# Reminders 08-04-09:

- Exam 3 Average 68%
- 8th Webassign due Tue 11:59PM
- <u>Exam 4 Chapters 9-11  Thursday</u>
- Standard Assessment p.283 #2 D, #4 A, #6 C, #7A; ignore the other questions.

# Objectives:

- Potential Energy
- Conservation of Energy

# Exam Difficulties:

1. Some of you are confusing horizontal and vertical motion.
2. Some of you don't are confused in calculating the direction of a projectile; it depends on instantaneous velocity components. It **NEVER EVER EVER** depends on displacement components.

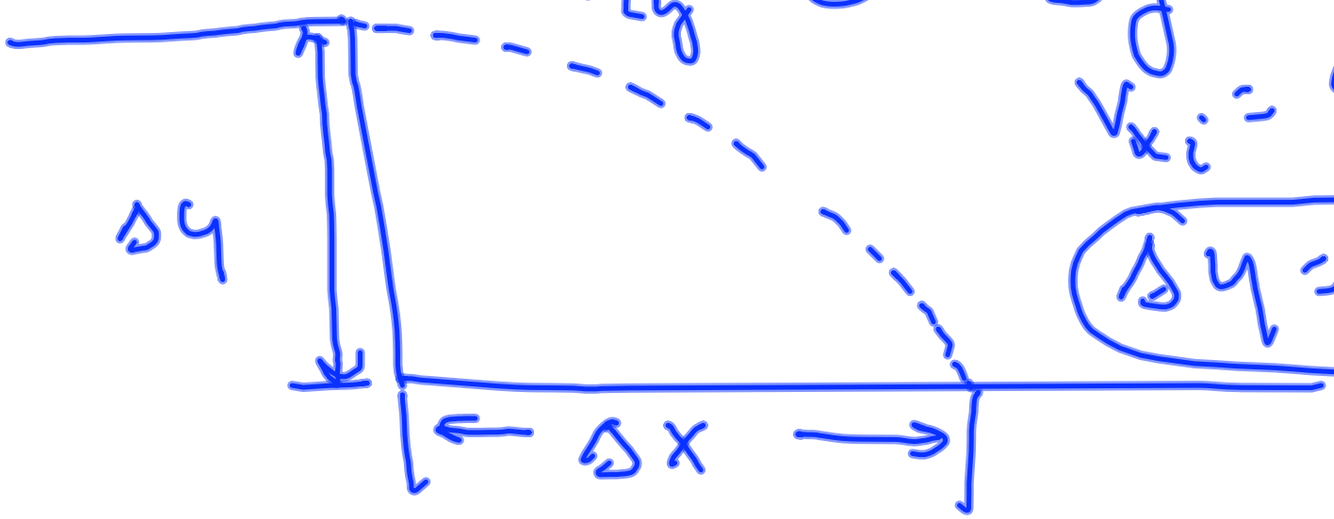
3. Some of you need understand that $F_{net}$ must be parallel to a, since Newton's second law says,

$F_{net}=ma$ (see problem 3b).

