

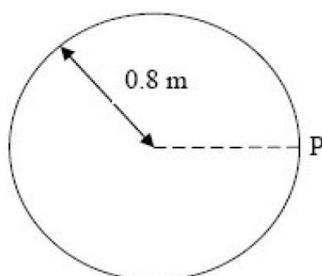
Circular Motion

MCQ

- 1 A carousel makes 8 revolutions in 1.0 minute. What is the angular velocity of the carousel?

A 0.13 rad s^{-1} B 0.84 rad s^{-1} C 8.0 rad s^{-1} D 50 rad s^{-1}

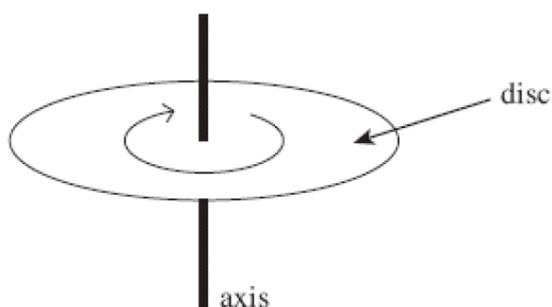
- 2 A model car moves in a circular path of radius 0.80 m at an angular speed of $\pi/2 \text{ rad s}^{-1}$.



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

A zero B 1.6 m C $0.4 \pi \text{ m}$ D $1.6 \pi \text{ m}$

- 3 The diagram shows a disc of diameter 120 mm that can turn about an axis through its centre.



The disc is turned through an angle of 30° in 20 ms. What is the average speed of a point on the edge of the disc during this time?

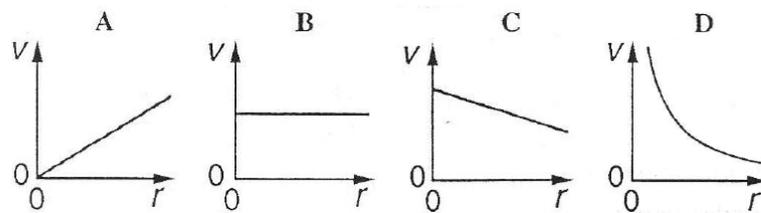
A $0.5 \pi \text{ m s}^{-1}$ B $\pi \text{ m s}^{-1}$ C $1.5 \pi \text{ m s}^{-1}$ D $2 \pi \text{ m s}^{-1}$

- 4 A disc is rotating about an axis through its centre and perpendicular to its plane. A point P on the disc is twice as far from the axis as a point Q. At a given instant, what is the ratio of the linear velocity at P to the linear velocity at Q?

A 4 B 2 C 1/2 D 1/4

- 5 A record on a turntable is rotating at a constant number of revolutions per second.

Which graph best represents the relation between the speed v of a point on the record and his distance r from the centre of rotation?



- 6 A particle travels in uniform circular motion. Which of the following correctly describes the linear velocity, angular velocity and centripetal acceleration of the particle?

| | <i>linear velocity</i> | <i>angular velocity</i> | <i>centripetal acceleration</i> |
|----------|------------------------|-------------------------|---------------------------------|
| A | constant | constant | varying |
| B | varying | varying | varying |
| C | varying | constant | varying |
| D | varying | constant | constant |

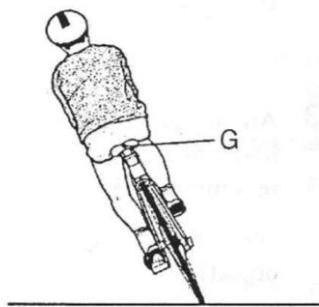
- 7 A student is sitting on the right-hand side in a bus, facing the direction of travel. The bus goes round a bend to the left. The student remains in the same position within the bus. What does the student experience?

A A force to the left and a force to the right
 B A resultant force to the left
 C A resultant force to the right
 D No resultant force

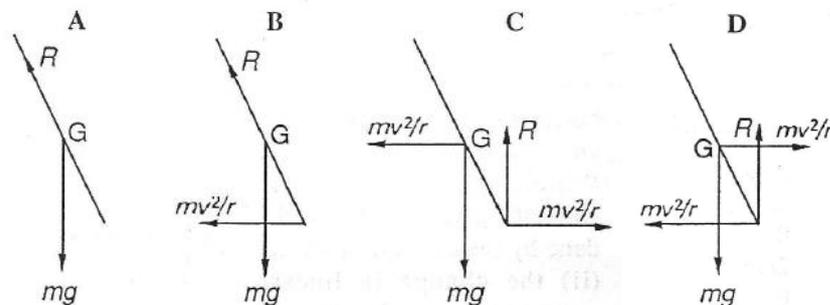
- 8 A racing car of mass 1200 kg travels at 31.5 m s^{-1} around a bend of radius 50 m. What is the force on the car necessary for this motion?

