JEE MAIN SEP 2020 (MEMORY BASED) | 5th Sep. SHIFT-1

Note: The answers are based on memory based questions which may be incomplete and incorrect.

1. Voltage range of Galvanometer of resistance R is 0 to 1V. When it's range increases up to 2V, for this the additional resistance required in series will be :

(1) R (2) 2R (3) 3R (4) 4R

Ans. (1)

Sol. It is given that $V_g = i_gR = 1$

Let the required resistance be r

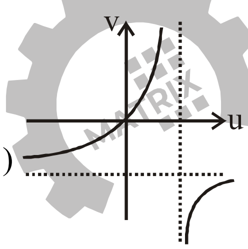
$i_g(R + r) = 2$

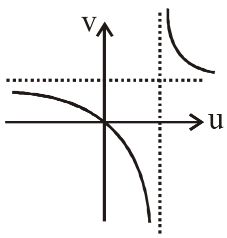
$$\frac{R+r}{R} = 2$$

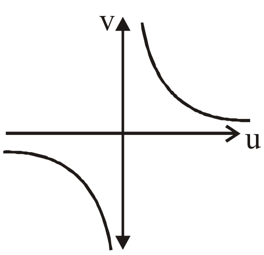
$$\frac{R+r}{R} = 2$$

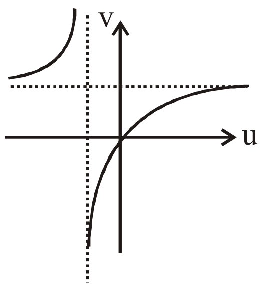
$r = R$

2. Which of the following graph represents relation between the image position (v) and object position (u) from the concave lens.

(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. By using relation $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

3. A bullet of mass 5g moving with a speed of 210 m/s hits a stationary plank and comes to rest. If half of its kinetic energy is absorbed by bullet itself and remaining half kinetic energy by plank, then what is the change in temperature of bullet in ºC : (Given specificheat of bullet is 6125 J/gº C

(1) 1 (2) 1.2 (3) 1.6 (4) 1.8

Ans. (4)

Sol. As per given condition

$$\frac{1}{2}\times\frac{1}{2}mv^2=(ms\Delta T)_{bullet}$$

$$\frac{1}{2}\times\frac{1}{2}\times5\times10^{-3}\times(210)^2=(5\times10^{-3})(6125)(\Delta T)$$

$\Delta T = 1.8$ ºC

4. In a photoelectric effect experiment potential difference between plates increases keeping incident light on cathode plate remains unchanged which of the following is correct about saturation current:

(1) Increases (2) Decreases (3) Remains same (4) First increases than decreases

Ans. (3)

Sol. Saturation current depends only on intensity of incident light.

5. Acceleration due to gravity at height $h=\frac{R}{2}$ is equal to acceleration due to gravity at depth d from the surface of earth then find d in terms of R. where R is radius of earth.

(1) $\frac{4}{3}R$ (2) $\frac{4}{9}R$ (3) $\frac{5}{9}R$ (4) $\frac{R}{3}$

Ans. (3)

Sol. It is given that

$g_n = g_d$

$$\frac{GM}{(R+h)^2}=\frac{GM}{R^3}(R-d)$$

$$\frac{GM}{(R+R/2)^2}=\frac{GM}{R^3}(R-d)$$

$$\frac{4GM}{9R^2}=\frac{GM}{R^2}\left(1-\frac{d}{R}\right)$$

$$\frac{4}{9}=1-\frac{d}{R}$$

$$\frac{d}{R}=1-\frac{4}{9}=\frac{5}{9}$$

$$d=\frac{5}{9}R$$

6. A disc of momentum of inertia I rotating about its own axis with angular speed w. It is placed on another disc of moment of inertia 3I which is at rest . Both disc have common axis of rotation. What will be the loss of kinetic energy upto both discs attain common angular velocity.

(1) $\frac{I\omega^2}{8}$ (2) $\frac{I\omega^2}{4}$ (3) $\frac{3I\omega^2}{8}$ (4) $\frac{5I\omega^2}{8}$

Ans. (3)

Sol. From angular momentum conservation

$I\omega + 0 = I\omega_C + 3\,I\,\omega_C$

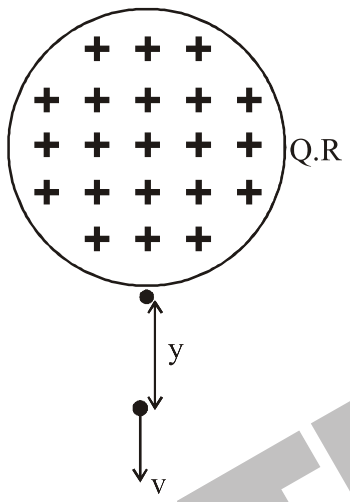
$\omega_C = \frac{\omega}{4}$

Loss of kinetic energy $=\frac{1}{2}I\omega^2-\frac{1}{2}(I+3I)\left(\frac{\omega}{4}\right)^2$

$=\frac{1}{2}I\omega^2-\frac{1}{2}I\frac{\omega^2}{4}$

$=\frac{3}{8}I\omega^2$

7. A uniformly charged sphere of charge Q and radius R is placed at some height from ground surface and sphere is fixed. Now a charged particle of mass m and charge q is released form rest just below to the sphere. What will be speed of particle after travelling Y - distance.



