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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 29 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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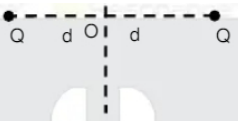
PART : PHYSICS

1. Two point charge each of same magnitude 'Q' are placed as shown in figure determine distance from O at equatorial axis where force on q is maximum.



(1) $\frac{d}{\sqrt{3}}$ (2) $\frac{d}{\sqrt{2}}$ (3) $\frac{d}{\sqrt{5}}$ (4) $\frac{d}{\sqrt{7}}$

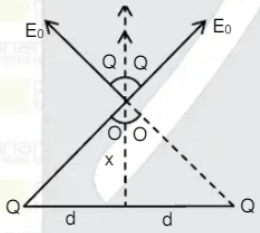
Ans. **(2)**

Sol. Force on q is

$F = qE$

$\Rightarrow \quad F = q\frac{2kQx}{(x^2+d^2)^{3/2}}$

for F = Fmax.



$E = 2E_0 \cos\theta$

$= \frac{2kQx}{(x^2+d^2)^{3/2}}$

$\Rightarrow \frac{d}{dx}\left[\frac{2x}{(x^2+d^2)^{3/2}}\right] = 0 \Rightarrow x = \frac{d}{\sqrt{2}}$

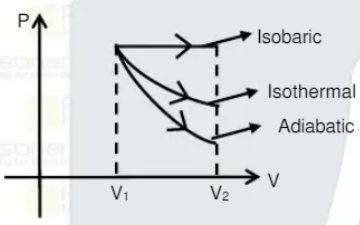
2. A gas is expanded from volume 'V_1' to 'V_2' by three different process these three process are isothermal, adiabatic and isobaric. Work done by gas in isothermal is W_1 and that in adiabatic is W_2 and that in isobaric is W_3. Select the correct option?

(1) $W_1 > W_2 > W_3$ (2) $W_2 < W_1 < W_3$ (3) $W_1 = W_2 = W_3$ (4) $W_1 > W_2 = W_3$

Ans. (2)

Sol. W = area under P-V curve

so according to graph



$W_3 > W_1 > W_2$

$V_1 \rightarrow V_2$ in three different ways

$W_1 \rightarrow$ Isothermal $W_2 \rightarrow$ Adiabatic

$W_3 \rightarrow$ Isochoric

$W_1 > W_2 > W_3$

$W_1 < W_2 < W_3$

3. Time period of earth rotating in orbit is 7hr. If radius is thrice then new time period of earth :

(1) 36 hr (2) 30 hr (3) 21 hr (4) 28 hr

Ans. (1)

Sol. $T^2 \times r^3$

$$\frac{7^2}{T^2} = \left(\frac{R}{3R}\right)^3$$

$$\frac{49}{T^2} = \frac{1}{27}$$

$T^2 = 49 \times 27$

$T = 7 \times 3\sqrt{3} = 21 \times 1.732$

$= 35.7$

4. The Height of T.V. tower is 125 m if its range is doubled for signal, find the new height :

(1) 125 m (2) 250 m (3) 500 m (4) 300 m

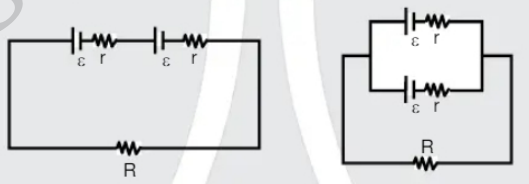
Ans. (3)

Sol. $d = \sqrt{2hR}$

$2d = \sqrt{2h'R}$

$h' = 4h = 4 \times 125 = 500$ m

5. Two Identical cell give same current across R resistance when they are in series combination and when they are in parallel combination. Find internal resistance of cell?



(1) R (2) 3R (3) $\frac{R}{2}$ (4) 5R

Ans. (1)

Sol. $$\frac{2\varepsilon}{R+2r} = \frac{\varepsilon}{R+\frac{r}{2}}$$

$\Rightarrow 2R + r = R + 2r$

$\Rightarrow r = R$

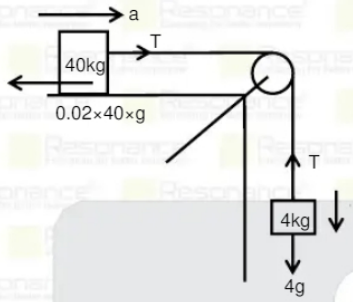
$r = R$

6. Find the acceleration of system shown.

(1) $\frac{4}{3}$ m/s² (2) $\frac{8}{12}$ m/s² (3) $\frac{8}{9}$ m/s² (4) $\frac{8}{11}$ m/s²

Ans. (4)

Sol.



