Lab 1 Position, velocity and acceleration by R.E. Tremblay

Purpose: To learn how to make position and velocity verses time graphs when given the position of an object at various times. You will also learn how to determine initial velocity and acceleration from these graphs.
Materials: Two pieces of graph paper, ruler.

Introduction: An object in free fall will accelerate down at a constant rate only when we disregard the effects of air friction. For the purposes of this lab., we will disregard air friction while we study what happens to the position, velocity and acceleration of a falling body as time goes on. You are part of an interplanetary exploration team that has been sent by the Federation to study planet 'X'. You have gone to three different locations on the planet and obtained position-time information on objects in free-fall.

Know: The ***slope of a position versus time*** curve represents the velocity of the object.
Know: The ***slope of a velocity versus time*** graph, represents the acceleration of an object.

Procedure: Hand in your preparation sheet before the lab begins.
1. Look at the position-time information at the end of this lab. The site that you will study is determined by the first letter of your last name. Inspect the data table at the end of this lab and determine which site you will study. ***Circle your site number***.

2. **Graph 1:** Make and analyze a ***position vs time*** graph from the data listed at your site on the data page of this lab.

2a. **Orient your graph paper so the time coordinates use the longer side**. Your graph should cover at least 2/3 of the graph paper and should be labeled position on the vertical axis and time on the horizontal axis. Include the appropriate units of measurement- meters for position and seconds for time.

Example position vs time graph

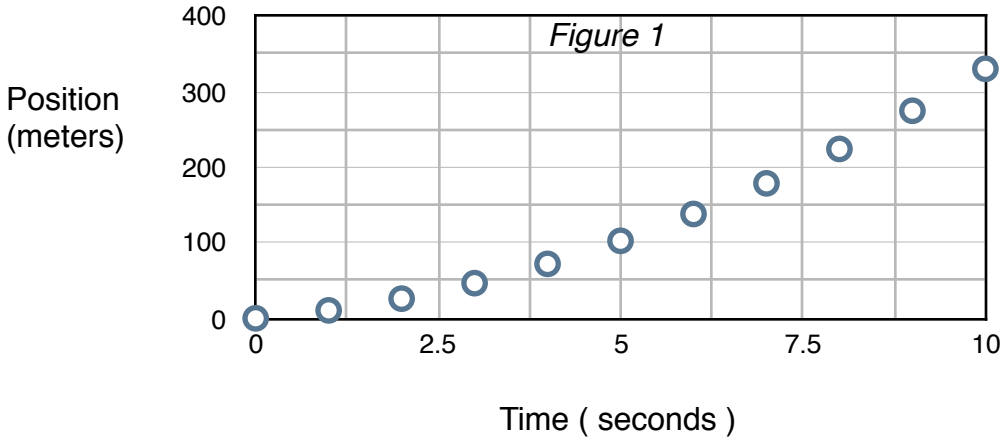
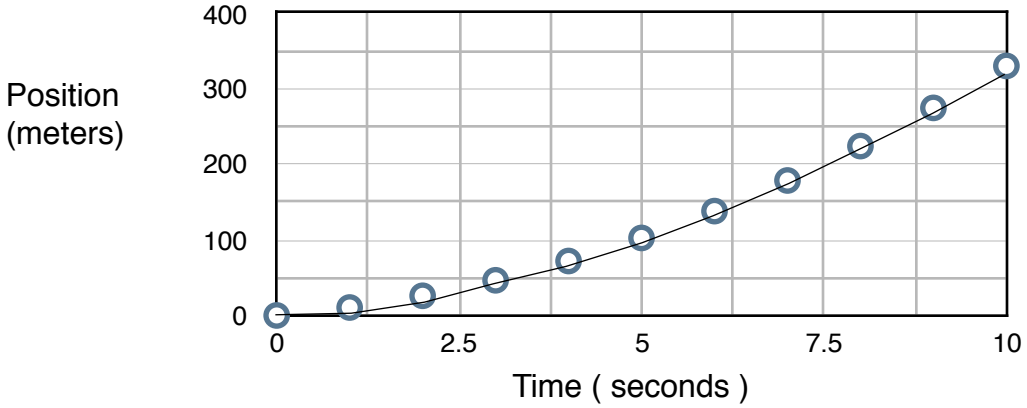


