6.2: Centripetal Force

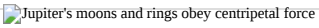

Figure 5.2.1

Jupiter's moons and ring materials follow all the laws of physics, including centripetal force and centripetal acceleration.

Centripetal Force

Centripetal force is, simply, the force that causes centripetal acceleration. Objects that move in uniform circular motion all have an acceleration toward the center of the circle and therefore, they must also suffer a force toward the center of the circle. That force is the centripetal force. For orbiting satellites, such as the moon orbiting the earth or the earth orbiting the sun, the centripetal force is produced by gravity. When an Olympic hammer thrower whirls a massive ball on a chain, the centripetal force is created by the athlete and transmitted by the chain.

Newton's second law shows the relationship between force and acceleration, F=ma. Since we have formulas expressing the relationships for centripetal acceleration, they can easily be altered to show the relationships for centripetal force.

$a_c=v^2/r$ and F=ma so $F_c=mv^2/r$

and

$a_c=4\pi^2r/T^2$ so $Fc=4\pi^2rm/T^2$

Practice applying centripetal force on a hockey puck so that it moves in a circle in the simulation below. Be sure to apply the equations above to help you solve for the magnitude of the centripetal force and the initial velocity of the puck:

Common Misconceptions

Many people incorrectly use the term *centrifugal force* instead of *centripetal force*. Often, you will hear the term centrifugal force used to describe the outward force pushing an object away from the center of a circle. In reality, however, centrifugal forces are inertial, or fictional, forces. They only exist in the frame of reference of the object that is moving and, even then, are theoretical. Physicists dealing in a moving frame of reference use centrifugal forces to ease calculations.

For a great explanation of the difference between centrifugal and centripetal force, see this video:

Have you ever played tetherball? It's a really fun game and a great example of how a centripetal force causes an object to move in a circle. The motion of the ball is governed by two forces - gravity and tension - that combine to generate a net centripetal force. Use the following simulation to adjust the ball mass, cable length and ball speed in a tetherball match to learn more:

Summary

- Centripetal force is the force that causes centripetal acceleration.
- Equations for centripetal force are $Fc=mv^2/r$ and $Fc=4\pi^2rm/T^2$.

Review

1. A runner with a mass of 78.6 kg, moving at a speed of 8.8 m/s, rounds a bend with a radius of 25 m. What is the centripetal force needed to keep this runner on the curve and what supplies this force?
2. A 1000. kg car rounds a curve of 50.0 m radius on a flat road with a speed of 14.0 m/s.
    1. Will the car make the turn successfully if the pavement is dry and the coefficient of friction is 0.60?
    2. Will the car make the turn successfully if the pavement is wet and the coefficient of friction is 0.20?
3. An 0.500 kg object tied to a string is swung around a person's head in a horizontal circle. The length of the string is 1.00 m and the maximum force the string can withstand without breaking is 25.0 N. What is the maximum speed the object may be swung without breaking the string?

Additional Resources

Interactive: Bobsled

PLIX: Play, Learn, Interact, eXplore: Centripetal Force Problems

Real World Application: Banked With No Friction

Video:

Study Guide: Circular Motion Study Guide