(1) $\sqrt{2gy}$

(2) $\sqrt{\frac{2kQq}{m}\frac{y}{R(R+y)}}$

(3) $\sqrt{2gy+\frac{2kQq}{m}\frac{y}{R(R+y)}}$

(4) $\sqrt{gy+\frac{kQq}{m}\frac{y}{R(R+y)}}$

Ans. (3)

Sol. From mechanical energy conservation

$$\Delta KE + (\Delta PE)_{Electo} + (\Delta PE)_{gravitationl} = 0$$

$$\frac{1}{2}mV^2 + \left(k\frac{Qq}{R+y} - k\frac{Qq}{R}\right) + (-mgy) = 0$$

$$\frac{1}{2}mV^2 = mgy + kQq\left(\frac{1}{R} - \frac{1}{R+y}\right)$$

$$V = \sqrt{2gy + \frac{2kQq}{m}\frac{y}{R(R+y)}}$$

8. A shell of relative density $\frac{27}{9}$ with respect to water, is just submerged in water. If it's inner and outer radius is r and R then $\frac{r}{R}$ will be :

(1) $\left(\frac{1}{3}\right)^{1/3}$ (2) $\left(\frac{2}{3}\right)^{1/3}$ (3) $\left(\frac{3}{4}\right)^{1/3}$ (4) $\left(\frac{5}{9}\right)^{1/3}$

Ans. (2)

Sol. In equilibrium

$$mg = F_B$$

$$\frac{4}{3}\pi(R^3 - r^3)\rho g = \frac{4}{3}\pi R^3 \rho_w g$$

$$\left[1 - \left(\frac{r}{R}\right)^3\right]\frac{27}{9}\rho_w = \rho_w$$

$$1 - \frac{r^3}{R^3} = \frac{9}{27}$$

$$1 - \frac{1}{3} = \frac{r^3}{R^3}$$

$$\frac{2}{3} = \frac{r^3}{R^3}$$

$$\frac{r}{R} = \left(\frac{2}{3}\right)^{1/3}$$

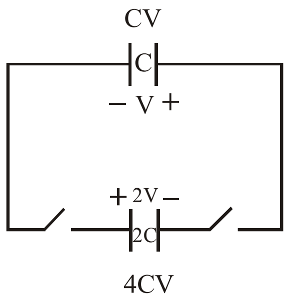
9. Two parallel plate capacitors of capacitance C and 2C are charged upto a potential difference V and 2V respectively. Now these capacitors are connected in parallel to each other such that positive charged plate of capacitor C is connected to negative charged plate of capacitors 2C. Find amount of change in potential energy of system.

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

Ans. (4)

Before

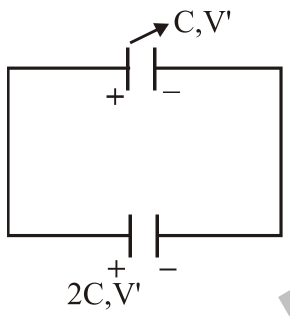
Sol.



Charge on C = CV

Charge on 2C = (2C) (2V) = 4CV

After connecting



From charge conservation, $2C(2V) - CV = (C + 2C)\,V' \Rightarrow 3CV = 3CV' \Rightarrow V' = V$

; Amount of change in potential energy of system,

$\Delta U = U_{in} = Uf_{inal}$

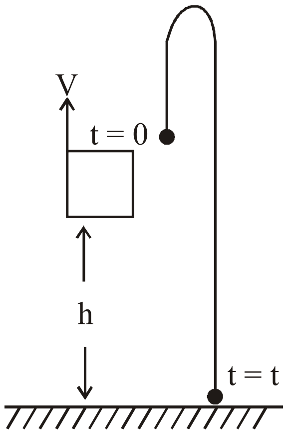
$$= \left(\frac{1}{2}CV^2 + \frac{1}{2}2C \times 4V^2\right) - \left(\frac{1}{2}CV^2 + \frac{1}{2} \times 2CV^2\right)$$

$\Delta U = 3CV^2$

10. A helicopter is rising up from ground with an acceleration of g m/s^2, starting from rest. after rising a height h, it attains a velocity of v m/s. At this instant a particle is now released from helicopter. Take t = 0 at releasing time, calculate the time t when particle reaches to the ground.

(1) $\sqrt{\frac{2h}{g}}$ (2) $2\sqrt{\frac{2h}{g}}$ (3) $\left(1+\sqrt{2}\sqrt{\frac{2h}{g}}\right)$ (4) $4\sqrt{\frac{2h}{g}}$

Ans. (3)

Sol. 

$\Rightarrow$ For upward motion of helicopter

$v^2 = u^2 + 2as$

$v^2 = 0 + 2gh$

$v = \sqrt{2gh}$

$\Rightarrow$ Now particle will start moving under gravity.

$S = ut + \frac{1}{2}at^2$

$-h = \sqrt{2gh}\ t - \frac{1}{2}gt^2$

$\frac{1}{2}gt^2 - \sqrt{2gh}\ t - h = 0$

than $\quad t = \dfrac{\sqrt{2gh} \pm \sqrt{2gh + 4 \times \frac{g}{2} \times h}}{2 \times \frac{g}{2}}$

$t = \sqrt{\frac{2gh}{g}}(1 + \sqrt{2})$

$t = \sqrt{\frac{2h}{g}}(1 + \sqrt{2})$