Laboratory

Spreadsheets

12A

Objective

- Learn some of the basics of a spreadsheet program (like Microsoft Excel).

References

Software needed:

1) A spreadsheet program (preferably Microsoft Excel)

Textbook reference: Chapter 12, pp. 391–399

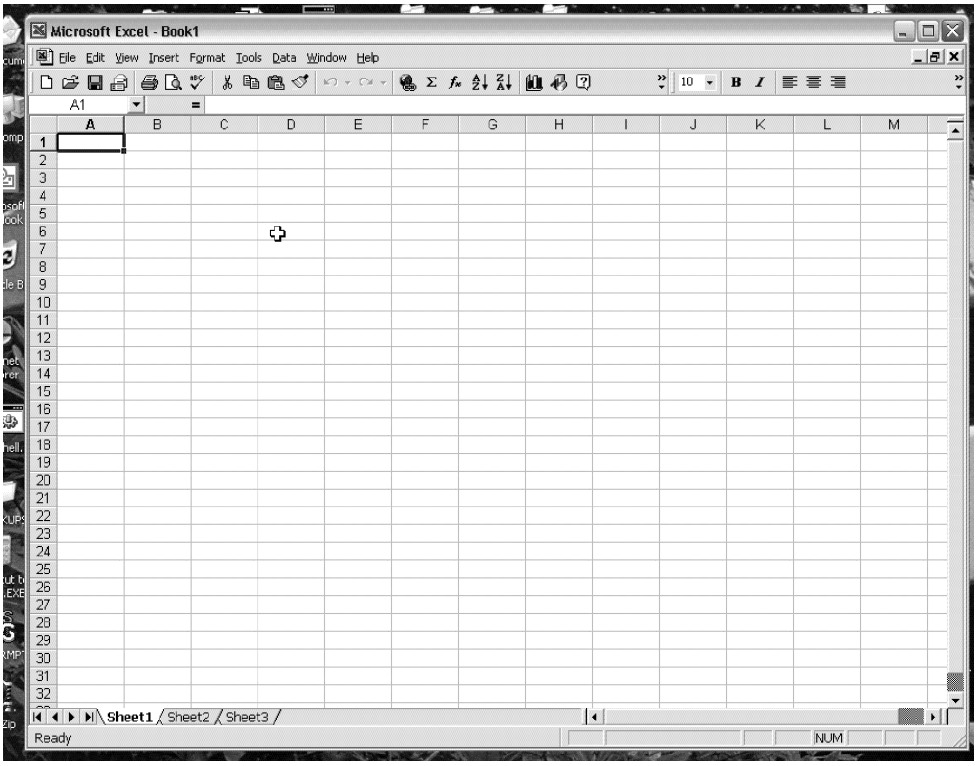
Background

Chapter 12, "Information Systems," introduces two major types of programs that are used in managing information: spreadsheets and databases. Both of these types are represented by a huge variety of products. Some spreadsheet programs even incorporate simple database functions.

This lab focuses on the spreadsheet program Microsoft Excel, which is widely used and available on both the Macintosh and the Windows platforms. Other programs, such as the spreadsheet program in Microsoft Works, are almost identical to this one. Macintosh office suites such as Appleworks also contain a spreadsheet program, and the formulas are similar. Office suites that exist for Linux, including StarOffice from SUN Microsystems, include a spreadsheet program that will even read and write in the Microsoft Excel file format.

Activity

While this lab uses Microsoft Excel to introduce spreadsheets, most spreadsheets are very similar. If you are using a different program, you may have to make minor adjustments, probably in the names of formulas. Check with your lab instructor for more details.

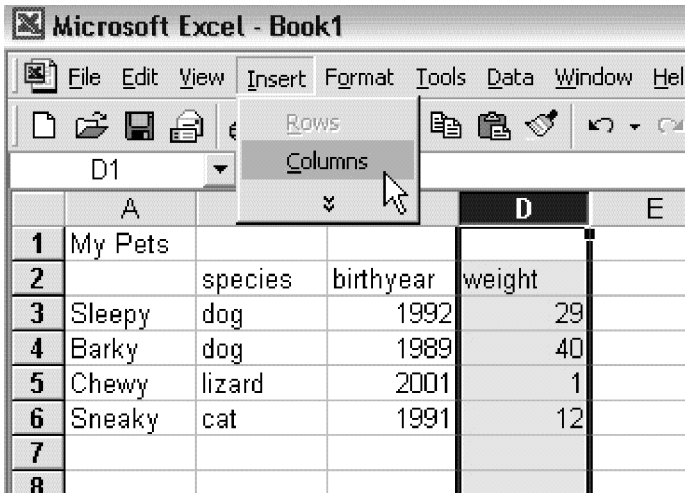


To begin, start Microsoft Excel and a blank worksheet will appear. (The version we are showing here is Excel 2000.)

