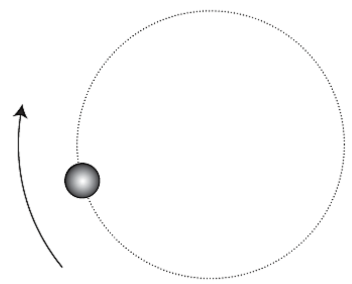
MECHANICS: CIRCULAR MOTION QUESTIONS

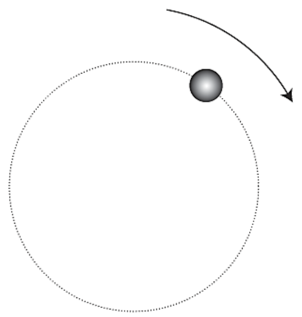
THROWING THE DISCUS - PART 1 (2010;1)

James is preparing to throw a discus by swinging it in a horizontal circle. The diagram below shows the path of the discus moving clockwise as seen from above.



(a) Draw **two labelled arrows** on the diagram above to show the **velocity and acceleration** of the discus at the instant shown.

(b) James releases the discus at the position shown in the diagram below. Draw an arrow showing the direction the discus travels. Explain why the discus then travels in the direction you have drawn



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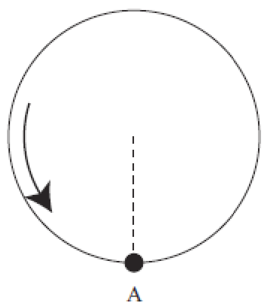
(c) Before throwing the discus, James swings it round in a horizontal circle at a constant speed of 11 ms^{-1}. The mass of the discus is 2.1 kg, and at one time he applies a horizontal force of 290 N to it. Calculate the radius of the discus's circular path.

CIRCULAR MOTION (2009;1)

Jordan ties a ball on a string and swings it in a horizontal circle in an anticlockwise direction, as shown below.

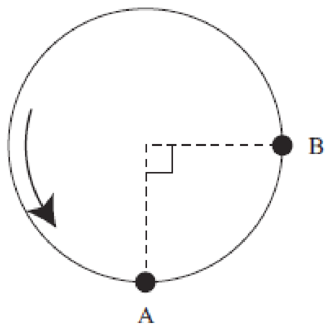


(a) On the diagram above, draw a labelled arrow to show the direction of acceleration of the ball at position A.

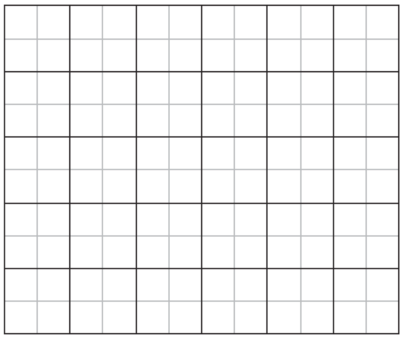
The ball continues to move at a constant speed of 5.0 ms^{-1} in a circular path. The radius of the circle is 1.59 m.

(b) Calculate the centripetal acceleration of the ball.

The diagram below shows the path of the ball as it swings from position A to position B.

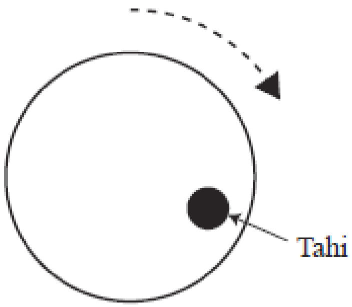


(c) On the diagram above draw arrows to indicate the direction of the velocity of the ball at each of the positions A and B. Hence, calculate the size and direction of the change in velocity of the ball as it swings from position A to position B. The ball is moving at a constant speed of 5.0 ms^{-1}. Show your working clearly. Draw a vector diagram to justify your calculations.



GOING TO THE PLAYGROUND (2008;2)

Tahi and Rua are at the playground. Tahi is sitting on a merry-go-round that is spinning clockwise. He is 3.0 m from the centre and has a speed of 1.5 ms^{-1}.

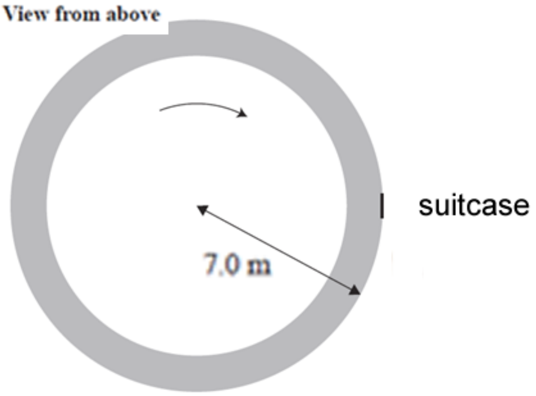


(a) Draw labelled arrows on the diagram to show the direction of Tahi's velocity and acceleration.
(b) State the name of this acceleration.
(c) Calculate the size of his acceleration.
(d) State the direction of the horizontal force acting on Tahi, and explain clearly why there must be a horizontal force acting on him.
(e) Rua pushes the merry-go-round so that its period is halved. Explain exactly what this does to the size of the horizontal force acting on Tahi.

THE BAGGAGE SECTION (2007;3)

The baggage at the airport is delivered on a horizontal circular conveyor belt that is moving at constant speed. The radius of the circular belt is 7.0 m.

