# 18 Worksheet (A2)

Data needed to answer questions can be found in the Data, formulae and relationships sheet.

1 Convert the following angles into radians.

   a   30° [1]
   b   210° [1]
   c   0.05° [1]

2 Convert the following angles from radians into degrees.

   a   1.0 rad [1]
   b   4.0 rad [1]
   c   0.15 rad [1]

3 The planet Mercury takes 88 days to orbit once round the Sun.
Calculate its angular displacement in radians during a time interval of:

   a   44 days [1]
   b   1 day. [1]

4 In each case below, state what provides the centripetal force on the object.

   a   A car travels at a high speed round a sharp corner. [1]
   b   A planet orbits the Sun. [1]
   c   An electron orbits the positive nucleus of an atom. [1]
   d   Clothes spin round in the drum of a washing machine. [1]

5 An aeroplane is circling in the sky at a speed of 150 m s^{-1}.
The aeroplane describes a circle of radius 20 km.
For a passenger of mass 80 kg inside this aeroplane, calculate:

   a   her angular velocity [2]
   b   her centripetal acceleration [3]
   c   the centripetal force acting on her. [2]

6 The diagram shows a stone tied to the end of a length of string.
It is whirled round in a **horizontal** circle of radius 80 cm.
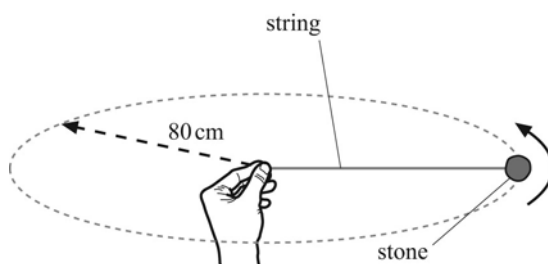
The stone has a mass of 90 g and it completes 10 revolutions in a time of 8.2 s.

   a   Calculate:

      i   the time taken for one revolution [1]
      ii   the distance travelled by the stone during one revolution (this distance is equal to the circumference of the circle) [1]
      iii   the speed of the stone as it travels in the circle [2]
      iv   the centripetal acceleration of the stone [3]
      v   the centripetal force on the stone. [2]

   b   What provides the centripetal force on the stone? [1]
   c   What is the angle between the acceleration of the stone and its velocity? [1]

7   A lump of clay of mass 300 g is placed
close to the edge of a spinning turntable.
The centre of mass of the lump of clay travels
in a circle of radius 12 cm.
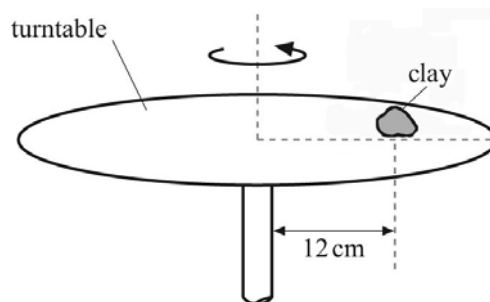
a   The lump of clay takes 1.6 s to complete one revolution.

   i   Calculate the rotational speed of the clay. [2]

   ii Calculate the frictional force between the clay and the turntable. [3]

b   The maximum magnitude of the frictional force F between the clay and the turntable is
70% of the weight of the clay. The speed of rotation of clay is slowly increased.
Determine the speed of the clay when it **just** starts to slip off the turntable. [4]

8   The diagram shows a skateboarder of mass 70 kg who drops through a vertical height
of 5.2 m.
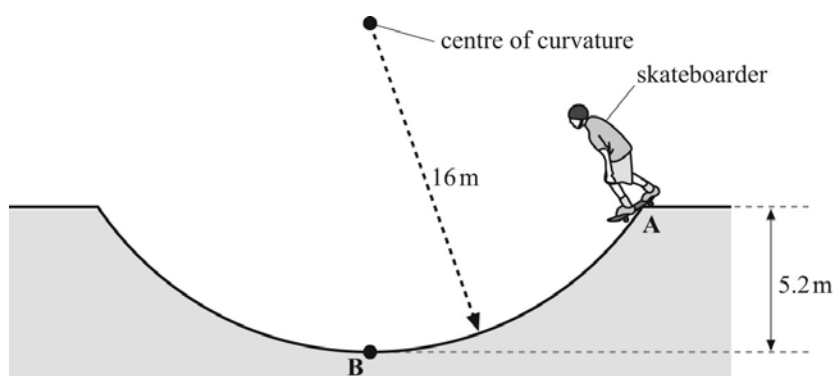
The dip has a radius of curvature of 16 m.

a   Assuming no energy losses due to air resistance or friction, calculate the speed of the
skateboarder at the bottom of the dip at point **B**.
You may assume that the speed of the skateboarder at point **A** is zero. [2]

b   **i**   Calculate the centripetal acceleration of the skateboarder at point **B**. [3]

    ii Calculate the contact force R acting on the skateboarder at point **B**. [3]

9   A car of mass 820 kg travels at a constant speed
of 32 m s^{-1} along a banked track.
The track is banked at an angle of 20°
to the horizontal.
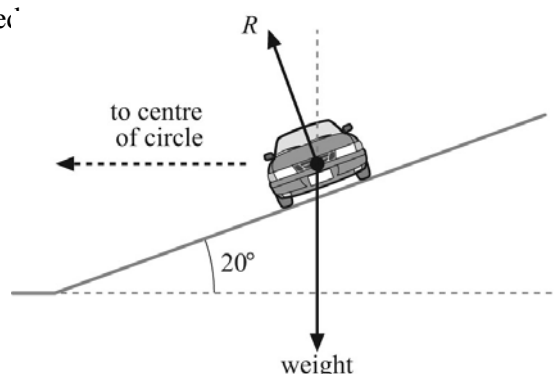
a   The net vertical force on the car is zero.
Use this to show that the contact force R on the car is 8.56 kN. [2]

b   Use the answer from **a** to calculate the radius of the circle described by the car. [4]

10 A stone of mass 120 g is fixed to one end of a light rigid rod.
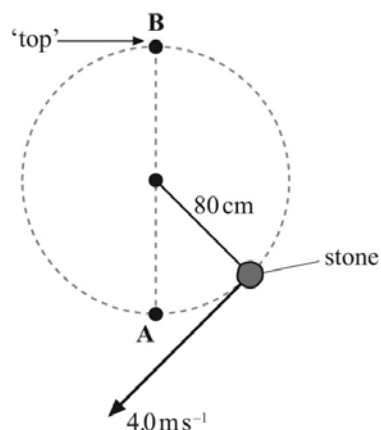
The stone is whirled at a constant speed of 4.0 m s^{-1} in a **vertical** circle of radius 80 cm.

Calculate the ratio: $\dfrac{\text{tension in the rod at } \mathbf{A}}{\text{tension in the rod at } \mathbf{B}}$ [6]

Total: ———— 59   Score: %