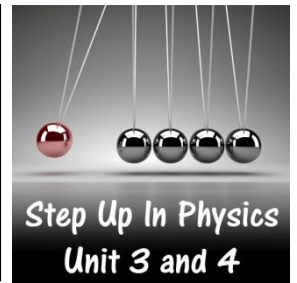


# Horizontal Circular Motion

## Problems Worksheet

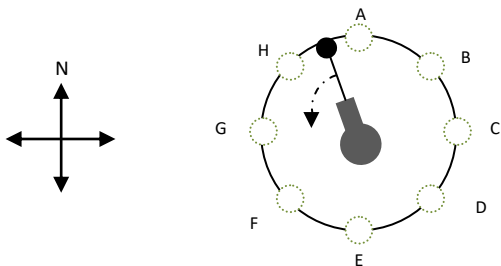


1. Ivan is sitting on a merry go round, 6.10 m from the centre. Ivan has a mass of 56.0 kg. The merry go round completes a rotation every 8.70 s.
  - a. Calculate Ivan's velocity.

- b. Calculate Ivan's acceleration.

- c. Calculate the frictional force acting on Ivan.

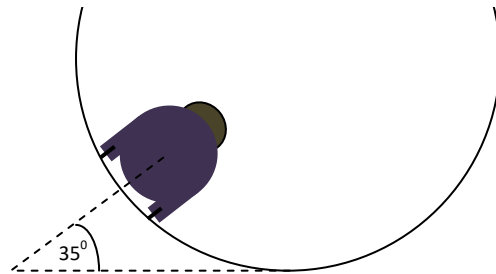
2. Holly is competing in a hammer throw event. Viewed from above, the path the hammer takes while Holly spins around is shown below.



- a. Which location (A-H) should Holly let go of the hammer to allow it to fly west?
  - b. Explain your choice with reference to relative physical principles.

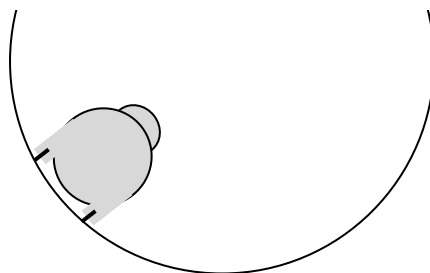
3. During construction of a freeway off ramp, the engineer in charge wishes to design the off ramp with the intention of the cars using the ramp not needing to use friction to help navigate the 60.0 m curvature radius of the off ramp. The average speed of cars using the off ramp is  $55.0 \text{ kmh}^{-1}$ . Calculate the banked angle of the off ramp the engineer should design for.

4. A bobsled team at the Winter Olympic games needs to use the curved walls to assist them with corners. There is negligible friction between the sled and the track.



The diagram shows the back of the bobsled taking a horizontal corner as it moves into the page. This horizontal corner has a 28.0 m curvature radius. The angle shown is made between the normal of the surface the bobsled is on and the horizontal plane.

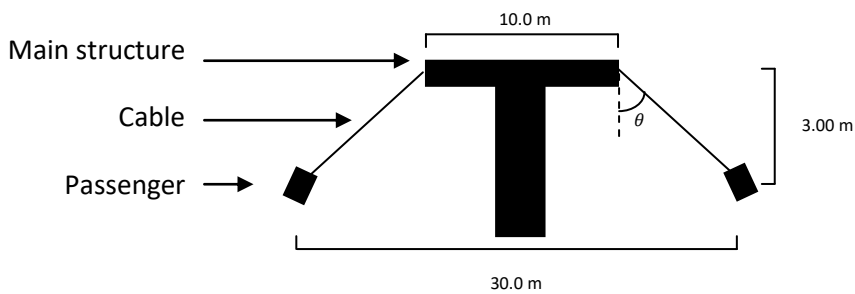
- a. Will the bobsled be turning to the right or turning to the left when viewed from behind?
- b. Draw a vector diagram showing the relationship between the physical forces acting on the sled and the net force.



- c. Calculate the velocity of the sled as it takes this particular corner.