4. Some of you don't realize that $v=\Delta x/\Delta t=2\pi r/T$ for circular motion.

$V_{iy} = 0$ $\Delta y = -1.2\,m$

$V_{xi} = 5.8\,m/s$

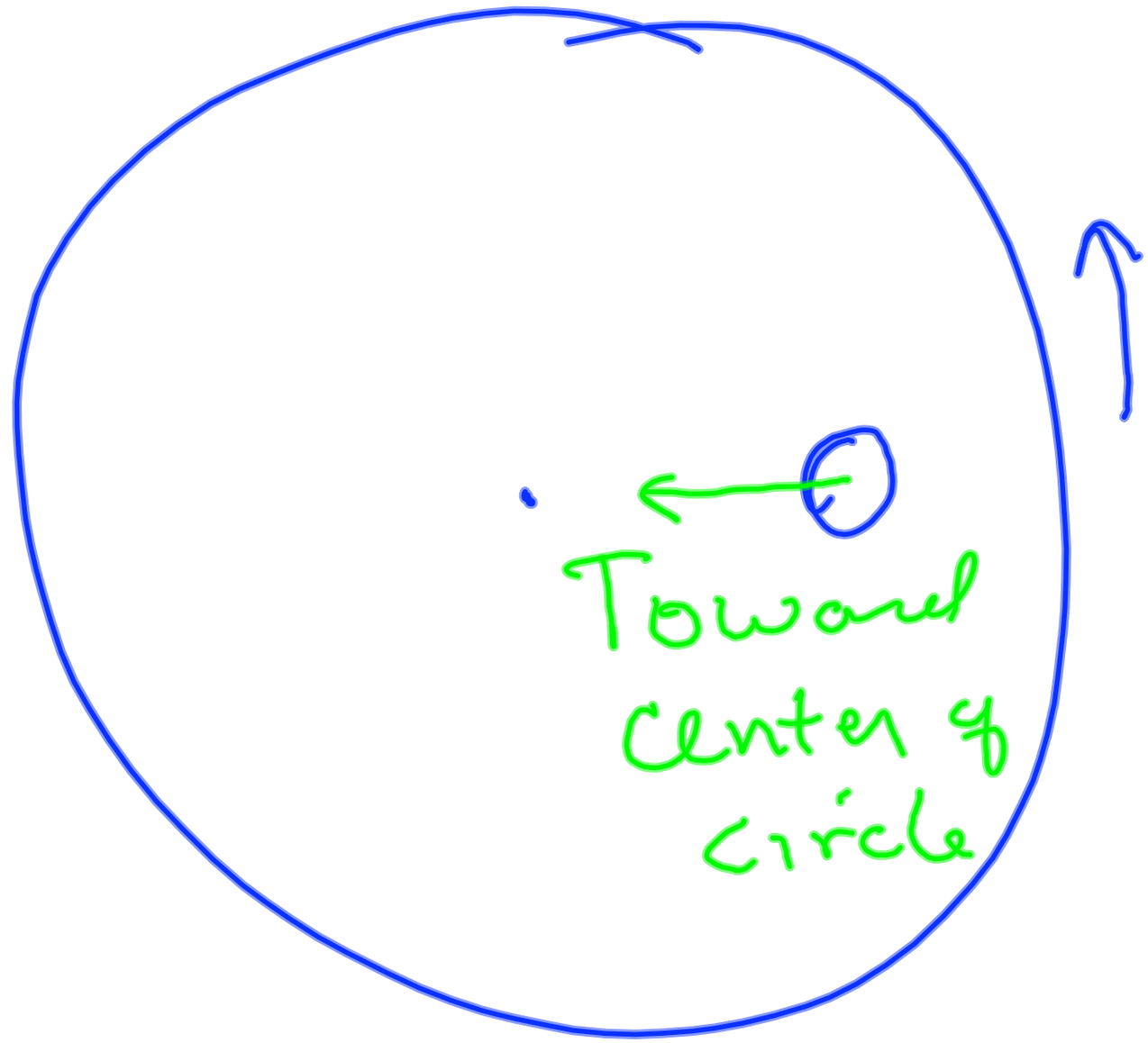



$\Delta y = \frac{1}{2} a_y t^2$

Speed never changes in horizontal direction, $a_x = 0$.

