NAME:

PX1512

Computing Lab Notes and Exercises

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Introduction to Computing

Introduction

This section of the course PX512 is intended to serve as an introduction to computing. In it, you should acquire and develop some of the computer skills that will help you throughout your studies here at University and beyond into your future career. We hope you will find these notes worth keeping as a reference.

Because first year students have a wide range of backgrounds and are reading a variety of different subjects, it is impossible to design a skills course that will suit everyone. The more computer literate will find this a relatively easy part of the course. Don't miss out doing it, though, for **you must pass the continuous assessment part of PX1512 in order to pass the whole course**. Some will find this course quite hard work and have to learn a great deal in short space of time. We think you will find it worth it, though.

If you are someone with very little experience of computing, let the demonstrator know so that he can devote a little more time to you. It can be worrying when you find yourself in the position of not understanding something that everyone around you seems to be finding very easy. It is tempting to remain quiet and not draw attention to yourself in the hope that other people will not then think you stupid. DON'T DO THIS! - *Ask for help*. For the more experienced computer users, if you see someone struggling please help them out. Explaining something to someone else will deepen your own understanding - or (as many teachers discover to their horror) expose the fact that there's more to it than you might have thought!

What you will be learning

WORD The UK school education system has invested in computers over the last few years and most UK students have some knowledge of word processing using the Microsoft package WORD. This package is part of the Microsoft Office suite that is supported on all University central facilities (and used by most University staff here). For this reason there will be no formal teaching of WORD. However, writing a letter is one thing but producing a professional looking report that includes equations, tables and technical diagrams is another matter. The Word section of these notes will let you revise the basic use of Word (or learn it if you know another word processor) and introduce more advanced features commonly used in scientific reports.

EXCEL All science students need to be able to process data, make calculations and draw graphs. Excel is a "spreadsheet program" capable of doing all of these things. Excel is also completely compatible with WORD, allowing you to incorporate your results into a report with relative ease. If you have taken the course 'Tools for Science' you'll have found that this course failed to include some useful Excel skills that we have included here.

ASTRONOMY EXERCISE A web-based exercise.

Classes

Each 2-hour class will be in the form of a self-study practical lab with a demonstrator on hand to answer questions if you are stuck. You are expected to work through these notes and hand in at the end of the class the work requested, **which will be marked**. Work *will not be accepted* more than a week later without a good reason.

Assessment

The sum total of the computing assessments is worth 15% of the total mark for the course (and hence 60% of the continuous assessment mark). The assignments will be weighted in the ratio 1:1:2 for the Word, Excel and Astronomy assignment.

Attendance

You should attend each class and make sure that you sign the attendance form. We don't mind if you prefer to attempt the work in your own time but if you get stuck please don't expect the demonstrator to help you out if you haven't attended the class sessions.

Teachers

The demonstrator this year is Ross MacPherson

Schedule

Lab 1 - *Word* - submission: 2 single page exercises, as described within the text (on page 7 and page 13)
Lab 2 - *Excel* - submission: a 2-page exercise as described on pages 14-15
Labs 3 & 4 - *Use of classroom for Astronomy exercise* - submission: a single document to be e-mailed, as described.

Print Budget

These classes require you to print a total of 4 pages for handing in. That shouldn't stretch anyone's print budget but please make sure your budget isn't empty.

Preparing a document with Word

Keyboard Skills

Many people get by using just two forefingers for typing. Time invested in teaching yourself to use all of your fingers is worth it. In order to do this, place your fingers over the middle row of letters with your left hand little finger resting over **A**, the next finger over **S** and so on for **ASDF**. Your first finger of your right hand should rest over **J**, the next over **K** and so on. **ASDF JKL;** are called your *home keys.* Each finger is then used to type only the letters nearest to it so that your little finger on your left hand will type **QAZ**, your left hand fourth finger **WSX** and so on. This will be slow work at first – but you will soon get used to it and after a little practice you will find it much faster than just using two fingers.

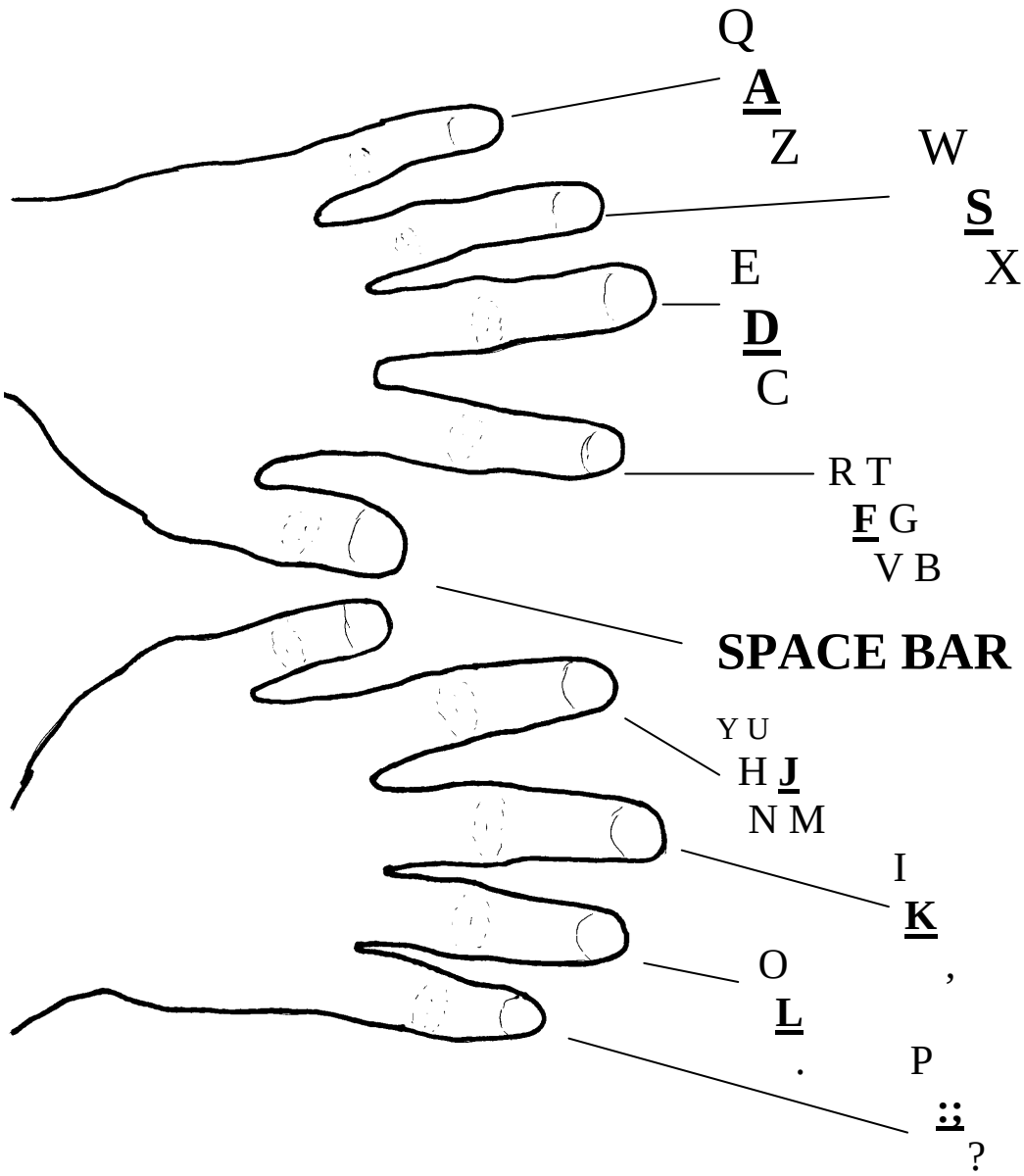


Figure 1: Home Keys

You won't be assessed on your typing skill in this course.

Introduction

Word is a document preparation package that you will find very useful for writing essays and project reports. If you belong to a student society, you will find some other features of Word very useful – for example, it is quite straightforward to prepare a newspaper, pamphlet, flier and so on.

Word is a product of the Microsoft Corporation and is updated every few years. On some versions of Word, the dialogue boxes may be slightly different from the images shown here. Word is almost universally available throughout the world and is without doubt the most popular word processing package.

To open Word, login to a PC in the classroom. There you should find the *Word 2003* icon on the desktop. Otherwise go to *Common Applications - Microsoft Office 2003*.