A $2.4 \times 10^4 \text{ N}$ away from the centre of the circle
 B $2.4 \times 10^4 \text{ N}$ towards the centre of the circle
 C $3.8 \times 10^4 \text{ N}$ away from the centre of the circle
 D $3.8 \times 10^4 \text{ N}$ towards the centre of the circle

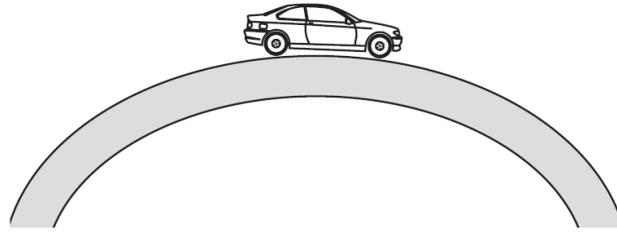
- 9 A young child of mass 20 kg stands at the centre of a uniform horizontal platform which rotates at a constant angular speed of 3.0 rad s^{-1} . The child begins to walk radially outwards towards the edge of the platform. The maximum frictional force between the child and the platform is 200 N. What is the maximum distance from the centre of the platform to which the child could walk without the risk of slipping?
- A 1.1 m B 1.3 m C 1.5 m D 1.7 m
- 10 The maximum safe speed of a car rounding an unbanked corner is 20 m s^{-1} when the road is dry. 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 the car to round the corner when the road is wet?
- A 5.0 m B 7.1 m C 10 m D 14 m
- 11 The diagram represents a cyclist making a left turn on a rough road surface at constant speed v , as viewed from behind. The total mass of the bicycle and rider is m and their combined centre of gravity is at G.



If R is the resultant force of the normal contact force and the frictional force, which vector diagram represents the directions of the forces acting on the bicycle and its rider?

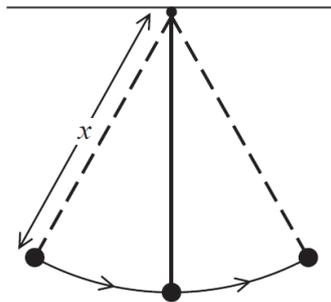


- 12 A car, mass m , drives over a circular hump-back bridge of radius r with a constant speed v .



When it is at the top of the bridge, what is the force on the car from the bridge?

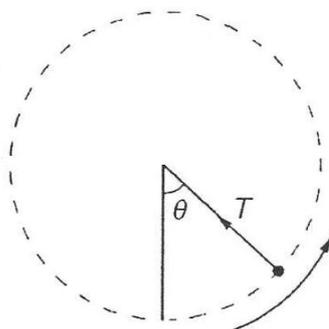
- A mg B $mv^2/r + mg$ C $mv^2/r - mg$ D $mg - mv^2/r$
- 13 A pendulum consists of a bob of mass m and a string of length x . The diagram shows the pendulum swinging through the arc of a circle. At the bottom of its swing the tension in the string is T and the velocity of the bob is v .



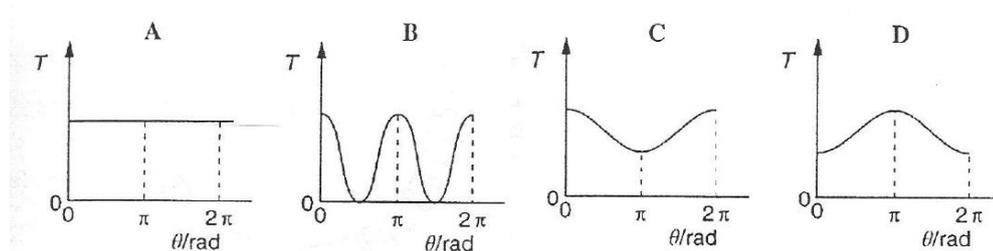
What is the tension acting on the bob at the bottom of the swing?

- A $mv^2/x - mg$ B $mv^2/x + mg$ C $mg - mv^2/x$ D mv^2/x

- 14 An object is fixed to one end of a light rod which rotates in a vertical circle at constant speed.



Which graph could represent the variation of tension T in the rod with angle θ ?



- 15 When the aircraft Concorde is moving in a horizontal plane at a constant speed of 650 m s^{-1} , its turning circle has a radius of 80 km. What is the ratio of the centripetal force to the weight of the aircraft?

