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JEE MAIN 2021

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

QUESTIONS & SOLUTIONS

Reproduced from Memory Retention

17 March, 2021 SHIFT-1

09:00 am to 12 Noon

Duration : 3 Hours Max. Marks : 300

SUBJECT - PHYSICS

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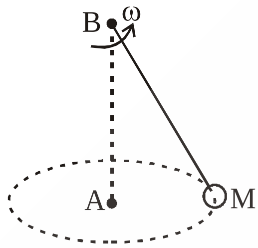
JEE(MAIN) 2021 (17 MARCH ATTEMPT) SHIFT-1

PHYSICS

1. A particle of mass M is rotating with constant angular velocity ω in a horizontal plane circle. Particle is suspended with the help of a string from point B. If L_A is angular momentum about A and L_B is angular momentum about B. Then



(1) L_A is constant in magnitude and direction

(2) L_B is constant in magnitude and direction

(3) L_A is variable in direction

(4) L_B is variable in magnitude.

Ans. **(1)**

Sol. Theoretical.

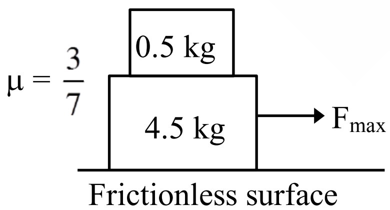
2. In Hydrogen atom electron is moving in circular orbit with speed v and principal quantum number of orbit is n then correct relation is.

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

Ans. **(2)**

Sol. $v = 2.16 \times 10^6 \text{ m/s} \times \frac{z}{n}$

3. In the two block system shown in figure evaluate the maximum force (in N) applied to lower block so that both move together. $g = 9.8 \text{ m/s}^2$



Ans. **21.00**

Sol. maximum acceleration

With which both move together = $\frac{3}{7}\times\frac{0.5}{0.5}\times 9.8$

$= 4.2\ m/s^2$

$F_{max} = 4.2 \times 5$

$= 21\ N$

4. To what minimum value radius of earth should be reduced so that escape velocity becomes ten times of its actual value?

Ans. **64.00**

Sol. $V_{es} = \sqrt{\frac{2GM}{R}}$

$V_{es}.\sqrt{R} = 10V_{es}\sqrt{R'}$

$R' = \frac{R}{100} = 64\ KM$

5. If a body performs SHM of amplitude A then displacement from mean position at which it's kinetic energy is equal to potential energy.

(1) Zero (2) $\pm\frac{A}{2}$ (3) $\pm\frac{A}{\sqrt{2}}$ (4) $\pm A$

Ans. **(3)**

Sol. KE = PE

$\frac{1}{2}k(A^2 - X^2) = \frac{1}{2}KX^2$

$A^2 - X^2 = X^2$

$2X^2 = A^2$

$X^2 = \frac{A^2}{2}$

$X = \pm\frac{A}{\sqrt{2}}$

6. At what energy level of unielectronic carbon has same energy as of hydrogen in ground state.

(1) 1 (2) 6 (3) 12 (4) 4

Ans. **(2)**

Sol. $E_n = -13.6\dfrac{Z^2}{n^2}$

$E_{n^{th}}$ of corbon = $E_{1^{st}}$ of Hydrogen

$-13.6 \times \dfrac{6^2}{n^2} = -13.6 \times \dfrac{1^2}{1^2}$

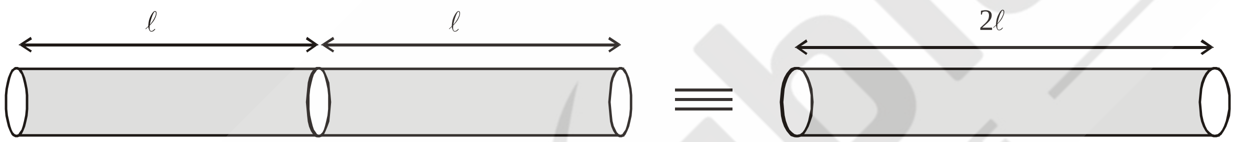
n = 6

7. Two identical rods are connected in series, having conductivity k_1 and k_2 respectively. What is the equivalent thermal conductivity.