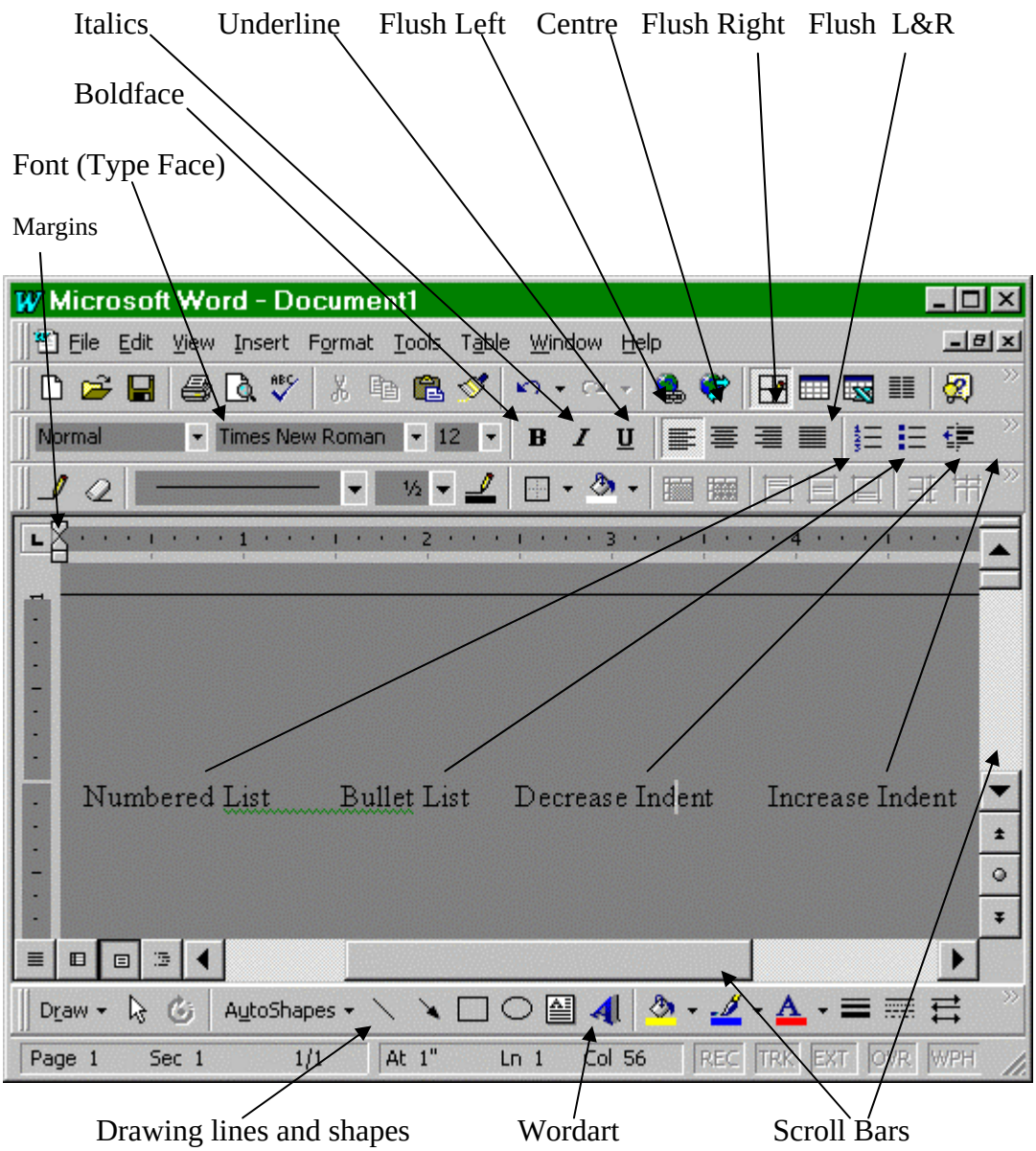


Figure 2: Example Word window

Basic Ideas

This section is revision for most of the class. A bullet point highlights paragraphs where you have to do something. Even if you think you know the basics, read through the next two-and-a half pages before coming to the first exercise because there are some hints and tips in the text.

There are typically **three ways** of performing an operation in Word. You can either:

1) use a reserved icon on a *toolbar*. You can place toolbars at the top, bottom or sides of the Word window but the top is the most common place.
2) use a drop-down menu and select the operation from the list on the chosen menu. The menus are normally accessed from a top toolbar and have names like File, Edit, etc. Experience tells you which menu to use in any circumstance.
3) Use a short-cut key instead of the mouse. E.g. *ctrl-x* (control key and *x* held down simultaneously) cuts out selected text, *ctrl-c* copies text and *ctrl-v* pastes text, and so on. *Help - Index - Keyboard shortcuts* will get you to the large list of short-cuts available. [Commands in italics in these notes, like the ones on the line above, generally indicate menu selections to make, or icons to choose or buttons to press; sometimes text to enter].

Word works on the principle that to operate on any text you must *select* that text first. This is done by moving the mouse pointer to one end of the text, holding down the left-hand mouse button and dragging the pointer across the selected text. Sometimes Word tries to be clever and anticipate that you want to select a whole word or whole sentence when in fact you don't want to. This can be annoying. Such anticpating action can be turned off from the *Tools - Options* menu but leave doing this until you are familiar with the package. One way around unwanted anticipation by the editor that usually works is to perform the selection backwards.

A second principle worth knowing is that Word will carry forward the format of the previous paragraph and apply it to the next one you type.

Changing the appearance of the text

- The best way to learn how to use Word is to play with it – try out some of the formatting options indicated in the previous figure. In order to do this, type in a few sentences and then position the mouse cursor to the immediate left of the first sentence, press down the left mouse button and keep it pressed down slide the mouse so that the highlighted text is the selection you want. When you press an icon relevant to the text, all of the highlighted text will become modified.

- Try starting with the bold face option – highlight your sentence and then click on the **B** button and your sentence will change to:-

Try starting with the bold face option – highlight your sentence and then click on the B button and your sentence will change to:-

- *Try the italics option.*

WE DON'T RECOMMEND using the underline option for emphasis. It is a relic of typewriter days when underlining was the only option available for emphasis. Modern documents generally look better without it. Underlining is used nowadays to highlight active web links in a document.

- To the left of the **B** button is a little number (probably set to 10 or 12). This number controls the 'point size' of the text (the unit is written 'pt'). Press on the arrow next to the number and try clicking on different text sizes, you can write in very small letters, or quite large letters.

- Now try changing the font (or the type face). It is probably set on Time New Roman, click on the arrow and move down the menu trying out different options. Arial looks a lot like a typwriter for example, ALGERIAN IS QUITE ORNATE, Comic Sans MS is quite good for writing party invitations, or Coronet is very pretty and a lot like some handwriting. One subtlety in Word is that a bullet point takes on the font of the end of the paragraph that it marks. If your bullet point looks funny or is a funny size, then put in a space at the end of the paragraph in normal text.

- Now return to Times New Roman 12 pt – take off any bold face, italic and underline options and write a paragraph consisting of several sentences. Remember that this is not a typwriter – you don't need to press carriage return when you come to the end of the line, the computer will do it for you. If you can't think what to write, copy this paragraph. Now highlight the paragraph and try the flush left option (just to the right of the **U** button). You will get something looking like this:

This is a **flush left** paragraph and looks a lot like the text you would get from a typewriter because text on successive lines does not end aligned. The paragraph above is flushed both left and right. An alternative description for the same effect is the printer's jargon word 'justified'. This paragraph is 'left justified'; most of the text in these notes is both left and right justified, meaning that it starts and ends at fixed points across the page, fractions of a space being inserted between words to pad out them out so that the alignment is almost exact.

You can also **centre** paragraphs using the
centre button next to the flush left button.
You will need this for writing titles or
when writing posters or on any other
occasion when you want centred text.

Sometimes you may want to use
the **flush right** option, for example
when writing the address in a letter.

Lists

In order to write out a list, press the carriage return key to a new line and then click on one of the list buttons – there are two, one for numberd lists and one for bullet lists (see Fig. 2).

1. Now every time you want to start a new item use the carraige return key.

2. And a new numbered line will appear.
3. For as many items as you want.
4. When you are on your last item, press return – a new item number that you don't want will appear.