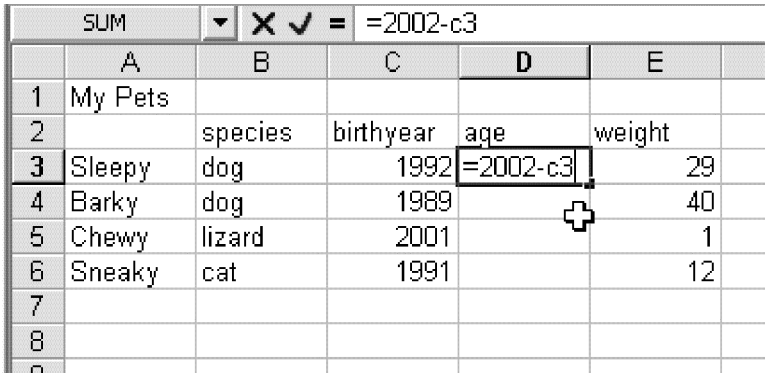
Your textbook contains all the necessary terminology about cells, formulas, ranges, and functions. Starting in cell A1, type in the data about fictitious pets shown below. Notice that some of the data is numerical and some is textual:

	A	B	C	D	E
1	My Pets				
2		species	birthyear	weight	
3	Sleepy	dog	1992	29	
4	Barky	dog	1989	40	
5	Chewy	lizard	2001	1	
6	Sneaky	cat	1991	12	
7					
8					

Oops! We forgot something. We need to know at a glance how old our pets are so we can buy the right kind of food and take them in for the proper shots. Let's insert a column between birthyear and weight. Click once on the D column header. This highlights the entire column. Then pull down the *Insert* menu and select *Columns*.



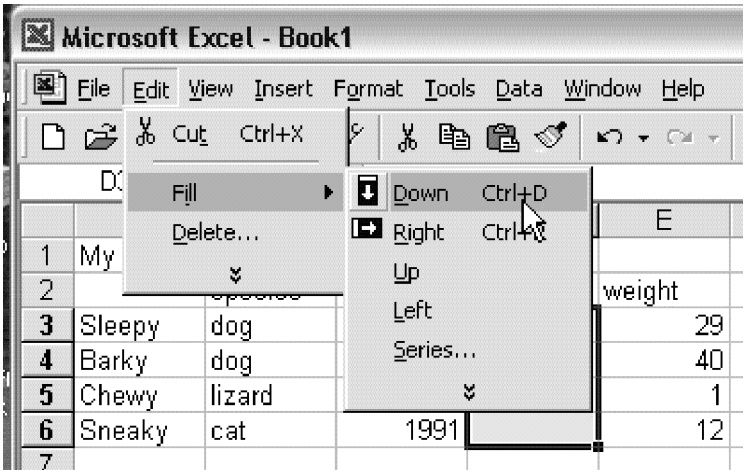
Don't just type the ages in! They can be calculated by subtracting the animal's birthyear from the current year, 2002. To tell Excel that you are entering a formula that will compute a value, rather than typing the value in directly, start with an equal sign. That doesn't really make a whole lot of sense, but it is the traditional way to enter a formula in most spreadsheets. As shown in the screenshot below, type the formula `=2002-c3` into cell D3 of your spreadsheet.



Press *Return* to finish entering the formula. Excel immediately calculates the result and puts 10 into the D3 cell.

Now we want to enter the same formula for all the animals. But rather than retyping the formula over and over, let's make Excel do it for us. Put the mouse cursor, which is a large plus sign, on top of D3 and drag it down to D6. All those cells will be highlighted. Excel outlines a highlighted area with a fat black line and then changes the color of the cells to gray.

Next we tell Excel to copy the formula into the first cell of the selected area. Pull down the *Edit* menu and select *Fill*. Since there is a submenu for *Fill*, a right arrow appears. Move the pointer over that arrow to see the next menu, and select *Down*. (Some spreadsheets put the commands *Fill Down* and *Fill Right* in one menu.)



After you complete this operation, you will see the following:

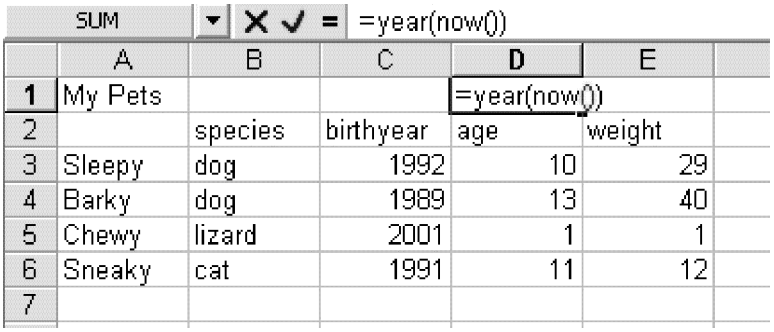
	A	B	C	D	E
1	My Pets				
2		species	birthyear	age	weight
3	Sleepy	dog	1992	10	29
4	Barky	dog	1989	13	40
5	Chewy	lizard	2001	1	1
6	Sneaky	cat	1991	11	12
7					

If you position the mouse cursor over cell D4 (or D5 or D6) and click once, you will see the formula that Excel is using for that cell. In the case of D4, the formula is `=2002-C4`. But the original formula was `=2002-C3`. Notice how clever Excel is! It automatically modified the part of the formula that needed to be varied, namely the reference to the animal's birthyear.

So your spreadsheet works pretty well and helps you keep track of your pets' ages. What happens, though, when the ball drops in Times Square on January 1, 2003? Do you have to go in and change all those formulas? Indeed!