$T - 8 = 40a$

$4g - T = 4a$

$32 = 44\ a$

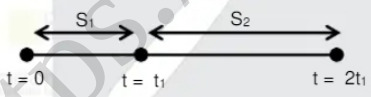
$a = \frac{8}{11}$ m/s²

7. A particle starts from rest along straight line path with cost acceleration. If covers 10 m distance in first t, sec. Find distance covered by it in nest t sec :

(1) 20 m (2) 30 m (3) 40 m (4) 50 m

Ans. **(2)**

Sol.



$S_1 = \frac{1}{2}\ a\ t_1^2$

$\Rightarrow \quad S_1 + S_2 = \frac{1}{2}\ a\ (2t_1)^2 = \frac{1}{2}\ a\ \ 4t_1^2$

$\Rightarrow \quad S_1 : S_1 + S_2 = 1 : 4$

$\Rightarrow \quad S_1 : S_2 = 1 : 3$

Here $S_1 = 10$ m

So, $S_2 = 30$ m

8. Electric Potential varies as $V = 3x^2$ find electric field at the point having Co-ordinates (1, 0, 3).

(1) – 6 V/m (2) – 8 V/m (3) 9 V/m (4) 10 V/m

Ans. (1)

Sol. We know that

$$E = -\frac{dv}{dx}$$

$$\Rightarrow E = -\frac{d}{dx}(3x^2) = -6x$$

at (1, 0, 3), $E = -6$

9. If maximum possible range of a projectile is 100 m what will be the maximum possible height for same speed :

(1) 100 m (2) 200 m (3) 50 m (4) 25 m

Ans. **(1)**

Sol. $R_{max} = u^2/g = 100$ m

$H_{max} = u^2/2g = 50$ m

10. Electric field of light is given by $E = 200[\sin(6 \times 10^{15}t) + \sin(9 \times 10^{15}t)]$. It is incident on a metal surface of work function 2.5 eV find the maximum kinetic energy of emitted electrons :

(1) 3.4 eV (2) 2.5 eV (3) 3.8 eV (4) 4 eV

Ans. **(1)**

Sol. $KE_{max.} = E - \phi$

$$= \frac{h\omega}{2\pi} - \phi$$

$$= \frac{4.14\times10^{-15}\times9\times10^{15}}{2\times3.14} - 2.5 = 5.9 - 2.5 = 3.4 \text{ eV}$$

11. A block of mass M is released from rest from height of y. When it fall down by y. its kinetic energy is :

(1) $mg(y - y_0)$ (2) $1/2\ mgy_0^2$ (3) mgy_0 (4) mgy_0^2

Ans. **(1)**

Sol. W by gravity = mgh

$h = y - y_0$

12. In the decay process ${}^{182}_{74}D \xrightarrow{\alpha} D_1 \xrightarrow{\beta^-} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\gamma} D_4$ find the atomic number and mass number of element D_4 :

(1) 174, 71 (2) 176, 72 (3) 174, 70 (4) 176, 71

Ans. **(1)**

Sol. ${}^{182}_{74}D \xrightarrow{\alpha} {}^{178}_{72}D_1 \xrightarrow{\beta^-} {}^{178}_{73}D_2 \longrightarrow {}^{174}_{71}D_3 \xrightarrow{\gamma} {}^{174}_{71}D_4$

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13. Equation of a simple pendulum is $\theta = \theta_0 \sin(\pi t + \phi)$. Find the length of pendulum :

(1) 1 m (2) 2 m (3) 0.5 m (4) 4 m

Ans. **(1)**

Sol. $\omega = \pi$

$$\sqrt{\frac{g}{\ell}} = \pi$$

$g = \pi^2\ell$

$\ell = \frac{g}{\pi^2} = 1\ m$

14. **Statement-1 :** Electric field changes the speed of charge particle but magnetic field does not change the speed.

Statement-2 : Charge particle travels perpendicular to electric field and parallel to magnetic field.

(1) Statement-1 is false, statement-2 is true

(2) Both statement is true & statement 2 is not the correct explanation of statement-1.

(3) Statement-1 is true, statement-2 is false.

(4) Statement-1 is true, statement-2 is true and statement-2 is the correct explanation of statement-1

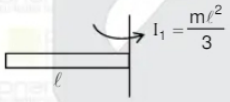
Ans. **(3)**

15. Moment of intertie of a rod about its end is I_1 Rod is bent into a ring and its moment of inertia about diameter is I_2 Find the $I_1 - I_2$.

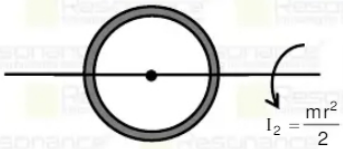
(1) $m\ell^2\left[\frac{1}{3}+\frac{1}{4\pi^2}\right]$ (2) $m\ell^2\left[\frac{1}{3}-\frac{1}{2\pi^2}\right]$ (3) $m\ell^2\left[\frac{1}{3}+\frac{1}{8\pi^2}\right]$ (4) $m\ell^2\left[\frac{1}{3}-\frac{1}{8\pi^2}\right]$

Ans. **(4)**

Sol.



