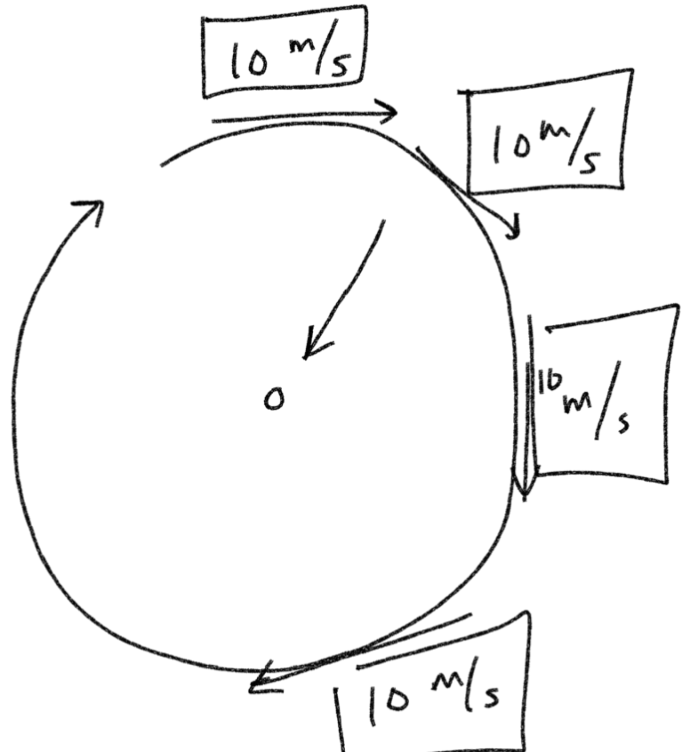
TH-6P General Physics Week 20 2/15

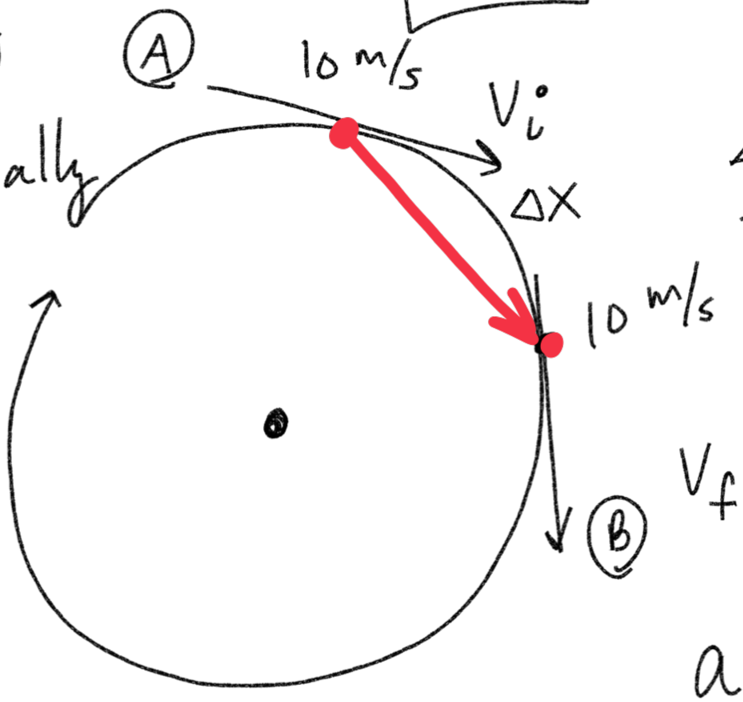
Uniform Circular Motion



If traveling in a circle, its direction is always changing

Velocity is a vector quantity, it has both a magnitude and direction.

velocity moves tangentally



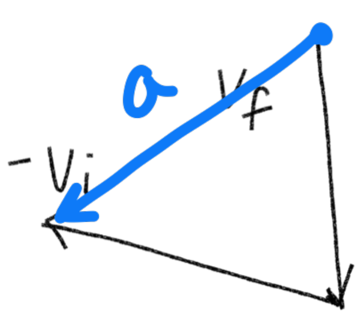
change in velocity

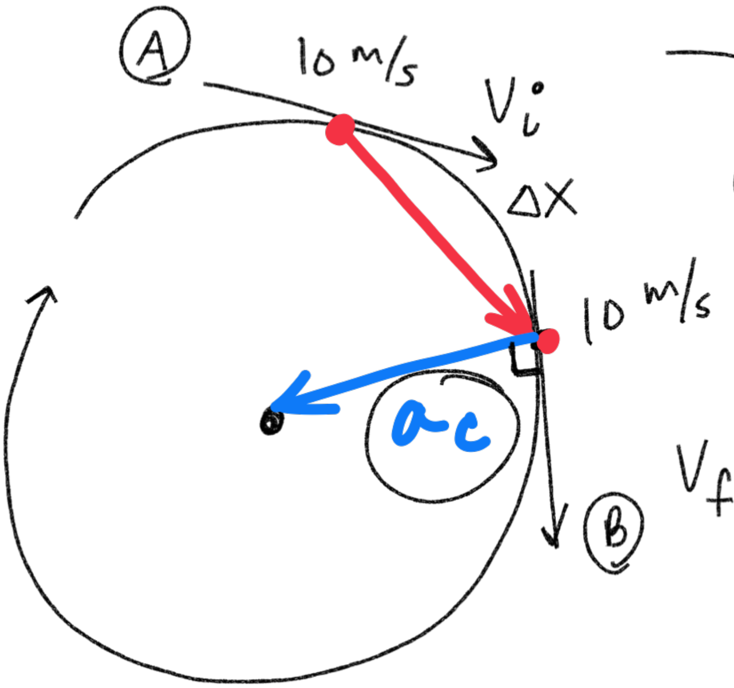
$$\frac{\Delta V}{\Delta t} = \text{acceleration}$$

