6.1 Circular Motion

Question Paper

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

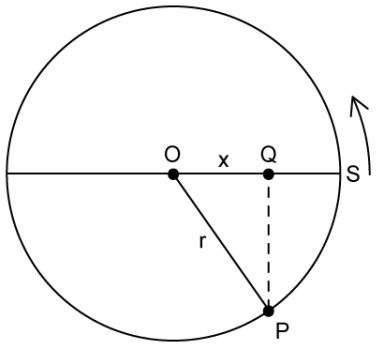
Time allowed: 20

Score: /10

Percentage: /100

Question 1

A particle rotates clockwise in a horizontal circle of radius r with a constant angular velocity ω. The particle is at S at time zero and at P at time t. Q represents the projection of point P onto the diameter through S. Measured with respect to the centre of orbit O, the displacement, linear velocity and linear acceleration of Q along OS are x, v and a respectively.



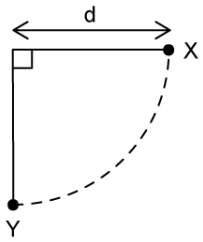
Which of the following sets of expressions is correct?

	x	v	a
A.	$r\cos\omega t$	$-r\omega\sin\omega t$	$r\omega^2\cos\omega t$
B.	$r\cos\omega t$	$-r\omega\sin\omega t$	$-r\omega^2\cos\omega t$
C.	$r\sin\omega t$	$-r\omega\cos\omega t$	$-r\omega^2\sin\omega t$
D.	$r\sin\omega t$	$r\omega\cos\omega t$	$r\omega^2\sin\omega t$

[1 mark]

Question 2

A simple pendulum consists of a bob of mass *m* at the end of a light inextensible thread of length *d*. The bob swings through point Y with velocity *v* and comes to an instantaneous rest at point X, where the string is just taut.



What is the tension in the thread as the bob passes point Y?

A. *mg*

B. 2*mg*

C. 3*mg*

D. 4*mg*

[1 mark]

Question 3

A particle travels in a circular path in a magnetic field with radius *x* and centripetal acceleration *a*.

What is the time taken for 15 complete rotations?

A. $2\pi\sqrt{\frac{x}{a}}$

B. $30\pi\sqrt{\frac{x}{a}}$

C. $2\pi\sqrt{\frac{a}{x}}$

D. $30\pi\sqrt{\frac{a}{x}}$

[1 mark]

Question 4

A mass m_1 is attached to one end of a light extensible string of length x. When the mass rotates with a linear speed v in a horizontal plane, an extension Δx is obtained.

Which of the following shows the correct expression for another mass m_2, if it is attached to the same light extensible string and rotated with the same linear speed v but rotates at twice the radius as that produced by m_1?

A. $m_2 = \dfrac{2m_1(x + \Delta x)}{\Delta x}$

B. $m_2 = \dfrac{2m_1(2x + \Delta x)}{\Delta x}$

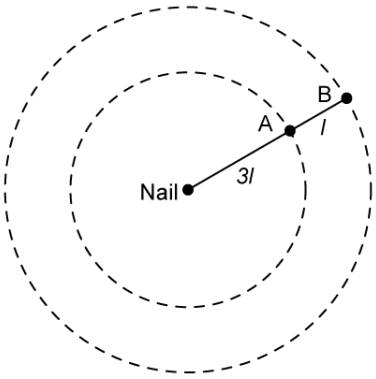
C. $m_2 = \dfrac{4m_1(x + \Delta x)}{\Delta x}$

D. $m_2 = \dfrac{2m_1(x + 2\Delta x)}{\Delta x}$

[1 mark]

Question 5

Two bobs A and B, of equal mass, are connected by a light inextensible string of length l.



Bob A is tied to a nail at the centre of a smooth table by another light, inextensible string of length $3l$. The bobs are then set into uniform motion on the surface of the table with the same angular velocity.

What is the ratio of the tension in the string connecting bob A and B to that in the string connecting bob A to the nail?