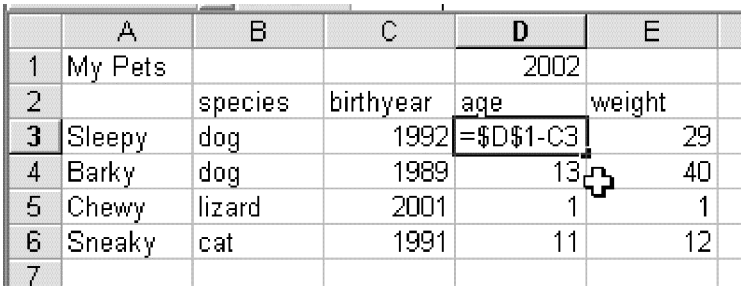
However, spreadsheets are enormously clever (well, actually, it's their inventors and programmers who are enormously clever) and they have built into them millions of solutions to pesky problems like this one, our need to keep the year current.

Here's one way: Position your cursor over cell D1 (which was originally empty) and type in the formula `=year(now())`, as shown next. Press *Return* when you're done. And yes, there are two empty parentheses after the word `now`, as shown.



What you have done is used the `now()` function, which delivers the current date and time (whenever this cell is recalculated). The `year()` function pulls just the year out of this date and time, so the number 2002 is plopped into cell D1, until you restart Excel on January 1, 2003 and open this spreadsheet, at which point the computer grunts from too much champagne and goes back to bed. (Actually, feeding champagne to your computer is frowned upon!) Okay, what will actually happen is the number 2003 will show up in cell D1.

We still have to make use of this value, so change the formula in cell D3 to the following: `=$D$1-C3`



This tells Excel to subtract the birthyear in cell C3 from the year right now, which is kept in cell D1. But what's with those dollar signs? Well, usually cell references used in formulas are *relative* to the cell that contains the formula. That's why the pet's age formula you first entered in cell D3 automatically adjusted itself when you filled the cells beneath it. That original formula you typed in D3, `=2002-C3`, referred to cell C3, just to the left of D3, where Sleepy's birthyear was recorded. When you filled the cells beneath D3, Excel modified the formula in each cell to refer to the appropriate cell to the left, where each pet's birthyear was recorded.

Putting the dollar signs into the formula's cell reference, `=$D$1-C3`, tells Excel that this is an *absolute* cell reference that always refers specifically to cell D1, rather than a relative cell reference that varies depending on the cell in which the formula is located.

Once you've entered the formula `=$D$1-C3` in cell D3, fill the three cells beneath it. The end result will look identical to what you saw before, but the underlying formula makes it more flexible and intelligent, so that you won't have to rewrite your spreadsheet each year.

There are many different spreadsheet functions, far too many to discuss here. Your textbook lists some common ones on p. 397. Virtually every spreadsheet has these functions, but their names vary.

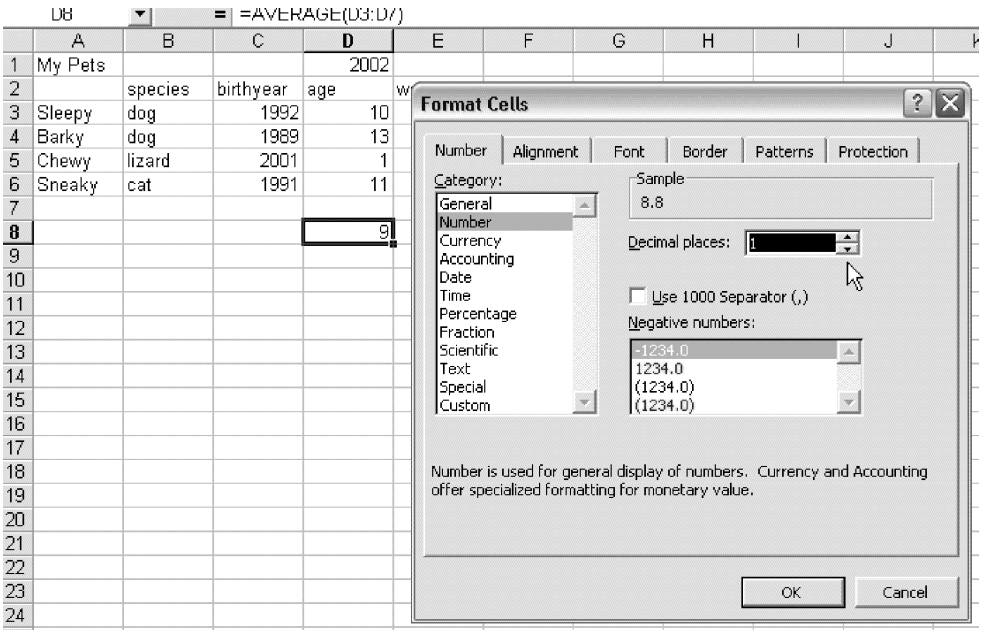
Go to cell D8 and type in

```
=average(D3:D6)
```

	A	B	C	D	E
1	My Pets			2002	
2		species	birthyear	age	weight
3	Sleepy	dog	1992	10	29
4	Barky	dog	1989	13	40
5	Chewy	lizard	2001	1	1
6	Sneaky	cat	1991	11	12
7					
8				=average(d3:d6)	
9					

