

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

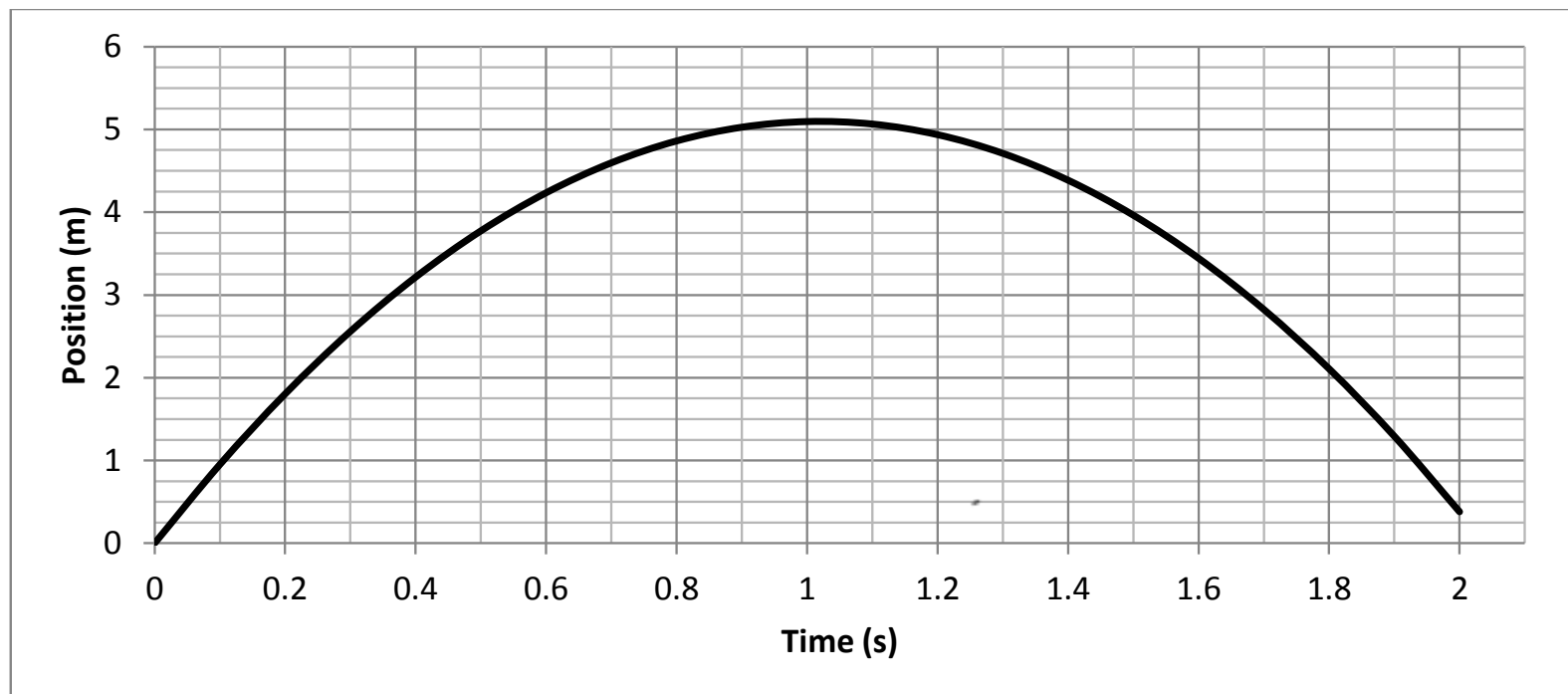
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1. You and your roommate are playing a game of catch. The graph shows the position of the ball as a function of time.