$\Delta x = v_{ix} t$

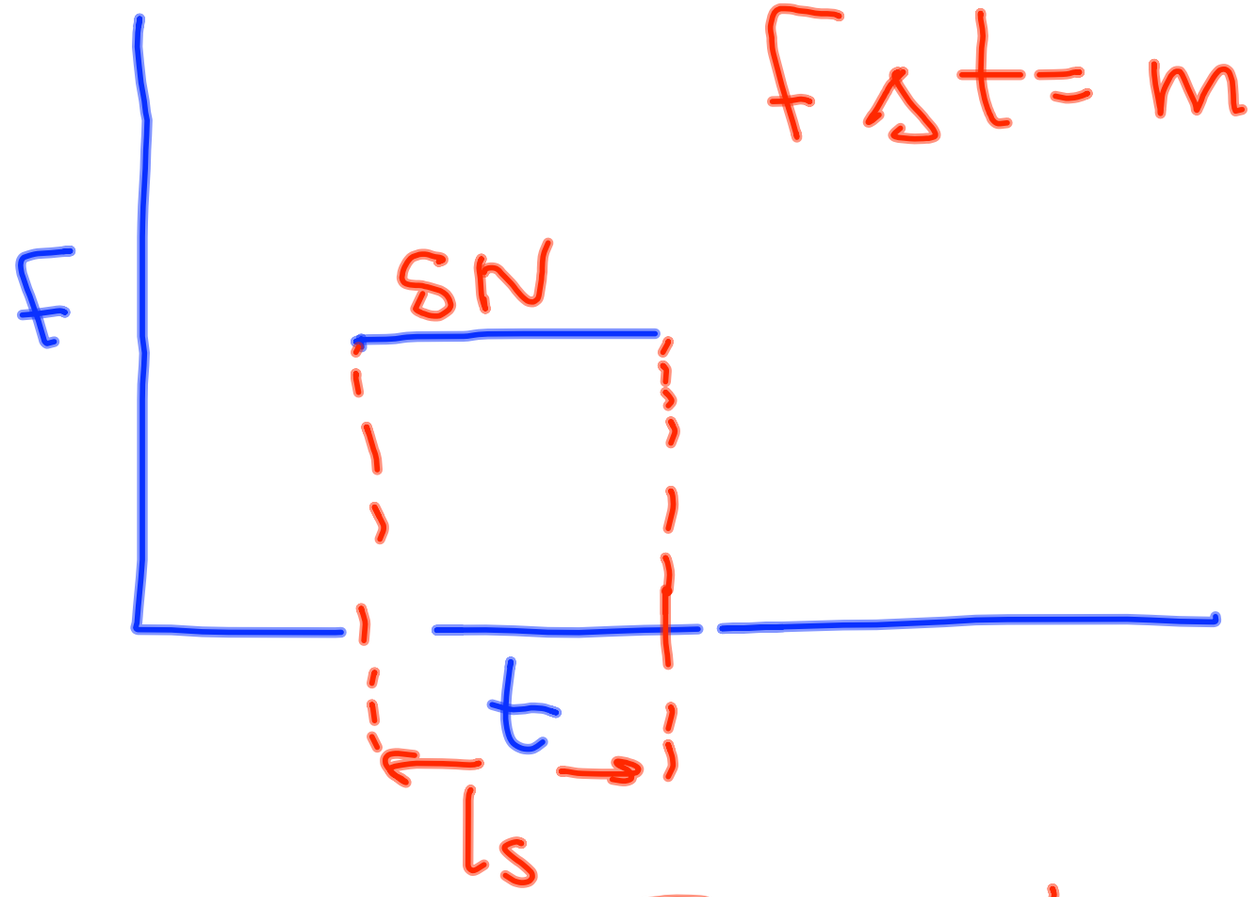
$\cancel{\theta = \tan^{-1}\left(\frac{\Delta y}{\Delta x}\right)}$ $\theta = \tan^{-1}\left(\frac{V_{yf}}{V_{xf}}\right)$