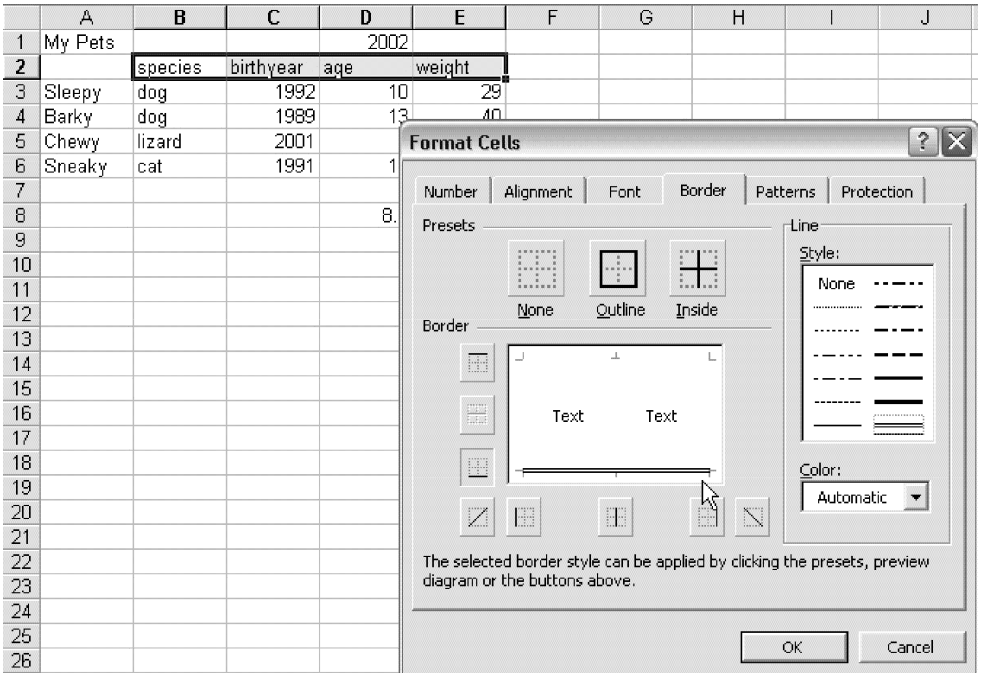
This computes the average of the cell range D3 through D6. Notice that in Excel a cell range is notated with a colon between two cell addresses, whereas other spreadsheets use two dots (see textbook p. 395). Moreover, some spreadsheets use the function name AVG instead of `Average`. If you're not using Microsoft Excel, check with your lab instructor or access the online help to see what notation your program uses.

You can control the way numbers, dates, and other material are formatted in cells. Select the cell by clicking on it with the cursor. The cell will become highlighted. Then pull down the *Format* menu and select *Cells*.... A new window pops up in which you can determine the number of decimal places and other formats:



Another commonly used formatting feature is the one that controls the borders and shading of cells. Suppose we want to put a double line underneath the cells that contain the column headings. Highlight cells B2 through E2, pull down the *Format*

menu again, and then click *Cells...*. When the tabbed pane appears, click on *Border* to display the border. Click once on the double line in the *Style* area, and then near the bottom of the big white area that says *Text*, as shown below:



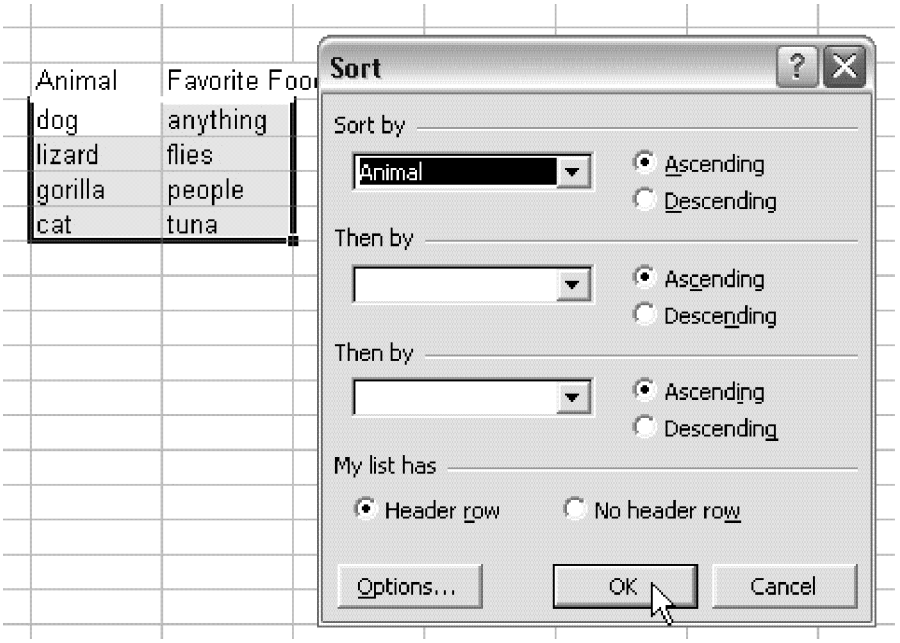
Do this again for the cells containing the pet names, but this time make it a border on the right side of the cells. Next, starting with cell B11, type in the information shown in the screenshot below:

	A	B	C	D	E
1	My Pets			2002	
2		species	birthyear	age	weight
3	Sleepy	dog	1992	10	29
4	Barky	dog	1989	13	40
5	Chewy	lizard	2001	1	1
6	Sneaky	cat	1991	11	12
7					
8				8.8	
9					
10					
11		Animal	Favorite Food		
12		dog	anything		
13		lizard	flies		
14		gorilla	people		
15		cat	tuna		

(Please note: In our hurry to enter some data, any data, into this spreadsheet, we may have gotten a little carried away. There is little in the scientific literature that endorses the notion that gorillas eat humans—in fact, most gorillas seem to find humans distasteful.)

