ROTATIONAL MOTION (PART 1)

SET 1

PROBLEMS FOR PRACTICE

(Data : $g = 9.8\ m/s^2$)

(1) Calculate the angular velocity and linear velocity of a tip of minute hand of length 10cm.

(Ans : 1.745×10^{-3} rad/s, 1.745×10^{-4} m/s)

(2) Propeller blades in aeroplane are 2m long

(a) When propeller is rotating at 1800 rev/min, compute the tangential velocity of tip of the blade.

(b) What is the tangential velocity at a point on blade midway between tip and axis?

(Ans : 376.8 m/s, 188.4 m/s)

(3) A car of mass 2000 kg rounds a curve of radius 250 m at 90 km/hr. Compute its,

(a) Angular speed

(b) Centripetal acceleration

(c) Centripetal force.

(Ans : 0.1 radian/s, 2.5 m/s^2, 5000 N)

(4) A bucket containing water is whirled in a vertical circle at arms length. Find the minimum speed at top to ensure that no water spills out. Also find corresponding angular speed. (Assume r = 0.75 m)

(Ans : 2.711 m/s, 3.615 rad/s)

(5) A motor cyclist at a speed of 5 m/s is describing a circle of radius 25 m. Find his inclination with vertical. What is the value of coefficient of friction between tyre and ground?

(Ans : 5° 51', 0.1020)

(6) A stone weighing 1 kg is whirled in a vertical circle attached at the end of a rope of length 0.5m. Find the tension at

(i) Lowest position (ii) Mid position

(iii) Highest position

(Ans : 58.8N, 29.4 N, 0 N)

(7) An object of mass 0.5 kg attached to a string of length 0.5 m is whirled in a vertical circle at constant angular speed. If the maximum tension in the string is 5 kg wt, calculate

(i) speed of object.

(ii) maximum number of revolutions it can complete in a minute.

(Ans : 6.641 m/s, 126.7 r.p.m.)

(8) what angle the road should be banked for this velocity? (Ans : 0.1417, 8° 4')

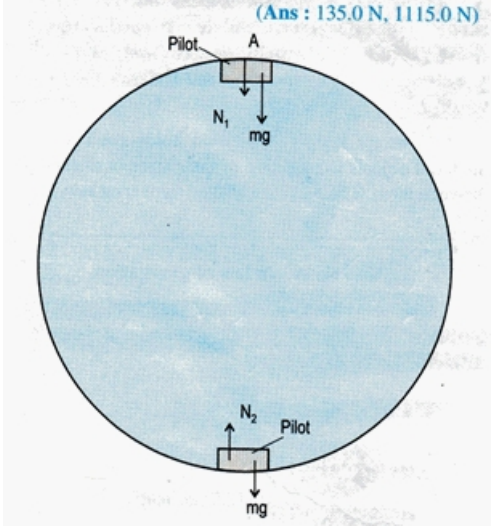
coefficient of friction to prevent skidding? At

(9) A pilot of mass 50 kg in a jet aircraft while executing a loop-the-loop with constant speed of 250 m/s. If the radius of circle is 5 km, compute the force exerted by seat on the pilot

(a) at the top of loop.

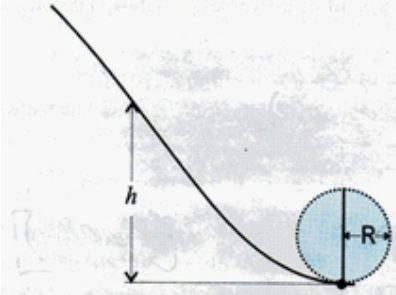
(b) at the bottom of loop.

(Ans : 135.0 N, 1115.0 N)



(10) A ball is released from height along the slope and move along a circular track of radius R without falling vertically downwards (Fig. 1.15).

Show that $h = \frac{5}{2} R$



(11) A block of mass 1 kg is released from P on a frictionless track which ends in quarter circular track of radius 2m at the bottom. (Fig. 1.16).

What is the magnitude of radial acceleration and total acceleration of the block when it arrives at Q ? (Ans : 39.2 m/s^2, 40.41 m/s^2)

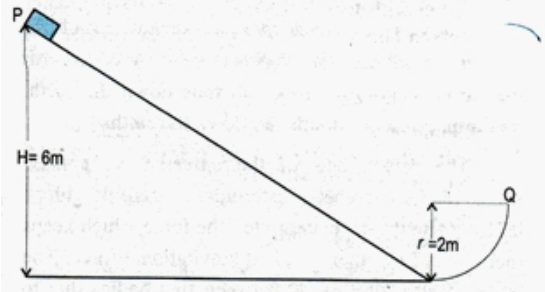


Fig. 1.16

(12) A circular race course track has a radius of 500 m and is banked to 10°. If the coefficient of friction between tyres of vehicle and the road surface is 0.25. Compute :

(a) the maximum speed to avoid slipping.

(b) the optimum speed to avoid wear and tear of tyres. ($g = 9.8$ m/s^2)

(Ans : 46.70 m/s, 29.39 m/s)

(13) The length of hour hand of a wrist watch is 1.5 cm. Find magnitude of

(a) angular velocity

(b) linear velocity

(c) angular acceleration

(d) radial acceleration

(e) tangential acceleration

(f) linear acceleration of a particle on tip of hour hand.

(a) 1.454×10^{-4} rad/s, (b) 2.182×10^{-6} m/s, (c) 0 rad/s^2 (d) 3.175×10^{-10} m/s^2, (e) 0, (f) 3.175×10^{-10} m/s^2)