(a) Draw an arrow in the diagram below to show the direction of the velocity of the suitcase that is on the moving circular belt.

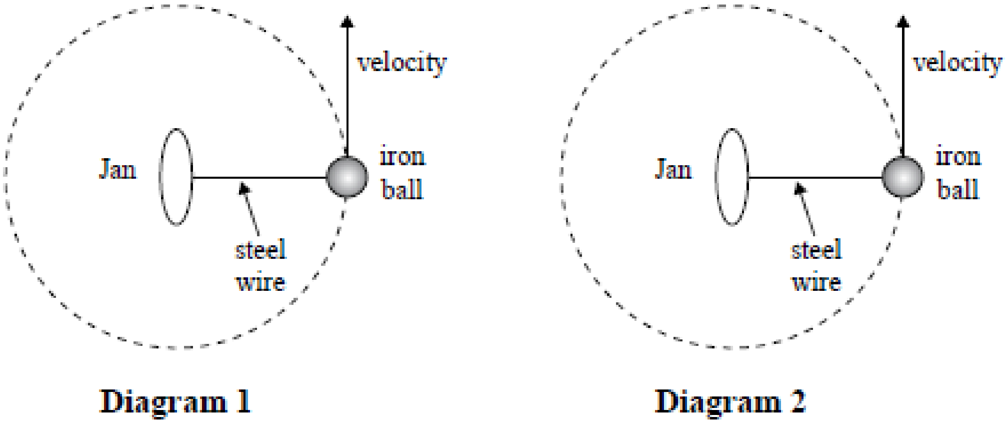


(b) Explain why the motion of the suitcase on the belt that is moving in a circle at constant speed is accelerated motion.

(c) Calculate the time it takes for the belt to complete one rotation if the unbalanced force on the suitcase is 5.5 N. The mass of the suitcase is 18 kg.

CIRCULAR MOTION (2006;2)

Jan is competing in a hammer-throw event. This event involves swinging a 10 kg iron ball attached to a steel wire in a horizontal circle. The diagrams below show Jan and the hammer from above.



(a) On Diagram 1, draw an arrow showing the direction of the iron ball's acceleration.

(b) On Diagram 2, draw an arrow showing the direction of the force the steel wire exerts on Jan.

(c) Explain why a horizontal force is needed on the ball, even though it is moving at constant speed.

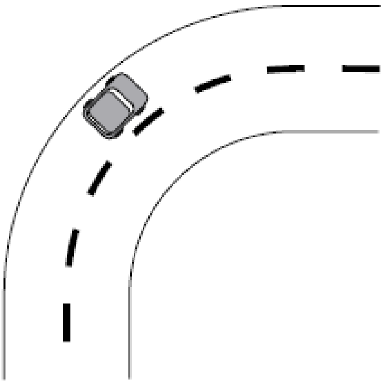
The ball rotates in a horizontal circle of radius 2.0 m.
The time for one rotation is 1.5 s.
The iron ball's mass is 10 kg.
The circumference of a circle is: $C = 2\pi r$.

(d) Calculate the size of the centripetal force acting on the iron ball.

(e) After a few rotations, the ball has the same radius of rotation, but a shorter period. Explain what effect this will have on the horizontal force acting on Jan.

TRAVELLING BY CAR (2006;1)

(a) A car is now travelling on the open road at a constant speed of 25 ms^{-1}. Part of the road forms the arc of a circle of radius 40 m. The mass of the car and its occupants is 1357 kg.



(i) On the diagram above, use a labelled arrow to show the direction of the resultant force acting on the car as it travels around the corner at constant speed.

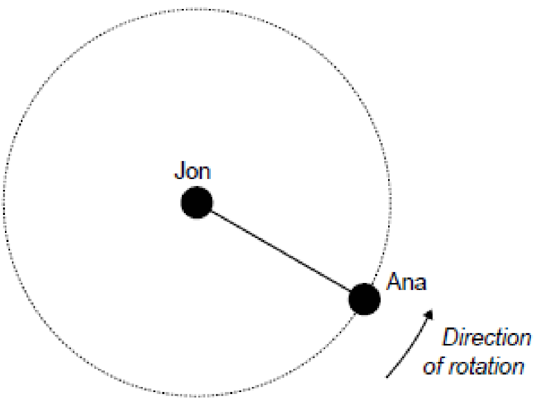
(ii) Calculate the value of this force. Give your answer to the correct number of significant figures

(iii) Explain clearly, with reasons, what would happen to the car if the road was icy and could not provide any of the force calculated in (ii).

SCHOOL TRIP - ICE SKATING (2004;4)

Ana and Jon are now practising ice skating routines. In a skating move, Jon spins Ana around in a horizontal circle.

You may assume that Ana moves in a circle as shown below.



(a) Draw an arrow on the diagram to show the direction of the tension force that Jon's arm exerts on Ana at the instant shown.

(b) If the radius of the circle is 0.95 m and the tension force in Jon's arm is 5.00×10^2 N, calculate the speed with which Ana is travelling around the circle. Give your answer to the correct number of significant figures.

(c) While Ana is still moving in a circle on the ice, Jon lets her go. Describe her velocity (speed and direction) after he releases her. Explain why Ana travels with this velocity.