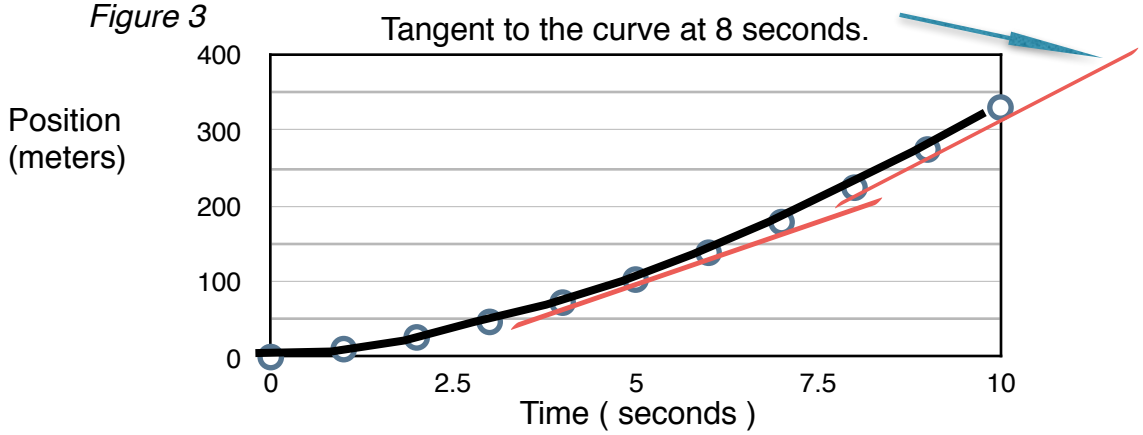
Figure 2



2b. Once you have entered all of the points on the graph, you should draw a **smooth**, curved line through them.

2c. **Using a ruler, draw and label lines that are tangent to the curve at each second**. As an example, I have drawn lines tangent to the curve at 5 and 8 seconds. You will draw ten lines tangent to the curve.

Figure 3



In the graph above, two lines are drawn that are tangent to the curve at different times. They are said to be tangent to the curve at those times because they are parallel to the curve at those times.

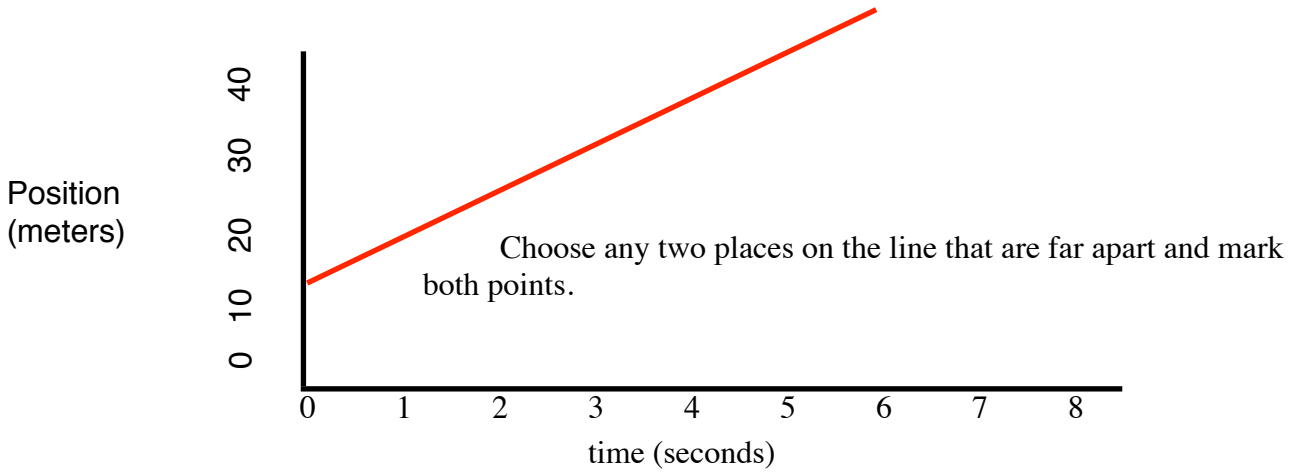
Study the diagram above until you are convinced that the lines are parallel to the graph at time = 5 sec. and at time = 8 seconds.

2d. **Determining the instantaneous velocity at each second:** The slope of the curve on a position versus time graph represents the object's velocity. We can determine the instantaneous velocity at each second by taking the slope of the tangent lines at 1 second, 2 second, 3 second etc. Place these velocities in the velocity vs time table of your data sheet. (Table 1).

