LONDON SCIENCE COLLEGE

Name:

Date:

CIRCULAR MOTION
TEST 1

A2-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 The Hubble space telescope was launched in 1990 into a circular orbit near to the Earth. It travels around the Earth once every 97 minutes.

(a) Calculate the angular speed of the Hubble telescope, stating an appropriate unit.

answer = _____

(3)

(b) (i) Calculate the radius of the orbit of the Hubble telescope.

answer = _____ m

(3)

(ii) The mass of the Hubble telescope is 1.1×10^4 kg. Calculate the magnitude of the centripetal force that acts on it.

answer = _____ N

(2)

(Total 8 marks)

2 In a football match, a player kicks a stationary football of mass 0.44 kg and gives it a speed of 32 m s^{-1}.

(a) (i) Calculate the change of momentum of the football.

_____

(ii) The contact time between the football and the footballer's boot was 9.2 m s. Calculate the average force of impact on the football.

_____

_____

_____

(3)

(b) A video recording showed that the toe of the boot was moving on a circular arc of radius 0.62 m centred on the knee joint when the football was struck. The force of the impact slowed the boot down from a speed of 24 m s^{-1} to a speed of 15 m s^{-1}.

Figure 1

(i) Calculate the deceleration of the boot along the line of the impact force when it struck the football.

_____

_____

_____

(ii) Calculate the centripetal acceleration of the boot just before impact.

_____

_____

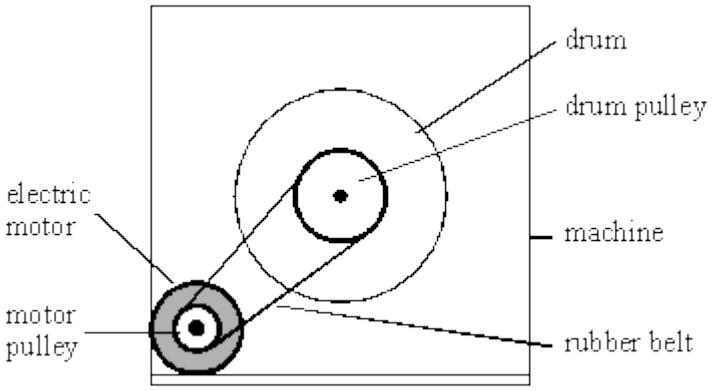
_____

(iii) Discuss briefly the radial force on the knee joint before impact and during the impact.

(4)

(Total 7 marks)

3 An electric motor in a machine drives a rotating drum by means of a rubber belt attached to pulleys, one on the motor shaft and one on the drum shaft, as shown in the diagram below.



(a) The pulley on the motor shaft has a diameter of 24 mm. When the motor is turning at 50 revolutions per second, calculate

(i) the speed of the belt,

(ii) the centripetal acceleration of the belt as it passes round the motor pulley.

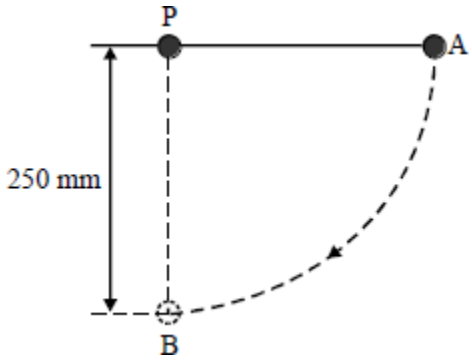
(5)

(b) When the motor rotates at a particular speed, it causes a flexible metal panel in the machine to vibrate loudly. Explain why this happens.

(2)

(Total 7 marks)

4



A 150 g mass is attached to one end of a light inextensible string and the other end of the string is fixed at a point P as shown in the diagram above. The mass is held at point A so that the string is taut and horizontal. The mass is released so that it moves freely along a circular arc of 250 mm radius.

When the string moves through the vertical position, the mass is at point B. Neglecting the effect of air resistance, calculate

(a) the kinetic energy of the mass,

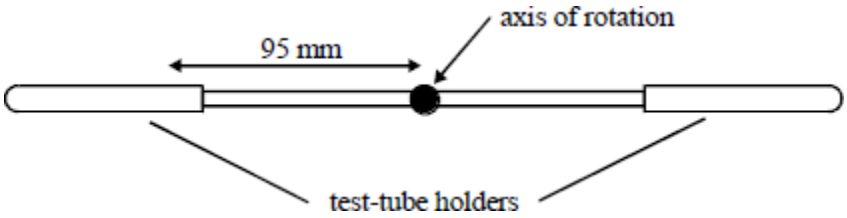
(b) the velocity of the mass,

(c) the centripetal force acting on the mass,

(d) the tension in the string.

(Total 6 marks)

5 A chemical centrifuge consists of two test-tube holders which can be spun round in a horizontal circular path at very high speed as shown. The centrifuge runs at a steady speed of 3000 revolutions per minute and the test-tube holders are horizontal.



(a) Calculate the angular speed of the centrifuge in rad s^{-1}.

(b) Calculate the magnitude of the acceleration at a point on the centrifuge 95 mm from the axis of rotation.