Set-up:

Algebra:

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

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{5\text{m} - 5\text{m}}{1.15 - 0.95} = 0\text{m/s}$$

Speeds:

Graph:

Observation:

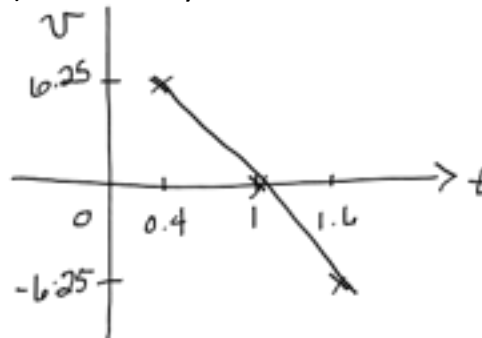
- b. Estimate the speed v at $t = 0.4\text{ s}$ and $t = 1.6\text{ s}$. Sketch a speed vs. time plot using the three speeds you estimated, including the speed in part (a). What do you observe?

$$t = 0.4\text{ s}$$

$$\bar{v} = \frac{(3.75 - 2.5)\text{m}}{0.2\text{s}} = \frac{1.25\text{m}}{0.2\text{s}} = 6.25\text{m/s}$$

$$t = 1.6\text{ s}$$

$$\bar{v} = \frac{(2.75 - 4)\text{m}}{0.2\text{s}} = \frac{-1.25\text{m}}{0.2\text{s}} = -6.25\text{m/s}$$



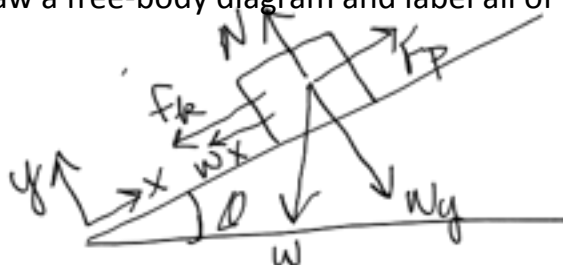
The velocity-time graph has negative slope \Rightarrow constant acceleration

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.



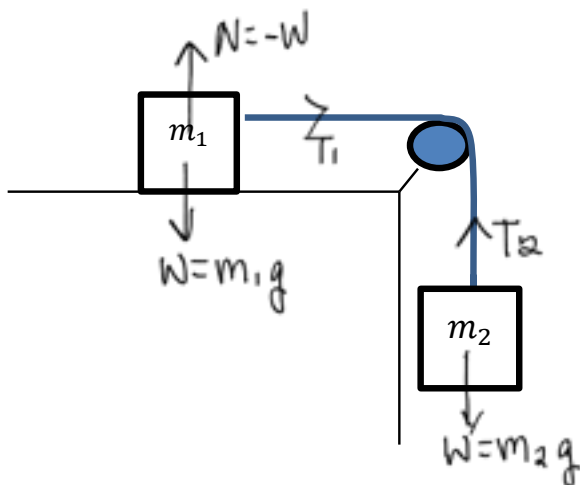
Set-up:
Algebra:
Substitutions:

- b. The cart has a mass $m = 25 \text{ kg}$. Let $\theta = 30^\circ$ 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.

$$\begin{aligned} \sum F_y &= 0 \\ N &= -W_y \\ N &= mg \cos \theta \\ &= 25 \text{ kg} (9.8 \text{ m/s}^2) (\cos 30^\circ) \\ &= 212.4 \text{ N} \\ f_k &= \mu_k N = 0.2 (212.4 \text{ N}) \\ &= 42.47 \text{ N} \\ W_x &= mg \sin 30^\circ \\ &= 25 \text{ kg} (9.8 \text{ m/s}^2) (0.5) \\ &= 122.63 \text{ N} \end{aligned}$$

downhill } $\Rightarrow \sum F_x = ma = 0$
const. velocity
 $\Rightarrow F_p = f_k + W_x = 165.1 \text{ N uphill}$

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

Answer:
Explanation (2 pts):

No. The frictionless table provides no force to counteract the tension caused by m_2 .

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.

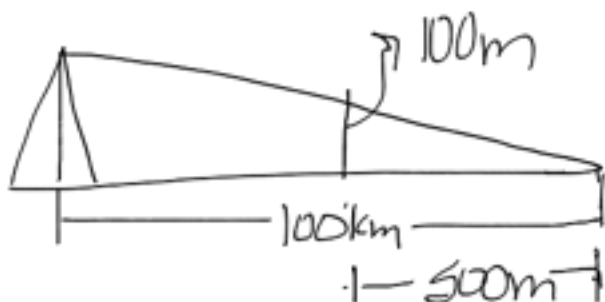
Description:
Missing information:

- 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?