But by pressing the list button again any list number in the paragraph the cursor is at will disapear and you will return to normal text.

Cut and Paste

One of the biggest advantages about using a wordprocessor, as opposed to a handwriting, is the ability to move text around to different places. In order to do this, you must highlight the text you want to move or delete and then, using the *Edit* menu (top left of the window between *File* and *View*) move down the drop down menu until you come to Cut, click the left mouse button and the highlighted text will disappear. It has not been lost – merely moved into memory called the **clipboard**. Now move the mouse cursor to where you want the text to be moved to and then once again on the *Edit* menu, click on *Paste*. The text will reappear from the clipboard – as many times as you want it to. You can copy diagrams, equations, pictures and other objects to the clipboard. The cut, copy and paste icons can be used instead of the drop-down Edit menu.

Margins

Occasionally you will want to alter the margins of your paragraph – for example when you write a quote. Along the top and left of the text screen you will see numbers – like a rule – opposite the scroll bars on the bottom and right of the screen. In the top left-hand corner there are two pointers and in the top right one pointer. You can drag these to alter the postion of the text on the screen.

- Try highlighting a small paragraph and adjust these indent bars.

> *This is a paragraph which could be a quote or an abstract or something else that you want indented from the rest of the text.*

When you have finished, make sure you move the indent bars back.

Exercise 1 for submission

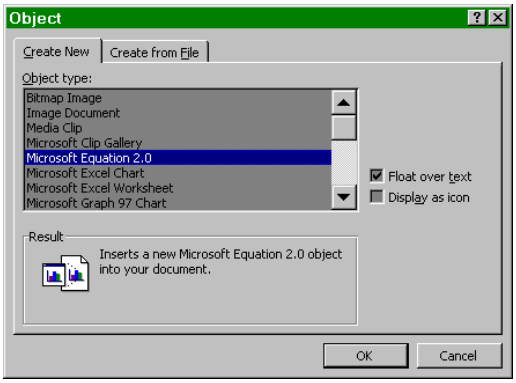
You now know how change the text size, type face, how to make it boldface or italic, how to center it, or otherwise change its appearance, make lists and indent text.

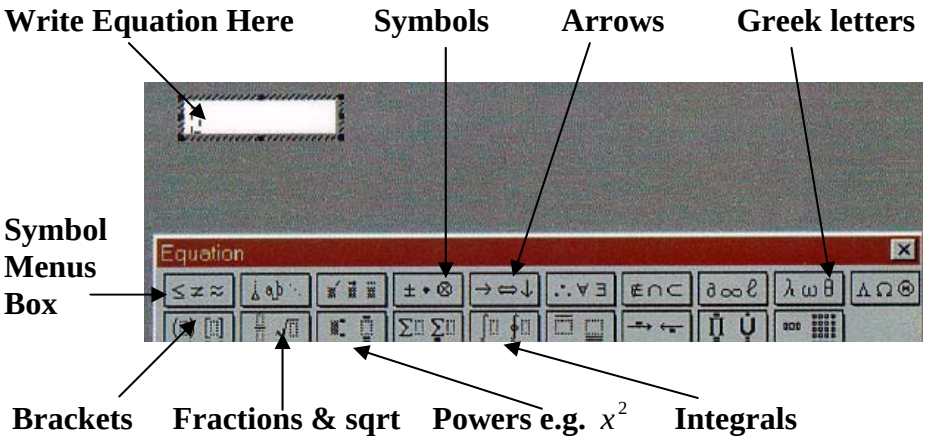
- Prepare an A4 poster advertising a lecture to be given on the 22nd of June 2009 at 2 pm in lecture theatre 1 of the Fraser Noble Building, given by Prof. *your own name*, Astronomer Royal (author of 'How to Catch a Star') on the subject of "Stars I Want to Introduce to You". If you know how to insert and format pictures into text, then select a suitable feature from the web and include it in your poster. If you don't know how to do this, then see our guidelines on page 11 and then attempt it.

- Once you have created your poster – save it by clicking *File* (top left hand corner of the window) – move down the list and click on *Save As***,** make sure you are in the directory that you want on your H: drive and then where it says *File Name***,** type in the name that you want to save the document as there will probably be a default name there already. In the box below this it should say ``Word Document'' – if it does not, click on the arrow to the right of the box and change it until it does. Print out the poster and hand it in.

Equations

Writing equations in Word is a bit like painting by numbers, a bit tedious and not needing any imagination but it will always yield a result. Some simple equations you can of course prepare using the keyboard: y = ax + b for example - you can even get Greek letters simply by choosing *Insert* - *Symbol*, but for more complicated equations you must use the equation editor. To get at the equation editor, look along the top of the window for the insert option (File Edit View Insert …..). Look down the insert menu and toward the bottom you will see *Object***,** click on this and a new box will appear. Move down the displayed list (figure left) until you come to an item that says something like *Microsoft Equation 3.0***.** Click on this item to highlight it and then press the **OK** button at the bottom of the box. Two boxes will now appear – one where you will assemble the equation and another giving you a list of options, shown in the illustration below. Each of the options are menu buttons that display options to insert hinted at by the symbols on the button.





- You need to know that spaces are automatically put in where needed - indeed, hitting the space bar won't produce a space (*Ctrl* - *spacebar* forces a space). Try to create the following equations **with the equation editor** and in the process familiarize yourself with the options within each symbol menu. The first row of symbol menus are for inserting special symbols such as Greek letters or mathematical symbols. The bottom row are formatting templates (e.g. for superscripts, brackets, summations, etc.). Note the position of the flashing cursor, which can be moved through your expression using the arrow keys. Now type the following equations:

$$F = ma; \qquad E = mc^2$$

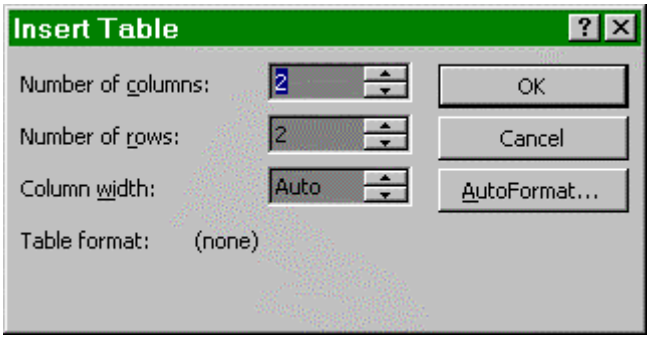
$$F = \frac{dp}{dt}; \qquad (M+m)P^2 = \frac{4\pi^2}{G}a^3$$

$$G_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}$$

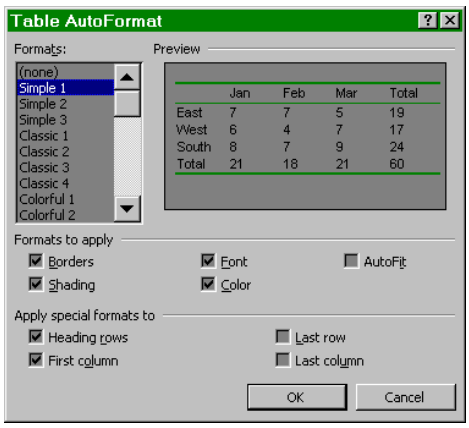
When you have finished setting up an equation, click on the screen a little way away from the equation box and you will revert to normal text mode. By clicking on the equation once, you can justify it (e.g. centre it) or by formating it as an object you can move it anywhere or give it a background colour, etc. By double clicking on the equation box you can go back to editing it. What you have typed above are some fundamental equations in physics, including Newton's second law of motion (in two forms), Einstein's energy-mass relationship, Newton's version of Kepler's second law and Einstein's field equations of General Relativity in a compact notation.

You can put equations on separate lines or incorporate them in a line of text: $y = \sqrt{4ax}$.

Tables



Preparing a table is not quite as difficult as doing equations. Look along the top menu (File, Edit, View…… Table) and click on *Table*, look down the drop-down menu for *Insert Table* and click on this option. The box shown left will appear. Click on the arrows by the *Number of columns*, *Number of rows* boxes until you have the right number of each – then click on the *Autoformat* button (bottom right below the **OK** and Cancel buttons). The box shown (below right) will now appear. Try clicking on a few of the different formats until you find one that you like – the preview screen will show you what they look like. Try experimenting with some of the other buttons as well – Font, Shading Color and so on. Now click on *OK* in this box, then on *OK* in the other box (above) – the table should appear in your document. You can then fill in each of the cells with your data. You will probably wish to adjust the size of the columns, which you will find that you can do with the mouse. Double arrows will appear when the mouse cursor touches on the cell border lines – by holding the left mouse button down you can drag the column or row dividing line to where you want it.



