PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 29

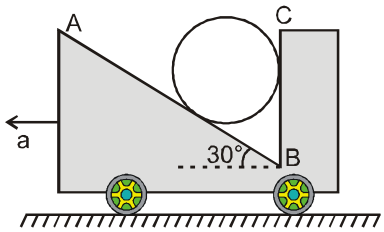
Total Marks : 25

Max. Time : 25 min.

Topics : Newton's Law of Motion, Center of Mass, Geometrical Optics, Surface Tension, Electrostatics

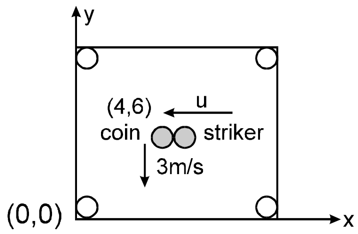
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Multiple choice objective ('–1' negative marking) Q.5	(4 marks, 4 min.)	[4, 4]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration '*a*'. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively. Neglect friction everywhere. Then as the magnitude of acceleration '*a*' of the carriage is increased, pick up the correct statement:



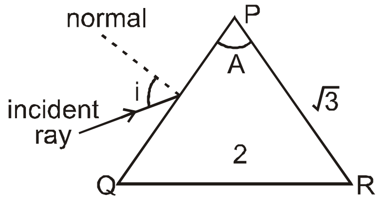
(A) N_{AB} increases and N_{BC} decreases.
(B) Both N_{AB} and N_{BC} increase.
(C) N_{AB} remains constant and N_{BC} increases.
(D) N_{AB} increases and N_{BC} remains constant.

2. On a smooth carom board, a coin moving in negative y–direction with a speed of 3 m/s is being hit at the point (4, 6) by a striker moving along negative x-axis. The line joining centres of the coin and the striker just before the collision is parallel to x-axis. After collision the coin goes into the hole located at the origin. Masses of the striker and the coin are equal. Considering the collision to be elastic, the initial and final speeds of the striker in m/s will be:



(A) (1.2, 0)
(B) (2, 0)
(C) (3, 0)
(D) none of these

3. A prism of angle A and refractive index 2 is surrounded by medium of refractive index $\sqrt{3}$. A ray is incident on side PQ at an angle of incidence i $(0 \le i \le 90°)$ as shown. The refracted ray is then incident on side PR of prism. The minimum angle A of prism for which ray incident on side PQ does not emerge out of prism from side PR (for any value of i) is



(A) 30°
(B) 45°
(C) 60°
(D) 120°

4. Assuming the xylem tissues through which water rises from root to the branches in a tree to be of uniform cross-section find the maximum radius of xylum tube in a 10 m high coconut tree so that water can rise to the top. (surface tension of water = 0.1N/m, Angle of contact of water with xylem tube= 60°)

(A) 1 cm (B) 1 mm (C) 10 μm (D) 1 μm

5. A particle is attached to an end of a rigid rod. The other end of the rod is hinged and the rod rotates always remaining horizontal without in contact with any thing else. It's angular speed is increasing at constant rate. The mass of the particle is 'm'. The force exerted by the rod on the particle is $\vec{F}$, then :

(A) $F \geq mg$

(B) F is constant

(C) The angle between $\vec{F}$ and horizontal plane decreases.

(D) The angle between $\vec{F}$ and the rod decreases.

COMPREHENSION

An uncharged ball of radius R is placed at a point in space and the region out side (from R to ∞ measured from centre of the ball) the ball is non uniformly charged with a charge density $\rho = \frac{C}{r^3}$ coul/m^3 where 'C' is a positive constant and r is the distance of a point measured from centre of the ball.

6. Electric potential at the centre of the ball is :

(A) Directly proportional to R (B) Directly proportional to R^2

(C) Inversely proportional to R (D) Inversely proportional to R^2

7. Electric field intensity at a distance x from centre of the ball (x > R) is :

(A) $\frac{C}{\epsilon_0 R^2} \ell n \frac{x}{R}$ (B) $\frac{C}{2\epsilon_0 R^2} \ell n \left(\frac{x-R}{R}\right)$ (C) $\frac{C}{2\epsilon_0 R^2}(R^2 - x^2)$ (D) $\frac{C}{\epsilon_0 x^2} \ell n \frac{x}{R}$

8. As we move away from ball's surface, electric potential :

(A) decreases. (B) increases.

(C) decreases then increases. (D) increases then decreases.

