Unit 1 *Homework Problems*

To get credit for the homework problems, you must include all of the following:

1. All final numerical answers must have the correct units.
2. All problems must include a reference to the Activity Guide activity or activities that are related to the problem, a discussion of ***how*** the activity is related, and a discussion of the ***concepts*** that were learned in the activity.

Section 1.5

1-1) Create a spreadsheet with the combined class data in Activity 1.5.1 and complete exercises (a) through (d) below by following the procedures outlined in Appendix A of the Workshop Physics Activity Guide.

(a) Use the computer spreadsheet average, max, and min functions to find the average, minimum, and maximum pitching speeds for the class. Please do this part ***before*** doing part (b). (**Hint**: You will need to learn to use spreadsheet functions to do this.) *Be sure to format the spreadsheet cells to give you two decimal places for each of your calculations.*

(b) Sort the data columns so that they lie in order from the lowest to highest pitching speed.

(c) Name the file and save it on a disk or on your H: drive, and e-mail me your spreadsheet.

(d) *Print a copy of your spreadsheet to hand in; put your name, section #, and date on it.*

1-2) Do *Reading Exercise* 1-7 at the end of Section 1-9 of the *Understanding Physics* textbook, which you can find on the bookshelf in your physics classroom, 150 Meldrum.

The *Galaxy Song* that was performed as part of a popular Monty Python movie provides a wonderful opportunity to practice changing units and expressing large numbers in scientific notation. Here are the words:

Galaxy Song

Just remember that you're standing on a planet that's evolving,
And revolving at **nine hundred miles an hour**,
That's orbiting at **ninety miles a second**, so it's reckoned,
A sun that is the source of all our power.
The sun and you and me and all the stars that we can see,
Are moving at a **million miles a day**,
in an outer spiral arm, at **forty thousand miles an hour**,
Of the Galaxy we call the Milky Way.
Our Galaxy itself contains a hundred billion stars.
It's **100,000 light years** side to side.
It bulges in the middle, **16,000 light years** thick
But out by us it's just **3,000 light years** wide

We're 30, 000 light years from galactic central point,
We go round every 200 million years.
And our Galaxy is only one of millions of billions
in this amazing and expanding Universe.
The Universe itself keeps on expanding and expanding
In all of the directions it can whizz
As fast as it can go, at the speed of light you know,
12 million miles a minute, and that's the fastest speed there is.
So remember when you're feeling very small and insecure,
How amazingly unlikely is your birth
And pray that there's intelligent life somewhere up in space,
Because there's bugger all down here on Earth.

words by Eric Idle (PRS)
Music by Eric Idle and John DuPrez (PRS)

You can listen to Eric Idle sing the Galaxy Song by following the link on the homework page, where you found this homework assignment.

1-3) The phrase "a hundred billion stars" in the first verse of the *Galaxy Song* can be written as 100 times 1,000,000,000 which can in turn be rewritten as 100×10^9 stars = 1.00×10^{11} stars. Find all the numbers in the First Verse of Galaxy Song that are printed in **bold letters** and write them in scientific notation with appropriate abbreviations for the units as shown on the inside front or back cover of most textbooks. **Note:** We assume that you are already familiar with the rules for translating numbers into scientific notation. If not, now would be a good time to visit your instructor for help.

1-4) Using information in the First Verse of the *Galaxy Song*, compare the speed of the Earth's revolution about its own axis with the speed of its orbit around the sun. Which speed is greater? **Hint**: You'll need to express the two speeds in the same units. Don't forget to use the chain-link method used in the example in Section 1-5 of the Matter & Interactions textbook.

Section 1.7

1-5) (a) Make a data table showing the times and positions you recorded in Activity 1.6.1 and re sketch the data points on a graph like that shown in Activity 1.7.1(a). The data table and graph are to be done entirely by hand. You might want to use a whole sheet of paper to create the graph.

(b) Use a ruler to draw a straight line that passes as close as possible to the data points you have graphed.

(c) Using methods you were taught in algebra, calculate the value of the slope, m, and find the value of the intercept, b, of the line you have sketched through the data. **Note**: You may want to consult Appendix E of the Workshop Physics Activity Guide (pp. A-27 and A-28).

Section 1.8

1-6) Create a mathematical model of the bowling ball motion data you collected in Activity 1.6.1. This project requires you to find what you think is the best value for the slope, m, and the y-intercept, b, for the computer graph you printed out in Activity 1.7.1 (b). You should:

I Follow the instructions on page A-28 in Appendix E of the Workshop Physics Activity Guide on *MATHEMATICAL MODELING WITH AN EXCEL SPREADSHEET.* By practicing with a tutorial worksheet entitled *modelingTutorial.xlsx* you can learn about the process of modeling for a linear relationship.