A	B	C	X	Y
1	2	3	1	**2**
3	2	1	2	**4**

Graphs, Diagrams and Pictures

Graphs

Word has its own graphics package where you can plot data stored in a table. Highlight the data in the table and, as with the equation editor, go in through the *Insert – Object* menu and select *Microsoft Graph Chart***.** You're better off drawing graphs on a specialist graphics package such as Excel and then importing the graph as a *picture*.

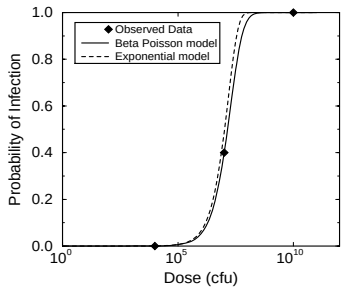


Figure 4: This Graph is imported from a graphics package. It's a bit small.

Drawings

Drawing simple schematic diagrams can be done quite well and economically in Word. In Word drawings, the individual elements of a drawing are represented as separate objects in the code. The advantage of doing this over a simple bit-map such as is created by the drawing package *Paint* is that **Word drawings are scalable to any size** without loss of detail. They also generally occupy less filespace than a bitmap picture.

You can draw directly onto a Word manuscript but the better approach is to use *Insert - Object - Microsoft Word Picture* which opens a new window for you. A box appears saying *Insert your drawing here*. **Ignore it!** Treat the whole page as your canvas. The box shows the area that will be returned by default onto your main page but you can reset the box boundaries to fit your own drawing, as described soon. Now use the drawing toolbar icons that appear at the bottom of the screen to assemble the picture from lines, curves, circles, etc. and you can add text. If the drwing toolbar isn't present, as seems to happen sometimes in the class-rooms, then fetch it by using *Tools - Customize - Toolbars* and check the *drawing* box. Worth knowing are the following points:

1. You can alter the thickness of lines, their style (e.g. solid or dashed) or whether they have arrows at their ends by using the draw buttons at the right of the toolbar.
2. If you click on the ellipse button, you can force the ellipse to be a circle by holding the *Shift* key down as you expand the cirlce. Holding both *Ctrl - Shift* together forces the circle to be centred on the cursor position as you expand it.
3. Holding the shift button while extending a line forces it to be horizontal or vertical, or to extend along the line already drawn.
4. Text boxes should have the 'No Fill' option chosen unless you deliberately want a background colour and 'No Line' unless you want them to have a rectangular box around them. Use the *Fill* and *Line* buttons on the draw toolbar.
5. There is a hidden grid of points covering the drawing and the default settting is to snap onto this grid the details of the objects you draw, such as the ends of lines or the centre of circles. It's best to give yourself the freedom of locating objects anywhere by

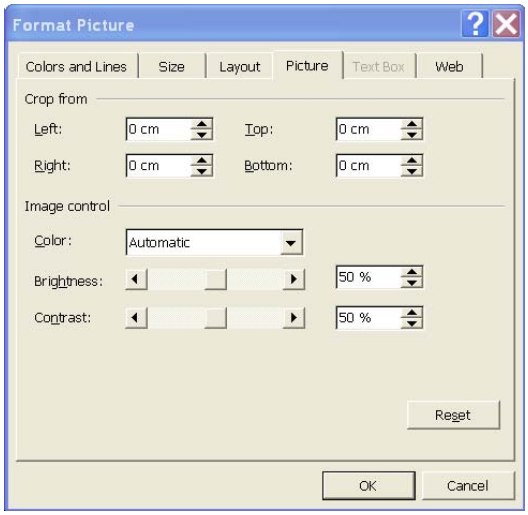
switching off this snap to grid. Do this by selecting *Draw* on the drawing toolbar, then *Grid* to raise the Drawing Grid dialogue box and finally uncheck the *snap object to grid* box.

Notice the little *Edit Picture* dialogue box that appears with just two buttons on it. When you have finished drawing, click on the *Reset Picture Boundaries* icon in this box and then on the *Close Picture* button and the picture will appear on your main page. On your main page, you can control the picture size by clicking on it and using the drag handles to alter its shape. (See a couple of paragraphs on if you aren't familiar with drag handles). If you click on *Format - Object*, you can alter its properties, such as allowing the picture to be anywhere on the page. One advantage of creating a separate picture object is that you can move it around or copy it easily as a single picture.

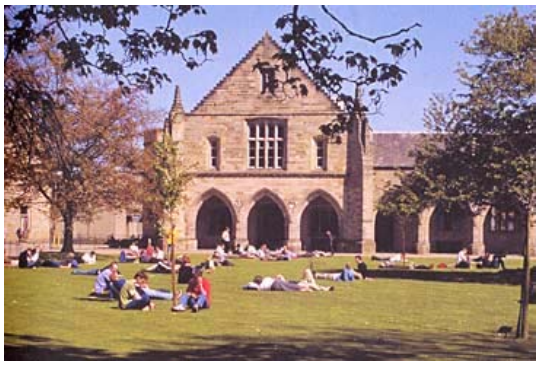
Pictures

This section tells you how to incorporate pictures into your document, re-scale a picture, re-position it and alter the spacing between the picture and the text. Inserting a pre-existing picture is easy. Use *Insert - Picture - From File* and then browse for the location of your picture.

When you have selected your file, click on *Insert***.** The picture will appear in your document. It will probably be the wrong size for what you have in mind. Click once on the picture to highlight it and little squares will appear on the sides and corners called 'drag handles'. Activate a drag handle by centring on it and sliding the mouse with the left-hand mouse button depressed. You will find that you can adjust the size of the figure.



If you wish to wrap text around the figure (so that text appears on all sides of the figure) you must do the following. Click on the picture once to highlight it, click on *Format* (between **Insert** and **Tools**), move down the menu to the bottom and click on *Picture***.** A new dialogue box will appear – (see figure right) –select *Layout***.** Click on one of the pictures in each of the rows to select the layout style. We suggest *Square*. You can also change the clearance between the text and picture using the *Advanced* button. When you have finished, click *OK***.** You will find that you can move the picture almost anywhere you like. It is a little more difficult to insert a figure caption now – you can't simply use center with a smaller letter head – instead try using *Insert* and then *Caption*.



- Minismise your Word document and open up Internet Explorer. *Right click* on the picture on the University home page and use the *Save Picture As…* option and save this in your filespace as the file *kings.jpg* for future use. [Today's web-page picture is likely to be different from the one shown on the right]. Now maximise your Word document

and insert the file *kings.jpg* where you want it. By default it is not likely to be the right size or in exactly the right place. Alter the size by clicking and using the drag handles, keeping the aspect ratio (the ratio of width to height) the same by moving a corner drag handle along a diagonal of the picture rectangle. Alter the location by using *Format* - *Object* (or *Picture* if the object is recognised) - *Layout* - *Square* - *OK* and you can now move the picture about the page.

Spell Checking

Please make sure the spell checker (nothing to do with Harry Potter) is active when you type anything for submission. Every year we get student work submitted that is spoilt by obvious misspelllings that Word could easily have flagged and corrected. Word also has quite a perceptive grammar checker. As you have been typing you may have noticed that every time you mispelled a word a thin red wavy line appeared beneath it. Sometimes if your grammar was a little suspect according to their rules, a thin green wavy line appeared to warn you. You can conduct a full spell check by pressing the **ABC** icon at the top of the screen (near the *Insert* menu button).

Printing and Previewing

Beside the spell checking icon is an icon with a picture of a piece of paper with a magnifying glass – clicking this allows you to preview your printed document at various different magnifications indicated by the % box at the top of the screen. You can also preview multiple pages at a time using the *Multiple Pages* icon that appears in print preview next to the % selcetion box. Click on this icon and run your mouse over the little images of pages. When you clock, as many pages as you have selected will appear on the screen. This is good for checking the layout of your report if it has pictures, tables and equations in it. To get back to your normal screen, click on *Close*. You can view your document in different layouts by using the *View* menu button and then selecting the view of your choice. I usually use *Print Layout*.

