3 Worksheet

acceleration of free fall $g = 9.81\ \text{m s}^{-2}$

Intermediate level

1 Convert the following angles into radians.
- **a** 30° [1]
- **b** 210° [1]
- **c** 0.05° [1]

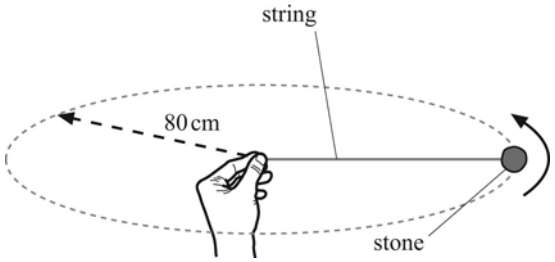
2 Convert the following angles from radians into degrees.
- **a** 1.0 rad [1]
- **b** 4.0 rad [1]
- **c** 0.15 rad [1]

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 $150\ \text{m s}^{-1}$.
The aeroplane describes a circle of radius 20 km.
For a passenger of mass 80 kg inside this aeroplane, calculate:
- **a** her centripetal acceleration [3]
- **b** 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.

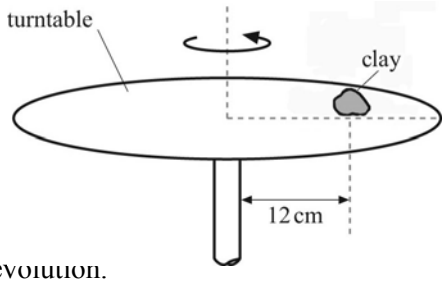


The stone has a mass of 90 g and it completes 10 revolutions in a time of 8.2 s.
- **a** Calculate:
  - **i** the time taken for one revolution [1]
  - **ii** the distance travelled by the stone during one revolution [1]
  - **iii** the speed of the stone as it travels in the circle [2]
  - **iv** the 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]

This distance is equal to the circumference of the circle.

Higher level

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.



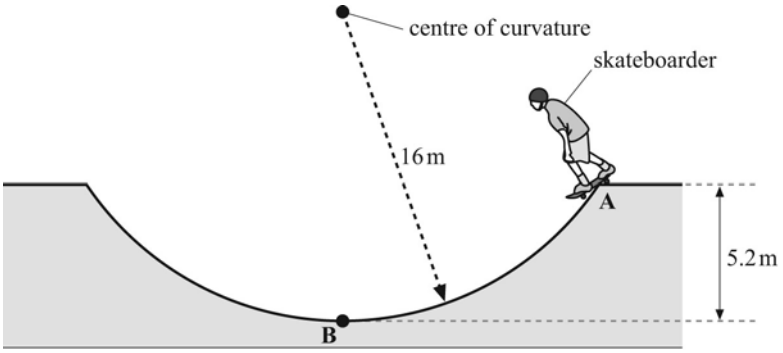
a The lump of clay takes 1.6 s to complete one revolution.

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.

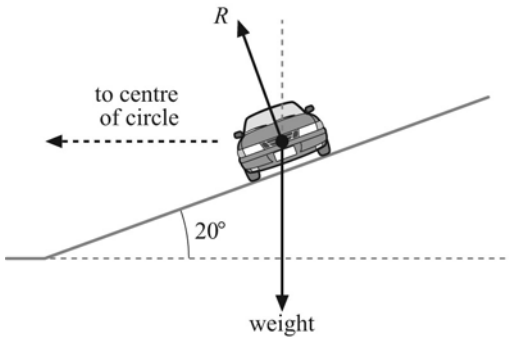
a Assuming no energy losses due to air resistance or friction, calculate the speed of the skateboarder at the bottom of the dip at point **B**.
You may assume that the speed of the skateboarder at point **A** is zero. [2]

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]

Extension

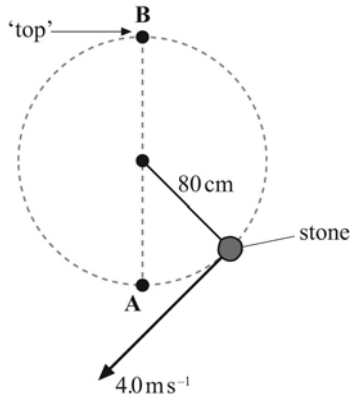
9 A car of mass 820 kg travels at a constant speed of 32 m s^{-1} along a banked track. The track is banked at an angle of 20° to the horizontal.



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: _____ Score: %
57