Circular Motion

1

Uniform Circular Motion

- Definition
  – moving in a circle at a constant speed
- Rotating
  – Moving around an axis located within the object itself (ie. spinning top)
- Revolving
  – Moving around an axis located outside the object (ie. Earth around the sun)

2

Uniform Circular Motion

- Period (T)
  - the amount of time it takes for an object to make one revolution around the circle
- Frequency (f)
  - The amount of revolutions or cycle each second
  - Notice the relation between Period and frequency

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

3

Circular (Tangential) Speed

- Speed of the object moving at a constant rate around a circular path
  - Start with the equation for velocity

$$v = \frac{d}{t}$$

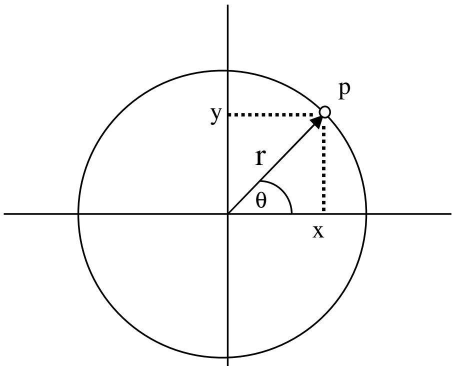
  - Then substitute the values for a circle

$$v = \frac{2\pi r}{T}$$

4

Angular Units

For rotating and revolving situations, it is easier to account for the change in the angle and radius rather than the x and y coordinates



Polar Coordinates (r,θ)

Where θ is the angular displacement (in radians) and r is the radius (in meters), or distance from the origin

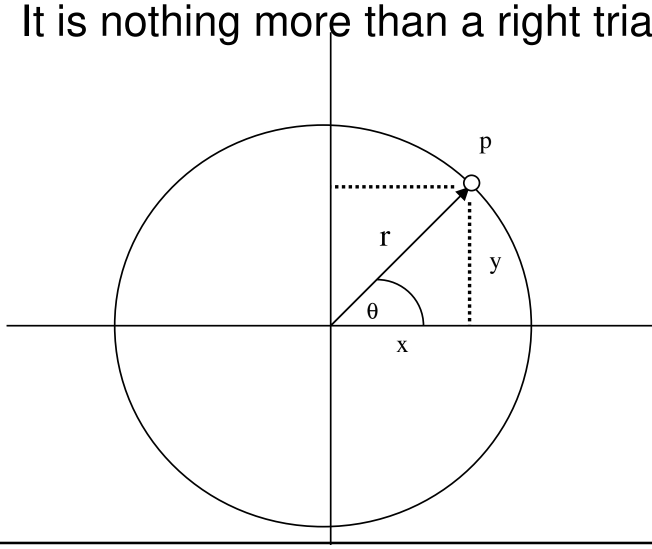
Note: Radians is a dimensionless unit.

Cartesian Coordinates (x,y)

5

Converting Between Polar and Cartesian

- It is nothing more than a right triangle



$$r = \sqrt{x^2 + y^2}$$

$$\theta = tan^{-1}\left(\frac{y}{x}\right)$$

$$x = r\ cos\theta$$

$$\mathrm{y} = r\ sin\theta$$

6

Describing Circular Motion

- Angular Displacement (θ)
  - The angle in radians that an object rotates or revolves around a center location
- Relating units
  - 1 revolution = 360° = 2π radians
- Converting
  - Use a "T-Chart" and 180°= π radians
- Example: Convert 23° to radians

$$\frac{23°}{} \Big| \frac{\pi}{180°} = 0.401 \text{ radians}$$

7

Describing Circular Motion

- Angular Velocity (ω)
  - how fast an object is spinning or rotating
  - the rate at which the angular displacement changes

$$\omega = \frac{\Delta\theta}{t}$$

8

Describing Circular Motion

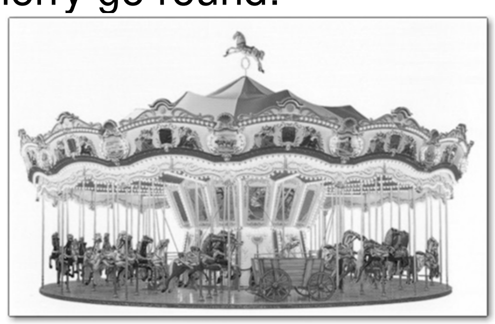
- Angular Velocity (ω)
  - If we look at an object making <u>one complete rotation or revolution</u>, the angular velocity of the object can be found using:

$$\omega = \frac{2\pi}{T} = 2\pi f$$

9

Tangential Velocity and Angular Velocity

- Consider a merry go round:



- Where do you have the largest angular velocity?
  - Same at all locations
- Where do you have the largest tangential velocity?
  - The outer edge of the merry go round

10

Tangential Velocity and Angular Velocity

- Consider a merry go round:

  - Based on your previous answers, tangential velocity is related to the distance you are from the center of rotation. This relationship is shown as:

$$v = r\omega$$

11