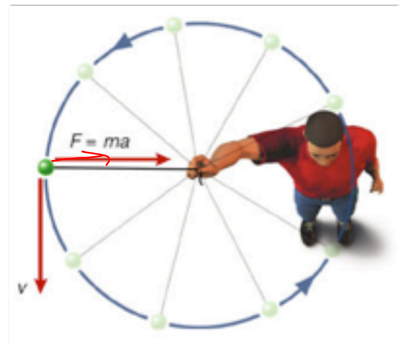
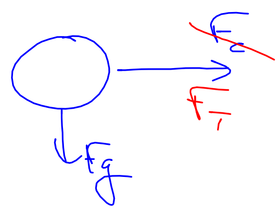
Uniform Circular Motion



- Even if the person continues to swing their arm at the same rate – this is still non-equilibrium (acceleration is present). Why?
- Centripetal – center seeking
- Velocity $v = \frac{2\pi r}{T}$ Not on formula Sheet
  Derive
  $v = \frac{\Delta x}{\Delta t}$
- Centripetal Acceleration (radial) $a_c = \frac{v^2}{r}$
- Centripetal Force: $F_c = ma_c = m\frac{v^2}{r}$
  - Always provided by an already existing force
- Centrifugal – fictitious force, center 'fleeing'
  - Lack of centripetal



Uniform Circular Motion

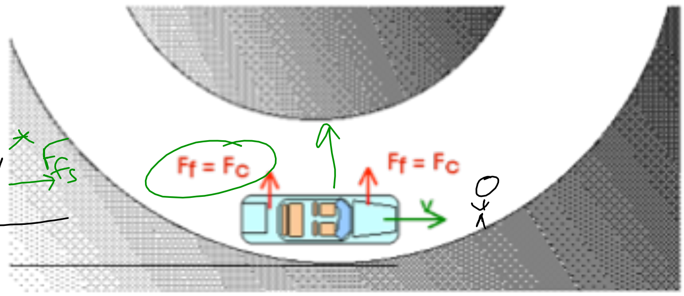
- Tension or Friction as F_c

$\Sigma F_x = F_{fs}$

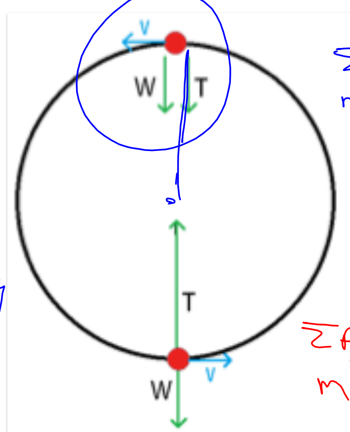
$m a_c = F_{fs}$

$m \frac{v^2}{r} = F_{fs}$

$m \frac{v^2}{r} = \mu_s F_N$



- Vertical Circles & F_c
  - *Apparent weightlessness



$\Sigma F_y = -(F_T + F_g)$

$m a_c = (F_T + F_g)$

$m a_c = F_T + F_g$

$m a_c - F_g = F_T$

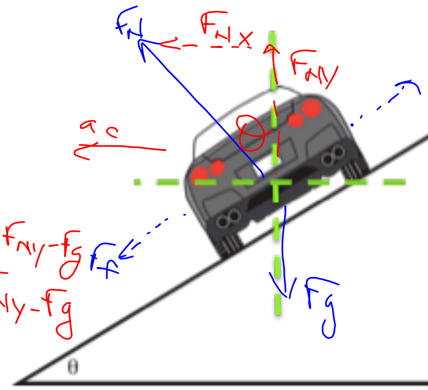
Top

$m a_c = F_T - F_g$

$m a_c + F_g = F_T$

- Banked Tracks

* depending on v, may have more F_f



$\Sigma F_x = F_{Nx}$

$m a_c = F_{Nx}$

$\Sigma F_y = F_{Ny} - F_g$

$0 = F_{Ny} - F_g$

Gravity

- Newton's Law of Universal Gravitation

$$F_G = G\frac{m_1 \cdot m_2}{r^2}$$

  - Inverse Square Law

- Determining the acceleration of gravity

$$F_g =$$

$$\cancel{m}g = G\frac{\cancel{m_1} \cdot m_2}{r^2}$$

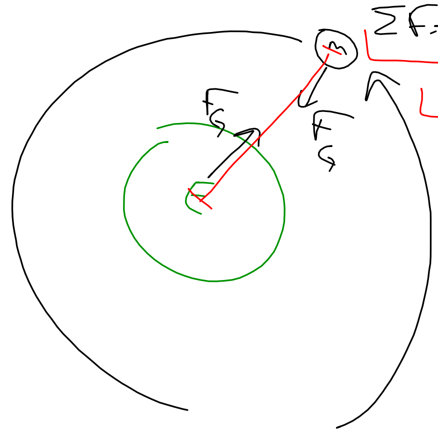
$$g = \frac{G \cdot m_E}{r_E^2}$$

$$2 \times m_E$$

$$\frac{1}{3} r_E^2$$

- Gravitation & Uniform Circular Motion

  Ex: Calculate the period of the moon around the earth in days based on Newton's Law of Universal Gravitation. Treat the Earth and Moon as point sources



