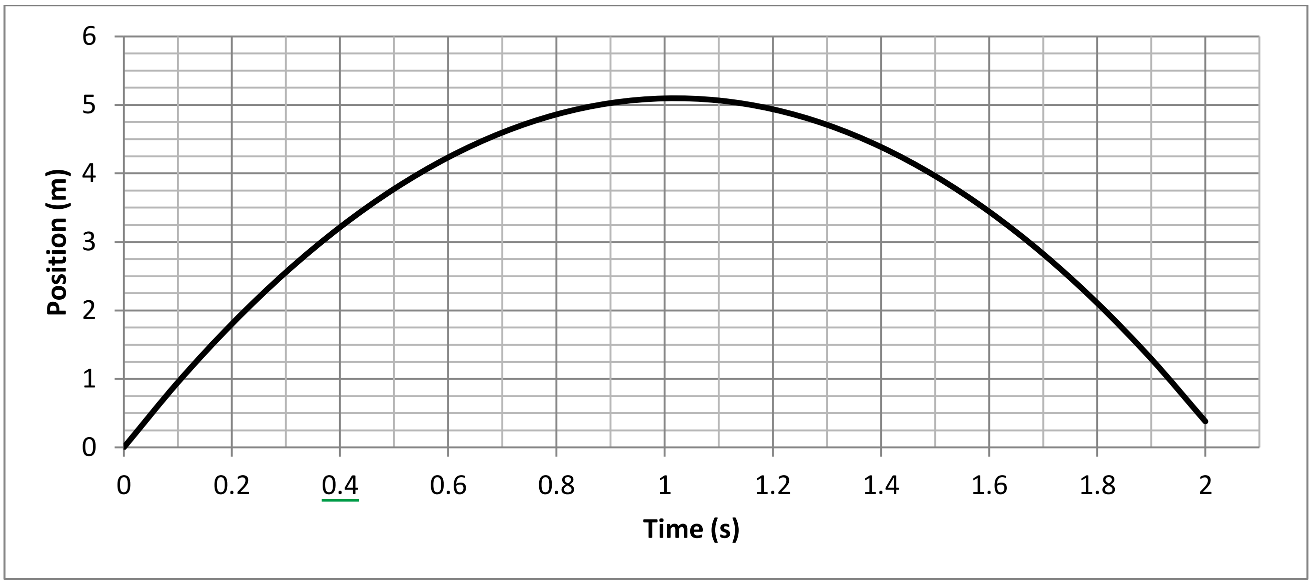
Name: ______________________ DISC: ____________ Score: _____ / 20

Instructions:

- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
5	5	5	5

1. You and your roommate are playing a game of catch. The graph shows the position of the ball as a function of time.



Set-up:
Algebra:

a. Using the graph, estimate the speed *v* at the time when the ball has reached its maximum height.

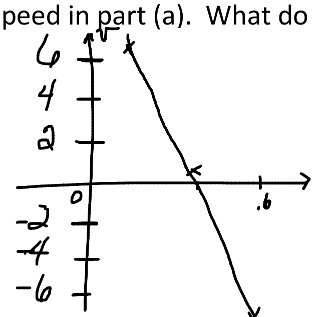
Max height v/s
Let Δt = 1.2s − 0.8s = 0.4s
Then Δx = 4.9m − 4.8m = 0.1m
⇒ 0.1m / 0.4s = 1/4 = 0.25m/s

Speeds:
Graph:
Observation:

b. Estimate the speed *v* at $t = 0.4\ s$ and $t = 1.6\ s$. Sketch a speed vs. time plot using the three speeds you estimated, including the speed in part (a). What do you observe?

Δt = 0.2s
Δx = 3.75m − 2.5m = 1.25m
v = 1.25m / 0.2s = 12.5m / 2s = 6.25m/s

1.6s: Δt = 0.2s
Δx = +2.75m − 4m = −1.25m
v = −1.25m / 0.2s = −6.25m/s

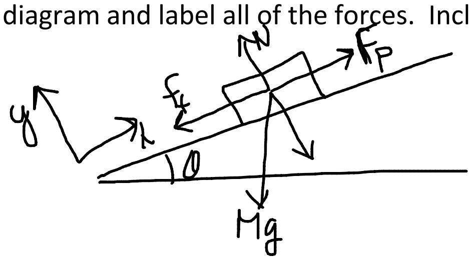


negative slope ⇒ const. acceleration

2. You are pushing a cart up a hill when the wheels fall off. If the hill makes an angle θ with the horizontal:

Diagram:
Force Labels:

a. Draw a free-body diagram and label all of the forces. Include the coordinate system.