I would need the height of the tree or the angle at which I am looking to use similar triangles or trig.

Set-up:
Algebra:
Substitutions:

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



$$\begin{aligned} \frac{100 \text{ m}}{500 \text{ m}} &= \frac{h}{100 \text{ km}} \\ \frac{100 \text{ km}}{5} &= h = 20 \text{ km} \end{aligned}$$

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Q1

Q2

Q3

Q4

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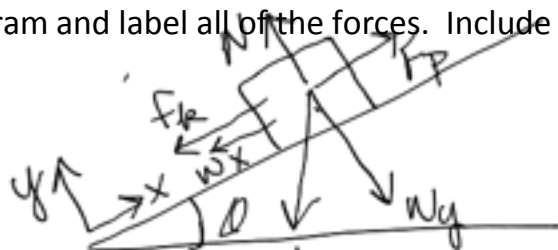
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1. You are pushing a cart up a hill when the wheels fall off. If the hill makes an angle θ with the horizontal:

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

Diagram:

Force Labels:



Set-up:

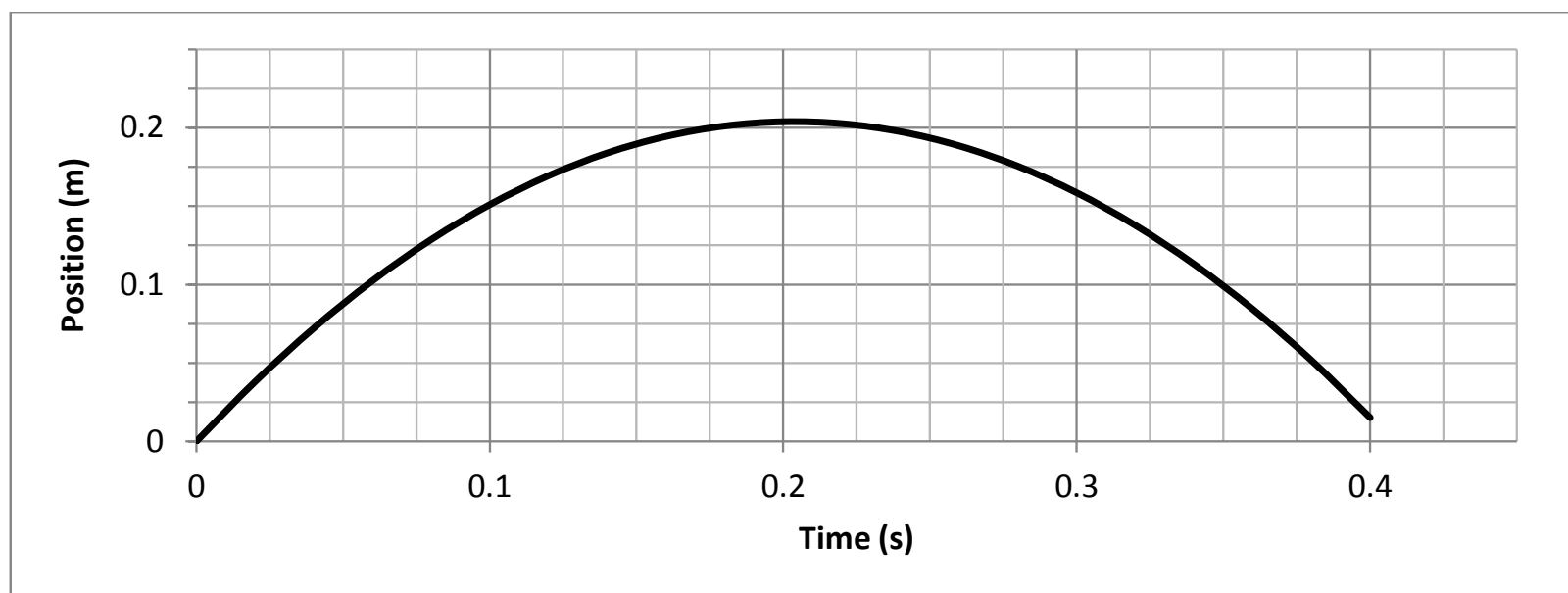
Algebra:

