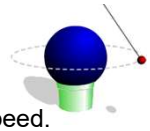
Circular Motion

What is circular motion ?

- When objects travel in a circle.



Uniform Circular Motion

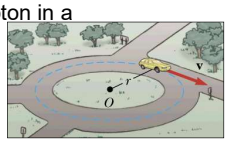
- Circular motion with constant speed.

Non-uniform Circular Motion

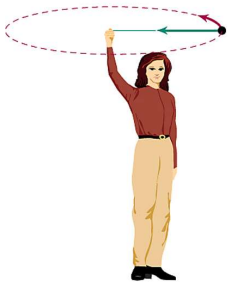
- Circular motion with changing speed

Circular Motion … Examples

– Earth moving around the Sun
– Electron moving around a proton in a hydrogen atom.
– Moving car in a roundabout.
– Bikers in a ball

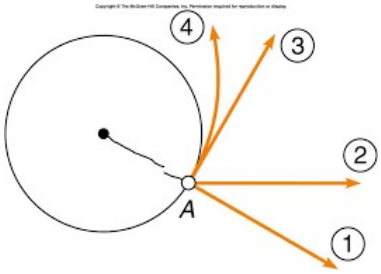


Is the ball accelerating ?

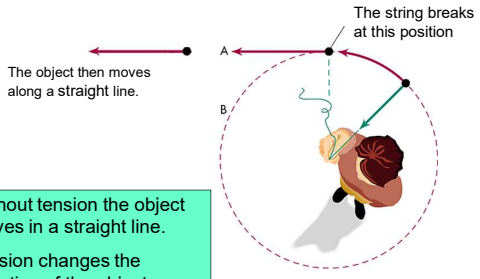


Voting Question:

Which way will the ball go?



When the string breaks . . .

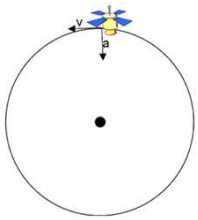


Without tension the object moves in a straight line.

Tension changes the direction of the object.

Parts of circular motion

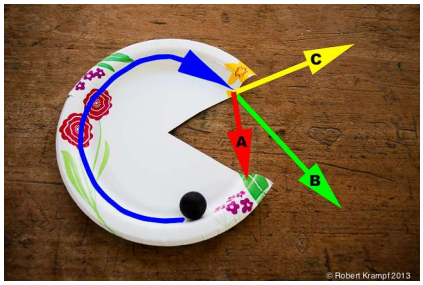
- Tangential velocity
- Centripetal acceleration
- Tangential acceleration



https://www.youtube.com/watch?v=8cL1IXDNSJQ

Voting Question:

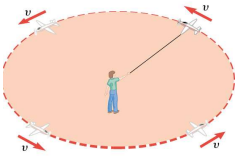
Which way will it go?



Velocity (Tangential)

Magnitude : $V = \frac{2\pi r}{T}$

- v = velocity
- r = radius
- T = period



Period : Time of one "cycle".

 = period

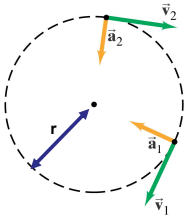
Problem

Nolan Ryan throws a baseball so that his 0.46 m forearm could travel a full circle in 0.065 seconds. How fast will a baseball leaving his hand travel?

Centripetal Acceleration

Magnitude : $a = \frac{v^2}{r}$

- a = acceleration
- v = velocity
- r = radius



Direction : Towards the centre

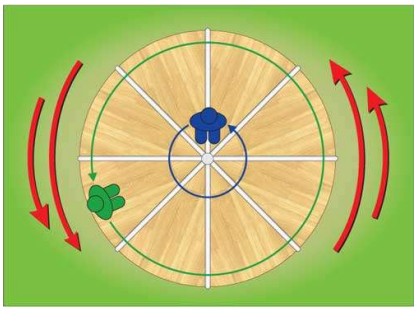
Q: Is the acceleration a constant?

Problem

The Wright Flyer's propeller makes 350 revolutions per minute. If the radius of the propeller was 1.3 meters, which what centripetal acceleration did the Wright Brothers' plane feel at Kitty Hawk in 1903?

Voting Question:
Who feels it more?

A = green
B = blue
C = same



Centripetal Force

- Acceleration is towards the center
  - •No such thing as a free lunch!
- Net force on an object in uniform circular motion
  - •Net force can come from anywhere
- Centripetal not centrifugal!

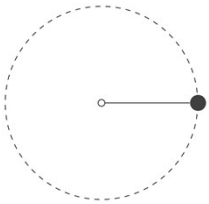
$$F = ma$$

$$F = \frac{mv^2}{r}$$ ⟸ Centripetal Force

Origin of Centripetal Force

Circular Motion	Centripetal Force
Satellite in orbit around Earth	Gravitational force of the Earth
Car moving around a flat-curve	Static frictional force
Car moving around a banked-exit	Static frictional force and normal force
Toy-plane tied to a rope and moving in a circle	Tension in the rope
Astronaut in a rotating space station	Normal force by the surface/floor
Rider at a roller coaster	weight and/or normal force

What does a free body diagram look like for an object in circular motion?



Problem

The Warwolf, a catapult with an arm 3.4 meters long, traveled roughly 76 m/s. The arm of the catapult's arm had a mass of 180 kg and a payload of 27 kg of Greek Fire and other explosives. How much centripetal force did the catapult generate in a 1304 siege on Stirling Castle?

How does a pizza toss work?

- https://www.youtube.com/watch?v=IGDUmGlMJzU

Why do you get pushed against the side of the car when you turn?