Set-up:
Algebra:
Substitutions:

b. The cart has a mass $m = 25\ kg$. Let $\theta = 30^o$ and the coefficient of kinetic friction $\mu_k = 0.2$. How much force must you apply to the cart to maintain a constant velocity up the hill? Assume you can direct your push directly up the hill.

① Constant velocity means $a=0$

$\therefore \Sigma F_{ext} = 0$.

② $\Sigma F_y = 0$

$N = -mg\cos\theta$.

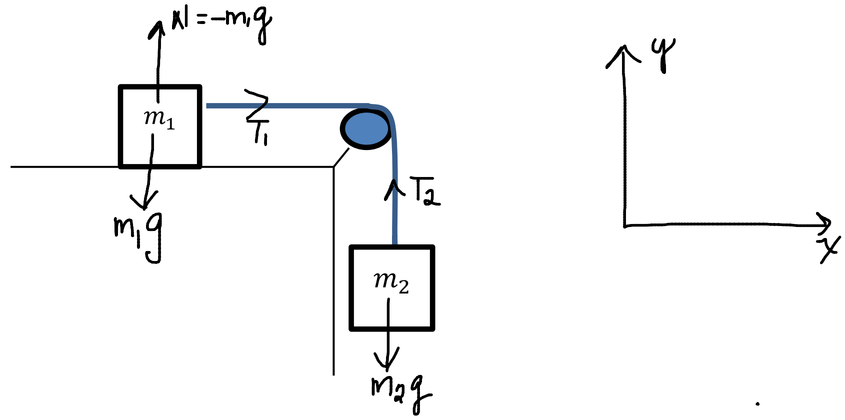
③ $\Sigma F_x = 0 = F_{\mu_k} + F_{push}$

$F_{\mu_k} = \mu_k N = 0.2(25kg)(9.81 m/s^2)\cos(30^o)$

$= 42.48 N$ downhill

$\therefore F_{push} = F_{\mu_k} = $ 42.48 N uphill

3. Two blocks are attached to each other by a massless cord as shown in the diagram below. Both the table and pulley are *frictionless*:



Force Vectors:
Labels:

a. Finish the free-body diagram by including all of the forces which can act on the blocks. Include a coordinate system.

Answer:
Explanation (2 pts):

b. Can this system be in equilibrium? Explain your reasoning.

No. There is no force opposing the tension caused by the hanging mass.

4. You want to determine the height of a mountain 100 km from your current position. You look around and notice that about 500 m away from you is a tall tree. You look up and notice that the peak of the mountain and the top of the tree are aligned.

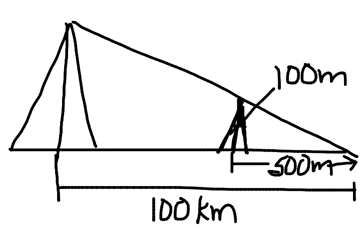
Description:
Missing information:

a. Describe how you would use this information to find the height of the mountain. What information do you still need to solve the problem?

If I know a) the height of the tree or b) the angle of view, I can use (a) similar triangles or (b) trig functions to find the height of the mountain.

Set-up:
Algebra:
Substitutions:

b. The tree is 100 m tall. How tall is the mountain?



$\frac{100 m}{500 m} = \frac{h_m}{100 km}$

$\frac{100 km}{5} = h_m$

$h_m = 20 km$

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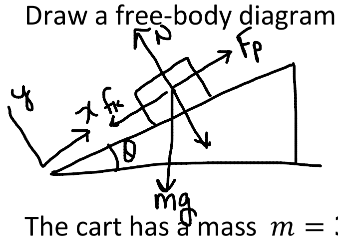
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
5	5	5	5

1. You are pushing a cart up a hill when the wheels fall off. If the hill makes an angle θ with the horizontal:

Diagram:
Force Labels:

a. Draw a free-body diagram and label all of the forces. Include the coordinate system.



