PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 53

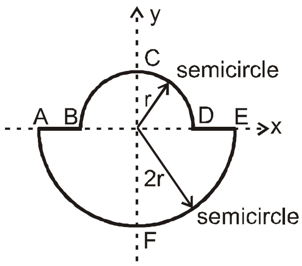
Total Marks : 23

Max. Time : 29 min.

Topics : Rotation, Capacitor, Center of Mass, Gravitation, Current Electricity, Electrostatics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.3	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.4 to Q.5	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. A uniform thin rod is bent in the form of a closed loop ABCDEFA as shown in the figure.

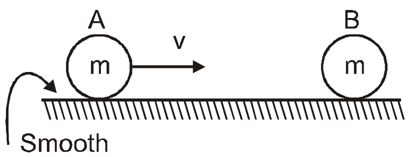


(A) > 1
(B) < 1
(C) = 1
(D) = 1/2

2. An uncharged parallel plate capacitor is connected to a battery. The electric field between the plates is 10V/m. Now a dielectric of dielectric constant 2 is inserted between the plates filling the entire space. The electric field between the plates now is

(A) 5 V/m
(B) 20 V/m
(C) 10 V/m
(D) none of these

3. In the figure shown, coefficient of restitution between A and B is $e = \frac{1}{2}$, then :



(A) velocity of B after collision is $\frac{v}{2}$

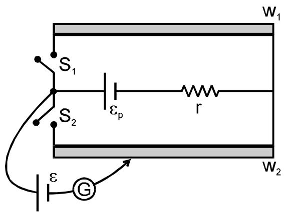
(B) impulse on one of the balls during collision is $\frac{3}{4}mv$

(C) loss of kinetic energy in the collision is $\frac{3}{16}mv^2$

(D) loss of kinetic energy in the collision is $\frac{1}{4}mv^2$

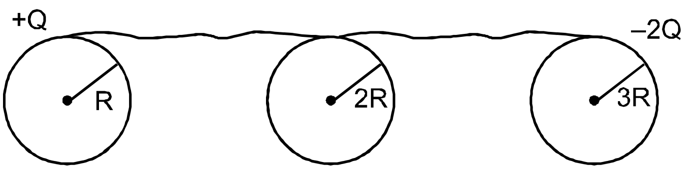
4. A spherical planet has uniform density $\frac{\pi}{2} \times 10^4$ kg/m^3. Find out the minimum period for a satellite in a circular orbit around it in seconds. (Use $G = \frac{20}{3} \times 10^{-11} \frac{N-m^2}{kg^2}$).

5. Two potentiometer wires w_1 and w_2 of equal length ℓ connected to a battery of emf ε_P and internal resistance 'r' through two switches s_1 and s_2. A battery of emf ε is balanced on these potentiometer wires. If potentiometer wire w_1 is of resistance 2r and balancing length on w_1 is $\ell/2$ when only s_1 is closed and s_2 is open. On closing s_2 and opening s_1 the balancing length on w_2 is found to be $\left(\frac{2\ell}{3}\right)$, then find the resistance of potentiometer wire w_2.



COMPREHENSION

Two conducting spheres of radius R and 3R carry charges Q and –2Q. Between these spheres a neutral conducting sphere of radius 2R is connected. The separation between the sphere is considerably large. Charge flows through conducting wire due to potential difference.



6. The final charge on initially neutral conducting sphere is :

(A) $-\frac{Q}{6}$ (B) $-\frac{Q}{3}$ (C) $\frac{Q}{3}$ (D) $-\frac{Q}{2}$

7. The decrease in electric potential energy of sphere of radius R is :

(A) $\frac{KQ^2}{4R}$ (B) $\frac{35KQ^2}{72R}$ (C) $\frac{KQ^2}{72R}$ (D) none

8. The final electric potential of sphere of radius 3R will be :

(A) $-\frac{KQ}{6R}$ (B) $-\frac{KQ}{2R}$ (C) $-\frac{2KQ}{3R}$ (D) $-\frac{3KQ}{R}$

Answers Key

1.	(B)	**2.**	(C)	**3.**	(B) (C)	**4.**	3000
5.	R = r	**6.**	(B)	**7.**	(B)	**8.**	(A)

Hints & Solutions

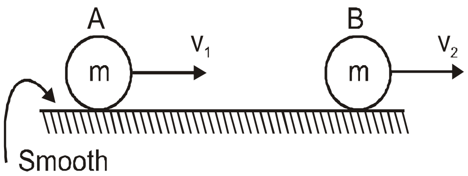
1. Moment of inertia of semicircular portions about x and y axes are same. But moment of inertia of straight portions about x-axis is zero.

