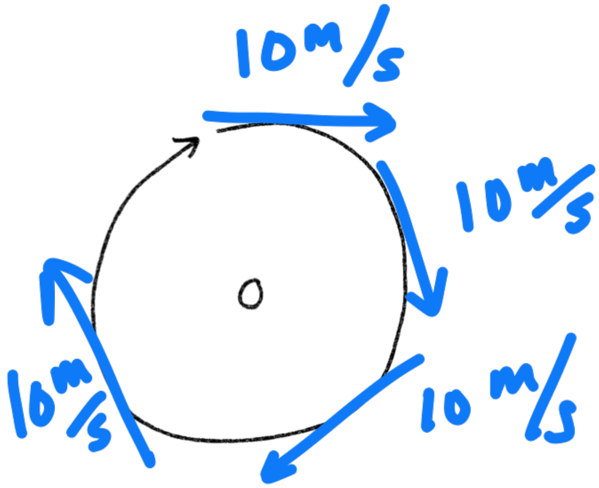
M-GP General Physics Week 20 2/19

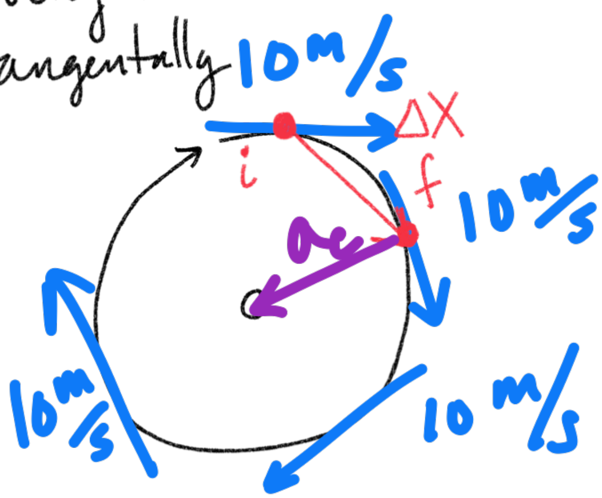
Uniform Circular Motion



If traveling in a circle, its direction is always changing.

Velocity is a vector quantity – it has both <u>magnitude</u> and <u>direction</u>.