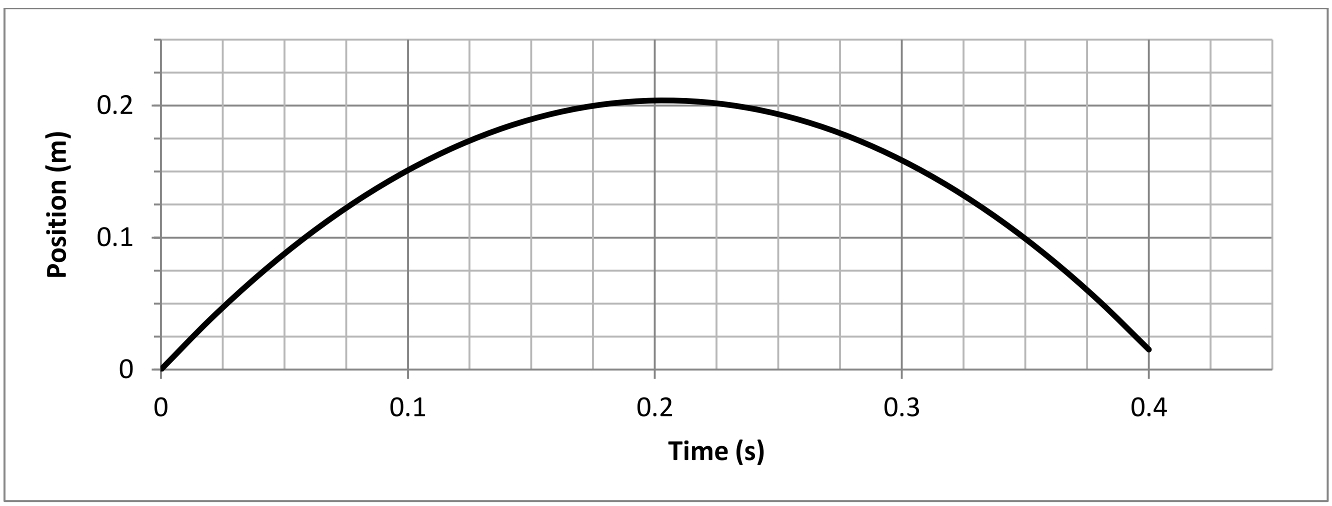
Set-up:
Algebra:
Substitutions:

b. The cart has a mass $m = 30\ kg$. Let $\theta = 15^o$ and the coefficient of kinetic friction $\mu_k = 0.15$. How much force must you apply to the cart to maintain a constant velocity up the hill? Assume you can direct your push directly up the hill.

1. $\Sigma F_y = 0$
$N = -mg\cos\theta$
$= 30kg(9.81 m/s^2)\cos(15^o)$
$= 284.272 N$

2) $\Sigma F_x = 0 = f_k + F_p$
$= -\mu_k N + F_p$
$= -0.15(284.272) + F_p$
$\Rightarrow F_p = 42.641\ N$

2. You and your roommate are playing a game of catch. The graph shows the position of the ball as a function of time.



Set-up:
Algebra:

a. Using the graph, estimate the speed *v* at the time when the ball has reached its maximum height.

max height ~0.2s
$\Delta t = 0.225s - 0.175s$
$= 0.05s$
$\Delta x = 0.2m - 0.2m = 0$
$\therefore v = 0$

Speeds:
Graph:
Observation:

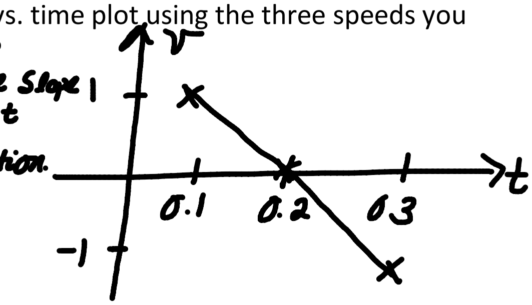
b. Estimate the speed v at $t = 0.1\ s$ and $t = 0.3\ s$. Sketch a speed vs. time plot using the three speeds you estimated, including the speed in part (a). What do you observe?