Substitutions:

- b. The cart has a mass $m = 30 \text{ kg}$. Let $\theta = 15^\circ$ 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.

$$\begin{aligned}
 \sum F_y = 0 &\Rightarrow N = -W_x \\
 W_y &= mg \cos \theta \\
 &= 30(9.81)(\cos 15^\circ) \text{ N} \\
 &= 284.27 \text{ N} \\
 \sum F_x = 0 & \\
 W_x + f_k + F_p &= 0 \\
 W_x &= 30(9.81)(\sin 15^\circ) \text{ N} \\
 &= 76.170 \text{ N} \\
 f_k &= 0.15 N = 0.15(284.27 \text{ N}) = 42.64 \text{ N} \text{ downhill} \\
 F_p &= 118.81 \text{ N}
 \end{aligned}$$

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.

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{(0.2 - 0.2) \text{ m}}{(0.225 - 0.175) \text{ s}} = \underline{\underline{0 \text{ m/s}}}$$

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?

$$\Delta t = 0.055$$

$$t = 0.15$$

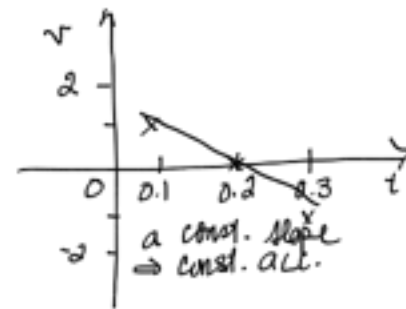
$$\Delta x = 0.175 - 0.125 \text{ m} \\ = 0.05 \text{ m}$$

$$\bar{v} = \frac{0.05 \text{ m}}{0.055} = 1 \text{ m/s}$$

$$t = 0.35$$

$$\Delta x = (0.175 - 0.125) \text{ m} \\ = -0.05 \text{ m}$$

$$\bar{v} = \frac{-0.05 \text{ m}}{0.055} = -1 \text{ m/s}$$



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?

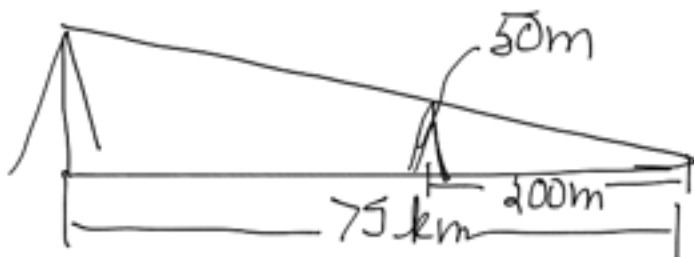
Either the angle of view or the height of the tree to use similar triangles or trig.

Set-up:

Algebra:

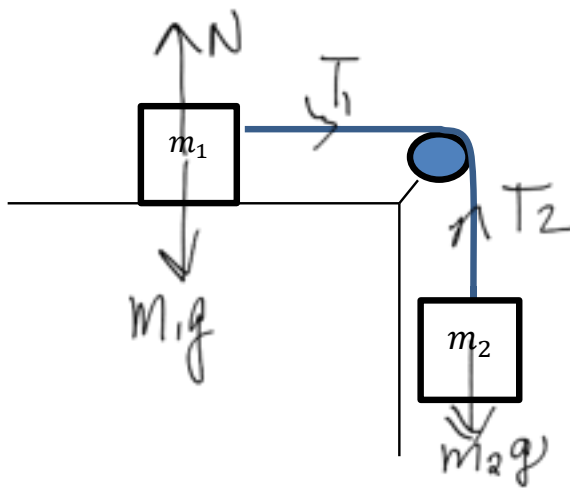
Substitutions:

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



$$\frac{50 \text{ m}}{200 \text{ m}} = \frac{h}{75 \text{ km}} \\ \frac{1}{4} (75 \text{ km}) = h \\ \underline{18.75 \text{ km}}$$

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

Answer:

Explanation (2 pts):

No. There is no force to counteract the tension caused by m_2 .