$$\sum F = F_G$$

$$\cancel{m_m} a_c = G \cdot \frac{\cancel{m_m} \cdot m_E}{r^2}$$

$$\frac{v^2}{\cancel{r}} = \frac{G \cdot m_E}{\cancel{r^2}}$$

$$v^2 = \frac{G \cdot m_E}{r}$$

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

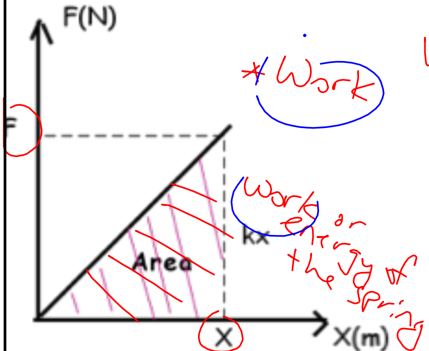
April 20, 2017

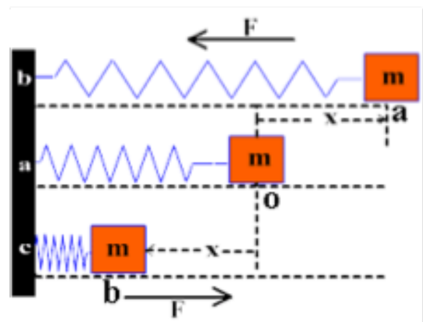
Simple Harmonic Motion

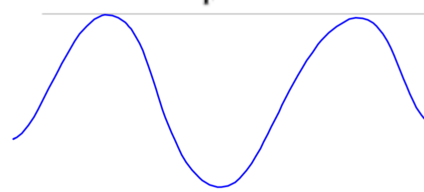
- Periodic motion with a restoring force $F_s = -kx$
  $|F_s| = k|x|$
- Can be model with wave variables, circular variables, sin/cos functions
- Can't use kinematics ☹ Why?
- *Energy of a Spring $U_s = \frac{1}{2}kx^2$
  - Conservative
- Force vs. Displacement Graph

*Work

$W = F \cdot d \cdot \cos\theta$







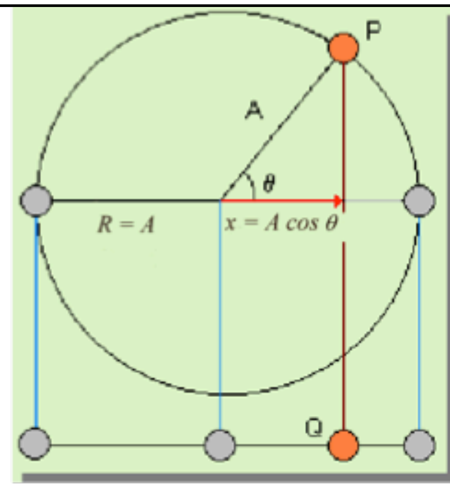
Simple Harmonic Motion

- Time-Dependent Functions

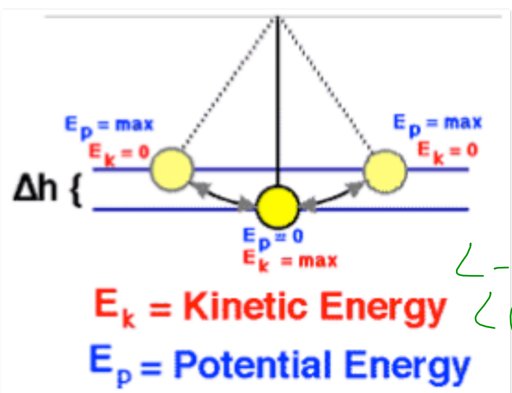
$$x = A\cos\theta$$

$$x = A\cos(\omega \cdot t)$$

$$* \; x = A\cos(2\pi f t)$$



- Pendulums



$L = x + h$

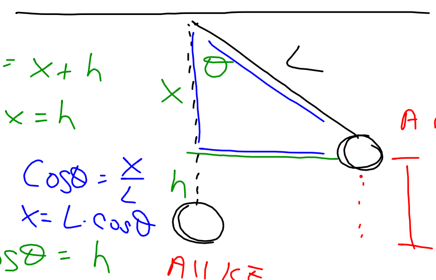
$L - x = h$

$\cos\theta = \frac{x}{L}$

$x = L \cdot \cos\theta$

$L - L\cos\theta = h$

$L(1 - \cos\theta) = h$



$mgh = \frac{1}{2}mv^2$

- Driven/Damped Harmonic Motion