II After using the tutorial, you can create a model for your bowling ball data. To do this:

(a) Open a modeling worksheet entitled *modelingWorksheet.xlsx* and enter a title for your bowling ball graph into cell A5.

(b) Set the y-label (cell A6) to *Position (m)*.

(c) Refer to your data table in Activity 1.6.1(b)). Enter the times you measured for the bowling ball in the *time* (s) column.

(d) Set the *y-exp* column heading (cell B7) to *x-data* (m) and enter the positions you measured for the bowling ball (probably something like 0.00, 2.00, 4.00, 6.00, and 8.00).

(e) Select (highlight) and replace the c_0 in the cell A1 with the symbol m (for slope). Similarly, select (highlight) and replace the c_1 in the cell A2 with the symbol b (for y-intercept).

(f) Set the *y-theory* column heading (cell C7) to *x-model* (m) and then put the appropriate equation for a straight line of the form Position = m*Time + b in cells C8 through C11. Be sure to refer to cells B1 for slope and B2 for y-intercept as absolute references, i.e. use B1 and B2 when including them in your cell formula.

(g) Change the values in cells B1 and B2 until your green theoretical line matches as closely as possible with your red experimental data points in the graph window.

(h) Hand in a printout of your modeling spreadsheet with the following written on it:

1. Your name, the date, and Problem **1-6** on it.

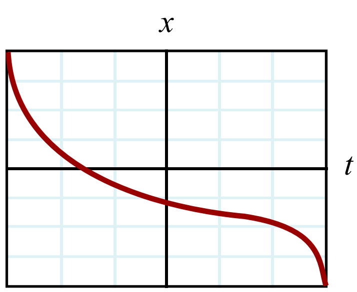
2. Report the average speed of the bowling ball that you calculated in Activity 1.6.1 (c) compared to the slope of the "best" fitting graph for your mathematical model.

3. Give the equation that provides the "best" mathematical model for the motion you studied in the form x = (? m/s) t + (? m). Here, x represents the position of the bowling ball (in meters), and t represents the time (in seconds). *Hint*: If you are unsure of what values to replace the question marks with, look back at part (g) above for some guidance.

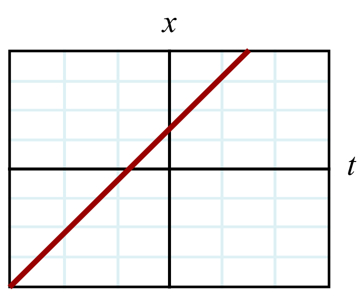
4. Discuss the meaning of the slope of a graph of *Position* vs. *Time*. What does it tell you about the motion of the bowling ball, i.e. does the ball slow down, speed up, or move at a constant speed?

5. Compare the values of m and b that you obtained using hand calculations (Problem 1-5) with those just obtained using computer modeling. Are they similar? They should be!

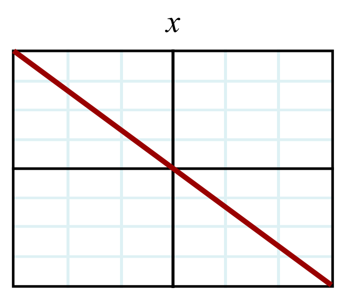
1-7) The graphs below represent possible functional relationships between time, t, and the position, x, of an object. **Note: The center of each graph is $t = 0$ s and $x = 0$ m.**



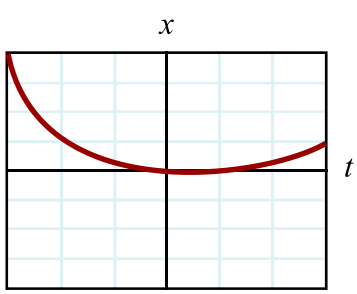
Graph A



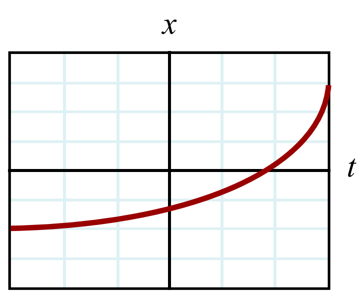
Graph B



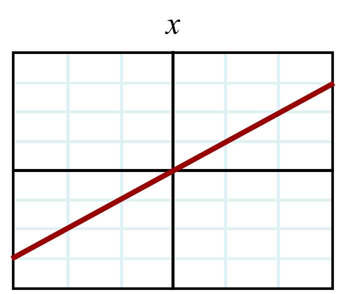
Graph C



Graph D



Graph E



Graph F

In each case indicate which, if any, of the four conditions hold:

1. x always increases when t increases
2. x always decreases as t increases
3. x is a linear function of t
4. x is proportional to t

Note: It is possible in each graph that none of the conditions hold, or only one holds, or two hold, or three hold at the same time.