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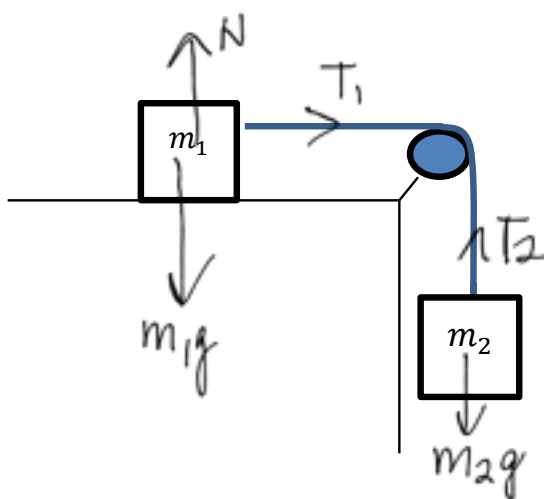
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1. Two blocks are attached to each other by a massless cord as shown in the diagram below. Both the table and pulley are *frictionless*:



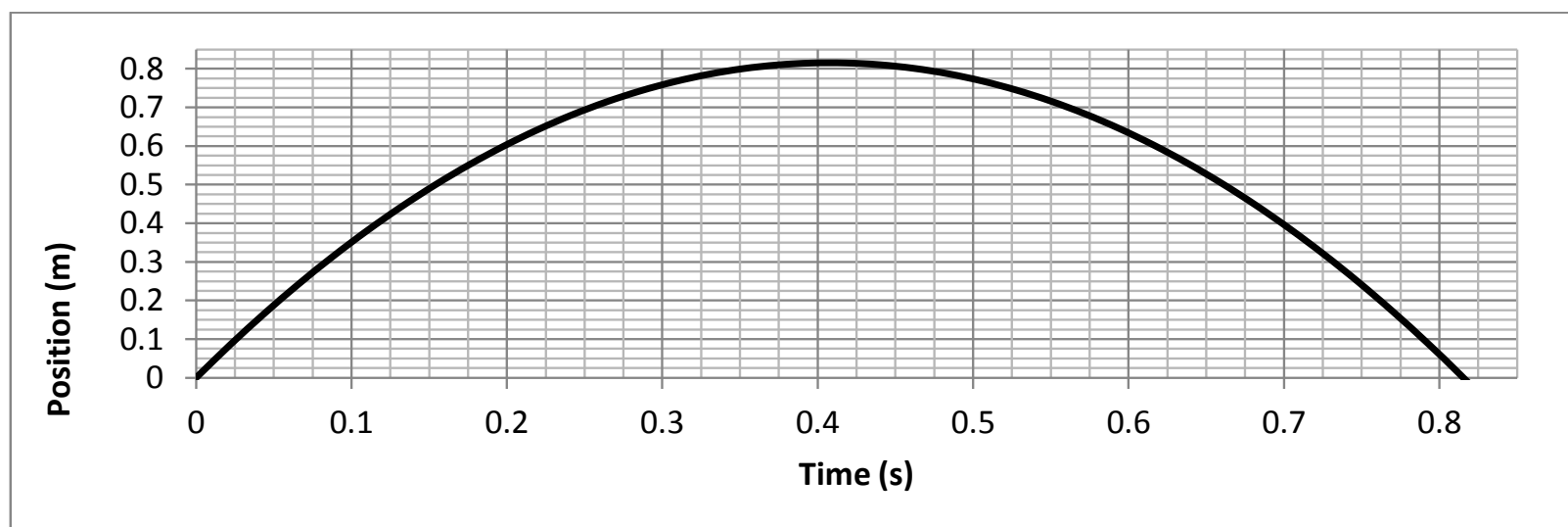
Force Vectors:
Labels:

- a. Finish the free-body diagram by including all of the forces which can act on the blocks. Include a coordinate system.
- b. Can this system be in equilibrium? Explain your reasoning.

