5}{5R^2}\right)$$

$$E = 4\pi G\rho_0\left(\frac{r}{3} - \frac{r^3}{5R^2}\right)$$

E is maximum when $\frac{dE}{dr} = 0 \Rightarrow \frac{dE}{dr} = 4\pi G\rho_0\left(\frac{1}{3} - \frac{3r^2}{5R^2}\right) = 0$

$$\Rightarrow r = \frac{\sqrt{5}}{3}R$$

$$E_{max} = 4\pi G\rho_0 \times \frac{\sqrt{5}R}{3}\left[\frac{1}{3} - \frac{1}{5} \times \frac{5}{9}\right]$$

$$E_{max} = \frac{8\sqrt{5}}{27}\pi G\rho_0 R$$

15. Two light rays having the same wavelength λ in vacuum are in same phase initially. Then the first ray travels a path L_1 through a medium of refractive index n_1 while the second ray travels a path of length L_2 through a medium of refractive index n_2. The two waves are then combined to produce interference. The phase difference between the two waves at the point of interference is:

(1) $\frac{2\pi}{\lambda}(L_2 - L_1)$ (2) $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$ (3) $\frac{2\pi}{\lambda}(n_2L_1 - n_1L_2)$ (4) $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$

Ans. **(2)**

Sol. The optical path between any two points is proportional to the time of travel.

The distance traversed by light in a medium of refractive index μ in time t is given by

$d = vt$ .....(i)

where v is velocity of light in the medium. The distance traversed by light in a vacuum in this time,

$\Delta = ct$

$= c \times \frac{d}{v}$ [from equation (i)]

$= d\frac{c}{v} = \mu d$ .....(ii) $\left(\text{Since, } \mu = \frac{c}{v}\right)$

This distance is the equivalent distance in vacuum and is called optical path.

Here, optical path for first ray $= n_1L_1$

Optical path for second ray $= n_2L_2$

Path difference $= n_1L_1 - n_2L_2$

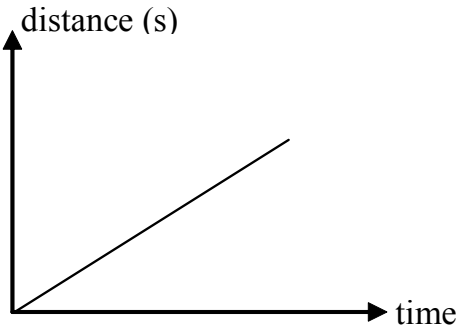
Now, phase difference

$$= \frac{2\pi}{\lambda} \times \text{path difference}$$

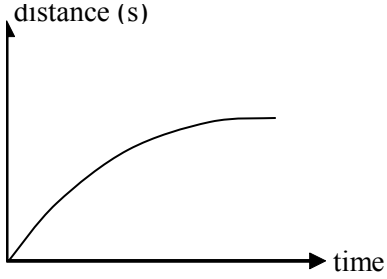
$$= \frac{2\pi}{\lambda} \times (n_1L_1 - n_2L_1)$$

16. Constant power P is supplied to a particle having mass m, initially at rest. Choose correct graph.

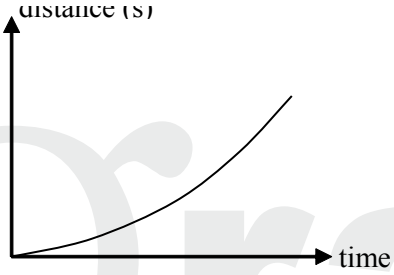
(1)



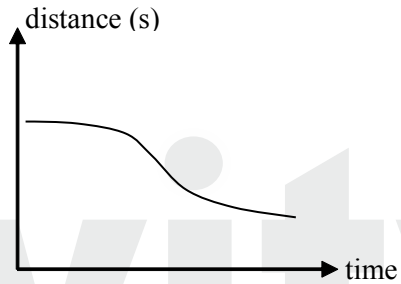
(2)



