PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 44

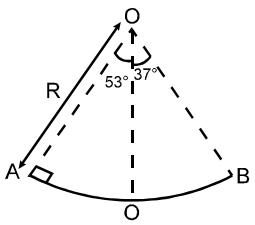
Total Marks : 31

Max. Time : 34 min.

Topics : Circular Motion, Relative Motion, Rectilinear Motion, Gravitation, Electrostatics, Geometrical Optics

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	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q. 8	(8 marks, 10 min.)	[8, 10]

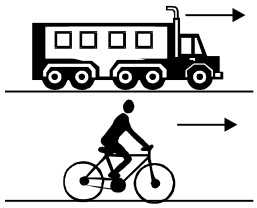
1. A section of fixed smooth circular track of radius R in vertical plane is shown in the figure. A block is released from position A and leaves the track at B. The radius of curvature of its trajectory when it just leaves the track at B is:



(A) R (B) $\frac{R}{4}$

(C) $\frac{R}{2}$ (D) none of these

2. A cyclist observes a passenger in a bus. He finds that the passenger closed his glass window displacing 20 cm in forward direction with constant speed in 1 sec. Bus overtakes the cyclist in 3 sec. Initially he was at the middle of the bus as shown in the figure. Length of the bus is 18 m. Both cyclist and bus are moving with constant speed in the same direction. Then velocity of the glass window with respect to cyclist was:



(A) 0.2 m/s (B) 2.8 m/s (C) 3.2 m/s (D) 3 m/s

3. A particle is moving rectilinearly so that its acceleration is given as $a = 3t^2 + 1$ m/s^2.Its initial velocity is zero.

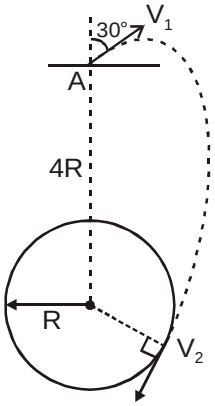
(A) The velocity of the particle at t=1 sec will be 2m/s.

(B) The displacement of the particle in 1 sec will be 2m.

(C) The particle will continue to move in positive direction.

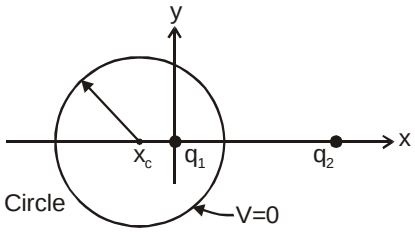
(D) The particle will come back to its starting point after some time.

4. A particle is projected from point A, that is at a distance 4R from the centre of the earth, with speed V_1 in a direction making 30° with the line joining the centre of the earth and point A, as shown. Find the speed V_1 if particle passes grazing the surface of the earth. Consider gravitational interaction only between these two. (use $\frac{GM}{R} = 6.4 \times 10^7$ m^2/s^2) Express you answer in the form $\frac{X}{\sqrt{2}}$ m/s and fill value of X.



COMPREHENSION

A point charge $q_1 = +6e$ fixed at the origin of a coordinate system, and another point charge $q_2 = -10e$ is fixed at x = 8 nm , y = 0. The locus of all points in the xy plane for which potential V= 0 (other than infinity) is a circle centered on the x-axis , as shown.



5. Radius R of the circle is

(A) 3nm (B) 6nm

(C) 7.5nm (D) 9nm

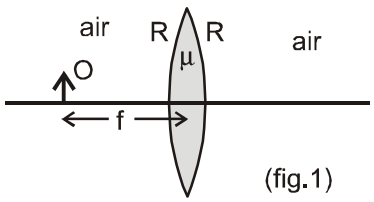
6. x-coordinate of the centre of the circle is -

(A) -2nm (B) -3nm (C) -4.5nm (D) -7.5nm

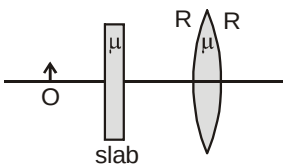
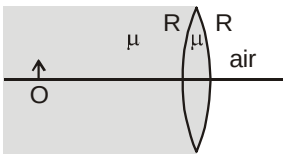
7. The potential at the centre of the circle is

(A) 0.32V (B) 0.77V (C) 1.2V (D) -1.2V

8. An object O (real) is placed at focus of an equi-biconvex lens as shown in figure 1. The refractive index of lens is $\mu = 1.5$ and the radius of curvature of either surface of lens is R. The lens is surrounded by air. In each statement of column I some changes are made to situation given above and information regarding final image formed as a result is given in column-II. The distance between lens and object is unchanged in all statements of column-I. Match the statements in column-I with resulting image in column-II.



(fig.1)

Column-I	Column-II
(A) If the refractive index of the lens is doubled (that is, made 2 μ) then	(p) final image is real
(B) If the radius of curvature is doubled (that is, made 2R) then	(q) final image is virtual
(C) If a glass slab of refractive index $\mu = 1.5$ is introduced between the object and lens as shown, then 	(r) final image becomes smaller in size in comparison to size of image before the change was made
(D) If the left side of lens is filled with a medium of refractive index $\mu = 1.5$ as shown, then 	(s) final image is of same size of object.