_____

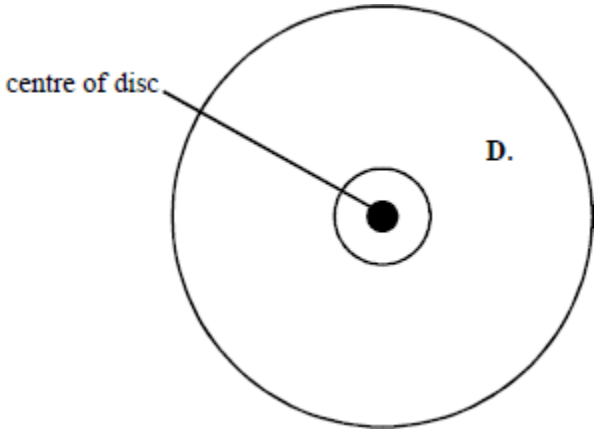
_____

(c) State the direction of the acceleration in part (ii).

_____

(Total 5 marks)

6 The figure below shows a dust particle at position **D** on a rotating vinyl disc. A combination of electrostatic and frictional forces act on the dust particle to keep it in the same position.



The dust particle is at a distance of 0.125 m from the centre of the disc. The disc rotates at 45 revolutions per minute.

(a) Calculate the linear speed of the dust particle at **D**.

(3)

(b) (i) Mark on the diagram above an arrow to show the direction of the resultant horizontal force on the dust particle.

(1)

(ii) Calculate the centripetal acceleration at position **D**.

(2)

(c) On looking closely at the rotating disc it can be seen that there is more dust concentrated on the inner part of the disc than the outer part. Suggest why this should be so.

_____

_____

_____

_____

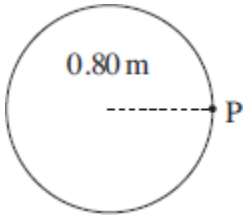
_____

_____

(3)

(Total 9 marks)

7 A model car moves in a circular path of radius 0.80 m at an angular speed of $\frac{\pi}{2}$ rad s^{-1}.



What is its displacement from point P 6.0 s after passing P?

A zero

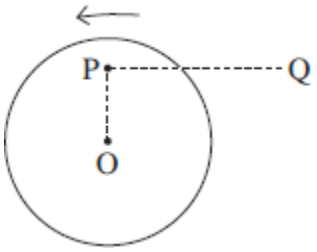
B 0.4π m

C 1.6 m

D 1.6π m

(Total 1 mark)

8 A small mass is placed at P on a horizontal disc which has its centre at O. The disc rotates anti-clockwise about a vertical axis through O with constant angular speed.



Which one of the following describes the force which keeps the mass at rest relative to the disc when in the position shown?

A the weight of the mass

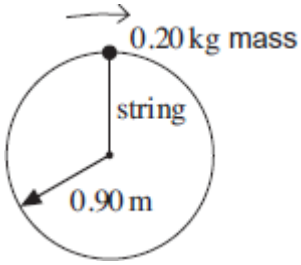
B a frictional force from P to Q

C a frictional force directed away from O

D a frictional force directed towards O

(Total 1 mark)

9 A 0.20 kg mass is whirled round in a vertical circle on the end of a light string of length 0.90 m.



At the top point of the circle the speed of the mass is 8.2 m s^{-1}. What is the tension in the string at this point?

A 10 N

B 13 N

C 17 N

D 20 N

(Total 1 mark)

10 The wheel of the London Eye has a diameter of 130 m and rotates at a steady speed, completing one rotation every 30 minutes. What is the centripetal acceleration of a person in a capsule at the rim of the wheel?

A 1.2×10^{-4} ms^{-2}

B 2.5×10^{-4} ms^{-2}

C 3.9×10^{-4} ms^{-2}

D 7.9×10^{-4} ms^{-2}

(Total 1 mark)

11 A small body of mass m rests on a horizontal turntable at a distance *r* from the centre. If the maximum frictional force between the body and the turntable is $\frac{mg}{2}$, what is the angular speed at which the body starts to slip?

A $\sqrt{\frac{gr}{2}}$

B $\frac{g}{r}$

C $\sqrt{\frac{g}{2r}}$

D $\frac{1}{2}\sqrt{\frac{g}{r}}$

(Total 1 mark)

12 A body of mass 0.50 kg, fixed to one end of a string, is rotated in a vertical circle of radius 1.5 m at an angular speed of 5.0 rad s^{-1}. What is the maximum tension in the string?

A 5.0 N

B 9.0 N

C 14 N

D 24 N

(Total 1 mark)

13 For a particle moving in a circle with uniform speed, which one of the following statements is **incorrect?**

A There is no displacement of the particle in the direction of the force.

B The force on the particle is always perpendicular to the velocity of the particle.

C The velocity of the particle is constant.

D The kinetic energy of the particle is constant.

(Total 1 mark)

14 A revolving mountain top restaurant turns slowly, completing a full rotation in 50 minutes. A man is sitting in the restaurant 15 m from the axis of rotation. What is the speed of the man relative to a stationary point outside the restaurant?

A $\frac{\pi}{100}$ m s^{-1}

B $\frac{3\pi}{5}$ m s^{-1}

C $\frac{\pi}{200}$ m s^{-1}

D $\frac{\pi}{1500}$ m s^{-1}

(Total 1 mark)