Now we need to put this little table about animal meal preferences into sorted order. For a small list like this it may seem trivial, but sorting is a pretty handy feature when you have large sets of data.

Pull down the *Data* menu and select *Sort...*. A new dialog box pops up and we will leave all the defaults as they are; click *OK* to sort.



Now let's use that table about animal foods. Assume our dogs, lizard, and cat are all typical animals, and like the favorite food listed for their species. Let's create a new column of pet information in our spreadsheet that will refer to our Favorite Food table to automatically determine what each of our pets prefers to eat. We will use Excel's `VLOOKUP` formula.

	A	B	C	D	E	F	G	H
1	My Pets			2002				
2		species	birthyear	age	weight			
3	Sleepy	dog	1992	10	29	=vlookup(b3,b12:c15,2)		
4	Barky	dog	1989	13	40			
5	Chewy	lizard	2001	1	1			
6	Sneaky	cat	1991	11	12			
7								
8				8.8				
9								
10								
11		Animal	Favorite Food					
12		cat	tuna					
13		dog	anything					
14		gorilla	people					
15		lizard	flies					

Click on F3 and type in the formula:

```
=vlookup(B3,$B$12:$C$15,2)
```

That's quite a fingerful! What does it all mean? VLOOKUP is a built-in Excel function that looks up items vertically in a table and delivers whatever information is associated with the items. In our example, B3 tells the formula to take the value in cell B3 (dog). Next, $B$12:$C$15 specifies the table spanning the range of cells from B12 to C15 (and, of course, we use the dollar signs again because the table is in an absolute location that stays the same regardless of which cell contains the VLOOKUP formula). The VLOOKUP goes to the specified table and checks to see whether the value contained in cell B3 is also in the first column of the table. Finally, the 2 in the formula tells Excel that if it finds a data match in the first column, it should return with whatever value appears in the second column of the table. VLOOKUP executes a vertical lookup in a table; there is also a horizontal lookup formula called HLOOKUP, which you can investigate on your own.

Here's the final product (with the table left out of the picture):

F3 = =VLOOKUP(B3,$B$12:$C$15,2)

	A	B	C	D	E	F
1	My Pets			2002		
2		species	birthyear	age	weight	
3	Sleepy	dog	1992	10	29	anything
4	Barky	dog	1989	13	40	anything
5	Chewy	lizard	2001	1	1	flies
6	Sneaky	cat	1991	11	12	tuna
7						
8				8.8		

The beauty of lookup tables is that if you later find that the favorite food of dogs is "dog chow," you need only change *one thing* in your spreadsheet and it will automatically recalculate all the cells affected by that change. Try it! Go to cell C13, the table cell that says dogs prefer "anything," replace that word with "dog chow," hit *Enter* or *Return* and watch what happens in cells F3 and F4.

Information systems try to avoid redundant information because of the *update problem*. For instance, suppose that you had not used the VLOOKUP function and had just typed the favorite foods in the columns associated with your pets. If you suddenly find that cats hate tuna, but love chicken, you can easily change Sneaky's preference. But if dogs suddenly love dog chow, you have to change two lines. No big deal in this small example, but remember that information in the real world is often amazingly vast and complex. How about a spreadsheet containing a line for every car-owner in the United States? That would stretch into roughly 100 million lines, and you wouldn't want to face the update problem there!

Exercise 1

Name _____ Date _____

Section _____

1) Start Microsoft Excel. You should be looking at a blank worksheet.

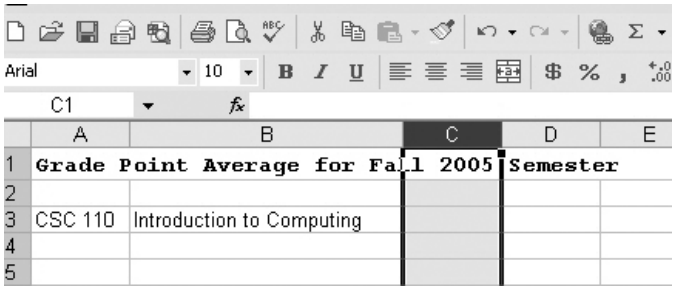
2) This exercise will help you compute your grade point average (GPA) for the courses you are taking. In cell A1, type

   `Grade Point Average for Fall 2005 Semester`

   in bold font.

3) Starting in cell A3, type the course identification. This varies from school to school, but usually starts with a departmental abbreviation followed by a course number. For instance, CSC 110 stands for "Computer Science, course #110."

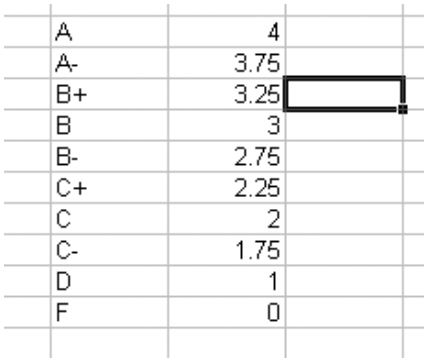
4) In cell B3, type the course name, such as "Introduction to Computing." You should widen column B by dragging on the bar line separating B and C near the top. Here's a screenshot:



5) In C3, type the number of credit hours for the course, and in D3 the letter grade you either will get, did get, or want to get (depending on where you are in the semester).

