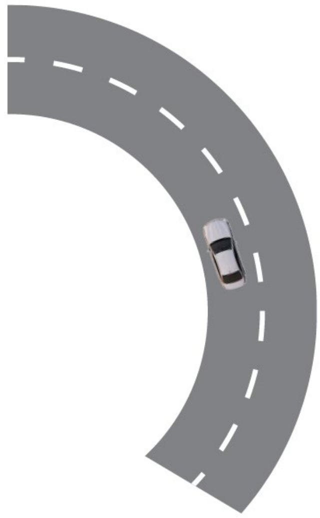
MECHANICS: CIRCULAR MOTION QUESTIONS

OPEN ROAD (2020;2)



Jo and Alex continue their drive and take a sharp bend in the road at a constant speed of 12 m s^{-1}.

(a) Draw an arrow on the car on the diagram to show the direction of the acceleration at this point.

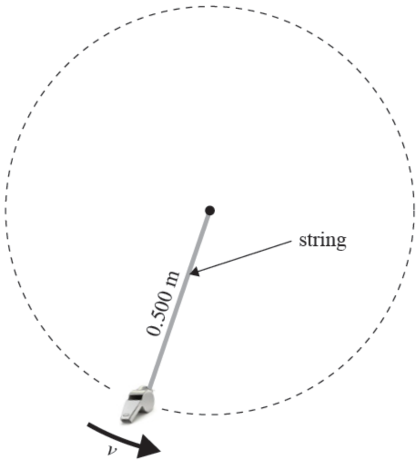
(b) Calculate the size of the acceleration if the radius of the bend is 25 m and explain what causes this acceleration.

(c) State TWO external factors that could change the motion of the car as it travels around the corner and explain how these factors would affect the motion.

HALF TIME AT THE HOCKEY MATCH (2019;2)

The teams are waiting for the second half of the game. While waiting, the referee swings her whistle in a horizontal circle above her head. Each rotation takes 1.40 seconds. The metal whistle has a mass of 40.0 g and it is swung in a circle of radius 0.500 m at a constant speed.

Plan view of swinging whistle



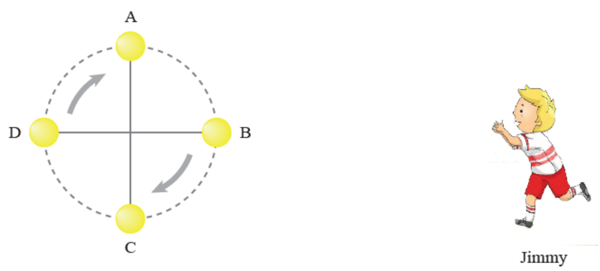
(a) Show that the speed of the whistle is 2.24 m s^{-1}.

(b) By determining the horizontal forces on the whistle, explain why it continues to move in a circular motion at a constant speed.

(c) The speed of the whistle is reduced to 1.0 m s^{-1}. Determine the size of the new horizontal force on the whistle and explain the likely result of reducing the speed on the motion of the whistle.

ALTERNATIVE LAUNCHERS (2018;2)

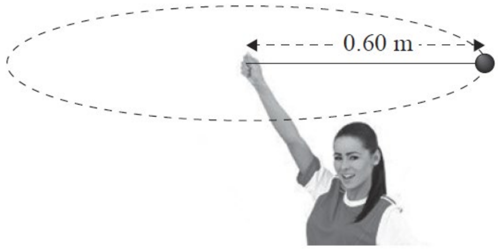
(d) Oliver tried launching a water balloon by connecting it to a string and swinging it around his head in a horizontal circle at a constant speed and releasing it.



(i) At which point would Oliver need to release the string, so that the balloon would travel directly to the right?

TORQUES AND ENERGY (2017;3)

(d) During one of her dance routines, Sally is spinning a ball above her head in a horizontal circle, as shown below.