ΔX = displacement

$$\Delta X = X_f - X_i$$

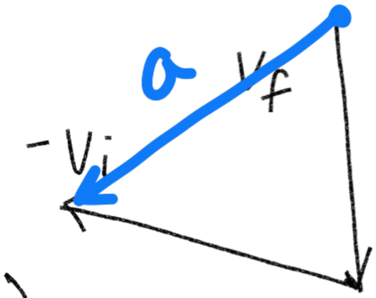
$$a = \frac{V_f - V_i}{\Delta t}$$





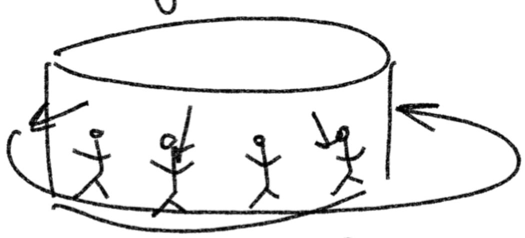
V_f

$a_c =$



centripetal acceleration is acceleration toward the center of the circle and perpendicular to the velocity

centrifugal acceleration



force away from the center

Gravity

$$a_c = \frac{v^2}{r} \rightarrow \frac{(m/s)^2}{m} = \frac{\frac{m^{\cancel{2}}}{s^2}}{\cancel{m}}$$

$$\boxed{a_c = m/s^2}$$

Radius of Earth: 6,378,100 m

velocity of Earth: 29,784.8 m/s

$$a_c = \frac{v^2}{r} = \frac{(29{,}784.8\ m/s)^2}{6{,}378{,}100\ m}$$

$$= \boxed{139.1\ m/s^2}$$

Noah placed a rock on a 3 m string. If he spun it at a constant 12 m/s in a circular motion, what is the centripetal acceleration?

$$a_c = \frac{v^2}{r} = \frac{(12\ m/s)^2}{3\ m} = \frac{144\ m^{\cancel{2}}/s^2}{3\ \cancel{m}}$$

$$\boxed{48\ m/s^2}$$

<u>satellite</u> $V = 17{,}000\ ^{mi}/_{hr}$

distance to the center of the earth $= 4000\ mi$

$$a_c = \frac{(V)^2}{r} = \frac{(17{,}000\ ^{mi}/_{hr})^2}{4{,}000\ mi}$$

$$\boxed{72{,}250\ ^{mi}/_{hr^2}}$$

We have a ship with a radius of 60 m. How fast would we need to go (in a circle) to simulate gravity?

$$a_c = \frac{v^2}{r}$$

$$60\,(9.8) = \left(\frac{v^2}{60m}\right)60$$

$$\sqrt{588} = \sqrt{v^2}$$

$$\boxed{v = 24.3\ ^{m}/_{s}}$$

$v = 16{,}760\ \mathrm{mi/hr} \rightarrow 7{,}492.4\ \mathrm{m/s}$

$r = 438\ \mathrm{mi} \rightarrow 704{,}893\ \mathrm{m}$

$$a_c = \frac{v^2}{r} = \frac{(7{,}492.4\ \mathrm{m/s})^2}{704{,}893\ \mathrm{m}} = \boxed{79.6\ \mathrm{m/s^2}}$$

1.) (8 pts) Tampy the Raccoon has discovered a pack of sinister looking squirrels approaching his maximum security bachelor pad (or maxi-pad for short). Determine the polar coordinates of the squirrels if they are currently 400 ft east and 550 ft north of the maxi-pad. Rectangular Coordinates (400 ft, 550 ft)

(r, θ)

$X = 400 \quad y = 550$

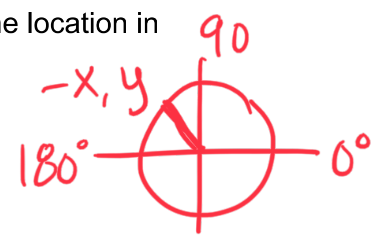
$r = \sqrt{x^2 + y^2} = \sqrt{(400)^2 + (550)^2} = 680\text{ ft}$

$\theta = \tan^{-1}\frac{y}{x} \quad \tan^{-1}\left(\frac{550}{400}\right) = 54°$

$\boxed{(680\text{ ft}, 54°)}$

2.) (8 pts) With the squirrel crisis averted, Tampy now trains his sights on the dumpster of a new Mediterranian restaurant that recently opened. According to his Raccoon-dar, the dumpster is located at the polar coordinates (1.8 mi, 124°). Find the location in rectangular coordinates.

(x, y)



$x = r\cos\theta$

$x = (1.8\text{ mi})(\cos 124) = -1.006 = -1.01\text{ mi}$

$y = r\sin\theta$

$y = (1.8\text{ mi})(\sin 124) = 1.49\text{ mi}$

$(-1.01\text{ mi}, 1.49\text{ mi})$