Let $\Delta t = 0.05s$

At $t = 0.1s$
$\Delta x = 0.05m$
$v = \frac{0.05m}{0.05s} = 1m/s$

at $0.3s$
$\Delta x = -0.05m$
$v = -\frac{0.05m}{0.05s} = -1m/s$

a negative slope ⇒ constant acceleration.



3. You want to determine the height of a mountain 75 km from your current position. You look around and notice that about 200 m away from you is a tall tree. You look up and notice that the peak of the mountain and the top of the tree are aligned.

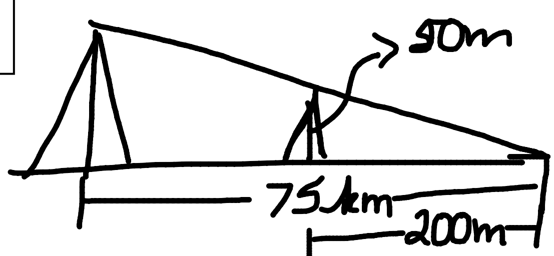
Description:
Missing information:

a. Describe how you would use this information to find the height of the mountain. What information do you still need to solve the problem?

If I know a) the height of the tree or b) the angle of view I can use (a) similar triangles or (b) trig. funcs. to find the height of the mountain.

Set-up:
Algebra:
Substitutions:

b. The tree is 50 m tall. How tall is the mountain?

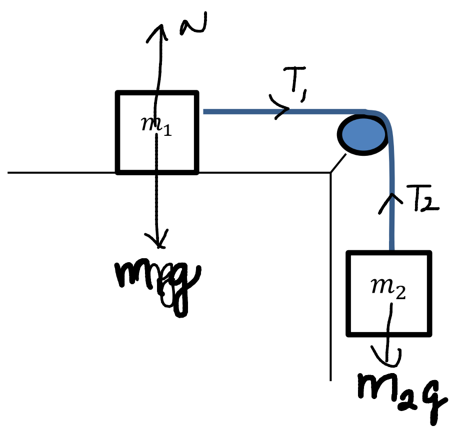


$$\frac{50m}{200m} = \frac{h_m}{75km}$$

$$\frac{1}{4} \cdot 75km = h_m$$

$$18.75\ km$$

4. Two blocks are attached to each other by a massless cord as shown in the diagram below. Both the table and pulley are *frictionless*:



Force Vectors:
Labels:

a. Finish the free-body diagram by including all of the forces which can act on the blocks. Include a coordinate system.

Answer:
Explanation (2 pts):

b. Can this system be in equilibrium? Explain your reasoning.

No. There is no force to counteract the tension caused by the hanging mass.

Name: ______________________________ DISC: ____________ Score: _____ / 20

Instructions:
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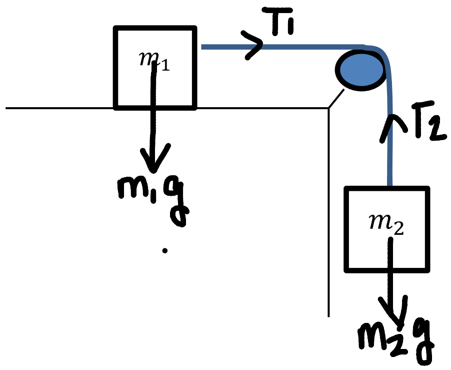
Q1	Q2	Q3	Q4
5	5	5	5

1. Two blocks are attached to each other by a massless cord as shown in the diagram below. Both the table and pulley are *frictionless*:



Force Vectors:
Labels:

