6.1 Circular Motion

Question Paper

Course	DP IB Physics
Section	6. Circular Motion & Gravitation
Topic	6.1 Circular Motion
Difficulty	Easy

Time allowed: 80

Score: /65

Percentage: /100

Question 1a

A bung is attached to a rope and a person swings the bung around their head. The bung moves in a horizontal circular path.

(a)
Circle four options from the list below, which are properties of all objects moving in a circle.

Period Heat energy Electricity Frequency Decay constant

Angular displacement Capacitance Angular speed Strangeness

[4]

[4 marks]

Question 1b

The length of the rope is r, and the bung is moving with velocity v. It is acted upon by force F.

(b)
Sketch the shape of the bung's path, labelling r, v and F.

[3]

[3 marks]

Question 1c

The bung travels though an angular displacement of $\frac{\pi}{8}$ rad.

(c)
Convert the angular displacement into degrees.

[3]

[3 marks]

Question 1d

It takes 0.5 s for the bung to complete one revolution. The radius of its circular path is 0.75 m.

(d)

(i)
Calculate the angular speed of the bung.

[4]

(ii)
Calculate the linear speed of the bung.

[2]

[6 marks]

Question 2a

A car is moving with uniform circular motion and experiences a centripetal force.

(a)

(i)
Define centripetal force.

[3]

(ii)
State the type of force which is responsible for the centripetal force on the car.

[1]

[4 marks]

Question 2b

The car has mass 500 kg and is travelling around a roundabout with a linear speed of 9 m s^{-1}. The radius of the roundabout is 12 m.

(b)
Determine the centripetal force acting on the car.

[2]

[2 marks]

Question 2c

The car proceeds to another roundabout which has radius 20 m. The angular speed of the car at this roundabout is 0.2 rad s^{-1}.

(c)
Calculate the centripetal acceleration of the car around this roundabout.

[3]

[3 marks]

Question 2d

At this second roundabout, the car is travelling at the maximum speed possible before it would skid. The coefficient of static friction determines the maximum speed possible and is given by $\mu_s = \frac{\omega^2 r}{g}$, where ω is the angular speed, r is the radius of the roundabout, and g is the acceleration due to gravity.

(d)
Determine the co-efficient of static friction between the tyres and the road.

[2]

[2 marks]

Question 3a

A planet orbits a star in 260 Earth days, which is 22 464 000 s.

(a)

(i)
State the angular displacement of the planet in 260 days, giving an appropriate unit with your answer.

[2]

(i)
Calculate the angular speed of the planet.

[4]

[6 marks]

Question 3b

The linear speed of the planet is 35 000 $m\,s^{-1}$.

(b)
Calculate the radius of the planet's orbit.

[2]

[2 marks]

Question 3c

The planet has a mass of 2.7×10^{24} kg and stays in orbit due to a centripetal force.

(c)
Calculate the centripetal force required to keep the planet in orbit.

[2]

[2 marks]

Question 3d

The planet experiences a centripetal acceleration.

(d)

(i)
Define uniform centripetal acceleration

[3]

(ii)
Determine the centripetal acceleration experienced by the planet.

[2]

[5 marks]

Question 4a

A fairground ride is moving with uniform circular motion.

(a)

(i)
Define angular displacement.

[2]

(ii)
Define angular speed.

[1]

[3 marks]

Question 4b

A child on the ride has an angular displacement of $\frac{\pi}{2}$ rad and angular speed of 0.3 rad s^{-1}.

(b)
Calculate the time required for the child to have this angular displacement.

[4]

[4 marks]

Question 4c

The radius of the ride is 8 m and the child's mass is 35 kg.

(c)
Determine the centripetal force on the child.

[2]

[2 marks]

Question 4d

(d)

(i)
Calculate the child's linear speed.

[2]

(ii)
Calculate the child's centripetal acceleration.

[2]

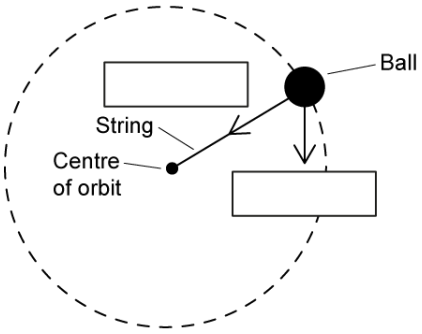
[4 marks]

Question 5a

The diagram shows the bath of a ball with two forces acting on it. The ball is attached to a string and is swung in a circle in a vertical plane. Air resistance is negligible.

(a)

(i)
Label the forces marked on the diagram below:



[2]

(ii)
State which of these forces provides the centripetal force on the ball.

[1]

[3 marks]

Question 5b

The centripetal force on the ball is not constant as the ball travels along its circular path.

(b)
Circle the correct words in the sentences below:

The **maximum / minimum** magnitude of centripetal force is found at the bottom of the circular path.
The **maximum / minimum** magnitude of centripetal force is found at the top of the circlular path.

[2]

[2 marks]

Question 5c

The radius of the circle is 0.8 m, the mass of the ball is 0.5 kg and the linear velocity is 2.4 m s^{-1}.

(c)
Calculate the centripetal force at the bottom of its circular path.

[3]

[3 marks]

Question 5d

The speed and acceleration of the ball varies as it moves around its circular path.

(d)
Circle the correct words in the sentences below:

The speed of the ball at the bottom of the circular path will be **faster / slower** than at the top.

The acceleration at the bottom of the circular path will be at a **minimum / maximum** compared to the top.

[2]

[2 marks]