

Section 1.

1. A person of mass 90 kg sits on the Super-Duper Ferris Wheel of Death that has a radius of 10 m and a period of rotation of 5 s. It rotates at a constant speed.

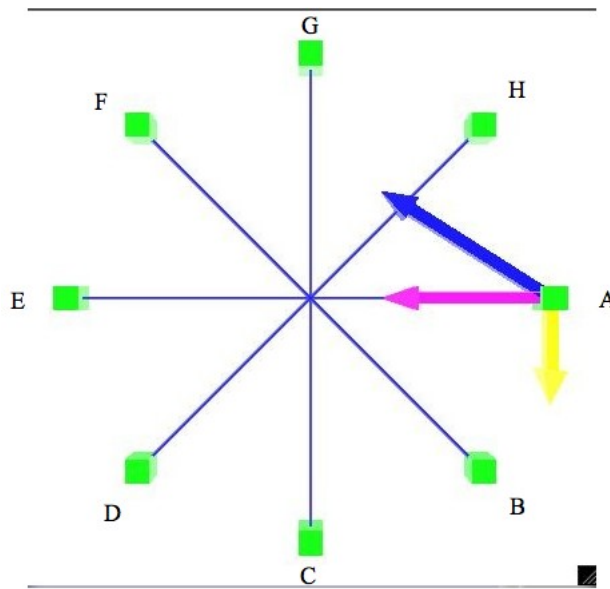


Figure 1:

- What is the magnitude of the radial (i.e. perpendicular) component of the net force on the person at any point?
- At point A, calculate the force of the chair on the person and express it as a vector.
- At point B, calculate the force of the chair on the person and express it as a vector.
- At point C, calculate the force of the chair on the person and express it as a vector.
- Suppose that an engineer wants a person to feel weightless at the top, point G. What should be the period of rotation for this to occur?
- If the person feels weightless at the top, what weight would they “feel” at point C? Keep in mind, this is the weight that a scale would read if the person was sitting on a scale during the ride.

2. In a pairs ice skating competition, a man holds his partner as she rotates around him in what is known as a death spiral.

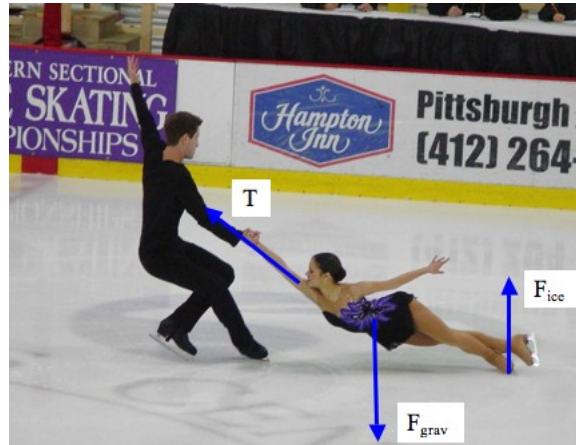


Figure 2:

- (a) If her mass is 50 kg and if she rotates in a circle of radius 2.2 m in 6 s at an angle of 35° , what is the tension in her arm?
- (b) If he rotates his partner with a great enough speed, she would lift off the ice. What is the minimum speed needed to just barely lift off the ice?
3. The planet Mars has a satellite, Phobos, which travels in an orbit of radius 9.4×10^6 m with a period of 7 h 39 min. Calculate the mass of Mars from this information.
4. Satellites, like those used for DirecTV, are in geosynchronous orbits, meaning that the period of their orbit is exactly 24 hours (so that the satellite maintains the same relative position in the local sky where I live). What is the radius of its orbit? Give your answer in meters. Also give it in units of earth radii, R_{Earth} .
5. You pull back a pendulum and release it. It oscillates back and forth. Explain why the net force on the pendulum bob is tangent to the path when the pendulum is at an endpoint, and the net force on the pendulum bob is radial when the pendulum is at its lowest point during its motion.
6. A child of mass 25 kg slides down a slide on a burlap bag at an angle of 30° . Assume that it is nearly frictionless.
- (a) What is the perpendicular (i.e. radial) component of the net force on the child?
- (b) What is the tangential component of the net force on the child?
- (c) What is the force by the slide on the child?
- (d) What is the acceleration of the child?
- (e) Suppose that there is a frictional force of 40 N on the child. What is the net force on the child and what is the acceleration of the child?