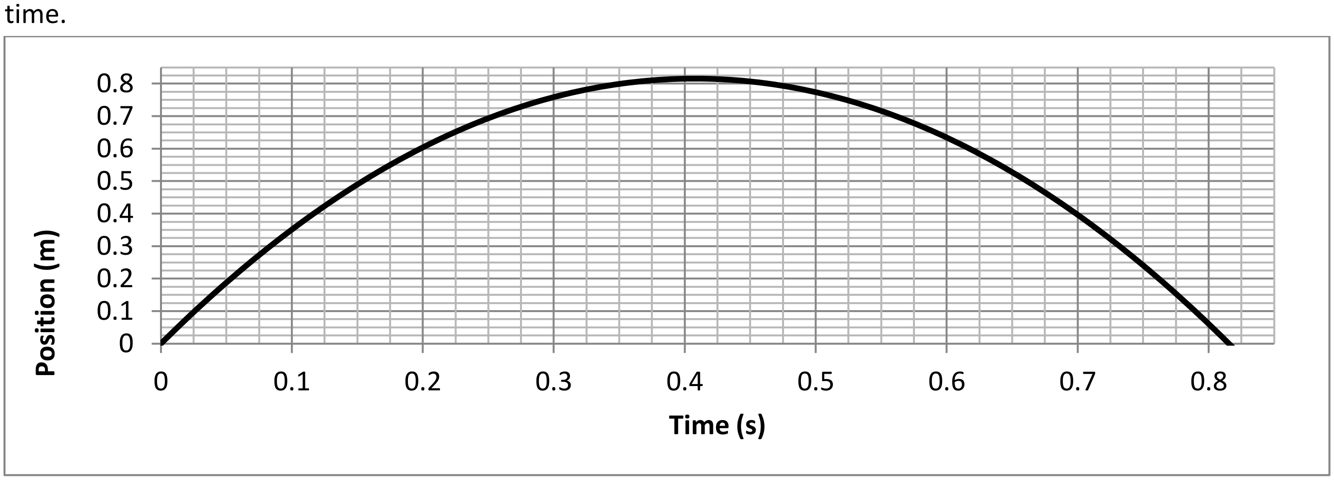
a. Finish the free-body diagram by including all of the forces which can act on the blocks. Include a coordinate system.

Answer:
Explanation (2 pts):

b. Can this system be in equilibrium? Explain your reasoning.

No. There is no force to counter-act the tension of the hanging mass.

2. You and your roommate are playing a game of catch. The graph shows the position of the ball as a function of time.



Set-up:
Algebra:

a. Using the graph, estimate the speed *v* at the time when the ball has reached its maximum height.

$h_{max}: t = 0.4s$
$\Delta t = 0.425s - 0.375s$
$= 0.05s$
$\Delta x = 0.825 - 0.825$
$= 0$

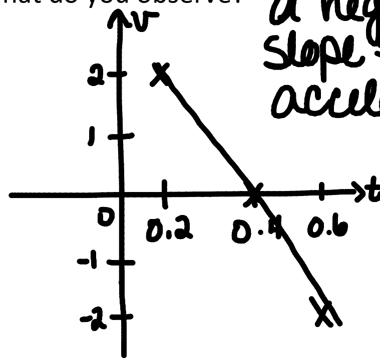
$\therefore v = \frac{0m}{0.05s}$
$= 0 m/s$

Speeds:
Graph:
Observation:

b. Estimate the speed v at $t = 0.2\ s$ and $t = 0.6\ s$. Sketch a speed vs. time plot using the three speeds you estimated, including the speed in part (a). What do you observe?

$t = 0.2s$
$\Delta t = 0.05s$
$\Delta x = 0.65s - 0.55s = 0.1m$
$v = \frac{0.1m}{0.05s} = \frac{10m}{5s} = \frac{2m}{s}$

$t = 0.6s$
$\Delta t = 0.05s$
$\Delta x = 0.55m - 0.65m = -0.1m$
$v = \frac{0.1m}{0.05s} = -\frac{2m}{s}$



a negative slope ⇒ const acceleration.

3. You want to determine the height of a mountain 125 km from your current position. You look around and notice that about 75 m away from you is a tall tree. You look up and notice that the peak of the mountain and the top of the tree are aligned.

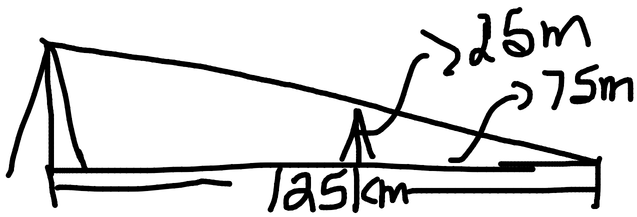
Description:
Missing
information:

a. Describe how you would use this information to find the height of the mountain. What information do you still need to solve the problem?

If I know either a) the height of the tree or b) the angle of view the problem can be solved using (a) similar triangles or (b) trig. functions.

Set-up:
Algebra:
Substitutions:

b. The tree is 25 m tall. How tall is the mountain?