Answers Key

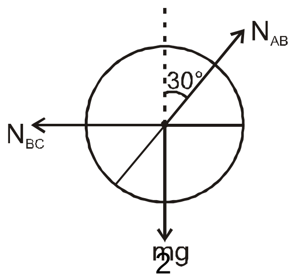
1. (C) **2.** (B) **3.** (D) **4.** (D)

5. (A), (C), (D) **6.** (C) **7.** (D)

8. (A)

Hints & Solutions

1. The free body diagram of cylinder is as shown.
Since net acceleration of cylinder is horizontal,
$N_{AB} \cos 30° = mg$



or $N_{AB} = \frac{2}{\sqrt{3}} mg$ .... (1)

and $N_{BC} - N_{AB} \sin 30° = ma$
or $N_{BC} = ma + N_{AB} \sin 30°$ .... (2)
Hence N_{AB} remains constant and N_{BC} increases with increase in a.

2. (B) The line of impact for duration of collision is parallel to x-axis.
The situation of striker and coin just before the collision is given as

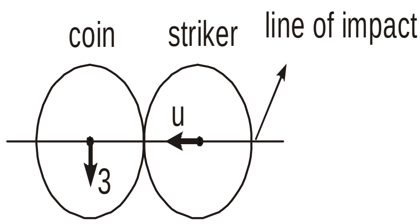


Figure (A)
before collision

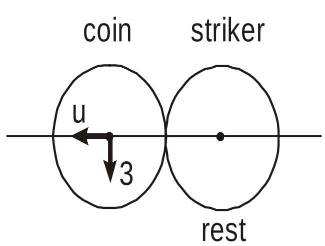
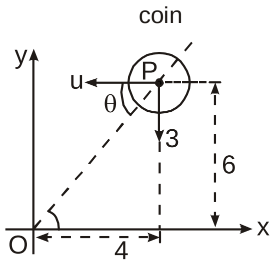


Figure (B)
after collision

Because masses of coin and striker are same, their components of velocities along line of impact shall exchange. Hence the striker comes to rest and the x-y component of velocities of coin are u and 3 m/s as shown in figure.



For coin to enter hole,
its velocity must be along PO

$\therefore\ \tan\theta = \frac{6}{4} = \frac{3}{u}$ or

$u = 2$ m/s **Ans. (2, 0)**

3. For no ray to emerge out of side PR

$A > 2C \Rightarrow \sin\frac{A}{2} > \sin C$

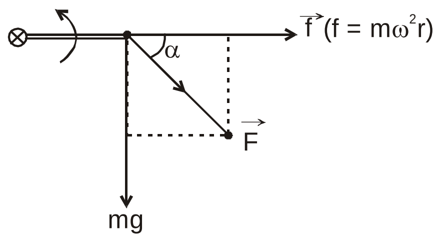
$\Rightarrow \sin\frac{A}{2} > \frac{\sqrt{3}}{2}$

or $A > 120°$

4. $\rho g h\, \pi r^2 = 2\pi r S \cos\theta$

$\Rightarrow r = \frac{2S\cos\theta}{\rho g h} = \frac{2\times1\times0.5}{10^3\times10\times10} = 10^{-6}$ m

5. $F = \sqrt{f^2 + (mg)^2}$



Now when the angular speed of the rod is increasing at const. rate the resultant force will be more inclined towards $\vec{f}$.
Hence the angle between $\vec{F}$ and horizontal plane decreases
so as with the rod.

6. Consider a spherical shell of radius r(r > R) and thickness dr. Then potential at centre due to it,

$$dV = \frac{K\,dq}{r} = \int_{r=R}^{r\to\infty} \frac{K(C/r^3)4\pi r^2}{r}dr$$

$$= (\text{const.})\int_{r=R}^{r\to\infty} \frac{1}{r^2}dr$$

$$= (\text{const.})\left(\frac{1}{R}\right)$$

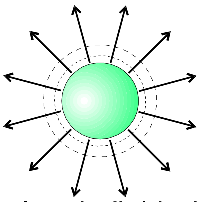
7. Using gauss theorem

$$\int \vec{E}.d\vec{s} = \frac{q_{in}}{\varepsilon_0}$$

$$E \times 4\pi x^2 = \frac{\int \rho\, dv}{\varepsilon_0} = \frac{\int_{r=R}^{R=x} \frac{C}{r^3} 4\pi r^2\, dr}{\varepsilon_0}$$

$$E \times 4\pi x^2 = \frac{(C)}{\varepsilon_0 x^2} \ell n\left(\frac{x}{R}\right)$$

$$\Rightarrow \qquad E = \frac{(C 4\pi)}{\varepsilon_0} \ell n\left(\frac{x}{R}\right)$$

8. 

Electric field will be radially outwards.
Electric potential decreases as we move in the direction of electric field.