(1) $\dfrac{2K_1K_2}{K_1+K_2}$ (2) $\dfrac{K_1K_2}{K_1+K_2}$ (3) $K_1 + K_2$ (4) $2K_1 + 2K_2$

Ans. (1)

Sol.



$R_q = R_1 + R_2$

$\dfrac{1}{K_{eq}}\dfrac{2\ell}{A} = \dfrac{\ell}{K_1A} + \dfrac{\ell}{K_2A}$

$\dfrac{2}{K_{eq}} = \dfrac{\ell}{K_1} + \dfrac{\ell}{K_2}$

$\dfrac{2}{K_{eq}} = \dfrac{K_1+K_2}{K_1K_2}$

$\mathbf{K_{eq}} = \dfrac{2K_1K_2}{K_1+K_2}$

8. A carnot engine work between two reservoirs at temperate 400 K and 800 K. Its work per cycle is 1200 J. Find heat supplied per cycle.

(1) 2400 J (2) 1800 J (3) 3200 J (4) 1600 J

Ans. (1)

Sol. $\eta = 1 - \dfrac{1}{2} = \dfrac{1}{2} = \dfrac{W}{Q}$

$\dfrac{1200}{Q} = \dfrac{1}{2}$

Q = 2400 J

9. A ring, disc, solid cylinder and solid sphere all are released from fixed incline plane of inclination θ. The minimum time taken by an object to arrive at bottom of incline, if all perform pure rolling.

(1) solid cylinder (2) solid sphere (3) ring (4) Disc

Ans. (2)

Sol. $a = \dfrac{g\sin\theta}{\left(1+\dfrac{I}{mR^2}\right)}$

$I_R = mR^2$, $a_R = g\sin\theta/2$

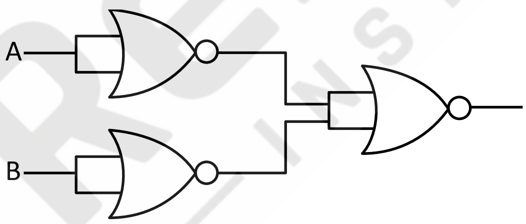
$I_D = \dfrac{mR^2}{2}$, $a_D = \dfrac{2}{3}g\sin\theta$

$I_{SC} = \dfrac{mR^2}{2}$, $a_{SC} = \dfrac{2}{3}g\sin\theta$

$I_{SS} = \dfrac{2}{5}mR^2$, $a_{SS} = \dfrac{5}{7}g\sin\theta$

$S = ut + \dfrac{1}{2}at^2$, $\left(t \propto \dfrac{1}{a}\right)$ solid sphere will take minimum time.

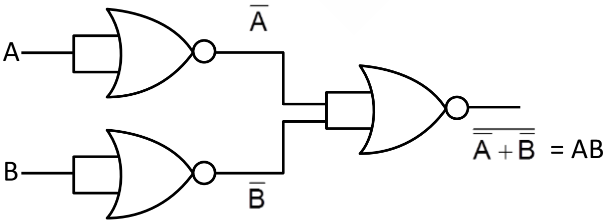
10. The circuit shown in figure below represents which of the following gates.



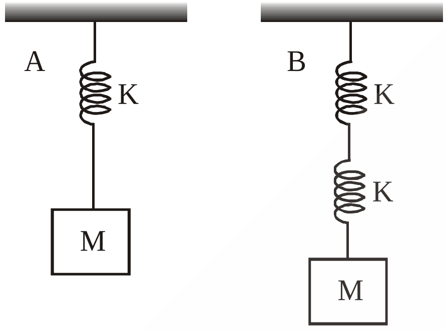
(1) NAND (2) XOR (3) AND (4) OR

Ans. (3)

Sol.



11. Two spring mass system are suspended as shown. If time period in A is T_A and in B is T_B and $\frac{T_A}{T_B} = \sqrt{x}$ evaluate x.