$$\vec{F}_{net} = m\vec{a}_c$$

# #2

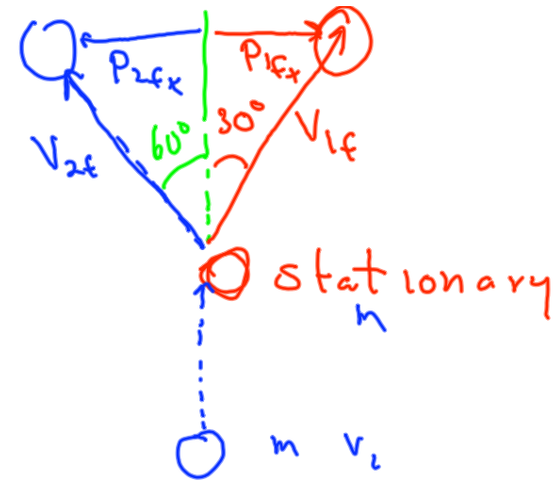
$F\Delta t = m\Delta v$




area under F vs. t curve is $m\Delta v = \Delta p$

$5\,N\text{-}s = m(v_f - v_i)$

# 5




$$\Sigma p_{ix} = 0 = mv_{2fx} + mv_{1fx} = 0$$

$$V_{2fx} = -V_{1fx}$$

$$V_2 \sin 60 = -V_1 \sin 30$$

$$\Sigma p_{iy} = mV_i = mV_{2fy} + mV_{1fy}$$

$$V_i = V_{2fy} + V_{1fy}$$

$$V_i = V_2 \cos 60 + V_1 \sin 60$$

$$V_2 \sin 60 = -V_1 \sin 30$$

$$V_i = V_2 \cos 60 + V_1 \sin 60$$

$$V_2 \left(\frac{\sqrt{3}}{2}\right) = -V\left(\frac{1}{2}\right) \Rightarrow \sqrt{3}\, V_2 = -V_1$$

$$V_i = V_2\left(\frac{1}{2}\right) + V_1\left(\frac{\sqrt{3}}{2}\right) \Rightarrow 2V_i = V_2 + \sqrt{3}\, V_1$$

2 equations + 2 unknowns
now solve them.

#6 $F\Delta t = \text{impulse} = \Delta p$

$= m\Delta v$

# Work and Energy

- Suppose an object is thrown up into the air and reaches a maximum height $h_f$. The work done by gravity is Work = $-mgh_f$ (assuming $h_i = 0$). The change in the object's potential energy is $mgh_f$ (assuming $h_i = 0$). This shows that the work done by gravity is equal to the negative of the change in PE.

$W_{up_g} = |mg||h_f| \cos 180 = -mgh_f$

$\Delta GPE_{up} = mgh_f$

$W_{gravity} = -\Delta GPE$ always true

Answer depends on what I choose as zero point

# Work and Energy

- Suppose a 1.00 kg rock is five meters above the ground. What is its potential energy?
  - Now suppose the rock is dropped. What can we say about its energy? Assume there is no air friction (no work is done by friction; no energy is lost as a result of friction).

If ground is h=0 then

$$GPE_i = (1.00\,kg)(9.80\,\tfrac{m}{s^2})(5.00\,m)$$

# Work and Energy

- Conservation of energy means that the total initial energy of an object is equal to its total final energy. The total energy of an object is equal to the sum of its potential energy and kinetic energy. Thus, conservation of energy says that

$$(1/2)mv_i^2 + mgh_i = (1/2)mv_f^2 + mgh_f$$

1 $KE_i + GPE_i = KE_f + GPE_f$

2 $TE_i = TE_f$

$-GPE_f + GPE_i = KE_f - KE_i$

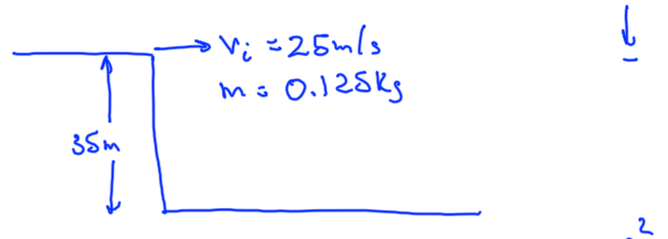
$-\Delta GPE = \Delta KE$

3 $\Delta KE + \Delta GPE = 0$

4 $TE_f - TE_i = 0$

5

- A 125 g rock is hurled horizontally off a 35 m high cliff with an initial velocity of 25 m/s.
  - What is its initial kinetic energy?
  - What is its initial potential energy?
  - What is its total initial energy?
  - What is its final energy just when it hits the ground below?
  - What is its final speed when it hits the ground?