6) Now enter some more courses. Many colleges permit students to take five per semester, with labs counting too. If you are on a quarter system or some other schedule, enter your information as appropriate for your school.

7) To turn the letter grades into grade points, you need to convert them to numbers. A lookup table is an ideal way to do this. To the right of your courses, create the lookup table, starting in cell H1. Here's a sample that is appropriate for some schools:



8) As you can see, the letter grades are on the left and their translated numerical values are on the right. Notice that the letter grades must be sorted in order for `VLOOKUP` to work.

9) In cell E3, type your lookup function call. Given that the grade table is in cells H1 through I10, you must type:

```
=VLOOKUP(D3,$H$1:$I$10,2,FALSE)
```

although you can use lowercase letters instead. The first argument, D3, specifies that we are going to lookup the value that is in cell D3, which will be a letter grade. The lookup table is given by argument 2, which is a range of cells. The dollar signs fix the range so that it remains exactly cells H1:I10, even if we fill down. The third argument, 2, says that we want to take the value from the 2nd column of the lookup table. And finally the fourth argument, FALSE, tells Excel that we are not looking in a set range in the lookup table, but instead we are trying to find an exact match. This means that if someone gives you a grade of Z or F+, the vlookup function won't find a number for it. If it were a range lookup, Excel would pick a value in the given range.

10) Fill down for the other courses.

11) In cell F3, write a formula that multiplies the number of credit hours by the translated grade. For example, if you entered the grade A− in cell D3, this formula should return 11.1, the value in cell C3 (3) multiplied by the value found in cell E3 (3.7).

12) Fill down for the other courses.

13) Write a function that adds up the column of credit hours. This would look like

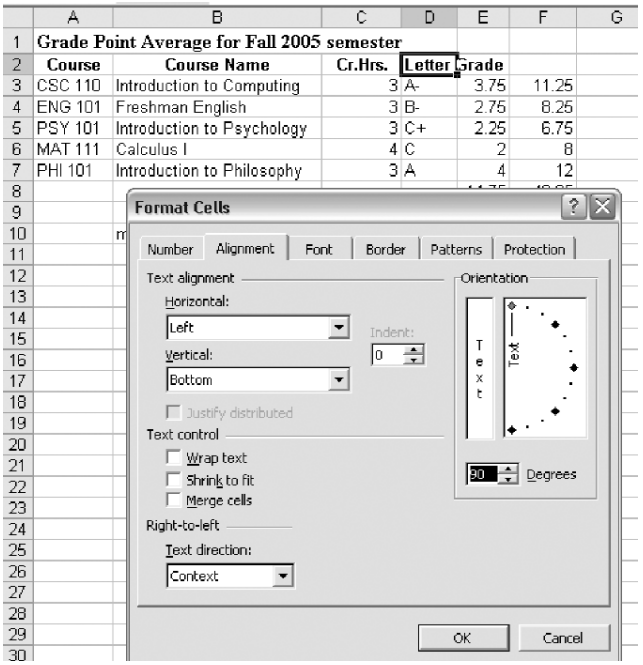
```
=SUM(C3:C7)
```

if there were five courses. Adjust the cell range to fit your data.

14) Do a similar sum for the column containing the translated numerical grade values, and another for their multiplied values.

15) Aren't functions fun? Write another one that divides the sum of multiplied values by the sum of credit hours, giving the grade point average. The result should go into C10.

16) Just to make our spreadsheet pretty (and self-explanatory), put some headers in the columns. For instance, in A2, put ***Course***. In B2, put ***Course name***. Column C gives the credit hours, which you might consider abbreviating at ***Cr. Hrs***. Column D is obviously the letter grade. Since the header ***Letter Grade*** might require the column to be expanded too much, seeing that the contents of the column are very short, let's stand it on end. Click on cell C2 and then click on Format in the menu across the top. When the menu appears, click on Cells...Then click on the Alignment tab and find the orientation section, which looks like half a clock. Click on the top diamond, which is at "12 noon." This means the text will stand on end. Here's what you will see:



17) Column E is the ***Numerical Grade***, and column F is the ***Quality Points*** for each course. Now center each header cell. To do this quickly, highlight all 6 cells in row 2 and click on the centering icon. (If the centering icon is not on your toolbar, click on Format, select Cells…, Alignment tab, pull down the horizontal menu and select Center.)

18) Unfortunately, by putting the headers in row 2, our spreadsheet looks a little crowded. Let's insert a blank row. Click on the 2 at the edge of row 2, which will highlight the entire row. Then click on Insert in the menu bar. Click on Rows and a new blank row will be inserted.

    Wait a minute!!! Won't this screw up our formulas that we so carefully wrote? Actually, no. Excel, like most modern, smart spreadsheets, knows that when you add rows or columns, the formulas have to be adjusted. Click on any formula to put your mind at rest that Excel did adjust them properly.

19) Format the GPA (Grade Point Average) to have 3 places after the decimal point. Format the values in columns E and F to have 2 places after the decimal point.