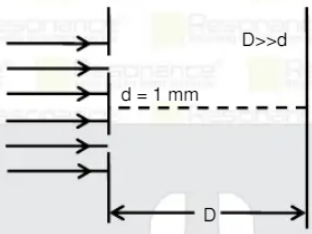
$\ell = 2\pi r$



$I_2 = \frac{m\ell^2}{8\pi^2}$

$I_1 - I_2 = m\ell^2\left[\frac{1}{3}-\frac{1}{8\pi^2}\right]$

16. If in YDSE set up screen is shifted towards plane of slit by 0.3 metre then fringe width changes by 0.4 mm. Determine wavelength 'λ' of light.



(1) $\frac{10^{-3}}{3}$ mm (2) $\frac{7}{3}\times10^{-3}$ mm (3) $\frac{4}{3}\times10^{-3}$ mm (4) $\frac{5}{3}\times10^{-3}$ mm

Ans. (3)

Sol. $\beta = \frac{\lambda D}{d}$

$\beta' = \frac{\lambda(D-0.3)}{d}$

$\beta - \beta' = \frac{\lambda\times0.3}{d}$

$\lambda = \frac{0.4\times10^{-3}\times d}{0.3}$

$0.4 = \frac{\lambda}{1}$

$\lambda = \frac{4}{3} \times 10^{-3} mm$

17. Time taken by a capacitance to reduce its energy by half is t_1 & time taken by the same capacitor to reduce its charge by 1/8th is t_2. The value of t_1/t_2 will be

(1) 1/3 (2) 1/6 (3) 1/2 (4) 1/4

Ans. (2)

Sol. $q = Qe^{-\frac{t}{\tau}}$ $U = \frac{q^2}{2C}$

$\frac{Q}{\sqrt{2}} = Qe^{-\frac{t_1}{\tau}}$

$t_1 = \tau \ell n \sqrt{2}$

$\frac{Q}{8} = Qe^{-\frac{t_2}{\tau}}$

$t_2 = \tau \ell n 8$

$\frac{t_1}{t_2} = \frac{\tau \ell n \sqrt{2}}{\tau \ell n 8} = \frac{\frac{1}{2}\tau \ell n 2}{3\tau \ell n 2} = \frac{1}{6}$

18. Verneir constant of verneir scale = 0.1 mm on measuring diameter of shaft. Main scale reading = 1.7 cm. If main scale coinsides with 5 division of verneir scale & zero error is – 0.05 cm. Diameter of shaft in cm is :

(1) 1.80 cm (2) 2.80 cm (3) 4.80 cm (4) 6.80 cm

Ans. **(1)**

Sol. Reading = MSR + L.C × $V_{S.R}$ + correction

Correction = – zero error = 0.05 cm

Reading = 1.7 + 0.1 × 10^{-1} (5) + 0.05

= 1.7 + 0.05 + 0.05

$\Rightarrow$ 1.80 cm

19. Two long wires are separated by 8 cm the magnetic field at the mid-point is 300 μT. Two wire carries current of same value which is :

(1) 30 A in opposite direction (2) 30 A in same direction

(3) 60 A in same direction (4) 60 A in opposite direction

Ans. (1)

Sol. Current is opposite direction

$B = \frac{2\mu_0 i}{2\pi 4cm} \Rightarrow 300 \times 10^{-6} = \frac{2 \times 2 \times 10^{-7} \times i}{4 \times 10^{-2}} \Rightarrow I = 30$ Amp.

20. If normal force exerted is 1/4th the weight of box find acceleration of lift.

(1) 3g/4 (2) g/4 (3) g/2 (4) g

Ans. (1)

Sol. mg – N = ma

$\frac{mg - mg}{4} = mg$

$a = \frac{3g}{4}$

21. Half-life of a radioactive sample is 5 years. Find time taken to reduce the sample 6.25% of its initial value.

(1) 20 years (2) 15 years (3) 25 years (4) 50 years

Ans. (1)

Sol. Time taken in 50% is T

Sol. Time taken in 50% is T_H

Time taken in 25% is $2T_H$

Time taken in 12.5% is $3T_H$

Time taken in 6.25% is $4T_H$

So $4T_H = 4 \times 5 = 20$ years

22. In resonance tube first resonance is obtain at 20 cm, then third resonance length will be :(frequency of source = 400 Hz, Speed of sound in air = 336 m/s)

(1) 60 cm (2) 104 cm (3) 60 cm (4) 100 cm

Ans. (2)

Sol. Wavelength of wave $\Rightarrow \lambda = \frac{V}{f} = \frac{336}{400} = 84\,cm$

At first resonance

$\frac{\lambda}{4} = \ell + e \Rightarrow \frac{84}{4} = 20 + e$

$\Rightarrow e = 1$

So third resonance length

$5\frac{\lambda}{4} = \ell_2 + e$

$5(21) = \ell_2 + 1$

$\ell_2 = 104$ cm