You can print out documents with the printer icon next to the preview icon – or by going through the File menu – *File – Print***.**

Concluding Remarks

As you can appreciate, Word can do many, many things. We haven't mentioned explicitly page numbers (*Insert* - *Page Numbers*), putting text in the header and footer regions (*View* - *Header and Footer*), altering the margins (*File* - *Page Setup*), undoing your previous edit(s) (use *Ctrl* - *z)* and other commonly useful facilities. You need to explore the menus and use the *Help* menu to expand your knowledge. However, these notes have covered a good many points and with some practice should now be able to produce a high quality document.

As you gain confidence, try exploring the many different pre-made formats that you can find in *File – New*. These are good for preparing a CV or a newsletter for a society or writing a business letter. Look at Wordart, which you can get at through the icon ***A*** at the bottom of the screen (see Fig. 2), where you can create effects as shown

left, or try compiling an index or a table of contents of your document using *Insert* then *Index and Tables***.**

Exercise 2 for assessment

Reproduce the following half-page report that includes a number of the features discussed in the pages above, namely a diagram, a table, an equation and formatted text. Include in the report your own name. As well as entering the text, you need to create the diagram, make the equation and insert and format the table. The layout need not be identical to that shown but should be a close approximation. Print off your report and hand it in to the demonstrator before you leave, or within the next week.

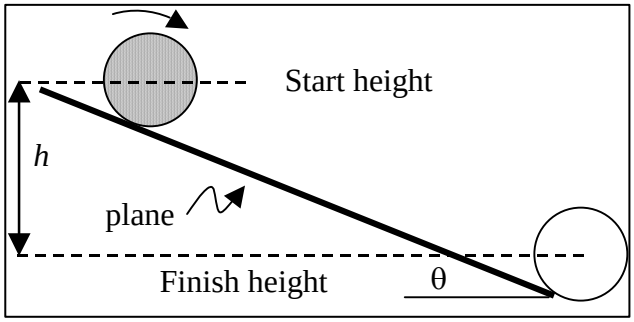
If you've skipped to here without reading all of the earlier text then you can go back and get guidance. We recommend this because there are points in the earlier text you might not know about.

The equation editor - page 8
Inserting tables - page 9
Drawing diagrams - page 10

Summary Report for PX1512

by *own name*

The experiment consisted of rolling a selection of cylinders various distances down an inclined plane so that they fell through different heights *h*. Each fall was timed. See the adjacent diagram.



The plane was set at a fixed angle of tilt of θ = 15°. The time, *t*, for a cylinder to roll down through the height *h* is expected to obey the equation:

$$t = \left[\frac{3h}{g \sin^2 \theta} \right]^{1/2} .$$

The results are summarised in the table below. Each time shown is the average of 5 trials at the given height.

Material	**Height *h* in mm**	**Time *t* in s**
Aluminium	300	1.20
Aluminium	400	1.35
Aluminium	500	1.59
Brass	300	1.17
Brass	500	1.55

PX1512 Excel

Introduction

Excel is a **spreadsheet** package. It allows you to present numerical data in a format suitable for inclusion in documents and it also enables you to perform calculations either on data or using equations and algorithms. Some typical examples of where you might use it are: to tabulate experimental results, perform calculations on them and plot graphs of results; to display numerical results produced by equations; to create balance sheets or accounts, to make inventories, and so on. Excel can be used to draw graphs (including three dimensional graphs), histograms, pi-charts and other diagrams. Automatic processing of Excel commands can be programmed.

To access Excel, login to a classroom PC and you should find the *Excel 2003* icon on the desktop. Otherwise go to *Common Applications - Microsoft Office 2003*.

This lab concentrates on three uses of Excel - namely **representing results graphically, mathematical evaluation,** and the data analysis task of **finding the best line that goes through a set of roughly linear data** (this is known as **regression**). This exercise assumes a basic knowledge of Excel. In particular, we assume that you know about:

- The appearance and functionality of the Excel window;
- Referencing cells, e.g. A1, and the difference between A1 and A1;
- Entering equations that involve cell references, e.g. =A1 + B1;
- Using functions from the Excel library, such as AVERAGE, STANDARD DEVIATION, etc.;
- Copying cell contents and the use of the 'fill handle' (the little black square at the bottom right of a cell) for row or column copying and filling;
- Formatting cells, including merging cells and putting borders around cells and groups of cells;
- Saving your work and printing selected areas of a spreadsheet.

Check out this list. If you're not sure about any of the items mentioned, ask the demonstrator at an appropriate time.

Exercises for assessment

Unlike the preceding Word section of these notes, in this Excel exercise you are expected to go through all the examples. What you hand in is a Word document of a couple of pages with some of the plots you have made pasted in. Organise your work like this:

- Open a new Word document and give it the title **Excel Exercise for PX1512** and underneath it put *by (your own name)* and add the date.

- For the first paragraph write the words "Daily temperature fluctuations" and then paste in a copy of the graph you have drawn that matches the second one shown on page 17.

- Head the next paragraph "Saturation vapour pressure of water" and paste in a copy of your version of the graph on page 18.

- Likewise for two further paragraphs headed "Wind chill", with the graph on page 19, and finally "Calibration graph" with the graph on page 21, only with the addition of the trendline and equation. The document should cover 2 pages. Print it out and hand it to the demonstrator, either on the day of the lab or no later than next week's lab. No submission, no mark.

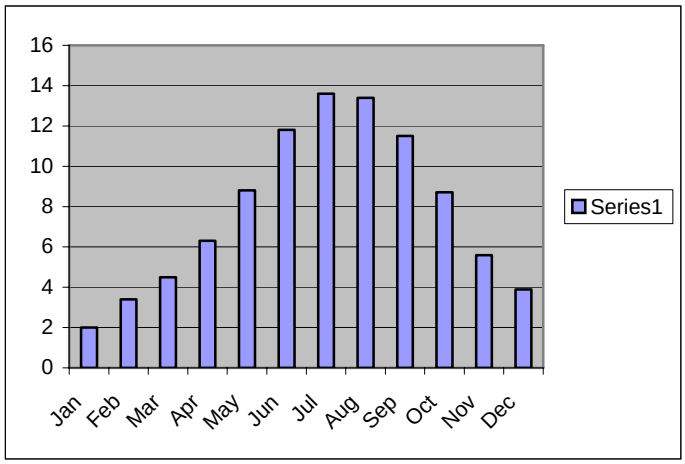
Plotting Functions

Excel has a wide range of plotting functions and there is no doubt that presenting data visually in a report is often more instructive than presenting it in tabular form. Files for this exercise have been made accessible from the class web page. Copy any files needed into your own file space by following this example.

1. Open your web browser (assumed IE) and go to our meteorology home page.
2. Locate the *Computing lab* link in the blue box on the left and *click* on it to take you to http://www.abdn.ac.uk/physics/meteo/complab.html.
3. Put the cursor over the words 'Aberdeen annual temperatures' and *right click* to raise the options menu from which you select *Save Target As...*
4. You will then get a dialogue box that asks you where in your file space you want to put the file *abdntemps.xls*. Choose a directory ('folder' is an equivalent description) to download the file into your own file space.
5. Minimise the IE browser and go to the directory where you have put your file. Finally, click on the file to open it in Excel.

I shouldn't have said 'finally' because that's the beginning of the exercise, just loading your data.

A bar graph



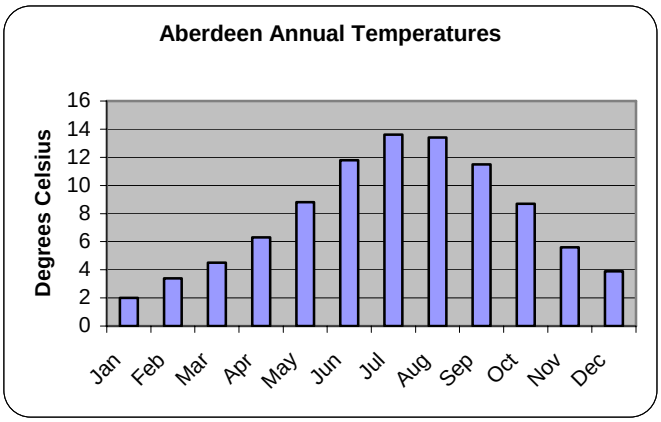
To plot the data you have just downloaded as a bar graph, highlight the data and choose *Insert - Chart - Column - Next - Finish* and the graph appears. You should get something like the picture here. (There may be a toolbar icon for *Insert - Chart*.)