(3)



(4)



Ans. **(3)**

Sol. $P.t = \frac{1}{2}mv^2 \Rightarrow v = \left(\sqrt{\frac{2P}{m}}\right)t^{1/2}$

$$s = \int_0^t v\,dt = \sqrt{\frac{2P}{m}}\int_0^t t^{1/2}\,dt$$

$$= \sqrt{\frac{2P}{m}} \cdot \frac{t^{3/2}}{3/2}$$

$$s = \sqrt{\frac{8P}{9m}} \cdot t^{3/2}$$

17. A p – n junction becomes active as photons of wavelength ; $\lambda = 400$ nm falls on it. Find the energy band gap?

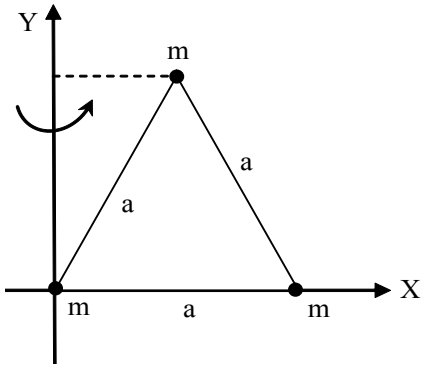
(1) 3.09 eV (2) 4.51 eV (3) 2.45 eV (4) 5.34 eV

Ans. **(1)**

Sol. $\lambda = 400$ nm

Band gap $E_g = \frac{hc}{\lambda} = \frac{1237.5}{400} = 3.09$ eV

18. In the diagram three point masses 'm' each are fixed at the corners of an equilateral triangle. Moment of inertia of the system about y-axis is $\frac{N}{20}ma^2$, N is:



(1) 25 (2) 50 (3) 75 (4) 100

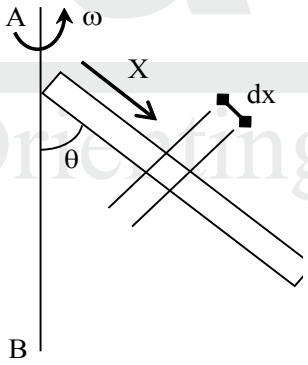
Ans. **(1)**

Sol. $I = 0 + ma^2 + m\left(\frac{a}{2}\right)^2$

$= \frac{5}{4}ma^2 = \frac{25}{20}ma^2$

N = 25

19. A rod is rotating with angular velocity ω about axis AB. Find $\cos\theta$



(1) $\frac{g}{2\ell\omega^2}$ (2) $\frac{g}{\ell\omega^2}$ (3) $\frac{2g}{\ell\omega^2}$ (4) $\frac{3g}{2\ell\omega^2}$

Ans. **(4)**

Sol. Torque of centrifugal force $\tau_{of} = dm.x\sin\theta\omega^2 x\cos\theta = \frac{m}{\ell}\omega^2\sin\theta\cos\theta\int_0^{\ell} x^2 dx$

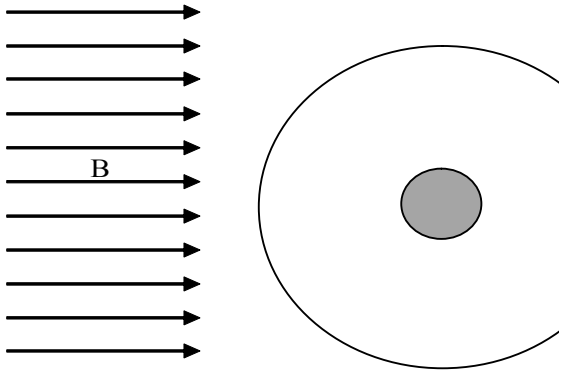
$\tau_{ef} = \frac{m\ell^2\omega^2\sin\theta\cos\theta}{3}$