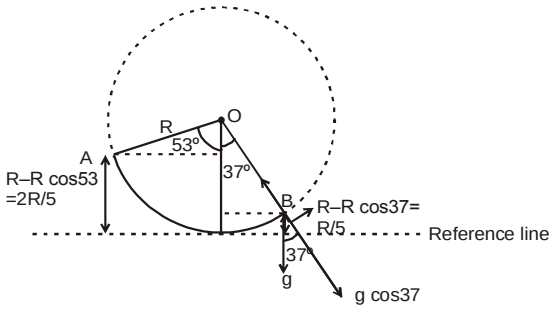
Answers Key

1. (C) **2.** (A) **3.** (A) (C) **4.** 8000
5. (C) **6.** (C) **7.** (B)
8. (A) p,r (B) q, r (C) q, r (D) q, r

Hints & Solutions

1. By energy conservation between A & B

$$\Rightarrow \quad Mg\ \frac{2R}{5} + 0 = \frac{MgR}{5} + \frac{1}{2}\ MV^2$$



$$V = \sqrt{\frac{2gR}{5}}$$

Now, radius of curvature r

$$= \frac{V_{\perp}^2}{a_r} = \frac{2gR/5}{g\cos 37} = \frac{R}{2}$$

$$r = \frac{V_{\perp}^2}{a_r} = \frac{2gR/5}{g\cos 37} = \frac{R}{2}$$

2. Relative displacement of glass window w.r.t. cyclist is 20 cm time taken = 1 sec.

So, relative velocity of glass window w.r.t. cyclist =

$\frac{20}{1}$ cm/sec. = 0.2 m/sec.

3. $a = 3t^2 + 1$

$$\frac{dv}{dt} = 3t^2 + 1 \quad \Rightarrow \quad \int_0^v dv = \int_0^1 (3t^2 + 1)\,dt$$

$$v = \left(t^3 + t\right)_0^1 = 2 \text{ m/s.}$$

$$\Rightarrow \quad v = t^3 + t$$

$$\therefore \int_0^s ds = \int_0^1 (t^3 + t)\,dt$$

$$\Rightarrow \quad S = \frac{1}{4} + \frac{1}{2} = 0.75$$

$$\Rightarrow \quad S = \frac{1}{4} \quad \frac{1}{2}$$

4. 8000

Conserving angular momentum $m.(V_1 \cos 60°)$.

$4R = m.V_2.R \quad ; \frac{V_2}{V_1} = 2.$

Conserving energy of the system

$m.(V_1 \cos 60°).\ 4R = m.V_2.R \quad ; \frac{V_2}{V_1} = 2.$

$$-\frac{GMm}{4R} + \frac{1}{2}mV_1^2 = -\frac{GMm}{R} + \frac{1}{2}mV_2^2$$

$$\frac{1}{2}V_2^2 - \frac{1}{2}V_1^2 = \frac{3}{4}\frac{GM}{R}$$

$$\text{or} \quad V_1^2 = \frac{1}{2}\frac{GM}{R}$$

$$V_1 = \frac{1}{\sqrt{2}}\sqrt{64 \times 10^6} = \frac{8000}{\sqrt{2}} \text{ m/s} \quad \textbf{Ans. 8000}$$

7. On the positive side of x axis, potential is zero at distance x_1 (it is between both charges), then

$$\frac{k.6e}{r} = \frac{k.10e}{8 - r} \qquad \Rightarrow r = 3\text{nm}$$

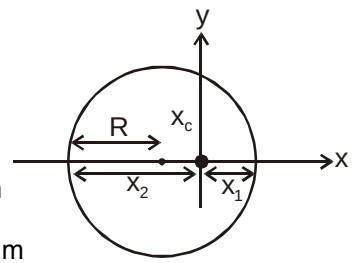
For the left side

$$\frac{k.6e}{x_2} = \frac{k.10e}{8 + x_2}$$

$\Rightarrow x_2 = 12\text{nm}$

$$R = \frac{x_1 + x_2}{2} = 7.5\text{nm}$$

$|X_c| = X_2 - R = 4.5$ nm



$$V_c = \frac{k.6e}{4.5 \times 10^{-9}} - \frac{k.10e}{12.5 \times 10^{-9}}$$

$$= 9 \times 10^9 \times 10^9 \times 1.6 \times 10^{-19} \left[\frac{4}{2} - \frac{4}{5}\right] = 1.44 \times \frac{8}{15}$$

8. (A) p,r (B) q, r (C) q, r (D) q, r

Initially the image is formed at infinity.

(A) As m is increased the focal length decreases. Hence the object is at a distance larger than focal length. Therefore final image is real. Also final image becomes smaller is size in comparision to size of image before the change was made.

(B) If the radius of curvature is doubled, the focal length decreases. Hence the object is at a distance lesser than focal length. Therefore final image is virtual. Also final image becomes smaller is size in comparision to size of image before the change was made.

(C) Due to insertion of slab the effective object for lens shifts right wards. Hence final image is virtual. Also final image becomes smaller is size in comparision to size of image before the change was made.

(D) The object comes to centre of curvature of right spherical surface as a result. Hence the final image is virtual. Also final image becomes smaller is size in comparision to size of image before the change was made.