Notice that **Excel plots the first row along the *x*-axis** and the second along the *y*-axis. It uses the month names as x-axis labels. This plot is not quite good enough for any report of yours. It lacks a title, the *y-axis* isn't labelled, etc. Let's tidy it up.

1. Click on the legend 'Series 1' and hit the *delete* key to get rid of it. This operation also selects the chart.
2. Click the *Chart* menu and then *Chart Options*. Select the *Titles* tab and enter a main title of *Aberdeen Annual Temperatures* and a (Y) axis title of *Degrees Celsius*. Then *OK*.

The Excel philosophy is that if you double click on a part of a chart or graph you will raise a context sensitive dialogue box that allows you to edit that bit. You can now edit the titles (e.g. changing their font, or the colour of their text), or the bars, or the background, any other part. The drag handles around the chart allow you to alter its size. Sliding the mouse while holding down the left button with the mouse pointer over the chart moves the chart around on your spreadsheet.

3. Try this editing technique by *double clicking* on the white area just inside the border. In the dialogue box that appears, tick the *Round corners* box - *OK*. I like round corners on plots. Your chart should now be like the one shown here. You can pause to look at the meteorological information on the chart, which is correct.



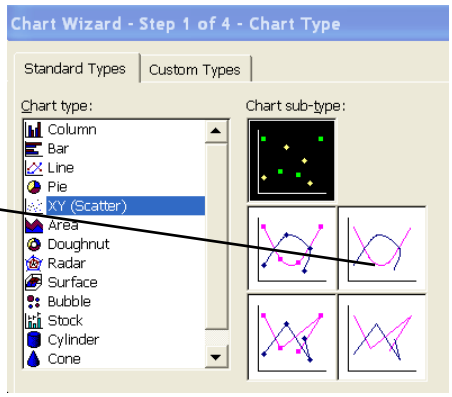
Notice that when you selected *Column* as the graph type there were various options available, shown by pictures on the right. The example here is the default option, namely the first one. It's the simplest kind but also the easiest for anyone to use who wants to read the actual numbers against the y-axis. You might choose another option for a 'glossy brochure' that was intended to convey impact but not be a source of precise numbers. Try a few of the other column options to see what they look like. It won't take long.

Scatterplots

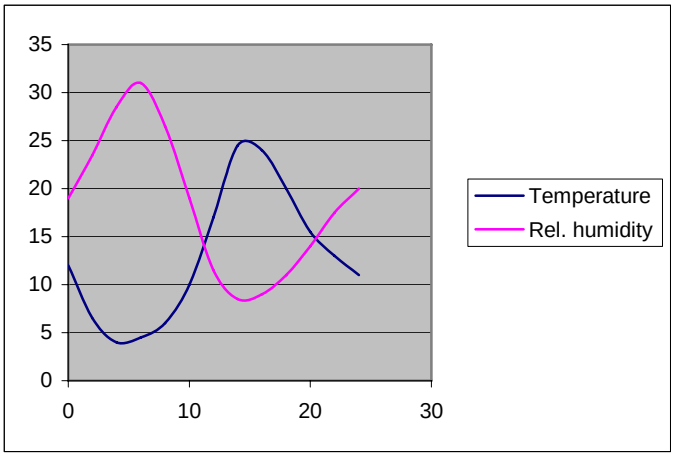
The most common way of presenting data in science is to use what just used to be called 'a graph' but which Excel refers to as a *Scatterplot*. This is simply a plot of one quantity against another, say *y* against *x*, when you are given a selection of pairs of values (*x*,*y*). Excel is often introduced in a management and business context where bar-charts, pi-charts, histograms and other ways of plotting regular data are shown, but scatterplots are left unexplained. In any science, you need to be confident about drawing scatterplots.

The following exercise will draw a graph like that found in fig. 5.13 of the meteorology textbook.

1. Copy the file *dailytemps.xls* from the computing lab web-page, as described above, and open it.
2. *Select* columns A, B and C. Start the chart wizard using *Insert - Chart* and under the *Standard Types* tab select *XY (Scatter)*, then under *Chart Sub-type* select the kind with no data points shown. The reason for this particular selection is that the graph is illustrative and there is no significance in the particular data values and hence there is no need to highlight them with a symbol. *Finish*. You will get a graph like the one on the next page. It needs prettying up, as usual.

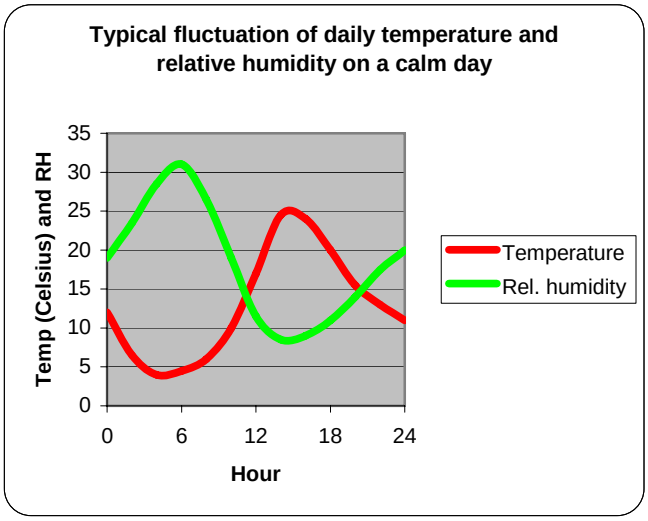


3. a. Highlight the chart and then use the *Chart* menu - *Chart Options* dialogue box to add a title *Typical fluctuation of daily temperature and relative humidity on a calm day*; an x-axis label of *Hour* and a y-axis label of *Temp (Celsius) & RH*.



b. *Select the chart* and stretch it vertically a bit

c. Using the double clicking technique mentioned in the last section, *double click* on the x-axis scale to raise the *Format Axis* dialogue box and select the *Scale* tab and alter the range of values to run from 0 to 24 in steps of 6.



d. *Double click* on the plotted temperature line and raise the *Format Data Series* dialogue box. In the 'line' section of the box (left-hand side), alter the 'color' to red and increase the width of the line. *OK*. In the same way, change the relative humidity line to a thicker, green line. Notice that the legend changes line styles in sympathy with your changes.

e. *Finally* give the outer box round corners and the result should look like the plot above. Copy it and paste into your Word page, as requested.

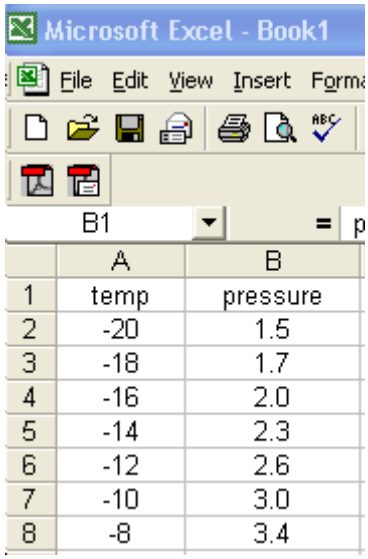
Excel always chooses the first column in your selection as the default x-axis. There are at several ways around this. You can order your columns so that the x-axis **is** the left-most column selected, by copying the x-axis data and putting in a new column on the left if necessary. This sounds a bit cumbersome but is a quick option. Alternatively, after you have selected the chart type (scatterplot), at step 2 of the chart wizard click on the *Series* tab and edit the x-axis and y-axis ranges selected for each column plotted. If you have already plotted the graph wrongly, then *select* the chart, click on the *Chart* icon on the toolbar and select *Source Data*, which gives you the *Source Data* dialogue box. Now select the *Series* tab, whereupon you will be able to edit the data used for the *x* and *y* directions at will, as just described.

