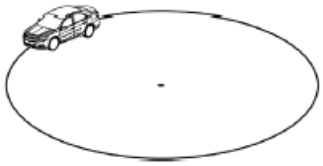
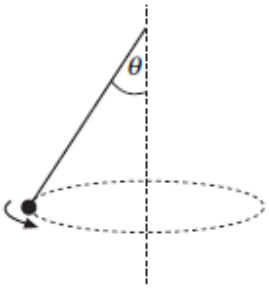
Homework 8

1)

A car travels at a uniform speed of 80 km h^{-1} on a horizontal circular track of radius 150 metres without slipping. Calculate the coefficient of friction between the tyres and the track. 3



2)

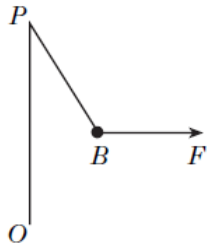


A particle of mass 2 kg is attached to one end of a light inextensible string of length 2 metres. The other end of the string is held fixed while the mass moves in a horizontal circle about a vertical axis at 5 radians per second.

Calculate the size of angle θ, between the string and the vertical axis. 5

3)

A ball B of weight 9 newtons is attached to one end of a light inextensible string. The other end of the string is attached to P, the top of a fixed vertical pole OP.



By exerting a horizontal force of magnitude F newtons, the ball is held in equilibrium, with the string taut and $\angle OPB = 30°$.

Calculate:

(*a*) the tension in the string; 2

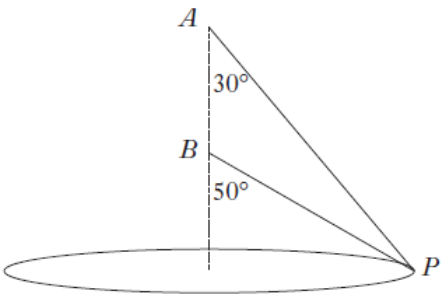
(*b*) the value of F. 2

Mark

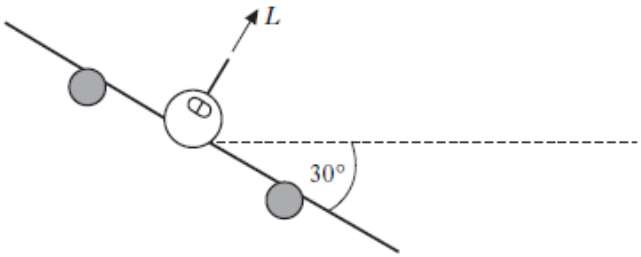
4) Two light inextensible strings each have one end attached to a particle P of mass 2 kg. The other ends of the strings are attached to fixed points A and B where A is vertically above B.

The particle moves with a constant speed in a horizontal circle whose centre is 30 cm below B. When the strings are inclined at 30° and 50° to the vertical, both strings are taut with the tension in AP twice that in BP.

Find the linear speed of the particle. **6**



5) An aircraft flies at constant speed U metres per second in a horizontal circular orbit of radius R metres.



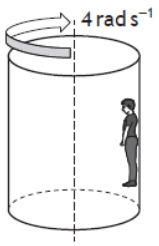
The wings of the aircraft are banked at 30° to the horizontal and generate a lift force of L newtons. This force acts perpendicular to the wing surface, as shown in the diagram.

Show that the radius of the circular orbit is given by

$$R = \frac{\sqrt{3}U^2}{g}.$$ **4**

Hence find an expression for the orbital period in terms of U and g. **2**

6) A ride at an amusement park consists of a hollow cylinder of radius 3·5 metres which rotates about its vertical axis of symmetry.



When the angular speed reaches 4 rad s^{-1} the floor is lowered and a person remains in contact with the inner surface of the cylinder without slipping.

What is the minimum coefficient of friction to prevent the person from slipping? **4**