Here's what your spreadsheet will look like:

	A	B	C	D	E	F
1	**Grade Point Average for Fall 2005 semester**					
2	**Course**	**Course Name**	**Cr.Hrs.**	**Letter Grade**	**Numerical Grade**	**Quality Points**
3	CSC 110	Introduction to Computing	3	A-	3.75	11.25
4	ENG 101	Freshman English	3	B-	2.75	8.25
5	PSY 101	Introduction to Psychology	3	C+	2.25	6.75
6	MAT 111	Calculus I	4	C	2.00	8.00
7	PHI 101	Introduction to Philosophy	3	A	4.00	12.00
8					14.75	46.25
9						
10		my grade point average	3.136			
11						

Exercise 2

Name _____ Date _____

Section _____

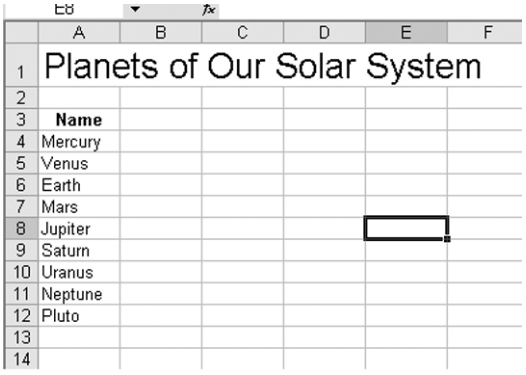
1) Start Microsoft Excel or create a new blank worksheet.

2) In this exercise, you will enter some data about the planets of the Solar System. In cell A1, create a title by typing

   Planets of Our Solar System

   and change its font to Arial 20.

3) In the first column, enter the names of the planets. You might have to expand the width of the column in order for the names to show up properly. You should also create a heading for this column: **Name**. Bold and center it. Here's a snapshot:



Here's the full set of data about the planets

Name	Type	Moons	Mass	Year	Distance
Mercury	rocky	0	0.06	0.241	0.38
Venus	rocky	0	0.82	0.615	0.72
Earth	rocky	1	1	1	1
Mars	rocky	2	0.11	1.88	1.52
Jupiter	gas	63	318	11.86	5.2
Saturn	gas	49	95	29.46	9.54
Uranus	gas	27	14.6	84.01	19.22
Neptune	gas	13	17.2	164.79	30.06
Pluto	rocky	1	0.0017	248.5	39.5

4) In the second column, enter the type of the planet by typing in either **rocky** or **gas**.

5) The third column will contain the number of moons. Enter both the data as well as the header.

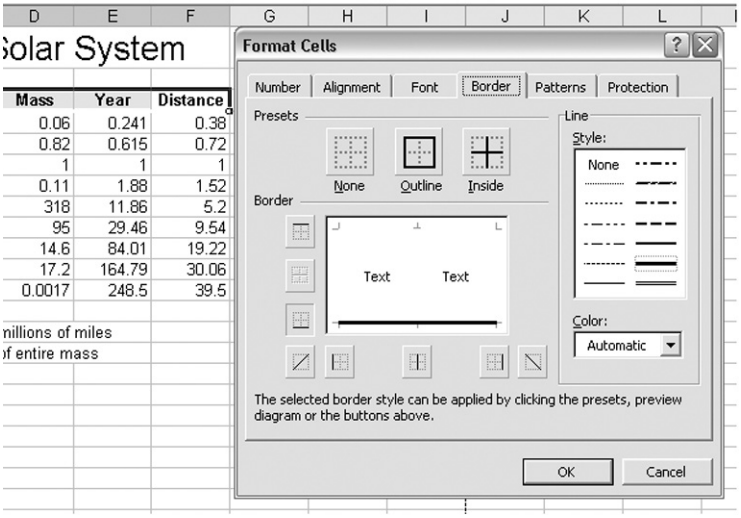
6) The fourth column is the mass (amount of material) in each planet, expressed relative to Earth. Many people think of mass as weight, though this isn't correct when there is no gravitational field to pull mass down. Still, mass is the property of material that would exhibit itself in the appropriate place. The Earth's mass is about 5.9736×10^{24} kilograms. That's about 6 septillion kilograms, or 13.2 septillion pounds. Quite huge! Now you can see why astronomers use bigger "units," namely whole planets.

7) The fifth column is the year of the planet, or the time it takes to go around the Sun once. Again, Earth's year is considered to be a unit, which is why it is 1. The way to read this data is that a year on Mars is 1.88 times that of Earth. Since Earth revolves around the Sun in about 365.25 days (yes, that's a fourth of a day), Mars must take 1.88×365.25 or 686.67 days to make one complete trip around good old Sol (our sun).

8) The last column is the distance of the planet from the Sun. Again, Earth is considered 1, because in reality Earth is about 92,750,690 miles from the Sun. (This concept of distance from the Sun is very complicated because the planets vary in their route around the Sun and all orbits are elliptical, or non-circular, which means that sometimes they are farther from the Sun than at other times. Interested students should sign up for Astronomy 101.)

9) In cell C14, put 93. In cell A14, enter "Earth from sun" and in cell D14 "millions of miles." If you type a string of letters in a cell where the column is too narrow, the letters spill over to the next column, unless there is something there already.