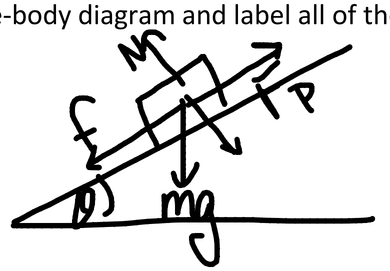
$\frac{25m}{75m} = \frac{hm}{125km}$

$hm = \frac{125km}{3} = 41.6\ km$

4. You are pushing a cart up a hill when the wheels fall off. If the hill makes an angle θ with the horizontal:

Diagram:
Force Labels:

a. Draw a free-body diagram and label all of the forces. Include the coordinate system.



Set-up:
Algebra:
Substitutions:

b. The cart has a mass $m = 35\ kg$. Let $\theta = 45^o$ and the coefficient of kinetic friction $\mu_k = 0.3$. How much force must you apply to the cart to maintain a constant velocity up the hill? Assume you can direct your push directly up the hill.

1) $\Sigma F_y = 0$
$N = -mg\cos 35^o$
$= 35(9.81)(0.8192)$
$= 281.26N$

2) $\Sigma F_x = 0$ v = const.
$F_p + F = 0$
$f = \mu N = 0.3(281.26N)$
$= 84.378N$ down the hill

∴ $F_{push} = -f_k$
$F_{push} = 84.4N$

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Q1	Q2	Q3	Q4
5	5	5	5

1. You want to determine the height of a mountain 50 km from your current position. You look around and notice that about 250 m away from you is a tall tree. You look up and notice that the peak of the mountain and the top of the tree are aligned.

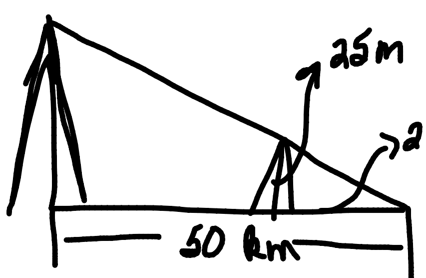
Description:
Missing information:

a. Describe how you would use this information to find the height of the mountain. What information do you still need to solve the problem?

If I know a) the height of the tree or b) the angle of view I can use (a) similar triangles or (b) trig. functions.

Set-up:
Algebra:
Substitutions:

b. The tree is 25 m tall. How tall is the mountain?



$$\frac{25\,m}{250\,m} = \frac{h\,m}{50\,km}$$

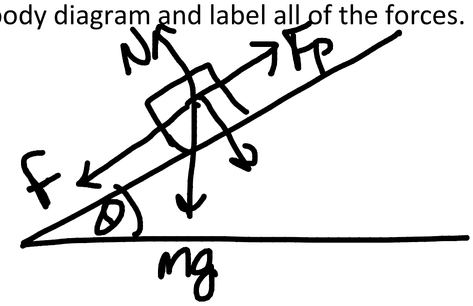
$$\frac{50\,km}{10} = h\,m$$

$h\,m = 5\,km$

2. You are pushing a cart up a hill when the wheels fall off. If the hill makes an angle θ with the horizontal:

Diagram:
Force Labels:

a. Draw a free-body diagram and label all of the forces. Include the coordinate system.



Set-up:
Algebra:
Substitutions:

b. The cart has a mass $m = 15\ kg$. Let $\theta = 25^o$ and the coefficient of kinetic friction $\mu_k = 0.25$. How much force must you apply to the cart to maintain a constant velocity up the hill? Assume you can direct your push directly up the hill.

$\sum F_y = 0$

$N = 15kg(9.81\,m/s^2)\cos 25^0$

$= 133.36\,N$

$\sum F_x = 0$ const. v.