How to Take the slope of a line

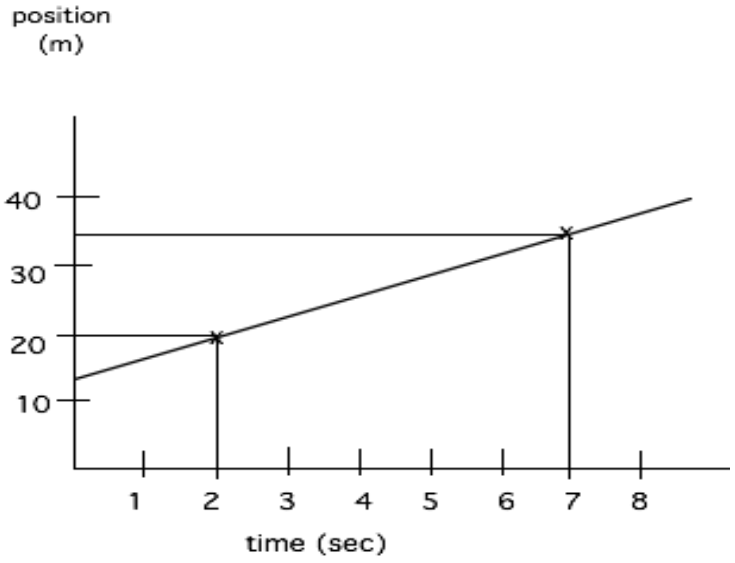
$$Slope \equiv \frac{\Delta Vertical}{\Delta Horizontal}$$; The symbol 'Δ' means change in.

The slope of a straight line never changes, so the lines that you draw tangent to the curve can be any convenient length. (Parallel lines have the same slope).
For practice, let's say that we want to find the slope of the straight line in the graph below.



Determine the **change in the vertical values**: in this example the vertical values are 35 m and 20 meter.

ΔVertical = 35m-20m = 15 meters



Determine the **change in the corresponding horizontal values:**
Looking at the graph we see that the times are 7 seconds and 2 seconds. Therefore, the change in time is 5 seconds.

ΔHorizontal = 7 sec - 2 sec = 5 seconds

Next, write the definition of slope, fill in the values, including units, and determine the answer.

$$Slope \equiv \frac{\Delta Vertical}{\Delta Horizontal} = \frac{15 meters}{5 seconds} = 3\frac{m}{sec}.$$

Because this is a position vs time graph, the slope represents the velocity of the object. Notice that the units of velocity in this example are m/s.

3. **Graph 2**: Make and analyze a graph of velocity verses time from the information in table 1.

3a Determining the initial velocity: **The velocity at zero time is referred to as the 'initial velocity'**. Read the initial velocity from your ***velocity vs time*** graph and enter its value in your data sheet.

3b. Determining 'g': Using a ruler, draw one straight line through the data points on your velocity-time graph. **Find g (the acceleration on planet 'X') by taking the slope of that line**. Enter its value on your data sheet.

Hand in your corrected prep sheet, the data sheet, both graphs, and a work sheet showing your calculations.

Name:_____

Lab 1 preparation: Please complete the following exercise before coming to lab. Hand this page in, ***before the beginning of the lab***.

Write the definition of slope:

For a position versus time graph, what does the slope of the curve represent?

For a velocity versus time graph, what does the slope of the curve represent?

Lines that are drawn tangent to the curve at a particular point, are always _____ to the curve at that point.

Data and results Name _____/Section _____

Data: Your 'Away Team' leader (the lab instructor) has decided that your site assignment will be determined by the first letter of your last name as: For example, if you last name begins with the letter C, you will analyze the data from site 1. Circle your site number.

'	**A- G' analyze site 1**		**'H-M' analyze site 2**		**'N-Z' analyze site 3**	
	position	**time**	**position**	**time**	**position**	**time**
	(m)	(sec)	(m)	(sec)	(m)	(sec)
	0	0	0	0	0	0
	10.5	1	12.5	1	14	1
	26	2	34	2	40	2
	46.5	3	64.5	3	78	3
	72	4	104	4	128	4
	102.5	5	152.5	5	190	5
	138	6	210	6	264	6
	178.5	7	276.5	7	350	7
	224	8	352	8	448	8
	274.5	9	436.5	9	558	9
	330	10	530	10	680	10

Table 1:

Instantaneous Velocity (m/s)	Time (Seconds)
	1
	2
	3
	4
	5
	6
	7
	8
	9
	10

Initial velocity, 'V_0' _____

Acceleration due to gravity, 'g' _____