Answer:
Explanation (2 pts):

No. There is no force to counteract the tension caused by m_2 .

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.

$$\bar{v} = \frac{\Delta y}{\Delta t} = \frac{(0.79 - 0.79) \text{ m}}{(0.425 - 0.375) \text{ s}} = \underline{\underline{0 \text{ m/s}}}$$

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?

$$\Delta t = 0.05 \text{ s}$$

$$t = 0.2 \text{ s}$$

$$\Delta x = (0.65 - 0.55) \text{ m}$$

$$= 0.1 \text{ m}$$

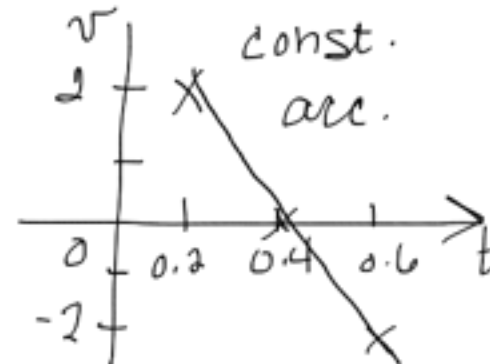
$$\bar{v} = \frac{0.1 \text{ m}}{0.05 \text{ s}} = \frac{10}{5} = 2 \text{ m/s}$$

$$t = 0.6 \text{ s}$$

$$\Delta x = (0.575 - 0.675) \text{ m}$$

$$= -0.1 \text{ m}$$

$$\bar{v} = -\frac{0.1 \text{ m}}{0.05 \text{ s}} = -2 \text{ m/s}$$



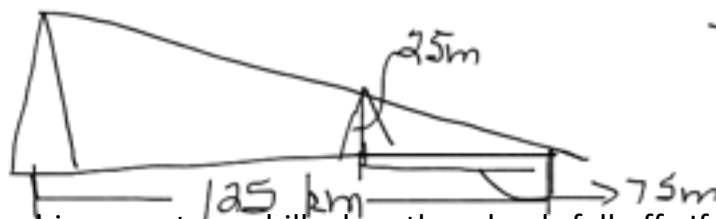
3. You want to determine the height of a mountain 125 km from your current position. You look around and notice that about 75 m away from you is a tall tree. You look up and notice that the peak of the mountain and the top of the tree are aligned.

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?

Either the angle of view or the height of the tree to use similar triangles or trig.

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



$$\frac{25 \text{ m}}{75 \text{ m}} = \frac{h}{125 \text{ km}}$$

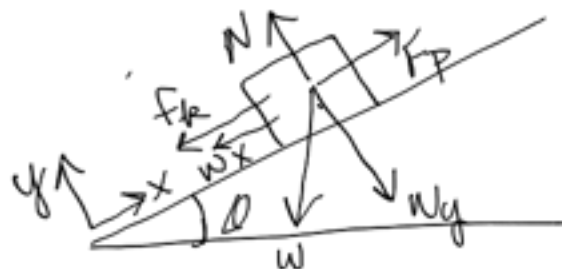
$$\frac{1}{3}(125 \text{ km}) = h$$

$$h = \underline{\underline{41.67 \text{ km}}}$$

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 $\theta = 45^\circ$ 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.

$$\sum F_y = 0$$

$$N + N_y = 0$$

$$N = 35(9.81) \frac{\sqrt{2}}{2} \text{ N}$$

$$= 121.4 \text{ N}$$

$$\sum F_x = 0$$

$$W_x + f_k + F_p = 0$$

$$f_k = 0.3 N = 36.42 \text{ N}$$

$$W_x = W_y = 121.4 \text{ N}$$

} \text{ downhill}

$$\Rightarrow F_p = W_x + f_k$$

$$= \underline{\underline{157.82 \text{ N}}}$$

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Q1

Q2

Q3

Q4

5

5

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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.

