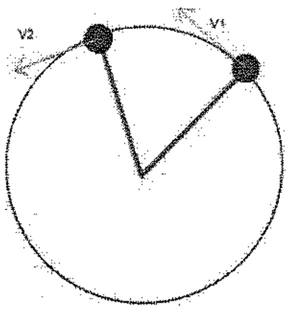
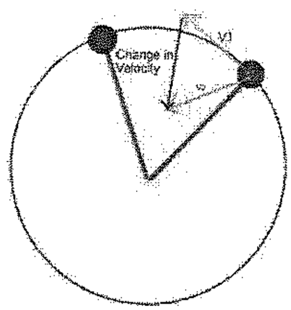
## Skill 25: Uniform Circular Motion and Centripetal Force

Objects moving in a circle at constant speed are undergoing acceleration because the direction of the velocity is changing even though the magnitude (size) of the velocity is constant. Moving in a circle at constant speed is therefore known as **uniform circular motion** (UCM). The acceleration experienced by an object that is changing direction but not magnitude of velocity is known as **centripetal acceleration.**

Centripetal means "center seeking". Centripetal force is the force that causes an object to follow a curved or circular path. In order for an object to follow a circular path the centripetal force must pull the object to the center.

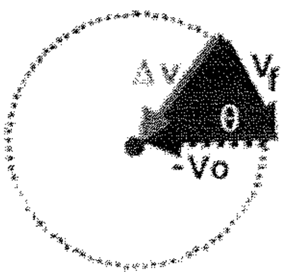


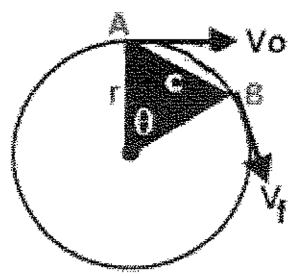

**$V_f = V_i + \Delta v$**

The direction of the change in velocity, Δv, is toward the center of the circle. Acceleration is the rate of change in velocity $\left(a = \frac{\Delta v}{t}\right)$, so if the change in velocity, Δv, is toward the center, acceleration is toward the center

To derive the equation for centripetal acceleration use the diagrams below:




$\Delta v = v_f = v_i = \text{v}$




$c = (v)(\Delta t)$

Comparing corresponding parts of similar triangle reveals:

$$\frac{\Delta v}{v} = \frac{c}{r} \quad \text{so} \quad \frac{\Delta v}{v} = \frac{(v)(\Delta t)}{r} \quad \text{which simplifies to} \quad \frac{\Delta v}{\Delta t} = \frac{v^2}{r}$$

Rewritten in terms of acceleration it becomes $\boldsymbol{a_c} = \frac{\boldsymbol{v^2}}{\boldsymbol{r}}$

Centripetal force is a special type of net force. Which means that $F_{net}=ma$ becomes $F_c=ma_c$

$F_c=ma_c$ substituting $a_c=\frac{v^2}{r}$ can be rewritten as $F_c=m\frac{v^2}{r}$ (not on PRT)

**Since the centripetal acceleration is toward the center the net force is toward the center. (Remember NET FORCE AND ACCELERATION ALWAYS AGREE IN DIRECTION).**