JEE MAIN April'19

PAPER WITH SOLUTION

9 April 2019 _ Evening _ Physics

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1. Moment of inertia of a body about a given axis is 1.5 kg m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1200 J, the angular acceleration of 20 rad / s^2 must be applied about the axis for a duration of :

(1) 3s (2) 2.5s (3) 5s (4) 2s

Sol. **4**

$\omega_f = \omega_i + \alpha t$

$\Rightarrow \omega_f = 20t$

$KE_R = \frac{1}{2} I\omega^2 = 1200J$

$\Rightarrow \frac{1}{2} \times (1.5) \times (20t)^2 = 1200$

$\Rightarrow t = 2s$

2. A test particle is moving ion a circular orbit in the gravitational field produced by a mass density $\rho(r) = \frac{K}{r^2}$. Identify the correct relation between the radius R of the particle's orbit and its period. T :

(1) T/R^2 is a constant (2) T^2/R^3 is a constant
(3) TR is a constant (4) T/R is a constant

Sol. **4**

$\delta(r) = \frac{k}{r^2}; M = \delta \times V$

Gravitational Field = Centripetal Force

$\Rightarrow \int_0^R \left(\frac{G}{R^2} 4\pi r^2 dr. \frac{k}{r^2} m\right) = m\left(\frac{2\pi}{T}\right)^2 R$

$\Rightarrow \frac{GK4\pi RKm}{R^2} = m\left(\frac{2\pi}{T}\right)^2 R$

$\Rightarrow \frac{T^2}{R^2} = \text{Const.}$

or $T \alpha R$

3. The area of a squre is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is :

(1) 37.03 cm^2 (2) 37.030 cm^2 (3) 37 cm^2 (4) 37.0 cm^2

Sol. **2**

Area = 5.29 cm^2

$\therefore$ Area of 7 squares

= 7 × 5.29 = 37.03 cm^2

4. The position of a particle as a function of time t. is given by

$x(t) = at + bt^2 - ct^3$

where a, b and c are constans, When the particle attains zero acceleration, then its velocity will be :

(1) $a + \frac{b^2}{3c}$ (2) $a + \frac{b^2}{c}$ (3) $a + \frac{b^2}{2c}$ (4) $a + \frac{b^2}{4c}$

Sol. **1**

$V = a + 2bt - 3ct^2$

$a = 2b - 6ct = 0$

$$\Rightarrow t = \frac{b}{3c}$$

$$\therefore v = a + \frac{b^2}{3C}$$

$$t = \frac{b}{3c}$$

5. Diameter of the objective lens of telescope is 250 cm. For light of wavelength 600 nm. coming from a distant object, the limit of resolution of the telescope is close to :

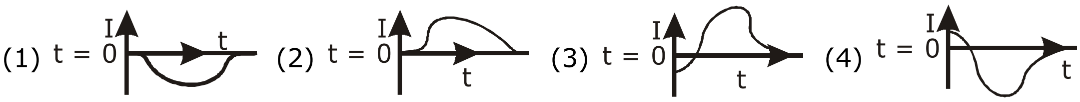
(1) 2.0×10^{-7} rad (2) 3.0×10^{-7} rad (3) 1.5×10^{-7} rad (4) 4.5×10^{-7} rad

Sol. **2**

Limit of resolution $= \dfrac{1.22\lambda}{d}$

$$= \frac{1.22\times600\times10^{-9}}{250\times10^{-12}} = 2.92\times10^{-7}$$

6. A very long solenoid of radius R is carrying current I (t) = $kte^{-\alpha t}$ (k>0), as a function of time (t ≥ 0). Counter clockwise current is taken to be positive. A circular conducting coild of radius 2R is placed in the equatorial plane of the solenoid and concentric with the solenoid. The current induced in the outer coil is correctly depicted, as a function of time, by :



Sol. **3**

7. 50 W/m² energy density of sunlight is normally incident on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on 1m² surface area will be close to ($c = 3\times10^8$ m/s)

(1) 30×10^{-8} N (2) 15×10^{-8} N (3) 20×10^{-8} N (4) 10×10^{-8} N

Sol. **3**

We know that :