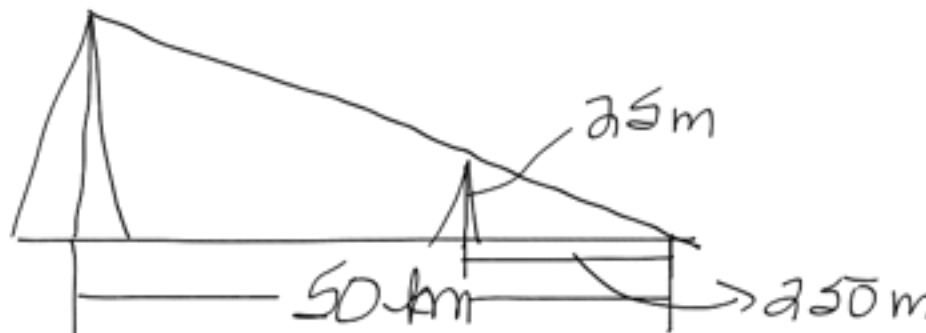
Description:
Missing
information:

- 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?

Either the angle of view or the height of the tree to use similar triangles or trig.

Set-up:
Algebra:
Substitutions:

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



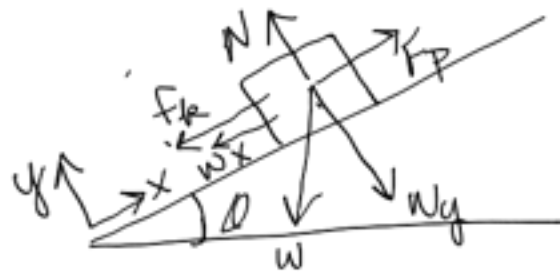
$$\frac{25\text{m}}{250\text{m}} = \frac{h}{50\text{km}}$$

$$\frac{50\text{km}}{10} = \underline{5\text{km} = h}$$

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 $m = 15\text{ kg}$. Let $\theta = 25^\circ$ 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.

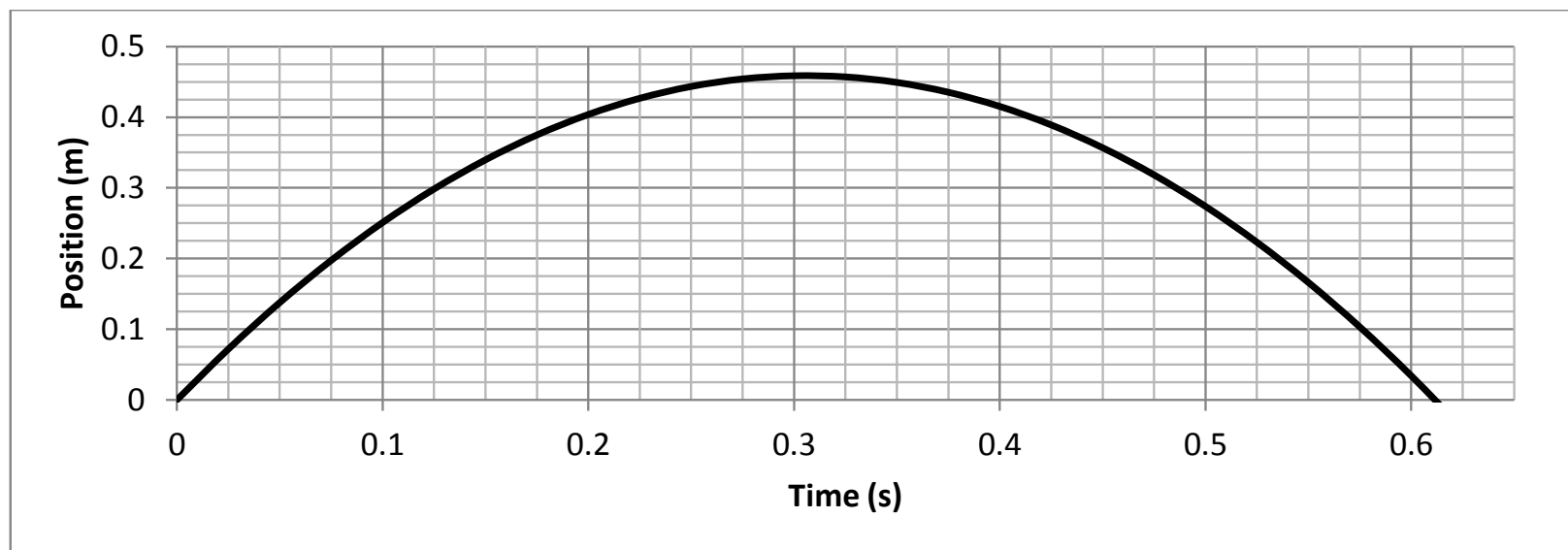
$$\begin{aligned} \Sigma F_y &= 0 \\ N + W_y &= 0 \\ N &= 15(9.81)\cos 25^\circ \\ &= 133.36\text{ N} \end{aligned}$$