Plotting a calculated curve

Suppose you need to know the saturation vapour pressure of water but haven't got access to any values. However, you remember the facts that at 0°C the value is 6 mbar and the pressure approximately doubles every 10 K. These 2 facts tell you that you can represent the required

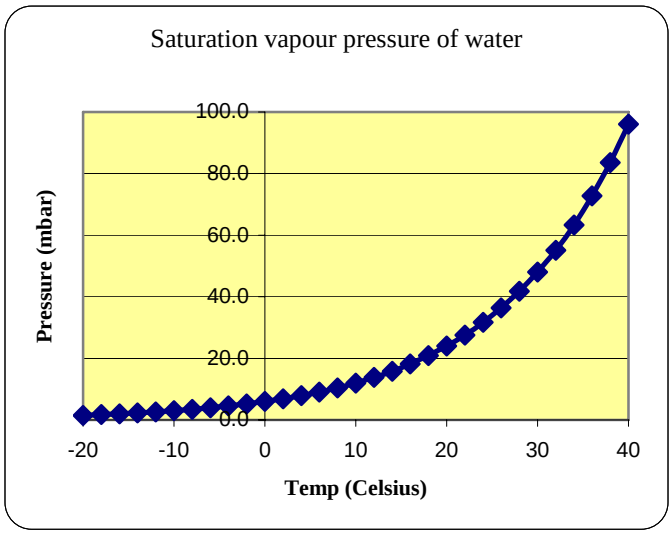
pressure P by the relationship $P = 6\times2^{T/10}$. This is enough to let you calculate the saturation vapour pressure over a range of temperatures. Let's choose -20°C to 40°C.

- Open Excel and head columns A and B with the words "temp" and "pressure". Put the values –20 in cell A2 and –18 in cell A3. Highlight cells A2 and A3 and put your cursor on the fill handle in the lower right of the highlighted rectangle. Now drag the fill handle down and it will automatically fill in column A for as long as you go with values increasing by 2 degrees in each cell. Stop at 40°C.
- Set cell B2 as "=6*2^(A2/10)". Don't put the quotes in, just the rest. Notice the use of the carat key (shift 6) to represent powers in Excel. Now highlight cell B2 and use the drag handle to run the formula down all the rows that have temperatures. The start of the spreadsheet should now look like the picture on the right.



	A	B
1	temp	pressure
2	-20	1.5
3	-18	1.7
4	-16	2.0
5	-14	2.3
6	-12	2.6
7	-10	3.0
8	-8	3.4

- You now have pairs of points in columns A and B that you want to graph (i.e. make a scatterplot). Use the same method as in the previous example to produce a properly labelled graph, like the one shown on the right. In particular, this graph has a caption and labels on the axes in 12 pt Times New Roman. The line thickness and background colour has been altered, as has the aspect ratio (the ratio of height to width). The background has been set to light yellow in my version, which contrasts well with blue diamonds but these colours don't show in a black & white copy.



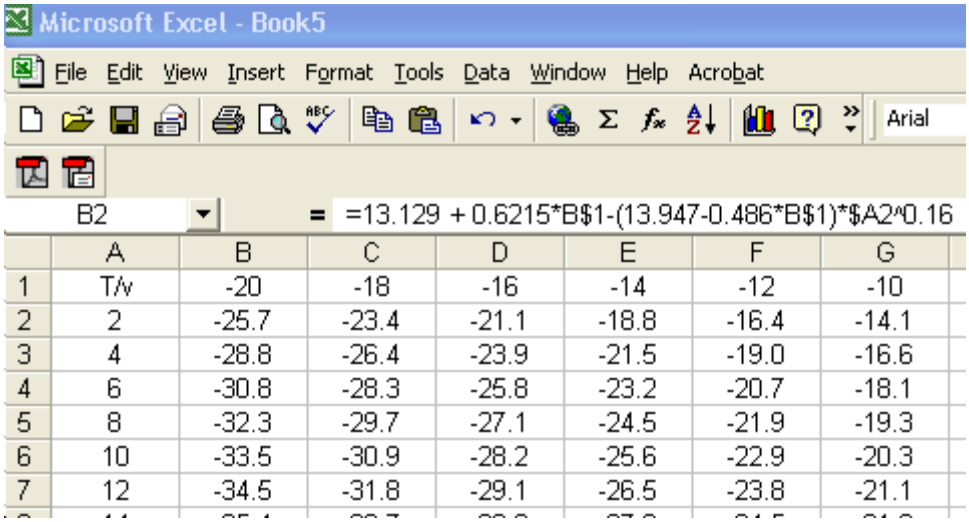
Two Dimensional Functions

It's quite common to want to know how something varies when it depends on two separate quantities. The example we're going to look at is 'wind chill'. Wind chill is the temperature that you feel on your skin when there is a wind blowing. It depends on the air temperature, T, **and** the wind speed, v. I've looked up an expression that will let us calculate the wind chill temperature, call it W, given the two factors T and v. The expression works for a reasonable range of temperatures and wind speeds equal to or greater than 2 m s^{-1}. It is:

$$W = 13.129 + 0.6215T - (13.947 - 0.486T)v^{0.16}$$

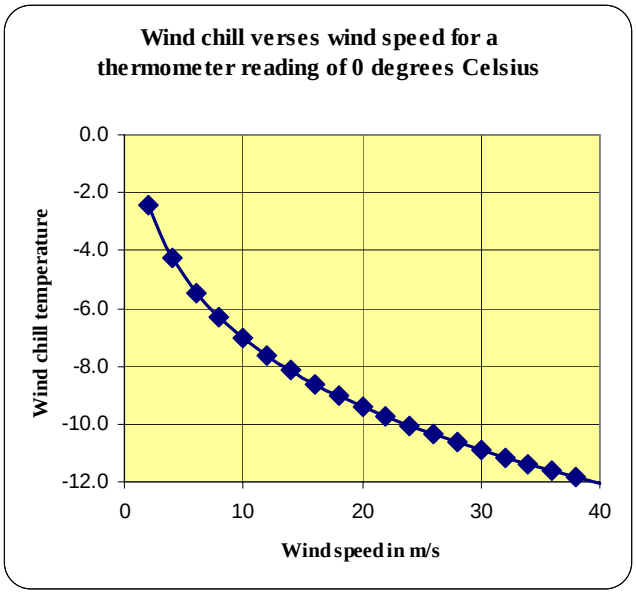
We're going to generate a table of the wind chill from -20°C to +10°C for wind speeds from 2 to 40 m s^{-1}.

- Open a new Excel sheet. Enter T/v in cell A1 as a heading to indicate that increasing temperatures are going to be along a row and increasing wind speeds down a column. This will be clear when you look at a section of the spreadsheet shown below.



	A	B	C	D	E	F	G
1	T/v	-20	-18	-16	-14	-12	-10
2	2	-25.7	-23.4	-21.1	-18.8	-16.4	-14.1
3	4	-28.8	-26.4	-23.9	-21.5	-19.0	-16.6
4	6	-30.8	-28.3	-25.8	-23.2	-20.7	-18.1
5	8	-32.3	-29.7	-27.1	-24.5	-21.9	-19.3
6	10	-33.5	-30.9	-28.2	-25.6	-22.9	-20.3
7	12	-34.5	-31.8	-29.1	-26.5	-23.8	-21.1

- Now enter the range of wind speeds down column A by putting the value 2 in A2, 4 in A3, selecting both A2 and A3 and using the fill handle to complete the column up to A21 which should have the value 40 in it. Repeat the process for row 1, starting with the value –20 in B1, -18 in C1 and using the selection and drag handle to fill the row up until Q1, which should have the value 10.
- Fortunately you will only have to type the formula above into one cell. In cell B2 type =13.129 + 0.6215*B$1-(13.947-0.486*B$1)*$A2^0.16 . Notice the use of the $ symbol. This will prevent the running index after the $ from changing when you drag the formula across the other cells and ensure that all the entries in a given column refer to the same temperature (that's the $1 at work) and all the entries in a given row refer to the same speed (the $A at work).
- Now get hold of the fill handle for B2 and drag it down to cell B21, filling in the first column. Grab the handle again with B2 to B21 selected and slide it across to column Q to complete the table. The top left of the table is reproduced here. Use the centre justify button to centre the entries for the whole table and the decimal place adjust button to reduce the number of decimal places to 1, which is all the formula merits.



Now we will use the scatterplot again to make a plot of wind chill verses wind speed for a thermometer temperature of 0°C. The extra point here is that the two columns you want to plot aren't adjacent. Select the data in cells A2 to A21. Now hold down the ctrl key and select the data in cells L2 to L21. You have successfully selected data to plot in non-adjacent columns. Now use your scatterplot skill to make a graph like the one shown on the previous page. The diagram has been reduced in size but note that the words are in Times New Roman, the font size 12 pt for the axes labels and 14 point for the title. The curve has been thickened, the vertical height stretched and the default background lightened (to pale yellow). The axes ranges have been tidied up and the wind speed labelling has been moved from its default at the y value of zero to the y value of –12. This last operation is done from the y axis dialogue box.