Ans. **2.00**

Sol. $T_A = 2\pi\sqrt{\frac{m}{K}}$

$T_B = 2\pi\sqrt{\frac{M}{2k}}$

$\frac{T_A}{T_B} = \sqrt{2}$

$x = 2$

12. A long solenoid having 1000 turns per unit length relative permeability of medium inside it is 500, current flowing in solenoid is 5A then find magnetic flux density inside solenoid ? $[\mu_0 = 4\pi \times 10^{-7}]$

(1) $\pi \times 10^{-2}$ T (2) π T (3) $\pi \times 10^{-3}$ T (4) $\frac{\pi}{5}$ T

Ans. **(2)**

Sol. $B = \mu n i$

$B = \mu_r \mu_u n i$

$B = 500 \times 4\pi \times 10^{-7} \times n \times 5$

$B = 500 \times 4\pi \times 10^{-7} \times n \times 5$

$B = \pi \times 10^{-3} \times n$

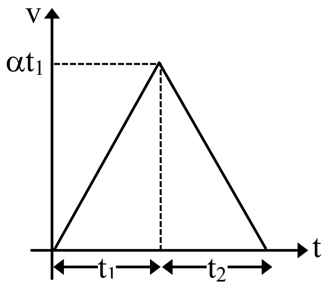
$B = \pi \times 10^{-3} \times n = \pi$

13. A car accelerates from rest at a constant rate α for some time and after which decelerate at constant rate β to come to rest. If the total time elapsed is t, find out the total distance travelled.

(1) $\frac{\alpha\beta}{2(\alpha+\beta)}t^2$ (2) $\frac{\alpha\beta}{(\alpha+\beta)}t^2$ (3) $\frac{\alpha^2 t^2}{(\alpha+\beta)}$ (4) $\frac{\beta^2 t^2}{(\alpha+\beta)}$

Ans. **(1)**

Sol.



$t_1 + t_2 = t$

$V = u + at$

$0 = \alpha t_1 - \beta t_2$

$\alpha t_1 = \beta t_2$

$t_2 = \frac{\alpha}{\beta} t_1$

$t_1 + \frac{\alpha}{\beta} t{=}1 = t$

$t_1 = \left(\frac{\beta}{\alpha+\beta}\right)t$

Distance $= \frac{1}{2}(t_1 + t_2) \times \alpha t_1$

$= \frac{1}{2} t \times \alpha\left(\frac{\beta}{\alpha+\beta}\right)t$

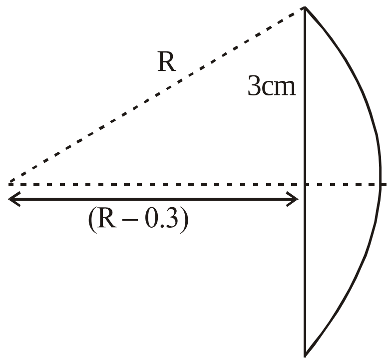
$= \frac{\alpha\beta}{2(\alpha+\beta)}t^2$

14. A plano convex lens of diameter 6 cm and thickness 3mm. The speed of light passed is 2×10^8 m/s. Then find the focal length of the lens.

(1) 30 cm (2) 15 cm (3) 0.3 cm (4) 1.5 cm

Ans. **(1)**

Sol.



$R^2 = 3^3 + (R - 0.3)^2$

$R^2 = 9 + R^2 + 0.09 - 2 \times 0.3R$

$2 \times 0.3\ R = 9.09$

$R = 15.15$ cm

$\mu = \frac{C}{V} = 1.5$

$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R}\right)$

$f \simeq 30$ cm

15. An object of mass m moving with velocity 20 m/s collides with another object. Its final kinetic energy is 5% of initial kinetic energy then evaluate its final speed.

(1) $v = 4\sqrt{5}$ m/s (2) $v = 2\sqrt{5}$ m/s (3) $v = \sqrt{15}$ m/s (4) $v = 2\sqrt{3}$ m/s

Ans. (2)

Sol. $\frac{1}{2}mv^2 = \frac{5}{100} \times \frac{1}{2} \times m \times 20^2$

$v^2 = \frac{1}{20} \times 20^2 = 20$

$v\sqrt{20} = 2\sqrt{5}$ m/s

16. Two soap bubble of radius a and b (>a) combine. Find out radius of curvature of common surface during process.

(1) $\frac{ab}{b-a}$ (2) $\frac{b-a}{ba}$ (3) $\sqrt{b^2 + a^2}$ (4) $\sqrt{b^2 - a^2}$