$\tau_{mg} = \tau_{of}$

$mg\frac{\ell}{2}\sin\theta = \frac{m\ell^2\omega^2\sin\theta\cos\theta}{3}$

$\cos\theta = \frac{3g}{2\ell\omega^2}$

20. In a diamagnetic sphere is a cavity, made at its centre and now paramagnetic material is inserted in the cavity. The sphere is kept in a external magnetic field then net magnetic field at centre (B_0) will be



(1) 0 (2) B (3) $B_0 > B$ (4) $B_0 < B$

Ans. **(3)**

Sol. When magnetic field is applied paramagnetic substance produces magnetic field in same direction so net magnetic field will be greater than external.

Gravity
Orienting Intelligence

JEE Main - 2020

Best Result in U.P.

Aditya Pandey

Percentile

99.936

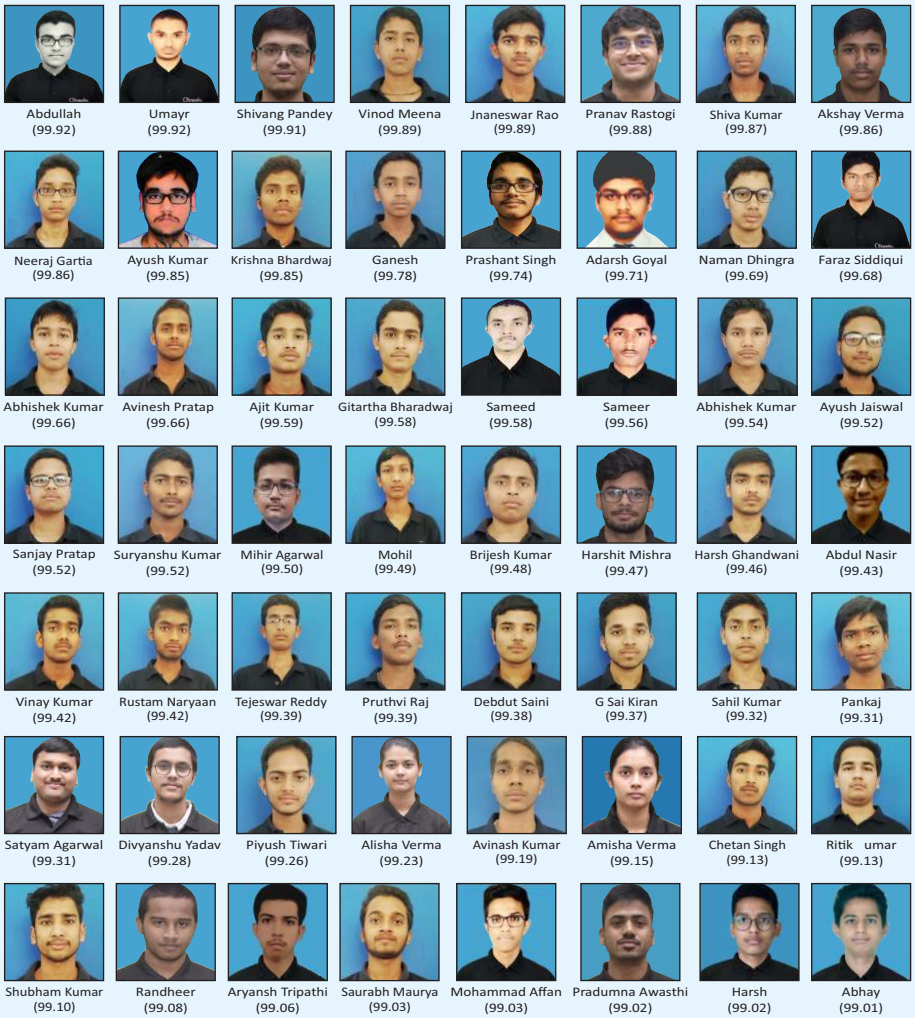
City Topper

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)