- d. Describe how the position of the next bobsled team would compare to the previous team if the next team took this corner at a higher velocity. Use physical principles to justify your answer.
5. A motorcyclist leans into the corner as she navigates a roundabout that is 16.0 m wide. The motorcyclist is travelling at  $35.0 \text{ kmh}^{-1}$  and the combined weight of the motorcyclist and her motorcycle is 1760 N.
- a. Draw a vector diagram showing the relationship between the physical forces acting on the motorcycle and the net force.
- b. Calculate the reaction force applied to the motorcycle by the road.
- c. When the motorcycle wheels pass over a slippery combination of water and oil on the road the frictional force decreases. What effect will this have on the horizontal and vertical components of the reaction force acting on the motorcycle?

6. A swing ride at the Perth Royal Show takes its passengers on a horizontal circular path. The dimensions of the ride while in motion are shown in the diagram below. The entire main structure spins around while the cables are attached to the outer edge of the main structure.



- a. Calculate the velocity of the passenger on the swing ride.
- b. Explain how the angle shown in the diagram would change as the velocity of the ride increases.
- c. Explain how the angle shown in the diagram would change as the mass of the passenger increases.
7. A top loader washing machine ends on a spin cycle which assists in removing a lot of the excess water the clothes absorbed during the wash cycle. The picture below shows the inside of the washing machine drum which spins with the clothes inside. Explain how the water is removed from the clothes in a spin cycle, referring to relevant physical principles.



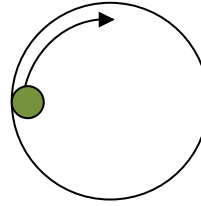
8. A party trick to play on friends is to challenge them to lift an olive (or similarly round object) off the table without touching it. When they fail, show them using a nearby empty glass how it is done. Simple tip the glass upside down, place it over the olive and spin the olive around the inside rim of the glass until it lifts off the ground and is racing around the inside of the glass.



A



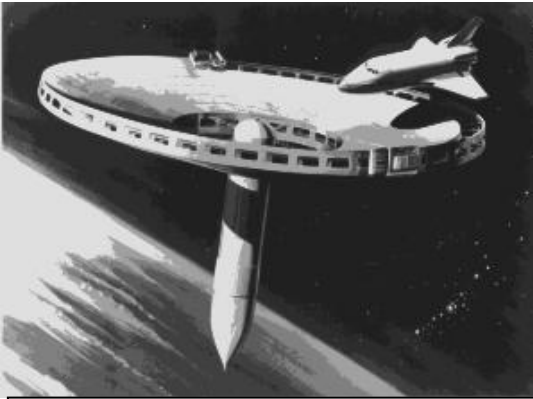
B



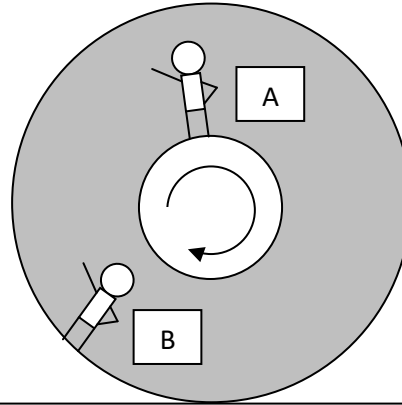
Path olive follows around glass

- a. Which glass (A or B) would you choose to complete the challenge of raising the olive off the table?
- b. Explain why only one of the glasses could complete the challenge while the other could not.
9. A tyre manufacture claims they have produced the safest tyres in the world. Each tyre is capable of providing 20.0 N of friction per kilogram of the car's mass. A car that is making use of these tyres approaches a corner at a  $80 \text{ kmh}^{-1}$ . The corner has a 17.0 m curvature radius. Justify whether the car could follow the curve of the corner or not.

10. A rotating wheel space station is a hypothetical concept that could allow for the creation of artificial gravity for astronauts on extended stays in space. The basic concept is that centripetal forces could be used as a replacement for the effects of gravitational forces.



Artist impression of a rotating wheel space station



Interior of rotating wheel space station viewed from above. Not to scale.

- Which astronaut (A or B) is standing in a suitable location which makes sense when simulating gravity by using a rotating wheel station?
- Describe how a rotating wheel space station could simulate gravitational forces. Refer to relevant physical principles in your description.
- Estimate the velocity of the edge of the space station where the astronaut should be standing such that the simulated gravitational force feels similar to the gravity experienced on Earth.