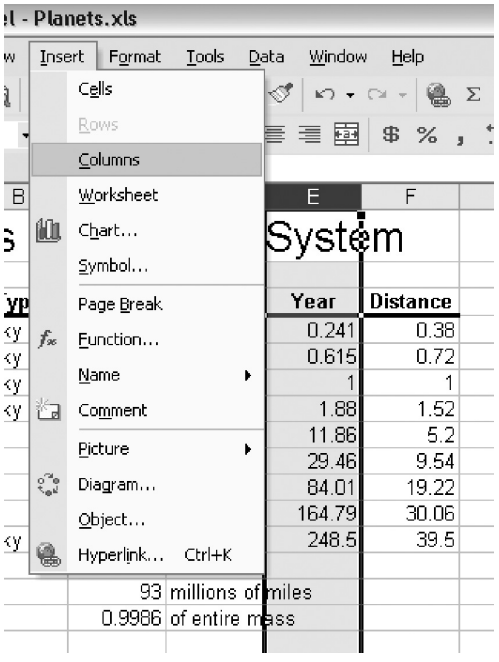
10) After you've entered the data, create a thick line under the headers to set them off from the data. Highlight cells A3 to F3. Then click on Format in the main menu in the menu bar. Select Cells…Then click on the Border pane. Click on the thick black line and then click on the bottom of the large white area, which represents the cells whose border you are modifying. Since you selected more than one cell, you will see the word Text twice, indicating two cells.



Once you finish entering data, your spreadsheet will look like the following:

	A	B	C	D	E	F	G
1	Planets of Our Solar System						
2							
3	**Name**	**Type**	**Moons**	**Mass**	**Year**	**Distance**	
4	Mercury	rocky	0	0.06	0.241	0.38	
5	Venus	rocky	0	0.82	0.615	0.72	
6	Earth	rocky	1	1	1	1	
7	Mars	rocky	2	0.11	1.88	1.52	
8	Jupiter	gas	63	318	11.86	5.2	
9	Saturn	gas	49	95	29.46	9.54	
10	Uranus	gas	27	14.6	84.01	19.22	
11	Neptune	gas	13	17.2	164.79	30.06	
12	Pluto	rocky	1	0.0017	248.5	39.5	
13							
14	Earth from sun		93	millions of miles			
15	SUN's mass		0.9986	of entire mass			

11) Just entering this much information would be a fair amount of work, but let's practice with some formulas. First, let's show what the mass of each planet is in kilograms. This data should go next to the current mass column, so first we need to insert a new column to the right of D. Click on E to highlight the entire column and then click on Insert in the main menu. Select Columns, which will cause one new column to be added *in front of* the highlighted column.



12) In cell E3, put a header **Mass(kg)** to indicate that the data in this column is mass in kilograms. To be perfectly clear, we should back up and change the header for column D to indicate that these mass values are abstract units where Earth = 1. To do this, click on cell D3. Then type **Mass**. Next hold down the ALT key (which is often next to the space bar) and press the ENTER key. This causes a break to occur in the data, putting what follows on the second line. Now type **(Earth=1)** and press ENTER again. This is what it will look like:

	A	B	C	D	E	F
1	Planets of Our Solar System					
2						
3	**Name**	**Type**	**Moons**	**Mass (Earth=1)**	**Mass(kg)**	**Year**
4	Mercury	rocky	0	0.06		0.241
5	Venus	rocky	0	0.82		0.615
6	Earth	rocky	1	1		1
7	Mars	rocky	2	0.11		1.88
8	Jupiter	gas	63	318		11.86
9	Saturn	gas	49	95		29.46
10	Uranus	gas	27	14.6		84.01
11	Neptune	gas	13	17.2		164.79
12	Pluto	rocky	1	0.0017		248.5
13						
14	Earth from sun		93	millions of miles		

13) We will put formulas in nine cells, E4 through E12, to express the mass in kilograms. But we won't repeat our work. Instead, we'll put the formula for Mercury into cell E4 and then copy it. In cell E4, type a formula that multiplies the value of D4 by Earth's approximate mass. To avoid typing all those zeroes, use Scientific Notation:

=D4*6.0e24

Recall that Scientific Notation is a way of expressing extremely large or extremely small numbers. 6.0e24 means 6.0×10^{24}. The letter "e" stands for exponent. Remember that in Excel formulas, the asterisk stands in for the multiplication symbol, partly out of respect for older FORTRAN programmers, but also because X would get confused with the letter X, as in row X.

14) To copy this formula quickly, click once on cell E4, the one we just entered the formula into. Then continue holding your mouse, and drag down until cells E5 to E12 are all highlighted. Hold down the CTRL key and press D, which does a **Fill Down** operation. This copies the formula in the top cell down into the ones below, making adjustments for which rows the cells are in. (You can also click on Edit in the menu bar, click on Fill, and select Down. The keyboard shortcut is often a lot faster!) There is always a **Fill Right** operation, which often comes in handy.

15) Do the same thing for Year, making a new Year column that shows the planet's revolution in Earth days. Use 365.25 for the number of Earth days in an Earth year. The new column's header should say **Year(in days)**. You should also rename the previous column as **Years (Earth=1)**.

16) Finally, we will do the same thing for distance, showing the planet's distance from the Sun in millions of miles by converting the Earth=1 value to real miles by multiplying by 93. However, instead of "hard coding" 93 into every formula, use the Earth distance

that appears in cell C14. But there's a catch here: if you type the following formula and fill down,

=G4*C14

what happens? Something goes wrong. Describe it by looking at the formulas for Venus and Earth.

17) To fix this problem, we need to anchor the C14 cell so it doesn't change in copied formulas. This is discussed in the activity. C14 needs to be changed to an absolute cell reference. Fix the formula for Mercury and fill down again.

Deliverables

Print up your spreadsheet or hand in the file electronically—consult your lab instructor for instructions.