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Introduction To Spreadsheets -- Part I

The computer can be used for scientific analysis in a multitude of different ways. One of the easiest techniques is to model simple situations with a spreadsheet. A spreadsheet is simply a grid that acts like a giant programmable calculator. Each box or *cell* on the grid can be linked to other boxes as part of a large ongoing calculation. In this activity you will learn the basics of spreadsheets, use a spreadsheet to explore the motion of falling bodies, and develop your own spreadsheet to simulate a car race.

I - Modeling a Falling Body

You already know that near the earth, gravity causes objects to accelerate at a rate of 9.8 m/s^2. Let's see how that really applies to an object falling down or being thrown up by looking at the position, velocity, and average velocity of this object at various points during its flight. In order to model this situation you must first determine the equations that are relevant.

The distance an object falls is shown with:___D =____________________________

The velocity of a falling object can be represented by: V = ___________________

The average velocity of an object (from start) is: $V_{av.}$ =______________________

You really want to see how these three change over a period of time for a moving object so your spreadsheet will be set up to generate values for a large number of "t's". Notice that two variables, V_i and D_i, are initial conditions. You will have to account for these as well.

II - Setting -up the spreadsheet.

1. Launch the application "Microsoft Works 3.0". It will ask you what kind of document you want to create, choose **'Spreadsheet'**.

2. You should see a spreadsheet grid. Let's set-up a place to change initial conditions so in the eight cells up in the top left corner, type the following:

	A	B
1	Starting Cond.	
2	Position (m)	0
3	Vi (m/s)	0
4	Time(s)	0

Note that the '0's' in cells B2 & B3 are parameters that you can change later. For now your object is released from height 'zero' with no initial velocity at time = 0 sec.

3. Now you have to set up the cells that will actually calculate D, V, and $V_{av.}$. Remember that we are observing changes through time. Let's look at the results in a tabular form so label columns like so (pay attention to their location):

ABCD

6	Time	Position	Velocity	V Average

4. Each box in this table has to be 'told' what to calculate/display. Start with the time column in cell A7. The first time to display is your starting time located in cell C4 so select cell A7 and type "**=C4**" and press 'return'.

We'll increase the time in .5 sec increments so the next cell in the table, A8, needs to have .5 added to the value in A7. Type "**=A7 + .5**" and 'return'.

5. If you wanted to observe this falling body for a long time, it would take a while to type all of these time values in, there is however a shortcut. Click A8 while holding down the mouse button. Drag the mouse down to highlight cells up to A50. Now go to the Edit menu and select '**Fill Down'.** The fill down function knows to increment what you typed in the first box by one cell so in A9 it puts 'A8 + .5' and so on....

6. Now all of the time values are set so we can do the actual calculations. Go to cell B7, C7, & D7. And type the following in each cell, pressing 'return' after each cell is done:

6	Time	Position	Velocity	V Average
7	=B4	=$B$2+$B$3*A7-0.5*9.8*A7^2	=$B$3+-9.8*A7	=($B$3+C7)/2

Notice the dollar signs put on B2 & B3. This tells the program not to increment these cells after a "Fill Down" operation. Does it make sense that cells B2 and B3 shouldn't be incremented? Why?

Before you go on make sure you understand how each of these formulas correspond to the formulas you wrote down in part I.

7. Now you need to fill these formulas down along with the time column. Select cells B, C, & D 7 -- B, C, & D 50. Again choose "**Fill Down**". The first few rows should look like this...

6	Time	Position	Velocity	V Average
7	0	0	0	0
8	1	-4.9	-9.8	-4.9
9	2	-19.6	-19.6	-9.8

8. Now you can change the initial conditions and immediately see what effects that has on the quantities in your table.

III - Analysis

Use your newly created spreadsheet to answer the following questions (verify with data):

1. When an object is thrown 'upward' with a speed of 20m/s, what speed does it return to its starting position with? With what velocity? Does the same thing happen with other speeds?
2. When an object returns to its starting point what is its average velocity?
3. When thrown upwards, what velocity does an object have at/near the top of its motion?
4. How does the amount of time it takes for an object to reach it maximum height compare to the time it takes to return to its starting position from that height.

5. At ~-500 m, which object has the greater speed: one thrown upwards initially or one dropped from rest.

When you are finished **<u>Do not save any changes!</u>**

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Introduction To Spreadsheets -- Part II

By now you should have a basic understanding of what spreadsheets can do. In this activity you will model a new situation using the techniques from part I. After you generate a table of values , you will copy those values into graphical analysis and make a printout.

I - The problem.

The spreadsheet you are to create will show the motion for three different race cars undergoing different types of motion. The following describes their motions in depth:

Car R -- Starts at ‘0’ with a velocity of 60 m / s.

Car B -- Starts at -30m with a velocity of 20 m / s and an acceleration of 4m / s^2.

Car M -- Starts from rest at -60m with an acceleration of 10 m / s^2.

II - The Spreadsheet

1) The physical layout of the spreadsheet has already been done for you. In the folder AP physics is a file “Car Race Template”. Use this as the basis for your spreadsheet. All you have to do is write in the formulas for the cells, linking them to the table of initial conditions and fill those formulas down the cells.

2) Your time intervals should be in 1 sec increments ($\Delta t = 1$). In other words each row should be one second ahead of the previous row.

3) Have your teacher check your spreadsheet for correctness when it is finished. Copy the data for Car R only by selecting it with the mouse and choosing “**Copy**” from the Edit menu.

4) Now launch the file “Car Race. GA” in the AP folder. Paste your data into the column “Position” in the window for Car R.

5. Repeat steps 3 and 4 for cars B and M. Your graph should display all three cars.

6. Make a printout of this graph. When you quit the applications **do not save any changes!**

III - Analysis

Study your graphs and adjust you spreadsheet to answer the following questions:

1. After 10 seconds which car is the furthest?
2. If the race were 1000m which car would win?
3. Would the winner change if car B started at 0?