velocity moves tangentally

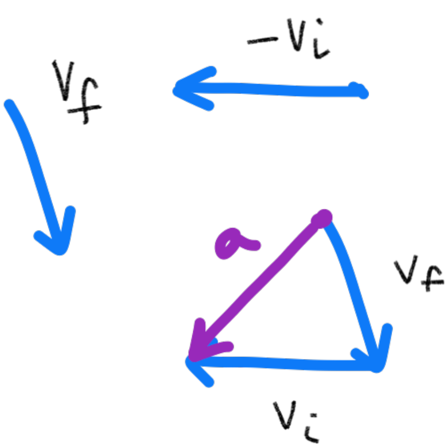


change in velocity

$\frac{\Delta V}{\Delta t}$ = <u>acceleration</u>

ΔX = displacement

$\Delta X = X_f - X_i$



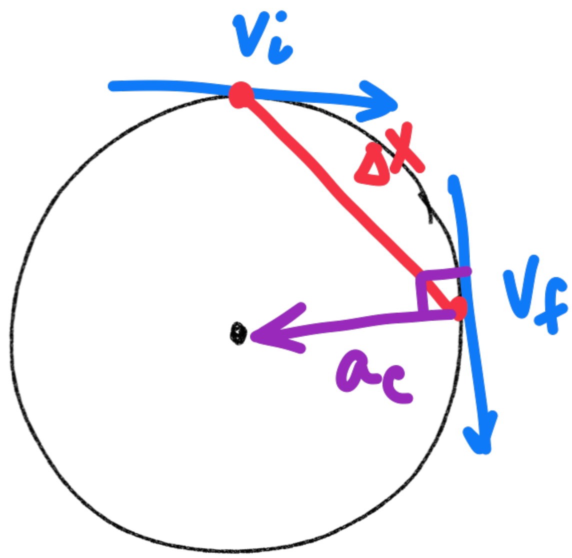
$V_f - V_i$

$V_f + (-V_i)$

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

a_c

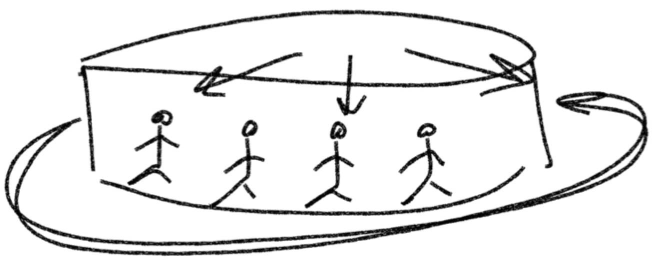
centripetal



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

centrifugal acceleration | $\boxed{\text{centripetal acceleration}}$

a_c

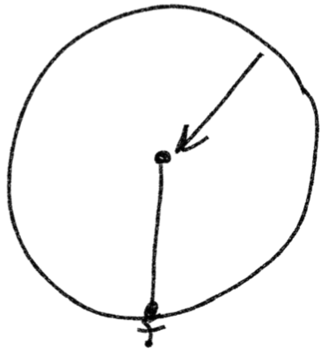


$$a_c = \frac{v^2}{r}$$

$v = \frac{m}{s}$

$r = m$

$$a_c = \frac{\left(\frac{m}{s}\right)^2}{m} = \frac{\frac{m^2}{s^2}}{\cancel{m}} = \boxed{m/s^2}$$



gravity: $-9.8\,m/s^2$

Radius of Earth: 6,378,100 m

velocity of Earth: 460 m/s

$$a_c = \frac{v^2}{r} = \frac{(460\,m/s)^2}{6{,}378{,}100\,m} = \boxed{0.0332\,m/s^2}$$

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

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

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

Satellite velocity: 376 m/s

distance to the center of the earth: 1,500,000,000 m

$$\begin{bmatrix} v = 7499\ m/s \\ r = \end{bmatrix}$$

$$a_c = \frac{v^2}{r} = \frac{(376\ m/s)^2}{1{,}500{,}000{,}000\ m}$$

$$= 0.000094251$$

$$\boxed{9.43 * 10^{-5}\ m/s^2}$$

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

$$a_c = \frac{v^2}{r} \qquad 60m\left(9.8\ m/s^2\right) = \left(\frac{v^2}{60m}\right)60m$$

$$a_c = 9.8\ m/s^2$$

$$\sqrt{v^2} = \sqrt{(60m)(9.8\ m/s^2)}$$

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

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)

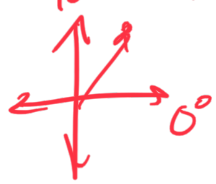
Polar Coordinates (r, θ)

$x = 400$ (+) $\quad y = 550$ (+)

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

$$\theta = \tan^{-1}\frac{y}{x} = \tan^{-1}\frac{550}{400} = 54^\circ$$

90°



$$\boxed{(680\text{ ft}, 54^\circ)}$$

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)

$$x = r\cos\theta$$

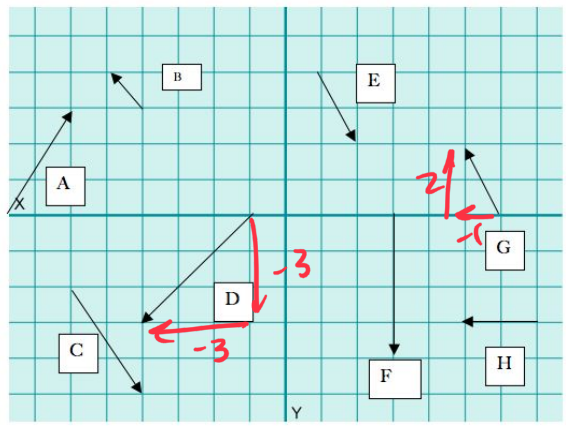
$$x = (1.8)(\cos 124^\circ) = -1.01\text{ mi}$$

$$y = r\sin\theta$$

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

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

3.) (12 pts, 6 pts each) Add or subtract each of the following vectors graphically using the table below. Please label each. Find the magnitude and direction of the resultant.



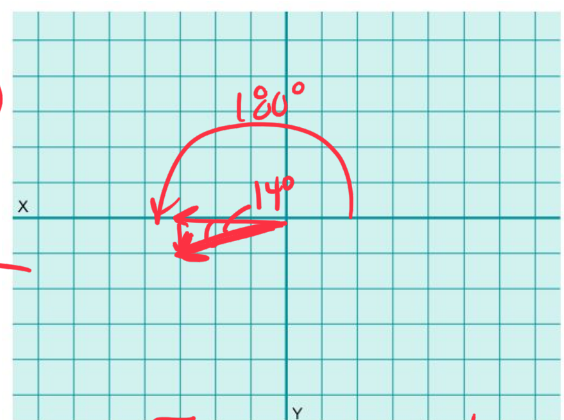
a) D + G

$D: \langle -3\hat{i} - 3\hat{j} \rangle$

$G: \langle -\hat{i} + 2\hat{j} \rangle$

$+$

$\langle -4\hat{i} - \hat{j} \rangle$



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

$\sqrt{(-4)^2 + (-1)^2}$

$\sqrt{16 + 1} = \sqrt{17}$

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

$\tan^{-1}\left(\frac{-1}{-4}\right) = 14°$

Magnitude = $\sqrt{17}$ Direction = 194

$14 + 180 = 194$

b) E - H

Magnitude = ________________ Direction = ________________