$\therefore I_x < I_y \quad$ or $\frac{I_x}{I_y} < 1$

2. As voltage applied across capacitor is same i.e. 10V in both case. Therefore in both case

$Ed = 10 \Rightarrow E = \frac{10}{d}$, as d is constant . Therefore electric field remians the same as 10 V/m

3. after collision



By momentum conservation in horizontal direction

$V = V_1 + V_2$ ....(i)

and

$e = \frac{V_2 - V_1}{V} = \frac{1}{2}$ ....(ii)

By (i) and (ii) $V_2 = \frac{3V}{4}$

So impulse on B

$= m\left(\frac{3V}{4}\right)$

and loss in K.E.

$= \frac{3}{16} mV^2$

4. Ans. 3000

Time period is minimum for the satellites with minimum radius of the orbit i.e. equal to the radius of the planet. Therefore.

$$\frac{GMm}{R^2} = \frac{mv^2}{R}$$

$$\Rightarrow V = \sqrt{\frac{GM}{R}}$$

$$T_{min} = \frac{2\pi R}{\sqrt{\frac{GM}{R}}}$$

$$= \frac{2\pi R\sqrt{R}}{\sqrt{GM}}$$

using $M = \frac{4}{3}\, p\, R^3.\, \rho$

$$T_{min.} = \sqrt{\frac{3\pi}{G\rho}}$$

Using values $T_{min} = 3000$ s

5. When S_1 is closed

$$i = \frac{\varepsilon_p}{2r + r} = \frac{\varepsilon_p}{3r}$$

$$\therefore \quad \varepsilon = \frac{\varepsilon_p}{3r} . r = \frac{\varepsilon_p}{3} \quad \text{............. (1)}$$

when S_2 is closed (Let resistance of w_2 be R)

$$i = \frac{\varepsilon_p}{R + r}$$

$$\varepsilon = \frac{\varepsilon_p}{R + r} . \left(R.\frac{2}{3}\right) \quad \text{............... (2)}$$

From (1) & (2) R = r. Ans.

Alternate Solution :

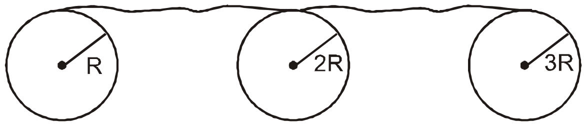
If in second case both S_1 & S_2 are closed,

$$\varepsilon = \frac{\varepsilon_p}{r + 2r}.\frac{2r}{\ell}.\frac{\ell}{2} = \frac{\varepsilon_p}{3}$$

$$\varepsilon = \frac{\varepsilon_p}{r + \frac{2rx}{2r + x}}.\frac{2rx}{2r + x}.\frac{2}{3}$$

$$\Rightarrow \frac{\varepsilon_p}{3} = \frac{4\varepsilon_p x}{2r + x + 2x}.$$

Sol.(57 to 59)



Final potential of spheres will be same

So, $K\frac{x}{R} = \frac{Ky}{2R} = \frac{K(-Q-x-y)}{3R}$

$y = 2x$ and $3x = -Q - x - y$

$\therefore$ $6x = -Q$

$x = -\frac{Q}{6}$ $\quad\quad$ $y = -\frac{Q}{3}$

Charge on sphere of radius 3R is $-\frac{Q}{2}$

Change in potential energy of sphere of radius 'R' is

$$\Delta U = \frac{KQ^2}{2R} - \frac{K(-Q/6)^2}{2R}$$

$$\Delta U = \frac{35KQ^2}{72R}.$$