Ans. (1)

Sol. $\frac{1}{R} = \frac{1}{a} - \frac{1}{b}$; $R = \frac{ab}{b-a}$

17. An electron of mass m and photon has same energy E. Find out the ratio of their wave length.

(1) $\frac{1}{c}\left(\frac{E}{m}\right)^{1/2}$ (2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$ (3) $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$ (4) $\frac{1}{c}\left(\frac{E}{4m}\right)^{1/2}$

Ans. (2)

Sol. For photon $E = \frac{hc}{\lambda}$

$$\lambda_p = \frac{hc}{E} \qquad \ldots\ldots(i)$$

For electron $\lambda_e = \frac{h}{\sqrt{2mE}}$ ……(ii)

$$\frac{\lambda_e}{\lambda_p} = \frac{\frac{h}{\sqrt{2mE}}}{\frac{hc}{E}} = \sqrt{\frac{E}{2mc^2}} = \frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$$

18. Two gases are mixed, if number of moles are n_1 & n_2, initial Temperatures are T_1 & T_2, masses are m_1 & m_2, degree of freedom are f_1 & f_2, then find final temperature?

(1) $\frac{f_1n_1T_1 + f_2n_2T_2}{n_1 + n_2}$ (2) $\frac{f_1n_1T_1 + f_2n_2T_2}{f_1 + f_2}$ (3) $\frac{f_1n_1T_1 + f_1n_2T_2}{f_1n_1 + f_2n_2}$ (4) $\frac{f_1T_1 + f_2T_2}{f_1n_1 + f_2n_2}$

Ans. (3)

Sol. initial internal energy = final internal energy

$$\frac{f_1}{2}n_1RT_1 + \frac{f_2}{2}n_2RT_2 = \frac{f_1}{2}n_1RT + \frac{f_2}{2}n_2RT$$

$$T = \frac{f_1n_1T_1 + f_2n_2T_2}{f_1n_1 + f_2n_2}$$

19. Find area covered (in km^2) by a antenna of height 30m : [R_e = 6400 km, π = 3.14]

Ans. 1206.00

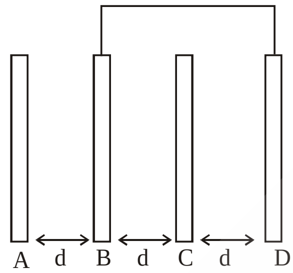
Sol. $d = \sqrt{2hR}$ area = πd^2

Area = $\pi(2hR) = 3.14 \times 2 \times 30 \times 6400 \times 10^3$. m^2

= 1205.76 km^2

$\approx$ 1206 km^2

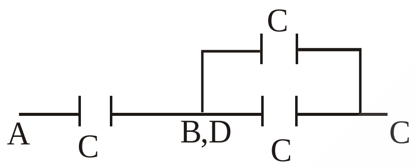
20. Four large conducting plates of length, $\ell = 2\text{m}$ & breadth $b = \frac{3}{2}\text{m}$ are arranged as shown in figure.



The equivalent capacitance between A & C is $\frac{x \in_0}{d}$ where x is:

Ans. **2.00**

Sol.



$$C = \frac{\in_0 A}{d}$$

$$C_{eq} = \frac{2C \times C}{2C + C} = \frac{2C}{3} = \frac{2}{3}\frac{\in_0 A}{d} = \frac{2}{3} \times \frac{\in_0}{d} \times 2 \times \frac{3}{2} = 2\frac{\in_0}{d}.$$

21. If current in a wire is $I = I_1 \sin \omega t + I_2 \cos \omega t$. Find out the reading of hot wire ammeter connected to it.

(1) $\frac{\sqrt{I_1^2 + I_2^2}}{2}$ (2) $\frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{3}}$ (3) $\frac{\sqrt{I_1^2 + I_2^2}}{2}$ (4) $\frac{I_1 + I_2}{2}$

Ans. **(1)**

Sol. $I_{RMS} = \frac{I_0}{\sqrt{2}} \frac{\sqrt{I_1^2 + I_2^2}}{2}$

22. Current in a wire is 10 ampere and area of cross section is 5 mm^2 & drift velocity is 2×10^{-3} m/sec then find electron number density.

