Circular Motion

Velocity is changing as an object goes around a circle. This is due to centripetal acceleration and centripetal force.

Distance around a circle

- Distance around a circle = Circumference
- Circumference = 2 x pi x radius = pi x diameter
- Measured in meters

Time to go around a circle

- The time interval to go around a circle once is called the Period ("T").

- The Period ("T") is measured in seconds.

The number of times around a circle in one second

- Frequency is the number of times around a circle in one second.

- Frequency is measured in Hertz.

- Frequency = 1/T = 1/Period

  Please note that Frequency and Period are inverses of each other.

Speed

- Speed = distance/time
- Speed around a circle = distance/time
- Speed around a circle = Circumference/Period

Velocity

- Velocity is the tangent to the circle at a given moment.

- The direction of the Velocity of an object is changing. Therefore, the object must be subjected to an unbalanced force and is accelerating.

Centripetal Acceleration

- Because an object's velocity is changing direction, it is under an unbalanced force and undergoing acceleration.

- This acceleration is "centripetal" meaning "center seeking" meaning it points toward the center.

- A(c) = (speed^2)/radius   (toward the center)

Centripetal Force

- The unbalanced force associated with centripetal acceleration is the centripetal force "F(c)."

- $F(c) = m \times A(c)$ toward the center

Example

- A 5.0 kg object travels clockwise in a horizontal circle with a speed of 20 m/s. The radius of the circle is 25 meters. Calculate the centripetal acceleration and centripetal force.

- A(c) = speed^2/radius = 20^2/25 = 16 m/s^2 (toward the center of the circle)

- F(c) = m x A(c) = 5 x 16 = 80 N (toward the center of the circle)

Example

- An object traveling in a circle makes 1,200 revolutions in 1.0 hour. If the radius of the circle is 10.0 m, calculate the speed of the object.

- Period = T = 3600 seconds/1200 rev = 3 s

- Speed = C/T = 2 x pi x radius/T
  $$= 2 \times 3.14 \times 10/3 = 21 \text{ m/s}$$

Group Activity

- A object with mass = 10.0 kg is revolving at various given speeds and radii. Calculate the A(c) and F(c) for each situation. Compare.
- 1.   speed = 10 m/s; radius 10 m
- 2.   speed = 20 m/s; radius 10 m
- 3.   speed = 30 m/s; radius 10 m
- 4.   speed = 10 m/s; radius 20 m
- 5.   speed = 10 m/s; radius 30 m