$$KE_i = \frac{1}{2} m v_i^2 = \frac{1}{2}(.125\,kg)(25\,m/s)^2 = 39\,J$$

$$GPE_i = mgh_i = (.125\,kg)(9.80\,\tfrac{m}{s^2})(35\,m) = 43\,J$$

$$TE_i = KE_i + GPE_i = 39\,J + 43\,J = 82\,J$$

$$TE_f = 82\,J = \frac{1}{2} m v_f^2 \quad \text{since } GPE_f = 0$$

$$v_f = \sqrt{\frac{2(82\,J)}{.125\,kg}} = 36\,m/s$$

$$\underbrace{\frac{1}{2} m v_i^2 + mgh_i}_{TE_i} = \underbrace{\frac{1}{2} m v_f^2}_{TE_f}$$

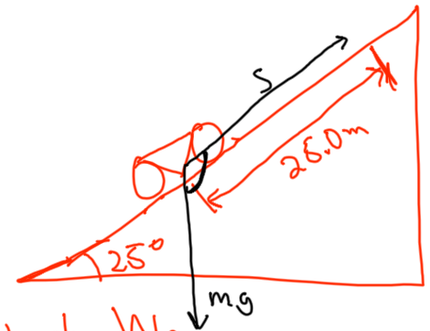
$$v_i^2 + 2gh_i = v_f^2$$

$$v_f = \sqrt{v_i^2 + 2gh_i}$$

magnitude of velocity vector

## Work and Energy-Examples

- A person on a bicycle is riding up a hill at 3.0m/s. The hill has a 25º incline. The mass of the bicycle and the person is 85 kg.
  - How much work is done by gravity after the bicycle travels a distance of 25.0 m? What is its change in potential energy?
  - How much work is done by the force required to move the bicycle up the hill, if the velocity is constant over the 25.0 m distance it travels? What is the magnitude of this force.
  - What is the work done by gravity if she rides down the hill? $+8800\,J$
  - The force is doubled over the next 10m. Find $v_f$.