Pressure (P) $= \dfrac{I}{C}(1+r)$

$$\Rightarrow P = \frac{1.25\times50}{3\times10^8}$$

$$\therefore F = \frac{1.25\times50}{3\times10^8}\times1$$

$$\simeq 20\times10^{-8}N$$

8. The physical sizes of the transmitter and receiver antenna in a communication system are :

(1) Proportional to carrier frequency

(2) inversely proportional to modulation frequency

(3) inversely proportional to carrier frequency

(4) independent of both carrier and modulation frequency

Sol. **3**

By Theory

9. A string 2.0 m long and fixed at its ends is driven by a 240 Hz vibrator. The string vibrates in its third harmoic mode. The speed of the wave and it fundamental frequency is :

(1) 180 m/s, 80 Hz (2) 320 m/s, 80 Hz (3) 180 m/s, 120 Hz (4) 320 m/s, 120 Hz

Sol. **2**

$f_3 = \frac{3V}{2\ell}$ (Both sides clamped) = 240

$\Rightarrow \frac{3 \times v}{2 \times 2} = 240$

V = 320 m/s

$\therefore f_0 = \frac{V}{2\ell} = \frac{320}{2 \times 2} = 80\text{Hz}$

10. A convex lens of focal length 20 cm produces images of the same magnification 2 when an object is kept at two distances x_1 and $x_2(x_1 > x_2)$ from the lens. The ratio of x_1 and x_2 is :

(1) 3 : 1 (2) 2 : 1 (3) 4 : 3 (4) 5 : 3

Sol. **1**

Magnfication is 2

If image is real, $x_1 = \frac{3f}{2}$

If image is virtual, $x_2 = \frac{f}{2}$

$\frac{x_1}{x_2}$ = 3 : 1

11. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of a acceleration at t = 1 ?

(1) 40 (2) 25 (3) 50 (4) 100

Sol. **3**

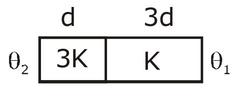
$\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$

$\vec{v} = \frac{d\vec{r}}{dt}$

$\vec{a} = \frac{d^2\vec{r}}{dt^2} = 30\hat{i} - 40\hat{j}$

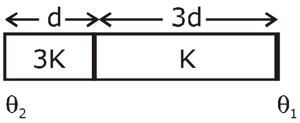
$\therefore |\vec{a}| = 50\text{m}/\text{s}^2$

12. Two materials having coefficients of thermal conductivity '3K' and 'K' and thickness 'd' and '3d', respectively, are joined to form a slab as shown in the figure.The temperatures of the outer surfaces are 'θ_2' and 'θ_1' respectively, ($\theta_2 > \theta_1$). The temperature at the interface is :



(1) $\frac{\theta_1}{3} + \frac{2\theta_2}{3}$ (2) $\frac{\theta_1}{6} + \frac{5\theta_2}{6}$ (3) $\frac{\theta_2 + \theta_1}{2}$ (4) $\frac{\theta_1}{10} + \frac{9\theta_2}{10}$

Sol. 4



$$\frac{3k(\theta_2 - \theta)}{d} = \frac{K(\theta - \theta_1)}{3d}$$

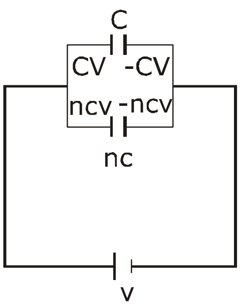
$$\Rightarrow 9\theta_2 - 9\theta = (\theta - \theta_1)$$

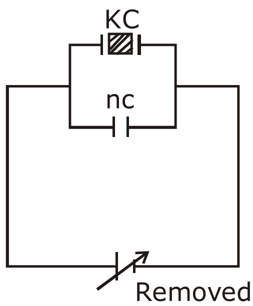
$$\theta = \frac{9\theta_2}{10} + \frac{\theta_1}{10}$$

13. The parallel combination of two air filled parallel plate capacitors of capacitance C and nC is connected to a battery of voltage, V. When the capacitors are fully charged, the battery is removed and after that a dielectric material of dielectric constnat K is placed between the two plates of the first capacitor. The new potential difference of the combined system is :

(1) $\frac{nV}{K+n}$ (2) V (3) $\frac{(n+1)V}{(K+n)}$ (4) $\frac{V}{K+n}$

Sol. 3





Initial :