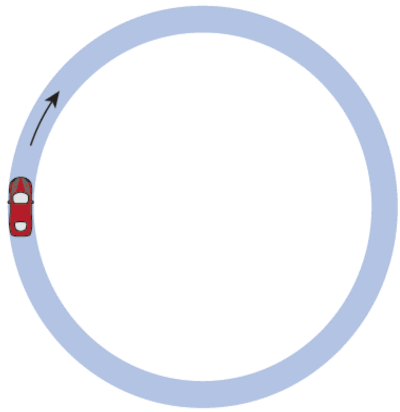
The ball of mass 0.050 kg makes 5 rotations in 4.0 s. The length of the string from the ball to Sally's hand is 0.60 m. Calculate the size of the force experienced by the ball during these rotations.

Motion (2016;1)

(d)

(i) Name the force acting on the car, and draw a labelled vector on the diagram above to show the direction of the force acting on the car at the instant shown.

(ii) Discuss the effect of the force on the size and direction of the velocity of the red car.

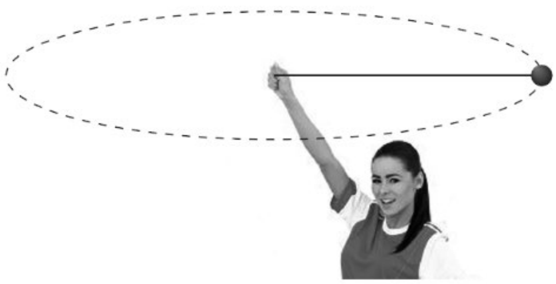


Circular motion and Torques (2015;4):

(a) Janet swings a ball tied on a string in a horizontal circle above her head. Explain why the ball is accelerating even though it is swinging at constant speed.

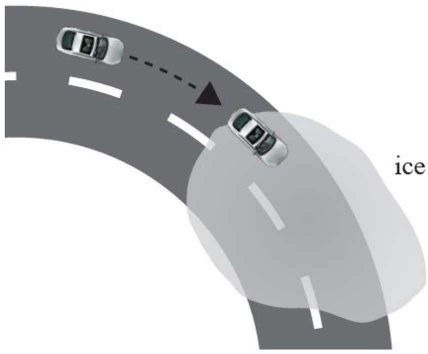
(b) The length of the string is 0.75 m. It takes 0.84 seconds for the ball to go around her head once. Calculate the acceleration of the ball.

(c) Name the force that causes the ball to accelerate as it goes in a circle. Explain why the force causes the ball to accelerate.



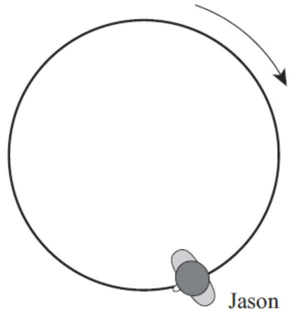
Shamilla drives to the Gym (2014;3)

(d) Shamilla drives her car at constant speed around a corner, and then drives over some ice, as shown in the diagram below. You can assume there is no friction between the ice and the tyres. Describe the net force on the car (if any) before and after she reaches the ice. Explain how the net force (if any) affects the motion of the car before and after she reaches the ice.



Motion (2013;1)

Jason spends a day at an amusement park. He stands on a merry-go-round, which turns at a constant speed. The diagram shows Jason standing on the merry-go-round, which is going around in a clockwise direction.

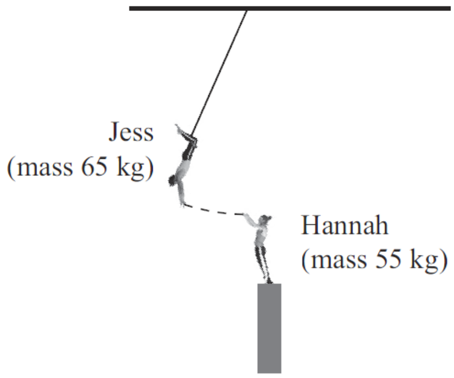


(a) On the diagram, draw an arrow on Jason to show the direction of his velocity at that point.