(1) 10^{25} (2) 6.25×10^{27} (3) 2×10^{23} (4) 4×10^{26}

Ans. **(2)**

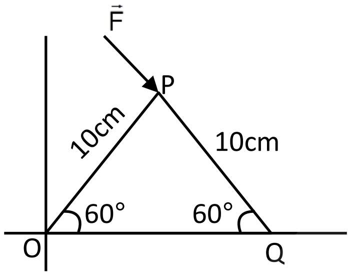
Sol. $I = neAV_d$

$$n = \frac{I}{eAV_d}$$

$$= \frac{10}{1.6 \times 10^{-9} \times 5 \times 10^{-6} \times 2 \times 10^{-3}}$$

$$= \frac{10^{25}}{16} = 6.25 \times 10^{27}$$

23. If a force $\vec{F} = (4\hat{i} - 3\hat{j})N$ is applied at a point P. Then for torque (in N-cm) about O and about Q



(1) $10\hat{i} - 10\sqrt{3}\hat{j}, 2\hat{i} + 8\hat{j}$ (2) $-(15 + 20\sqrt{3})\hat{k}, (15 - 20\sqrt{3})\hat{k}$

(3) $-(8 + 8\sqrt{3})\hat{k}, (15 + 20\sqrt{3})\hat{k}$ (4) $-(15 + 20\sqrt{3})\hat{k}, (-15 + 20\sqrt{3})\hat{k}$

Ans. (2)

Sol. $\vec{\tau}_0 = (5\hat{i} + 5\sqrt{3}\hat{j}) \times (4\hat{i} - 3\hat{j})$

$= -15\hat{k} - 20\sqrt{3}\hat{k}$

$\vec{\tau}_p = 15\hat{k} - 20\sqrt{3}\hat{k}$

24. If vernier calliper has positive error of 0.2 mm. If zero of vernier scale lies between 8.5 cm and 8.6 cm. If 6th division of vernier scale coincides with main scale. Then reading will be: (L.C. = 0.1 mm)

(1) 8.56 cm (2) 8.54 cm (3) 8.58 cm (4) 8.60 cm

Ans. (2)

Sol. Reading = $8.5 + \frac{(0.1) \times 6}{10} - \frac{0.2}{10} = 8.54$ cm

25. If series combination of two resistance is s and parallel combination is p and if s = np then find minimum value of n :

Ans. 04.00

Sol. s = np

$R_1 + R_2 = n\left[\frac{R_1R_2}{R_1 + R_2}\right]$

$(R_1 + R_2)^2 = nR_1R_2$

So n = **04.00**

26. A polyatomic gas has 24 vibrational degree of freedom. find its γ.

(1) 1.03 (2) 1.6 (3) 2 (4) 1.3

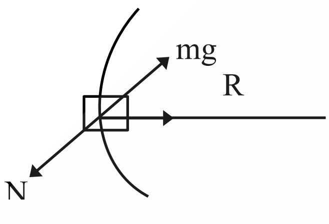
Ans. (1)

Sol. $\gamma = 1 + \frac{2}{f}$.

$\gamma = 1 + \frac{2}{30} = 1.066$

Option closest is (1)

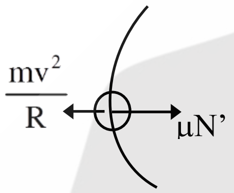
27. A car is moving with velocity v on circular turn of radius R. Mass of the car is m. Evaluate the negative lift (F_L) acting on the car.



(1) $\frac{mv^2}{\mu R} - 2mg$ (2) $\frac{mv^2}{2\mu R} - mg$ (3) $\frac{mv^2}{\mu R} - mg$ (4) $\frac{mv^2}{3\mu R} - mg$

Ans. **(3)**

Sol.



$\mu(mg + F_L) = \frac{mv^2}{R}$

$F_L = \frac{mv^2}{\mu R} - mg$

28. **Coming Soon**

29. **Coming Soon**

30. **Coming Soon.**