$C_{eq} = C + nc = c(1+n)$

$Q_i = (n+1)cv$

Final

$C_{f_{eq}} = nc + kc = c(n+K)$

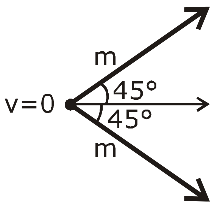
$$V = \frac{Q_i}{c_{eq}} = \frac{(n+1)cv}{(n+k)c} = \left(\frac{n+1}{n+K}\right)V$$

14. A particle of mass 'm' is moving with speed '2v' and collides with a mass '2m' moving with speed 'v' in the same direction. After collision, the first mass is stopped completely while the second one splits into two particles each of mass 'm', which move at angle 45° with respect to the original direction.
The speed of each of the moving particle will be :

(1) $v/(2\sqrt{2})$ (2) $\sqrt{2}v$ (3) $v/\sqrt{2}$ (4) $2\sqrt{2}v$

Sol. **4**

Initial 

Finall 

$p_i = 2mv + 2mv = 4mv$

$p_f = \frac{mv'}{v2} + \frac{mv'}{\sqrt{2}}$

$\therefore 4mv = \frac{2mv}{\sqrt{2}} \Rightarrow v' = 2\sqrt{2}V$

15. A thin smooth rod of length L and mass M is rotating freely with angular speed ω_0 about and axis perpendicular to the rod and passing through its center. Two beads of mass m and negligible size are at the center of the rod initially. The beads are free to slide along the rod. The angular speed of the system, when the beads reach the opposite ends of the rod, will be :

(1) $\frac{M\omega_0}{M+3m}$ (2) $\frac{M\omega_0}{M+2m}$ (3) $\frac{M\omega_0}{M+6m}$ (4) $\frac{M\omega_0}{M+m}$

Sol. **3**
By Coam :

$L_i = L_f \Rightarrow \frac{ML^2}{12}\omega_0 = \left[\frac{ML^2}{12} + m\left(\frac{L}{2}\right)^2 + M\left(\frac{L}{2}\right)^2\right]\omega_f$

$\Rightarrow \omega = \frac{M\omega_0}{M+6m}$

16. A wooden block floating in a bucket of water has $\frac{4}{5}$ of its volume submerged. When certain amount of an oil is poured into the bucket, it is found that the block is just under the oil surface with half of its volume under water and half in oil. The density of oil relative to that of water is :
(1) 0.7 (2) 0.5 (3) 0.6 (4) 0.8

Sol. **3**

Initial : $\frac{4}{5}\rho_w Vg = mg$ (1)

Final : $\frac{V}{2}\rho_w g + \frac{V}{2}\rho_{oil} g = \frac{4}{5}\rho_w Vg$ (2)

$\Rightarrow \frac{1}{2}\rho_w + \frac{\rho_{oil}}{2} = \frac{4}{5}\rho_w$

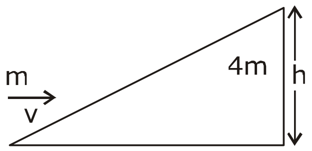
$\Rightarrow \frac{\rho_{oil}}{2}\left(\frac{4}{5} - \frac{1}{2}\right)\rho_w$

$\Rightarrow \frac{\rho_{oil}}{\rho_w} = \frac{3}{5} = 0.6$

17. A wedge of mass M = 4m lies on a frictions plane. A particle of mass m approaches the wedge with speed v. There is no friction between the particle and the plane or between the particle and the wedge. The maximum height climbed by the particle on the wedge is given by :

(1) $\frac{2v^2}{7g}$ (2) $\frac{v^2}{2g}$ (3) $\frac{2v^2}{5g}$ (4) $\frac{v^2}{g}$

Sol. **3**



By Momentum Conversion

$p_i = p_f$

mv = 5mv'

$\Rightarrow V' = \frac{V}{5}$

By Energy Conserve :

$\frac{1}{2}mv^2 = \frac{1}{2}5m(V')^2 + mgh$

$\Rightarrow h = \frac{2}{5}\frac{V^2}{g}$

18. A He^+ ion is in its first excited state. Its ionization energy is :

(1) 6.04 eV (2) 13.60 eV (3) 48.36 eV (4) 54.40 eV

Sol. **2**

I excited state $\Rightarrow$ n = 2

For He^+ $E = -13.6 \times \frac{z^2}{n^2}$

Z = 2

N = 2

$\therefore E_n = -13.6$ eV

19. A moving coil galvanometer has a coil with 175 truns and area 1 cm^2. Its uses a torsion band of torsion constant 10^{-6} N-m/rad. The coil is placed in a magnetic filed B parallel to its plane. The coil deflects by 1° for a current of 1mA. The value of B (in Tesla) is approximately.