Want $W_g$

$W_g = |mg||s|\cos 115$

$= (85\,kg)(9.80\,\frac{m}{s^2})(25.0\,m)\cos 115°$

$= -8800\,J$

$\Delta GPE = +8800\,J$

$W_{cyclist} = +8800\,J$ because $\Delta KE = 0$

$W_{net} = \Delta KE$

$W_g + W_{cyclist} = 0$

$-8800\,J + W_{cyclist} = 0$

$W_{cyclist} = +8800\,J$

$F_{cyclist}(25.0\,m) = 8800\,J$

$F_{cyclist} = \frac{8800\,J}{25.0\,m} = \underline{350\,N}$

$$W_{net} = \Delta KE$$

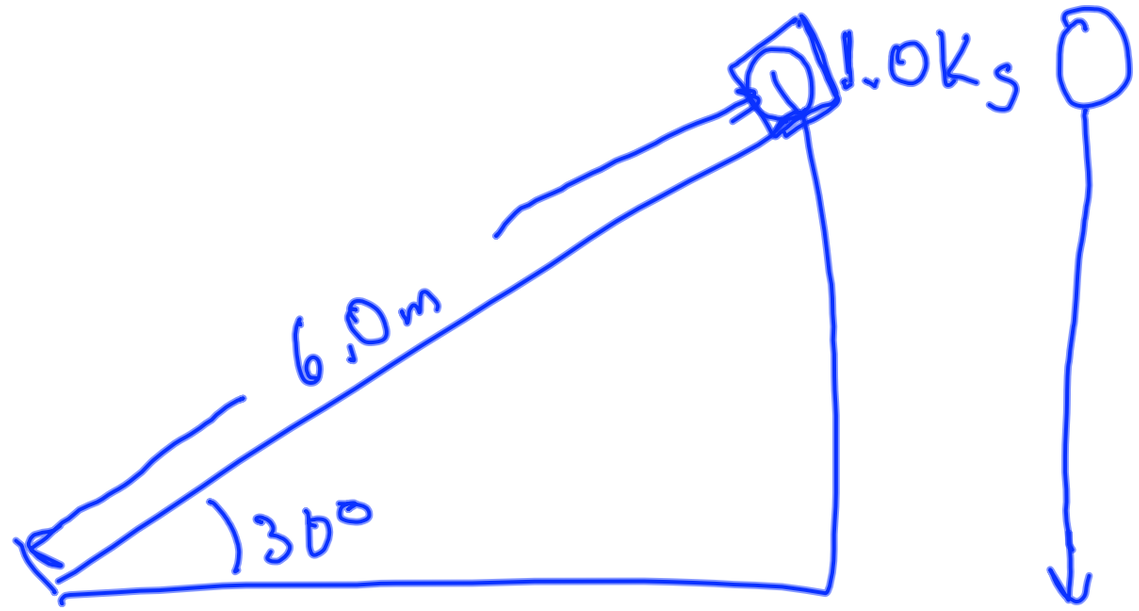
$$W_g + W_{cyclist} = \frac{1}{2} m \left( v_f^2 - v_i^2 \right)$$

$$mg(10m)\cos 115 + (700N)(10m) = \frac{1}{2} m \left( v_f^2 - v_i^2 \right)$$

$$mg(10m)\cos 115 + 7000J = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$mg(10m)\cos 115 + 7000J + \frac{1}{2} m v_i^2 = \frac{1}{2} m v_f^2$$

$$\sqrt{\frac{2mg(10m)\cos(115) + (14{,}000J) + mv_i^2}{m}} = v_f$$




$\Delta GPE = GPE_f - GPE_i$

let $GPE_f = 0$

$GPE_i = mgh$

$= (1.0\,kg)(9.80\,m/s^2)(6.0\,m \sin 30°)$

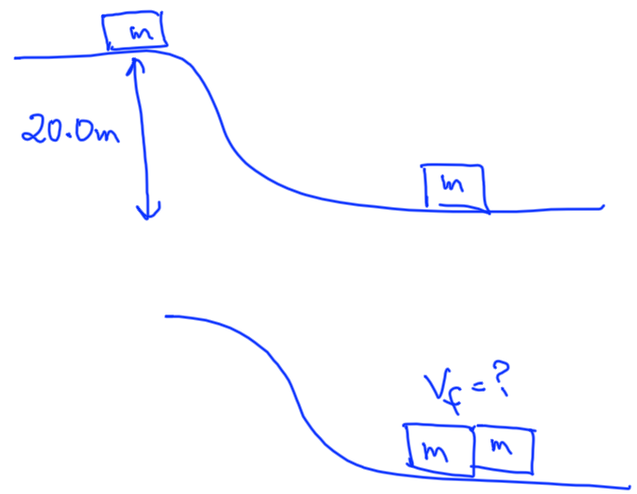
$(3.0)(9.8) = 29.4\,J$

$\Delta GPE = -29.4\,J$

$\Delta KE = +29.4\,J$

$\Delta GPE + \Delta KE = 0$

- **A railroad car rolls from rest from the top of a 20.0m hill and collides with a stationary railroad of equal mass at the bottom of the hill. If the two cars stick together after the collisions what is the, what is their final speed?**




Conserve p

$\Sigma p_i = \Sigma p_f$ $\quad V_i = 19.8\,m/s$ see below

$m v_i = (m+m) V_f$

$V_f = \frac{m V_i}{m+m} = \frac{V_i}{2} = \frac{19.8\,m/s}{2} = 9.9\,m/s$

Need $V_i$ Conserve Energy before collision

$TE_i = TE_f$

$\cancel{m} g h = \frac{1}{2} \cancel{m} v^2$

$2gh = v^2$

$v = \sqrt{2gh} = \sqrt{2(9.8\,m/s^2)(20.0\,m)}$

$= 19.8\,m/s$