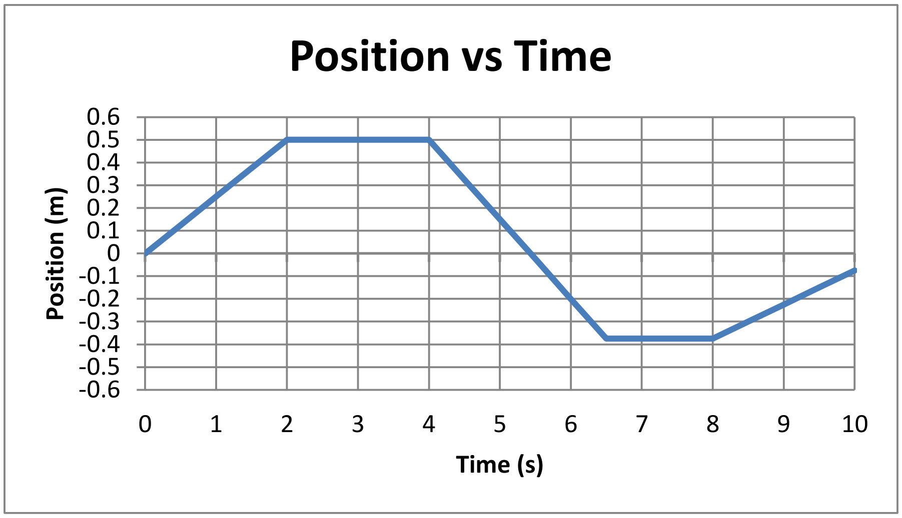
Name: ______________________ DISC: ____________ Score: _____ / 20

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
10	10	5	5

1. You observe a cart moving in a straight line and plot its position versus time as shown in the graph **(Lecture 3 pp. 5-7; Discussion 3-2)**:



Speeds: 1 pt each

a. Using the graph fill in the following table of *velocities*:

TIME	VELOCITY
From 0 s to 2 s	$\frac{(0.5-0)m}{(2-0)s}=\frac{0.5}{2}\frac{m}{s}=0.25\frac{m}{s}$
From 2 s to 4 s	$\frac{(0.5-0.5)m}{(4-2)s}=\frac{0.0}{2}\frac{m}{s}=0\frac{m}{s}$
From 4 s to 6.5 s	$\frac{(-0.375-0.5)m}{(6.5-4)s}=\frac{-0.875}{2.5}\frac{m}{s}=-0.35\frac{m}{s}$
From 6.5 s to 8 s	$\frac{(-0.375-(-0.375))m}{(8-6.5)s}=\frac{0}{1.5}\frac{m}{s}=0\frac{m}{s}$
From 8 s to 10 s	$\frac{(-0.375-(-0.075))m}{(10-8)s}=\frac{-0.36}{2}\frac{m}{s}=-0.15\frac{m}{s}$

Remember, the velocity is the *slope* of a position vs. time graph. We can calculate the velocity between each time point on the graph using $v=\Delta x/\Delta t$.

Average Speed (2 pts):

b. What is the average *speed* of the cart?

The average speed of the cart can be calculated by taking the sum of the speeds and dividing by the total number of speeds measured:

$$v = \frac{[0.25 + 0 + 0.35 + 0 + 0.15]\ m/s}{5} = 0.15\frac{m}{s}.$$

Full credit to be given for any other correct averaging technique including:

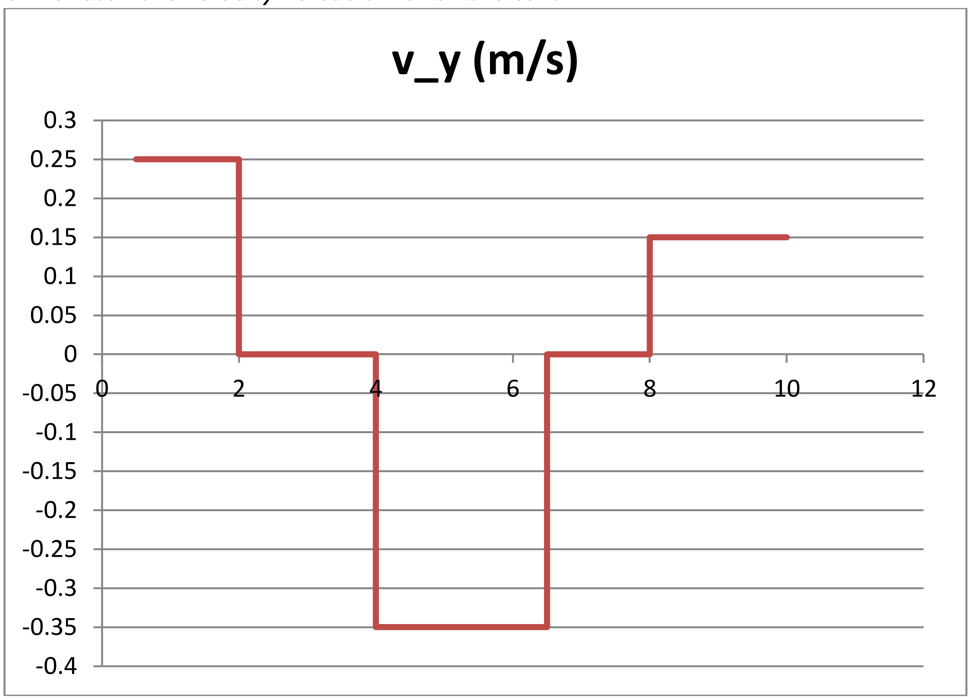
The time-weighted average:

$$v = \frac{\left[0.25\frac{m}{s} \times 2\ s + 0\frac{m}{s} \times 2\ s + 0.35\frac{m}{s} \times 2.5\ s + 0\frac{m}{s} \times 1.5\ s + 0.15\frac{m}{s} \times 2\ s\right]}{10\ s} = 0.1675\frac{m}{s}.$$

Simple point averages (i.e. picked a couple of points and took the average).

Sketch (3 pts):

c. Sketch the *velocity versus time* for the cart:



For my group this problem provided an array of errors:

Part a) (some variation from "official" answers is expected:

1) **Taking areas instead of slopes to calculate the velocity (-3 pts—this was the point of the exercise)**
2) **Not showing work (-2 pts)**
3) **Misc. arithmetic errors (-1 pt each)**

Part b):

1) **Numbers coming from seeming nowhere (-1 pt)**
2) **Confusing speed with velocity (i.e. not getting the signs right) (-1 pt)—this is the point of the exercise**
3) **For those who used total displacement/total time—incorrect calculation of the displacement (-1 pt).**

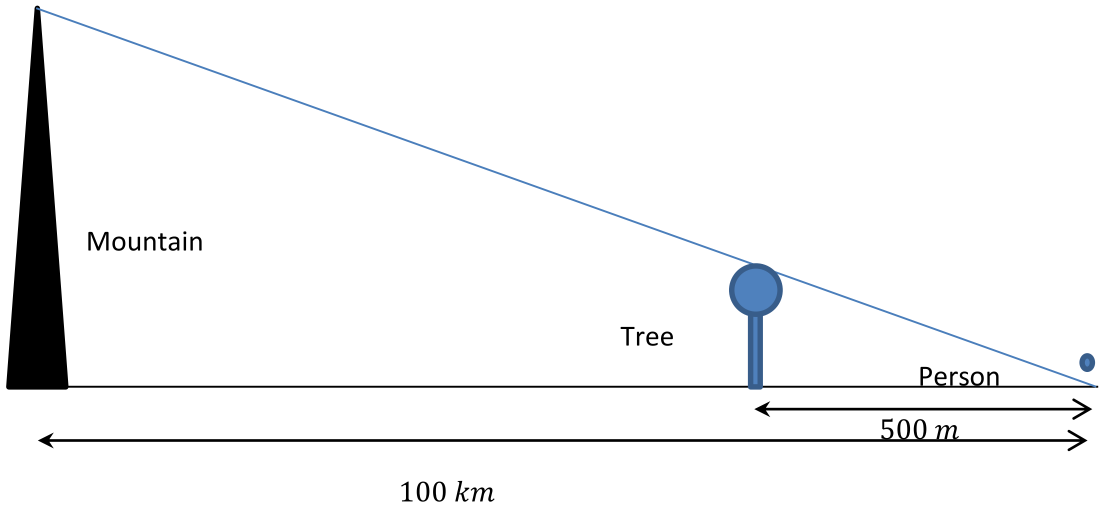
Part c):