(1) 10^{-2} (2) 10^{-4} (3) 10^{-1} (4) 10^{-3}

Sol. **4**

BiNA = cϕ

$$\Rightarrow B = \frac{C\phi}{NiA} = \frac{10^{-6} \times \pi}{10^{-3} \times 175 \times 10^{-4}}$$

$$= \frac{\pi}{18 \times 175} = 0.0010 = 10^{-3}T$$

20. A massless spring (k = 800 N/m), attached with a mass (500g) is completely immersed in 1 kg of water. The spring is stretched by 2cm and released so that it starts vibrating. What would be the order of magnitude of the change in the temperature of water when the vibrations stop completely ? (Assume that the water container and spring receive negligible heat and specific heat of mas = 400 J/kg K, specific heat of water = 4184 J / kg K)

(1) 10^{-4} K (2) 10^{-1} K (3) 10^{-3} K (4) 10^{-5} K

Sol. **4**

Energy of spring is transferred to water and block.

$$\therefore \frac{1}{2}kx^2 = m_1s_1\Delta T + m_2s_2\Delta T$$

$$\Rightarrow \frac{1}{2} \times 800 \times \left(\frac{2}{100}\right)^2 = \frac{1}{2} \times 400\Delta T + 1 \times 4184\Delta T$$

$$\Rightarrow \Delta T = 3.64 \times 10^{-5}K$$

$\therefore$ 10^{-5} K

21. The resistance of a galvanometer is 50 ohm and the maximum current which can be passed through it is 0.002 A. What resistance must be connected to it in order to convert it into an ammeter of range 0–0.5 A ?

(1) 0.5 ohm (2) 0.002 ohm (3) 0.02 ohm (4) 0.2 ohm

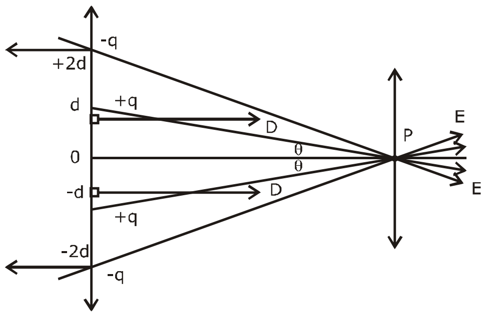
Sol. **4**

$$S = \frac{I_gR_g}{I - I_g} = \frac{2 \times 10^{-3} \times 50}{0.5 - 2 \times 10^{-3}} = 0.2\Omega$$

22. Four point charges –q, +q, +q and –q are placed on y–axis at y = –2d, y= –d, y = +d and y = +2d, are respectively. The magnitude of the electric field E at a point on the x - axis at x = D, with D >> d, will behave is :

(1) $E \propto \frac{1}{D^3}$ (2) $E \propto \frac{1}{D^4}$ (3) $E \propto \frac{1}{D}$ (4) $E \propto \frac{1}{D^2}$

Soll. **2**



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

$$E_f = 2E\cos\theta$$

$$= 2\times\frac{kq}{\left(d^2+D^2\right)^2}\cdot\frac{D}{\sqrt{d^2+D^2}} - \frac{2\times kq}{\left(d^2+D^2\right)^2}\cdot\frac{D}{\sqrt{(4d^2+D^2)}}$$

$$= \frac{2kqD}{\left(d^2+D^2\right)^{3/2}} - \frac{2KqD}{\left(4d^2+D^2\right)^{3/2}}$$

$$\therefore\ E \propto \frac{1}{D^4}$$

23. The specific heats, C_P and C_V of a gas of diatomic molecules, A, are given (in units of J mol^{-1}K^{-1}) by 29 and 22, respectively. Another gas of diatomic molecules, B, has the corresponding values 30 and 21 . If they are treated as ideal gases, then :
(1) Both A and B have vibrational mode each.
(2) A has a vibrational mode but B has none.
(3) A is rigid but B has a vibrational mode.
(4) A has one vibrational mode and B has two.

