Hello

- Find the circumference of a circle with a radius of 0.75m.

4.712m

Uniform Circular Motion

Determining Speed

- How do we determine the speed of an object moving in a straight line?

$$V = \frac{\Delta x}{t}$$

Angular Velocity

- The velocity of an object moving in a circular path.

- If I know the radius of a circle, how can I determine the speed of an object traveling around it?

A car drives in a circle with a radius of 3 m in 4 sec. What is the car's velocity?

$$V = \frac{2\pi r}{t} = \frac{2\pi \cdot 3m}{4s} = 4.712 \ \frac{m}{s}$$

A motorcycle rides around a cage with a radius of 4m in 2.5sec. What is the velocity of the motorcycle?

Tangential and Angular Velocity

- Velocity in a straight line.
- When an object moves in a circle, something has to keep the object in the circle.
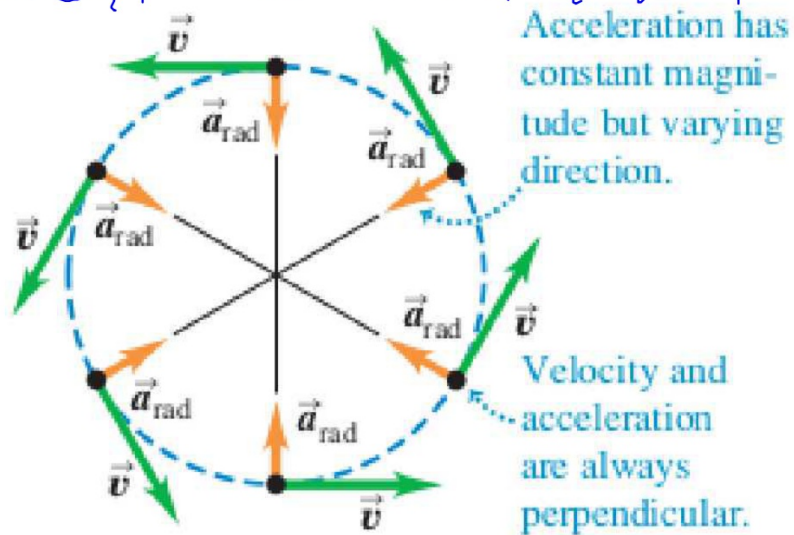- Some force has to keep the object moving in a circle.

Velocity and inward force

- What's keeping the object moving in a circle?
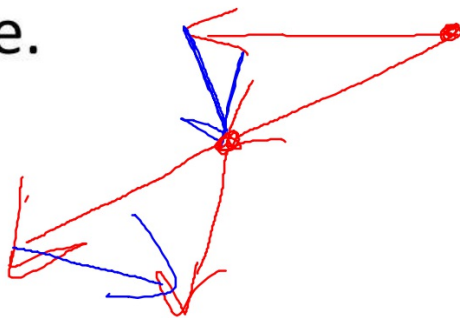- What happens when that force is no longer present?

Velocity Vector in Circular Motion

Centripital acceleration

Acceleration has constant magnitude but varying direction.

Velocity and acceleration are always perpendicular.

Acceleration = ΔV/t

- ΔV=Vf-Vi
- Draw the vectors for two points on a
  circle.

Centripetal Acceleration

- A center seeking force.
- The tension on a rope is from the pull towards the center.
- There is NO centrifugal (center fleeing) force. You can't push with a rope.

Determining Acceleration

- V is the velocity that an object moves around a circle.

- r is the radius of the circle.

- $a = V^2/r$

Students are playing crack the whip. If the person on the outside (5m from the center) is running at 4m/s, what is their acceleration?

$V = 4 \, m/s$ U_e: $a_c = ?$

$r = 5m$

Eqn: $a_c = V^2/r = \dfrac{\left(4\frac{m}{s}\right)^2}{5m}$

$\dfrac{16 \, m*/s^2}{5 \, m} = 3.1 \, m/s^2$

A child sits 3.5m from the center of a merry go round. If it makes one revolution every 11 sec, what is the centripetal acceleration of the child?

$r = 3.5m$

$t = 11s$

$a_c = ?$

$V = \dfrac{2\pi r}{t} = \dfrac{3.5 \cdot 2\pi}{11s}$

$V = 2 \, m/s$

$a_c = V^2/r = \dfrac{(2 \, m/s)^2}{3.5m} = \dfrac{4 \, m^2/s^2}{3.5m} = 1.14 \, m/s^2$

Determining Centripetal Force

- F=ma.

- If we know the centripetal acceleration of an object and it's mass, we can solve for the force on the object.

If the student from the previous problems has a mass of 62kg, what is the force on their arm?
From the "crack the whip" problem.

$K: \quad m = 62 \, kg$

$\qquad a = 3.1 \, m/s^2$

$F = ? = ma = 62 \, kg \cdot 3.1 \, m/s^2 = 192.2 \, N$

If the motorcycle and it's rider have a combined mass of 200kg, what is the force exerted on the ~~cage?~~ rider by the cage?

K_i $r = 4m$

$t = 2.5s$

$$a_c = \frac{4\pi^2 r}{t^2} = 25 \text{ m/s}^2$$

Determine the average acceleration of the demo.

- How are you going to collect the data?
- What is the magnitude of the force acting on the object?

$m = 60g = 0.06 kg$

$r = 70cm = 0.7m$

$t = 8.5 / 10 = 0.85s$

Sum of the Accelerations

- I have a bucket of water on a rope.
- I swing it over my head and do not want the water to spill out.
- The centripetal acceleration needs to be greater than the acceleration of gravity.

Approach

- The centripetal acceleration has to be greater than or equal to the acceleration due to gravity.

- If they are equal, draw an FBD for the bucket at the top and the bottom of the circular path.

The radius of the circle is ____m. What is the longest period that will allow the water to stay in the bucket?

Figure 17-1 *Spinning a bucket filled with water over your head.*

Put it all together

- If you know the radius and the period, you can solve for velocity.
- You can now solve for acceleration.
- If you know the mass of the object, you can determine the centripetal force on the object.

Why we don't fly off the spinning Earth

- Earth has a radius of 6.37 x 10^6m.
- If the period is one day, what is the centripetal acceleration of Earth?
- What is the centripetal force on a 65kg person?

$a_c = 0.033 \, m/s^2$

$F_c = 2.2 \, N$