1) **Graphs which do not match results of part a) (even if the graph is correct) (-2 pts)**

2. 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. **(Homework 2)**

Sketch (3 pts):

a. Make a sketch of this system. Remember to label all features.



Description (2 pts):

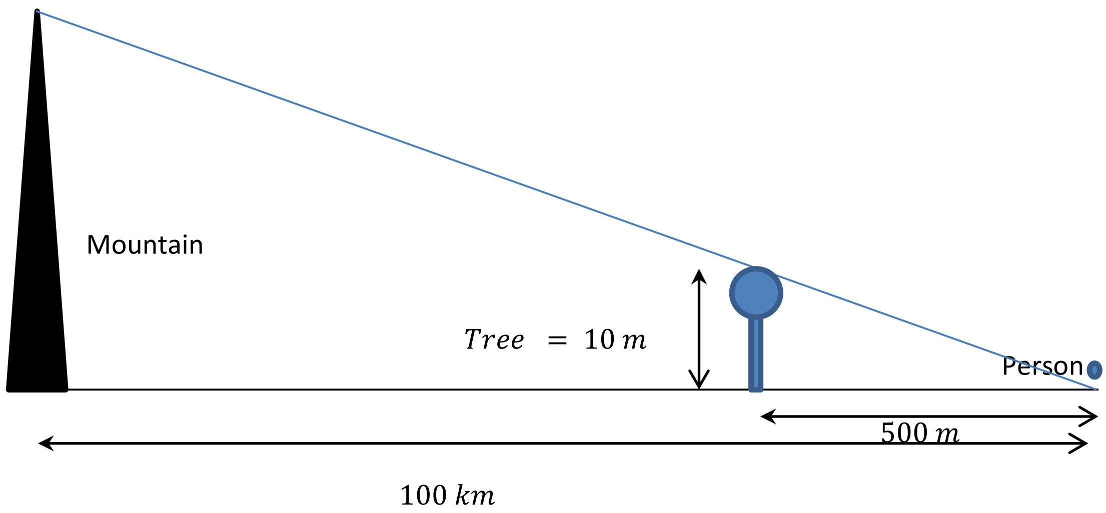
b. Since you cannot measure the height of the mountain directly, describe the technique or techniques you would use to determine the height of the mountain.

The easiest way to solve this problem is to triangulate using similar triangles, if you know the height of the tree.

Otherwise if you can measure the angle (using an astrolabe or protractor, for example) at which you view the mountain and the tree-top simultaneously, you can use your trig functions (you know how far the tree is from you and how far the mountain is from you) to calculate the height of the mountain.

c. The tree is $10\ m$ tall. Find the height of the mountain.
Given this new information, the method of similar triangles is the easiest technique:

Mountain height (5 pts):



$$\frac{\boldsymbol{Mountain}}{\mathbf{100}\ \boldsymbol{km}} = \frac{\mathbf{10}\ \boldsymbol{m}}{\mathbf{500}\ \boldsymbol{m}} = \frac{\mathbf{1}}{\mathbf{50}}$$

$$\boldsymbol{Mountain} = \frac{\mathbf{100}\ \boldsymbol{km}}{\mathbf{50}} = \mathbf{2}\ \boldsymbol{km}$$

Overall this problem went very well for my group. The most common errors were:

Part a): Incorrect diagram (number of points deducted depended on the errors made)

Part b): Not knowing either they needed to calculate the angle at which the person viewed the tree top, or the use of the method of similar triangles (this was very rare) (-1 to 2 pts depending on the severity)

Part c): Arithmetic errors: (-1 pt each different error)