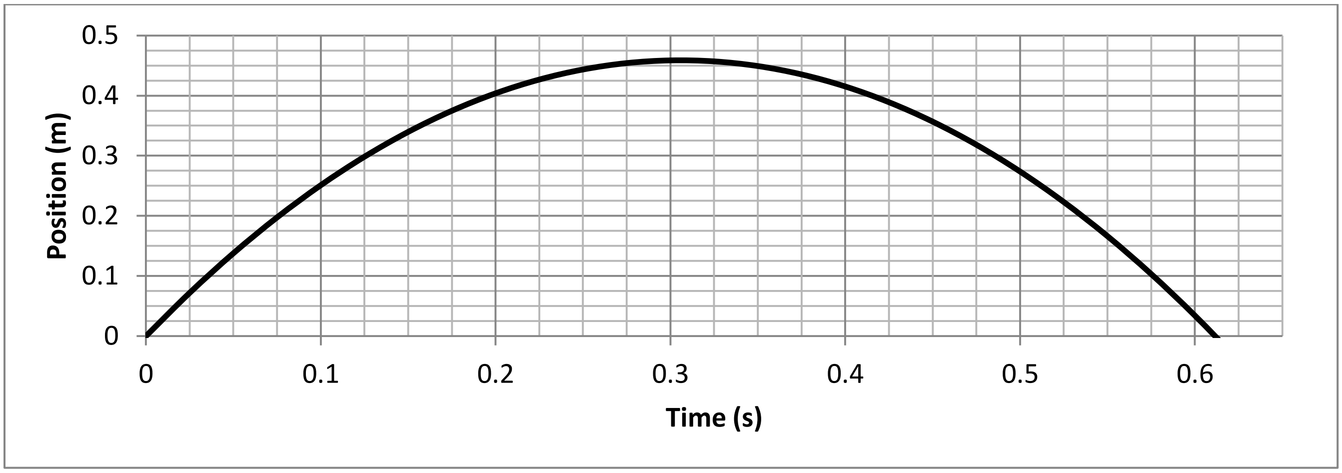
$F_p + f = 0$

$f = \mu_k N = 0.25(133.36N)$

$= 33.34N$ down hill

$\therefore F_p = 33.34N$ up

3. You and your roommate are playing a game of catch. The graph shows the position of the ball as a function of time.



Set-up:
Algebra:

a. Using the graph, estimate the speed *v* at the time when the ball has reached its maximum height.

hmax @ ~0.3s

Δt = 0.325s - 0.275s
= 0.05s

Δx = 0.45m - 0.45m = 0

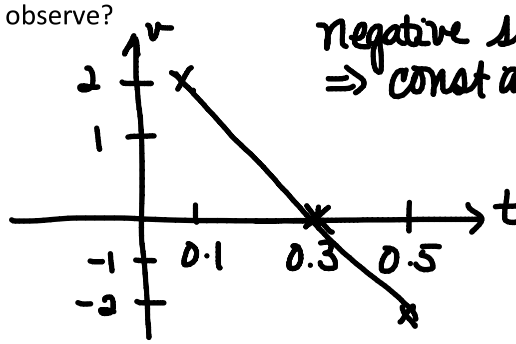
∴ v = 0 m/s

Speeds:
Graph:
Observation:

b. Estimate the speed *v* at $t = 0.1\ s$ and $t = 0.5\ s$. Sketch a speed vs. time plot using the three speeds you estimated, including the speed in part (a). What do you observe?

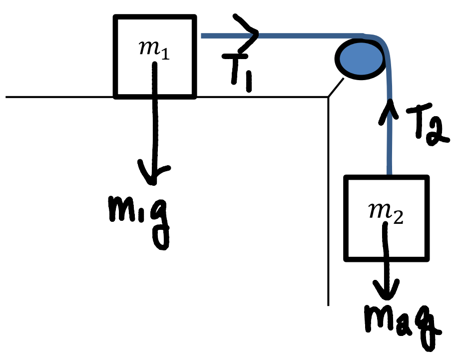
t = 0.1s
Δt = 0.05s
Δx = 0.3 - 0.2m
= 0.1m
v = 0.1m / 0.05s = 2 m/s

t = 0.5s
Δt = 0.05s
Δx = 0.225 - 0.325m
= -0.1m
v = -0.1m / 0.005m = 2m/s



negative slope
⇒ const acceleration

4. Two blocks are attached to each other by a massless cord as shown in the diagram below. Both the table and pulley are *frictionless*:



Force Vectors:
Labels:

a. Finish the free-body diagram by including all of the forces which can act on the blocks. Include a coordinate system.

Answer:
Explanation (2 pts):

b. Can this system be in equilibrium? Explain your reasoning.

No. There is no force counter-acting the tension caused by the hanging weight.