Sol. **2**

$$\frac{C_P}{C_V} = r = \frac{f+2}{f}$$

Case 1 :

$$r = \frac{29}{22} = 1.31 = \frac{f+2}{f} \Rightarrow 0.3f = 2$$

$\Rightarrow f = 6.3$ Vibrational present

Case 2 :

$$r = \frac{30}{21} = 1.42 = \frac{f+2}{f}$$

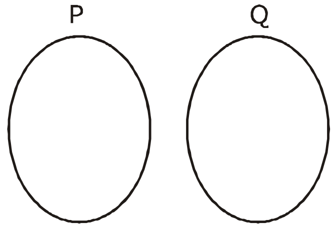
$$\Rightarrow 0.42f = 2$$

$\Rightarrow f = \frac{2}{0.42} = 4.76$ Vibrational absent

24. Two coils 'P' and 'Q' are seperated by some distance. When a current of 3A flows through coil 'P', a magnetic flux if 10^{-3} Wb passes through 'Q'. No current is passed through 'Q'. When no current passes 'P' and a current of 2 A passes through 'Q', the flux through 'P' is :

(1) 3.67×10^{-3} Wb (2) 3.67×10^{-4} Wb (3) 6.67×10^{-3} Wb (4) 6.67×10^{-4} Wb

Sol. **4**



$\phi_1 = mi_1$

$\Rightarrow M = \dfrac{10^{-3}}{3}$

$\phi_2 = mi_2$

$\Rightarrow \theta_2 = \dfrac{10^{-3}}{3} \times 2 = 6.67 \times 10^{-4}\,\text{Wb}$

25. In a conductor, if the number of conduction electrons per unit volume is 8.5×10^{28} m^{-3} and mean free time is 25 fs (femto second), its approximate resistivity is : (m_e = 9.1×10^{-31} kg)

(1) 10^{-7} Ωm (2) 10^{-5} Ωm (3) 10^{-8} Ωm (4) 10^{-6} Ωm

Sol. **3**

26. Two cars A and B are moving away from each other in opposite directions. Both the cars are moving with a speed of $20 ms^{-1}$ with respect to the ground. If an observer in car A detects a frequency 2000 Hz of the sound coming from car B, what is the natural frequency of the sound source in car B ? (speed of sound in air = 340 ms^{-1})

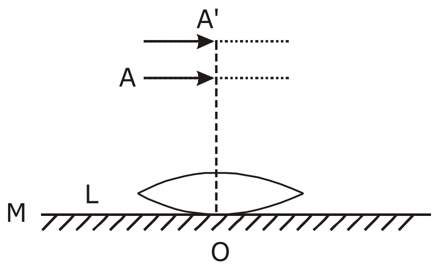
(1) 2250 Hz (2) 2150 Hz (3) 2300 Hz (4) 2060 Hz

Sol. **1**

$f' = 2000 = f_0\left(\dfrac{340 - 20}{340 + 20}\right)$

$\Rightarrow f_0 = 2250\text{Hz}$

27. A thin convex lens L (refractive index = 1.5) is placed on a plane mirror M. When a pin is placed at A, such that OA = 18 cm, its real inverted image is formed at A itself, as shown in figure. When a liquid of refractive index μ_l is put between the lens and the mirror, the pin has to be moved to A', such that OA' = 27 cm, to get its inverted real image at A' itself. The value of μ_l will be :



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

Sol. 4

$$\frac{1}{f_1} = \frac{1}{2} \times \frac{2}{18} = \frac{1}{18}$$

$$\frac{1}{f_2} = \frac{(\mu_1 - 1)}{-18}$$

When μ_1 is filled between lens and mirror

$$P = \frac{2}{18} - \frac{2}{18}(\mu_1 - 1) = \frac{2 - 2\mu_1 + 2}{18}$$

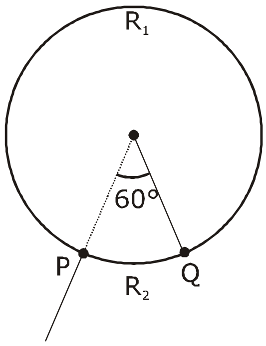
$$= F_m = -\left(\frac{18}{2-\mu_1}\right)$$

$2 = 6 - 3\mu_1$
$3\mu_1 = 4$
$\mu_1 = 4/3$

28. A metal wire a resistance 3Ω is elongated to make a uniform wire of double its previous length. This new wire is now bent and the ends joined to make circle. If two points on this circle make an angle 60° at the centre, the equivalent resistance between these two points will be :

