# Unit 6 · Circular Motion

WORKSHEET

Full marks 32

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 32

## 1 Key words [4]

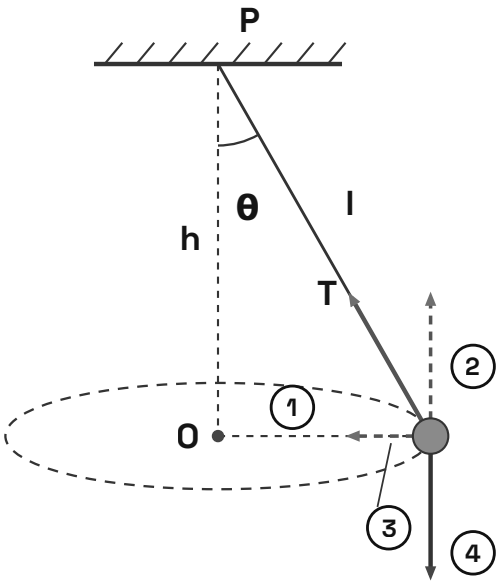
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

| | | | | |
|---|---|---|---|---|
| **angular velocity** | **banking** | **centrifugal force** | **centripetal force** | **critical velocity** |
| **frequency** | **hertz** | **period** | **radians** | **tangential** |

The angle turned through by the radius of a body moving in a circle, divided by the time taken, is its _____, measured in _____ per second. The time for one full turn is the _____, and the number of turns in one second is the _____. A body in a circle needs a resultant force towards the center, the _____. The outward push felt in a turning bus is a pseudo-force, the _____. Raising the outer edge of a road at a bend is called _____. The least speed at the top of a vertical circle, for the string to stay tight, is the _____.

## 2 Label the diagram [2]

The diagram shows a conical pendulum: a bob moving round a horizontal circle on a string. Write the force, component or length that belongs in place of 1 to 4. Each carries 0.5 mark.




**1.** _____ **2.** _____

**3.** _____ **4.** _____

## 3 Multiple choice [5]

Choose the correct option for each of the following questions.

**i.** The SI unit of angular velocity is: [1]

**a.** m/s
**b.** rad/s
**c.** rad/s$^2$
**d.** rev

**ii.** A stone whirled on a string in a horizontal circle is suddenly let go. It moves off: [1]

**a.** towards the center of the circle
**b.** straight outward, along the radius
**c.** along the tangent to the circle at the point where it was let go
**d.** round the same circle

**iii.** A wheel turns at 300 revolutions per minute. Its angular velocity is about: [1]

**a.** 5 rad/s
**b.** 31.4 rad/s
**c.** 300 rad/s
**d.** 1885 rad/s

**iv.** A car goes round a bend of radius 100 m at 20 m/s. Its centripetal acceleration is: [1]

**a.** 0.2 m/s$^2$
**b.** 2 m/s$^2$
**c.** 4 m/s$^2$
**d.** 2000 m/s$^2$

**v.** A stone on a string goes round a vertical circle at exactly the critical velocity. At the top of the circle, the tension in the string is: [1]

**a.** zero
**b.** equal to the stone's weight
**c.** twice the stone's weight
**d.** six times the stone's weight

## 4 Short answers [7]

Write short answers to the following questions.

**a.** When a bus turns sharply, the passengers seem to be thrown outward. Is there really an outward force on them? Explain. [2]

**b.** Why does a cyclist lean inwards when going round a bend? [2]

**c.** On a level bend of radius 50 m, the coefficient of friction between the tyres and the road is 0.5. Find the greatest speed, in km/h, at which a car can take the bend without skidding. ($g = 9.8\ m/s^2$) **[3]**

## 5 Long answer **[4]**

Write a long answer to the following question.

A stone of mass m goes round a vertical circle of radius r on a string, just fast enough to keep the string tight at the top. Using the conservation of energy, show that its speed at the bottom must be at least $\sqrt{5gr}$, and find the tension in the string at the bottom then.

## 6 Numerical problems **[7]**

Solve the following problems. Show your working. Take $g = 9.8\ m/s^2$.

**a.** A conical pendulum has a bob of mass 0.2 kg on a string 1.0 m long, which makes 30° with the vertical. Find i. the tension in the string, ii. the radius of the circle and the bob's speed, and iii. the time for one turn. **[4]**

**Answer:**

**b.** Bishal swings a 2 kg bucket of water in a vertical circle of radius 0.9 m. Find the least speed it must have at the top so that the water doesn't fall out, and the least speed at the bottom. **[3]**

**Answer:** _____

## 7 Think **[3]**

A stone is whirled in a vertical circle on a string. Describe the stone's path if the string breaks i. at the very top of the circle, and ii. at the very bottom.

## 8 Activity: Centripetal force with a string (not marked)

Pass a string through a ballpoint pen's empty tube. Tie a rubber stopper to the top end and a bunch of keys to the bottom end. Hold the tube and whirl the stopper in a horizontal circle so that the keys hang still. Mark the string to set the radius, and time 20 turns.

| Radius r (m) | Time for 20 turns (s) | Period T (s) | Speed $v = 2\pi r/T$ (m/s) | $v^2/r$ ($m/s^2$) |
|---|---|---|---|---|
| 0.20 | | | | |
| 0.30 | | | | |
| 0.40 | | | | |

The keys' weight is the same each time. What do you notice about $v^2/r$?