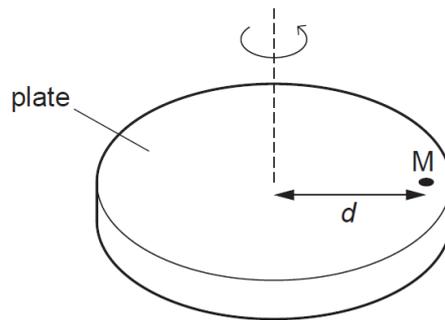
- A 0.53 B 1.9 C 52 D 540

Structured Questions

- 16 A coin, mass 10 g, is placed on a horizontal turntable. The turntable is observed to make 3 revolutions in π seconds.

- (a) Calculate the speed of the coin when it is at a distance 5.0 cm from the centre of the turntable.
- (b) What is the acceleration of the coin in (a)?
- (c) What is the frictional force acting on the coin?

- 17** The moon takes 27.3 days to complete a revolution around the Earth and the radius of orbit is 3.83×10^8 m. Calculate the following quantities of the Moon
- (a) the angular velocity,
 - (b) the speed and
 - (c) the centripetal acceleration.
- 18** A horizontal flat plate is free to rotate about a vertical axis through its centre, as shown below.



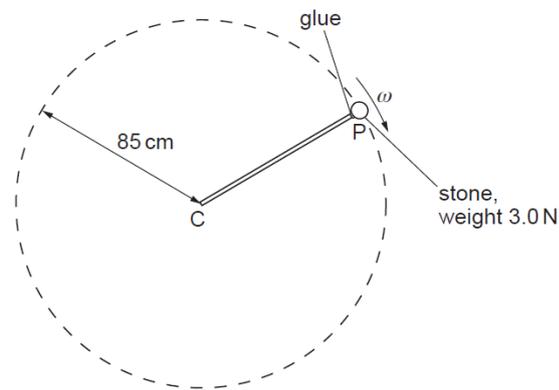
A small mass M is placed on the plate, a distance d from the axis of rotation. The speed of rotation of the plate is gradually increased from zero until the mass is seen to slide off the plate.

The maximal frictional force F between the plate and the mass is given by the expression $F = 0.72 W$, where W is the weight of the mass M . The distance d is 35 cm.

- (a) Determine the maximum angular velocity for the mass M to remain on the plate.
- (b) The plate in (a) is covered, when stationary, with mud.

Suggest and explain whether mud near the edge of the plate or near the centre will first leave the plate as the angular speed of the plate is slowly increased.

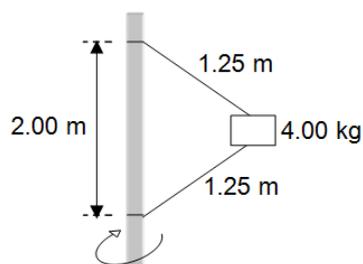
- 19** A stone of weight 3.0 N is fixed, using glue, to one end P of a rigid rod CP, as shown below.



The rod is rotated about end C so that the stone moves in a vertical circle of radius 85 cm. The angular speed ω of the rod and stone is gradually increased from zero until the glue snaps. The glue fixing the stone snaps when the tension in it is 18 N.

For the position of the stone at which the glue snaps,

- (a) on the dotted circle of the figure above, mark with the letter S the position of the stone,
- (b) calculate the angular speed ω of the stone
- 20** A 4.00 kg mass is attached to a vertical rod by means of two cords. When the system rotates about the axis of the rod, the cords are extended as shown in the figure below and the tension in the upper cord is 70.0 N.



- (a) Show that the tension in the lower cord is 20.0 N.
- (b) Determine the number of revolutions the system makes in one minute.
- (c) Find the angular velocity at which the lower cord just goes slack. Assume that the tension in the upper cord does not change.
- (d) Explain qualitatively what happens if the angular velocity is less than that calculated in (c).

Answers

MCQ

BBABA CBBAD ADBCA

Structured Questions

- 16 (a) 0.30 m s^{-1}
- (b) 1.8 m s^{-2}
- (c) 0.018 N
- 17 (a) $2.66 \times 10^{-6} \text{ rad s}^{-1}$
- (b) 1000 m s^{-1}
- (c) $2.72 \times 10^{-3} \text{ m s}^{-2}$
- 18 (a) 4.5 rad s^{-1}
- (b) The mud near the edge will leave the plate first. Centripetal force increases as the distance from the axis of rotation increases given the same angular velocity and mass. Therefore, mud near the edge will require a greater centripetal force to keep it on the plate and will leave the plate first.
- 19 (a) Directly below C
- (b) 7.7 rad s^{-1}
- 20 (b) 40.5 revolutions
- (c) 3.74 rad s^{-1}
- (d) As angular velocity decreases, tension in the upper cord will decrease due to a drop in the centripetal force required to keep the mass moving in a circle. In addition, as tension in the upper cord decreases, the angle which the upper cord makes with the vertical will also decrease in order for the vertical component of the upper cord tension to balance the weight, which is unchanged.