(1) $\frac{7}{2}\Omega$ (2) $\frac{5}{3}\Omega$ (3) $\frac{12}{5}\Omega$ (4) $\frac{5}{2}\Omega$

Sol. 2



$R_i = 3\Omega$
Double llength
$R_f = 4R_i = 12\Omega$

$$\therefore R_1 = \frac{5\pi}{3 \times 2\pi} \times R_f = \frac{5}{6} \times 12 = 10\Omega$$

$$R_2 = \frac{\pi}{3 \times 2\pi} \times R_f = \frac{1}{6} \times 12 = 2\Omega$$

$$\therefore R_{eq} = \frac{R_1 R_2}{R_1 + R_2} = \frac{5}{3}\Omega$$

29. A particle 'P' is formed due to a completely inelastic collision of particles 'x' and 'y' having de-Broglie wavelength 'λ_x' and 'λ_y' respectively. If x and y were moving in opposite directions, then the de-Broglie wavelength of 'P' is :

(1) $\dfrac{\lambda_x\lambda_y}{\lambda_x - \lambda_y}$ (2) $\dfrac{\lambda_x\lambda_y}{\lambda_x + \lambda_y}$ (3) $\lambda_x - \lambda_y$ (4) $\lambda_x + \lambda_y$

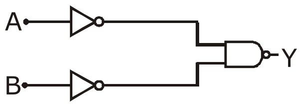
Sol. **1**

$$\frac{h}{\lambda_x} - \frac{h}{\lambda_y} = \frac{h}{\lambda}$$

$$\Rightarrow \frac{1}{\lambda} = \frac{\lambda_y - \lambda_x}{\lambda_x\lambda_y}$$

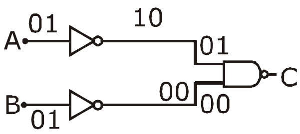
$$\Rightarrow \lambda = \frac{\lambda_x + \lambda_y}{\lambda_y - \lambda_x} = \frac{\lambda_x\lambda_y}{|\lambda_x - \lambda_y|}$$

30. The logic gate equivalent to the given logic circuit is :



(1) NAND (2) AND (3) OR (4) NOR

Sol. **3**



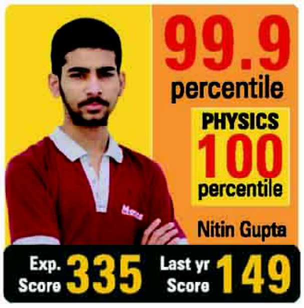
O/P of OR Table

A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

मोशन ने बनाया साधारण को असाधारण

JEE Main Result Jan'19

4 RESIDENTIAL COACHING PROGRAM (DRONA) STUDENTS ABOVE 99.9 PERCENTILE



Total Students Above 99.9 percentile - **17**

Total Students Above 99 percentile - **282**

Total Students Above 95 percentile - **983**

% of Students Above 95 percentile $\frac{983}{3538}$ = **27.78%**

Scholarship on the Basis of 12th Class Result

Marks PCM or PCB	Hindi State Board	State Eng OR CBSE
70%-74%	30%	20%
75%-79%	35%	25%
80%-84%	40%	35%
85%-87%	50%	40%
88%-90%	60%	55%
91%-92%	70%	65%
93%-94%	80%	75%
95% & Above	90%	85%

New Batches for Class 11th to 12th pass
17 April 2019 & 01 May 2019

हिन्दी माध्यम के लिए पृथक बैच

Scholarship on the Basis of JEE Main Percentile

Score	JEE Mains Percentile	English Medium Scholarship	Hindi Medium Scholarship
225 Above	Above 99	Drona Free (Limited Seats)	
190 to 224	Above 97.5 To 99	100%	100%
180 to 190	Aboev 97 To 97.5	90%	90%
170 to 179	Above 96.5 To 97	80%	80%
160 to 169	Above 96 To 96.5	60%	60%
140 to 159	Above 95.5 To 96	55%	55%
74 to 139	Above 95 To 95.5	50%	50%
66 to 73	Above 93 To 95	40%	40%
50 to 65	Above 90 To 93	30%	35%
35 to 49	Above 85 To 90	25%	30%
20 to 34	Above 80 To 85	20%	25%
15 to 19	75 To 80	10%	15%

सैन्य कर्मियों के बच्चो के लिए 50% छात्रवृत्ति | **प्री-मेडिकल में छात्राओं को 50% छात्रवृत्ति**