A. 1:2

B. 3:4

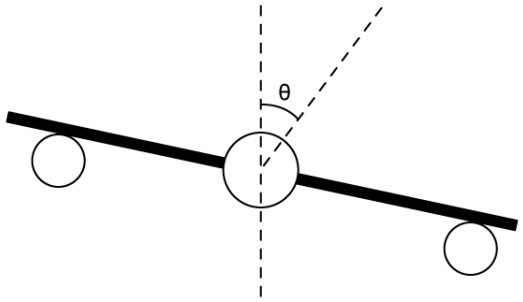
C. 4:7

D. 4:9

[1 mark]

Question 6

An aircraft moves in a horizontal plane at a constant linear speed *v* and makes a turn of radius *r*.



Which of the following expressions is true for the tilt angle θ?

You may wish to use the relationship:

$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

A. $\theta \propto r$

B. $\theta \propto \frac{1}{r}$

C. $\tan\theta \propto r$

D. $\tan\theta \propto \frac{1}{r}$

[1 mark]

Question 7

The maximum speed for a car to safely move round a corner when the road is dry is 10 m s^{-1}. The maximum frictional force between the road surface and the wheels of the car is halved when the road is wet.

What is the maximum safe speed for a car to go round the corner when the road is wet?

A. $\sqrt{2}$ m s^{-1}

B. $2\sqrt{2}$ m s^{-1}

C. $5\sqrt{2}$ m s^{-1}

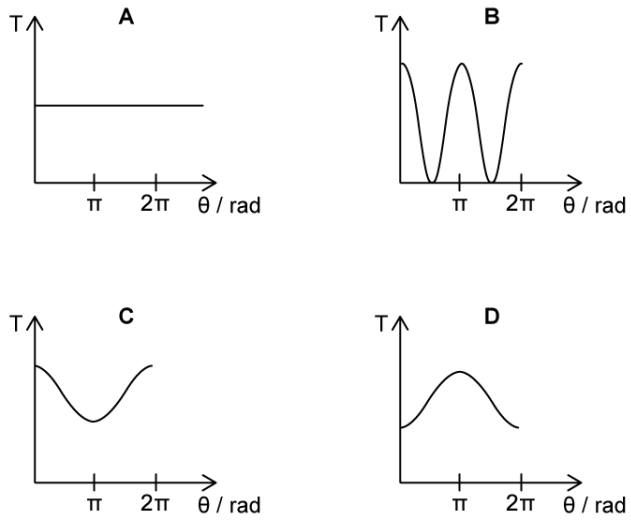
D. $10\sqrt{2}$ m s^{-1}

[1 mark]

Question 8

A conker attached to a string is whirled in a vertical circle at constant speed.

Which of the following correctly shows the variation of the tension T in the string with the angular displacement θ?



[1 mark]

Question 9

A small object is attached to a string and whirled in a vertical circle at a constant speed. The magnitude of the net force F on the object at the top of the circle is given by:

$$F_{top} = T + mg$$

Where T is the tension in the string, m is the object's mass and g is the acceleration of free fall.

The magnitude of the net force on the object at the bottom of the circle is given by:

$$F_{bottom} = T - mg$$

Which of the following statements is correct?

A. The net force on the object at the bottom of the loop is greater than the net force at the top

B. The net force on the object decreases as the object moves from the bottom to the top of the loop

C. The net force on the object at the top of the loop is greater than the net force at the bottom

D. The net force on the object is the same at the top and at the bottom of the loop

[1 mark]

Question 10

Two masses m_1 and m_2 are fixed on a horizontal circular rotating platform. m_2 is half as massive as m_1 and is fixed at a distance three times as far from the centre as m_1. The net force on m_1 is F_1 and the net force on m_2 is F_2.

Which of the following statements is correct?

A. $F_1 = \frac{1}{2}F_2$

B. $F_1 = \frac{1}{3}F_2$

C. $F_1 = \frac{2}{3}F_2$

D. $F_1 = 2F_2$

[1 mark]