$$\begin{aligned} \Sigma F_x &= 0 \\ f_k + W_x + F_p &= 0 \\ f_k &= 0.25(133.36\text{ N}) \\ &= 33.34\text{ N} \\ W_x &= 15(9.81)\sin 25^\circ \\ &= 62.19\text{ N} \end{aligned}$$

$\Rightarrow F_p = \underline{95.53\text{ N}}$

} down hill

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.

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{(0.45 - 0.45) \text{ m}}{(0.325 - 0.275) \text{ s}} = \underline{\underline{0 \text{ m/s}}}$$

Speeds:
Graph:
Observation:

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

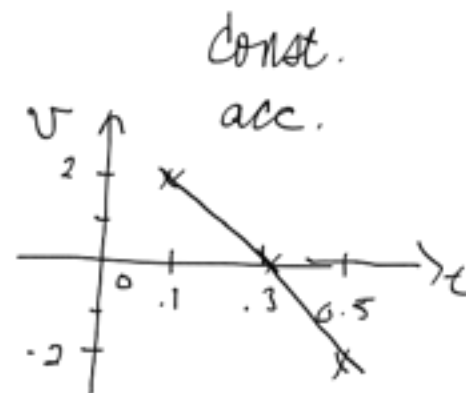
$$\Delta t = 0.05 \text{ s}$$

$$t = 0.1:$$

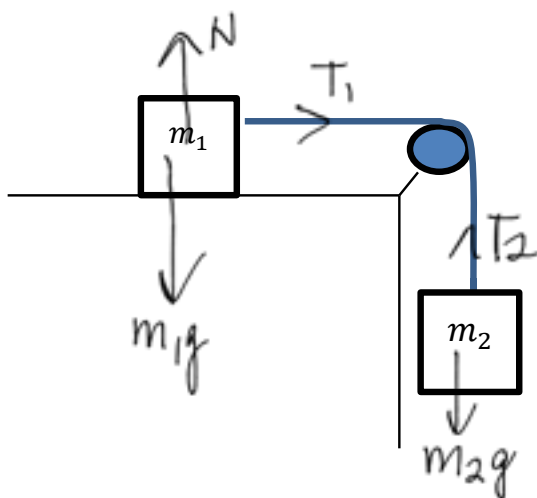
$$\frac{\Delta x}{\Delta t} = \frac{(0.3 - 0.2) \text{ m}}{0.05 \text{ s}} = \frac{0.1}{0.05} \text{ m/s} = \underline{\underline{2 \text{ m/s}}}$$

$$t = 0.5$$

$$\frac{\Delta x}{\Delta t} = \frac{0.25 - 0.35 \text{ m}}{0.05 \text{ s}} = \frac{-0.1}{0.05} \text{ m/s} = \underline{\underline{-2 \text{ m/s}}}$$



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

Answer:
Explanation (2 pts):

No. There is no force to counteract the tension caused by m_2 .