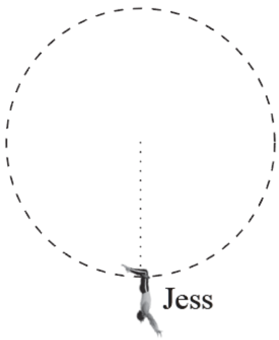
(b) The radius of the merry-go-round is 4.0 m. The merry-go-round takes 15 s to do a complete circle. Jason has a mass of 65 kg. Calculate the centripetal force needed to keep Jason moving in a circle.

The Trapeze (2012;1)

Jess is a trapeze artist at the circus. As part of her act she hangs on a long rope and swings downwards. When she gets to the lowest point she grabs onto Hannah and they keep moving together.



(d) In the diagram below draw an arrow to show the direction of the tension force when Jess is at the lowest point in her swing.



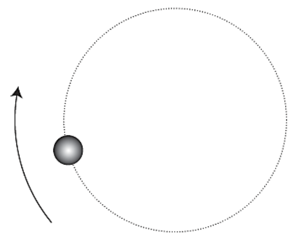
(e) Jess is moving in a circular path. When she gets to the lowest point in her swing, and just before she grabs onto Hannah, the tension force in the rope is **greater** than the gravity force acting on her. Explain why.

The bike ride (2011;1)

(d) Jacquie the bike rider rides along a horizontal circular path at constant speed. Describe what it is that provides the **force needed** to keep the bike going in a circle. State the **direction of this force**.

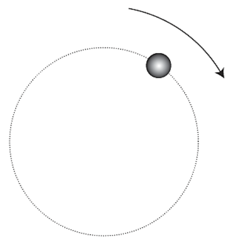
Throwing the discus - part 1 (2010;1)

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



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

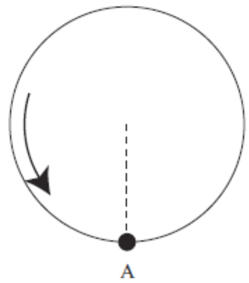
(b) James releases the discus at the position shown in the next diagram. Draw an arrow showing the direction the discus travels. Explain why the discus then travels in the direction you have drawn



(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)

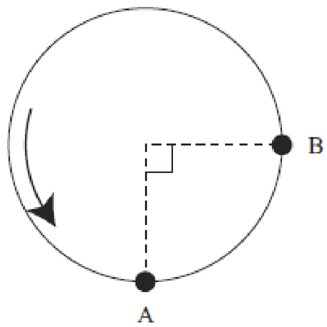
Jordan ties a ball on a string and swings it in a horizontal circle in an anticlockwise direction, as shown below.



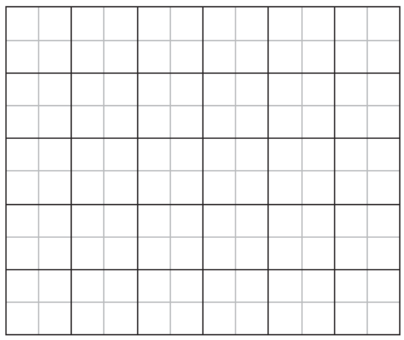
(a) On the diagram, draw a labelled arrow to show the direction of acceleration of the ball at position A.

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.

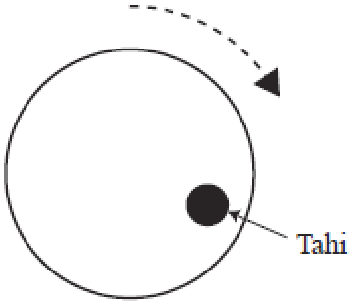


(c) On the diagram above draw arrows to indicate the direction of the velocity of the ball at each of the positions A and B. Hence, calculate the size and direction of the change in velocity of the ball as it swings from position A to position B. The ball is moving at a constant speed of 5.0 ms^{-1}.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



Going to the playground (2008;2)

