Physics Honors:
Circular Motion

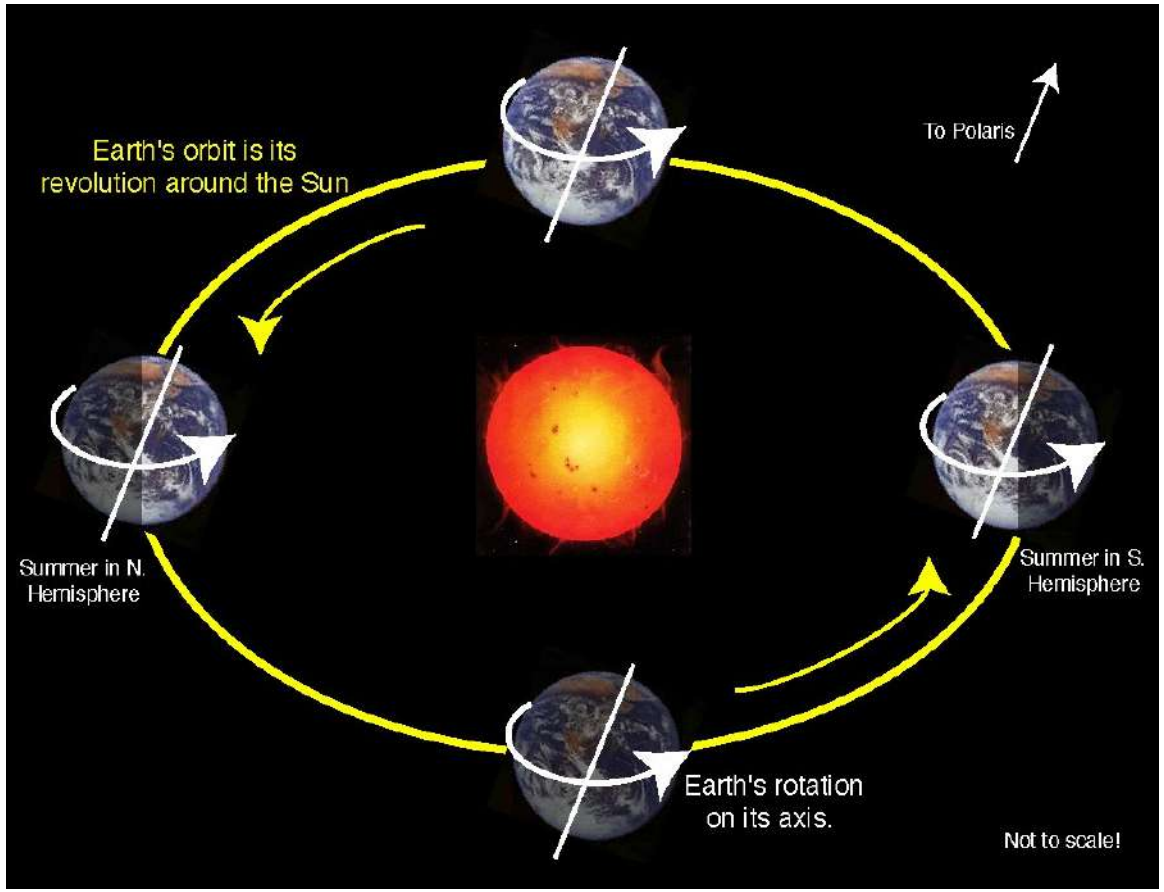
Linear vs. Circular Motion

- So far this year, all the motion that we have talked about has been in a straight line.
- When objects are moving in a straight line, we call that **linear motion**
- When objects are moving in circles, we call that **circular motion**

- **All the basic rules about how objects move are the same, but we need extra vocabulary to discuss how things move in a circle**

Circular Motion Terms

- The point or line that is the center of the circle is the **axis of rotation**.
- If the axis of rotation is inside the object, the object is **rotating (spinning)**
- If the axis of rotation is outside the object, the object is **revolving.**



Period

The period (T) for an object is how many seconds it takes to complete one cycle of motion

$$T = \frac{time}{\#\ of\ cycles}$$

A runner completes 6 laps around a circular track in 360s. Find the period

Frequency

The frequency (f) for an object is the number of cycles that are completed in 1 second

$$f = \frac{\#\ of\ cycles}{time}$$

A sewing machine makes 30 stitches in 10 seconds. What is the frequency?

Period and Frequency

- Period and frequency are inverses. So if we know period and want to know frequency, we can use this equation

$$T = \frac{1}{f}$$

Or

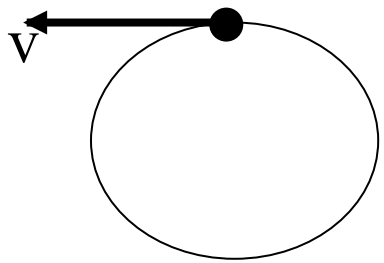
$$f = \frac{1}{T}$$

Linear/Tangential Velocity

- Objects moving in a circle still have a linear velocity

$$\textbf{linear velocity} = \frac{\textbf{distance}}{\textbf{time}}$$

- This is often called **tangential velocity,** since the direction of the linear velocity is tangent to the circle.



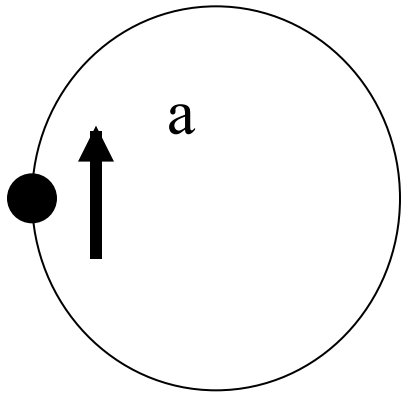
Centripetal Acceleration

- Acceleration is a vector, so it includes both magnitude and direction.
- As an object moves around a circle, the direction of motion is constantly changing.
- Therefore, an object moving in a circle is constantly accelerating.

Centripetal Acceleration

- The acceleration of an object moving in a circle points toward the center of the circle.

- This is called a centripetal (center pointing) acceleration.



Centripetal Acceleration

The centripetal acceleration depends on:

- The linear speed of an object
- The radius of the circle

$$A_{cent} = \frac{v^2}{r}$$

A_{cent} = Centripetal Acceleration

V - linear velocity

r - radius of circle

Centripetal Acceleration Practice

- What is the acceleration of an object that has a velocity of 25.0 m/s and is moving in a circle of radius 10.0 m?

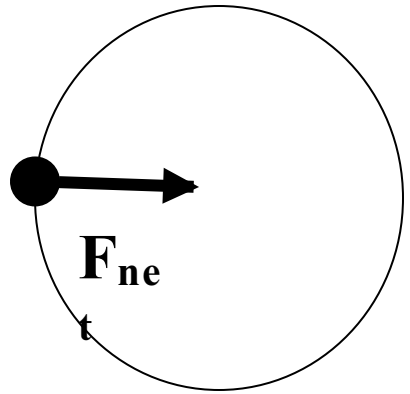
Centripetal Force

- Newton's Second Law says that if an object is accelerating, there must be a net force on it.
- For an object moving in a circle, this is called the centripetal force.
- The centripetal force points toward the center of the circle.

Centripetal Force

- In order to make an object revolve about an axis, the net force on the object must pull it toward the center of the circle.

- This force is called a centripetal (center seeking) force.



Centripetal Force

- Centripetal force on an object depends on:
  - **The object's mass**
  - **The object's speed**
  - **The object's distance from the axis (radius).**

Centripetal Force

Newton's Second Law says that F=m*a for a straight line.

So, if we replace the acceleration with $\mathbf{a}_{\mathbf{cent}}$, we can create the equation for $\mathbf{F}_{\mathbf{cent}}$, the centripetal Force

$$F_{cent} = \frac{mv^2}{r}$$

Centripetal Force Practice

- What is the net force acting on a 5.0 kg object that has a velocity of 15 m/s and is moving in a circle of radius 1.5 m?

Centripetal Force Practice

1. What is the net force acting on a 52 kg object that has a velocity of 8.0 m/s and is moving in a circle of radius 1.6 m?

2. A 40.0 kg object is experiencing a net force of 240 N while traveling in a circle of radius 0.8 m. What is its velocity?