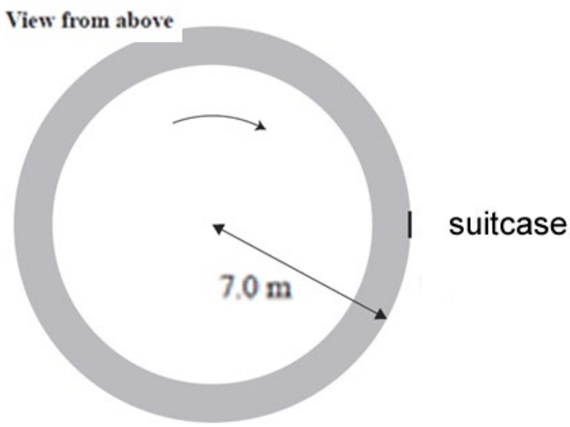
Tahi and Rua are at the playground. Tahi is sitting on a merry-go-round that is spinning clockwise. He is 3.0 m from the centre and has a speed of 1.5 ms^{-1}.



(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.

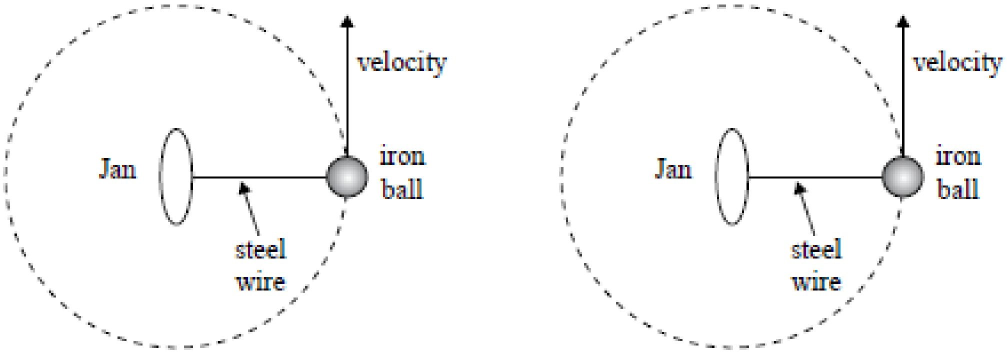


Diagram 1 **Diagram 2**

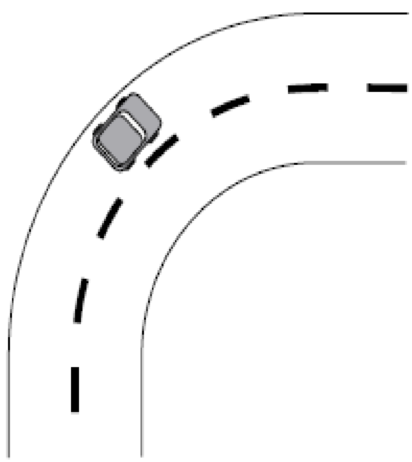
(a) On Diagram 1, draw an arrow showing the direction of the iron ball's acceleration.
(b) On Diagram 2, draw an arrow showing the direction of the force the steel wire exerts on Jan.
(c) Explain why a horizontal force is needed on the ball, even though it is moving at constant speed.

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 (2005;1)

(g) 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.



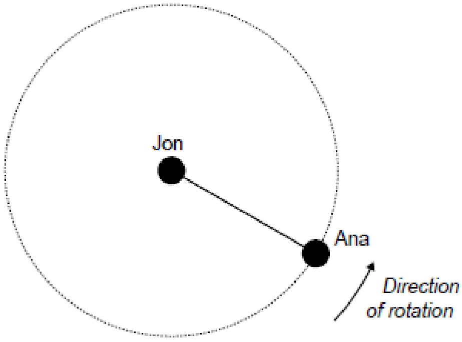
(i) On the diagram above, use a labelled arrow to show the direction of the resultant force acting on the car as it travels around the corner at constant speed.
(ii) Calculate the value of this force. Give your answer to the correct number of significant figures
(iii) Explain clearly, with reasons, what 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.

(e) 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.



(f) 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.

(g) 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.