Data Analysis

In order to use the Data Analysis software you may find that you first need to click on the *Tools* menu - go down and select *Add-Ins* then select *Analysis Toolpak.* The whole procedure takes about 30 seconds to install the software - so be patient. After this, in order to use one of the Data Analysis tools **once you have selected some data**, simply click on *Tools* and select *Data analysis*. If you click on *Tools* without any data selected, then the Data Analysis option may not appear.

There are many data analysis tools in Excel. We shall look at two.

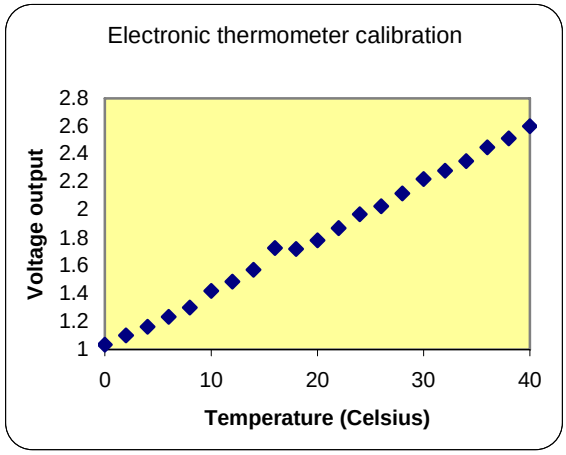
Regression Analysis

Regression is what you do when you find the best smooth curve to represent a set of points that are dotted around a bit. This fitting means taking a function that has constants in it and finding the best values for the constants so that the resulting function runs through the points in a way that 'best fits' the data. The most common kind of regression is called **linear regression** in which the constants just appear linearly. Thus in the expression $y = ax^2 + bx + c$ that might represent a curve through a set of points, the value of y depends linearly on a, b and c, the unknown constants, and hence linear regression is what you need to determine the appropriate values of a, b and c.

Excel has limited but useful regression facilities. It can fit polynomials through data and in particular a straight line through a set of points, the line being represented by $y = ax + b$. In Excel jargon, this line is called a **trendline.** This section of the notes shows two ways of finding the trendline. The first very simple way can write the trendline equation on your graph. The second way gives you more detailed statistics associated with the trendline. First we need some data.

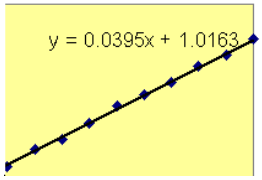
- Open the file *calib.xls* that is with the other files on the web page as described earlier. This file contains the results of calibrating an electronic thermometer against a 'gold standard' thermometer that was the best available at the time. The first column represents temperature readings (from the thermometer) and the second the voltage output of the electronic thermometer recorded on a voltmeter that read to mV. The task

is to find the best straight line that represents this data and the uncertainties in the parameters of that line.

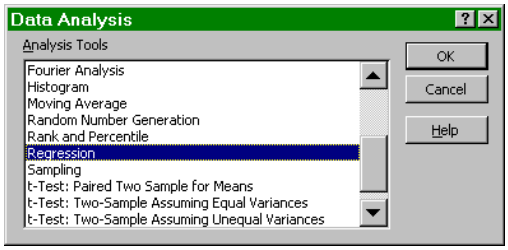


- Now make a scatterplot of the data, which should look like the picture here.

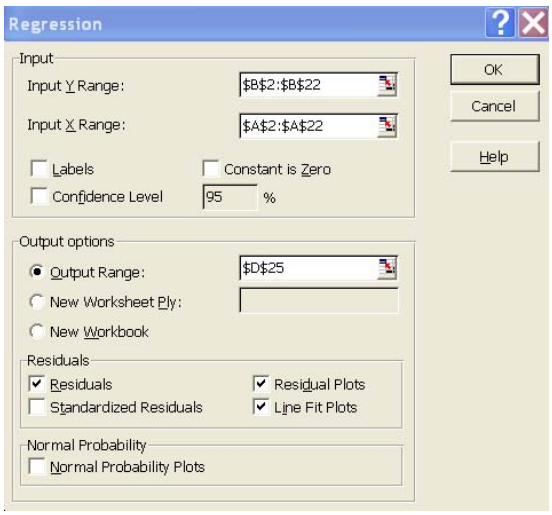
- To find the trendline, first click on a data point on the graph. On the *Chart* menu select *Add Trendline* and this will throw up the *Add Trendline* dialogue box. In this box under the *Type* tab select *Linear* and then click on the *Options* tab and tick *Display equation on chart*. Finally, click on *OK*. The equation should now appear and the trendline should be drawn in. The top right hand section of the graph should now look like the image shown on the right here. You can see that the line fits the data quite well and it has the equation $y = 0.0395x + 1.0163$. In our context, the y values are voltage outputs and the x values the temperatures. The slope of the graph gives the sensitivity of the electronic thermometer, namely 0.0395 volts per degree. You can move the equation about on the graph.



The advantage of using a computer to calculate the regression equation is that you can get a whole lot more statistics at the same time that may let you extract more information from your data. This fuller information is found by using the Data Analysis pack explicitly to make the regression. Highlight a cell on the spreadsheet and under the *Tools* menu select *Data Analysis* to raise the menu shown here. Select *Regression*. You now get the quite complicated *Regression* dialogue box. This is how I fill it in.



- Click the *Input Y range* box to make sure the cursor is flashing there. Now select the y values on your spreadsheet, namely B2 to B22 in this exercise. When you release the mouse button the range will be transferred into the box. Similarly, click on the *Input X range* box and then select the x data running from A2 to A22.
- For the *Output options* select *Output Range*, click on the white box to the right and then on a cell where you'd like the regression output to start. I have chosen D25
- Finally, select *Residuals*, *Residual Plots* and *Line Fit Plots* to produce three optional pieces of supplementary output.



You now get 3 tables of output and two graphs for your money. Lets look briefly at all this. The first table is headed SUMMARY OUTPUT. You can ignore this.

The next table is headed ANOVA, which is statistical jargon for '**an**alysis **of** **va**riance'. There is some useful information here. The second sub-table of information starts Coefficients, etc., as in the illustration above. I would personally tidy up the table if I were going to keep it by reducing the number of decimal places shown and centring the information in the cells, but that's a personal preference. More importantly, the *Standard Error* column shows the random errors in the two parameters you have found in the regression, worked out on the assumption that the deviations of your data from the line represent the random errors in your data. Hence the calibration figure of 0.0395 volts per degree is known to ±0.0004. The constant 1.0163 is known to ±0.0096, which is effectively ±0.01. For the statistically knowledgeable, these ± values are 1 standard error or, if you like, one standard deviation in the distribution of the constants. The next column showing the *t Stat* is the reciprocal of the fractional accuracy with which you know the constants. 100/(*t Stat* value) gives you the % accuracy. Thus 100/96 (≈1%) tells you that the figure of 0.0395 for the calibration constant is known to 1%. The next column tells you the probability that the values you have found differ from zero just due to random sampling. The probabilities are negligible in this example but sometimes they can tell you that an intercept or slope you have a number for isn't really significantly different from zero.

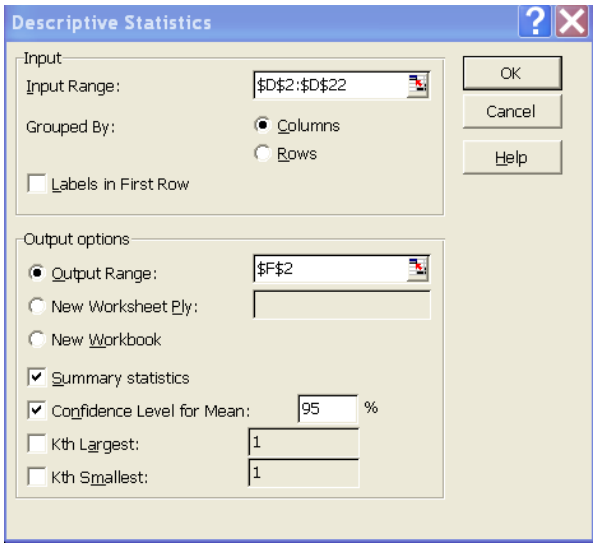
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.01629004	0.009615537	105.6925	8.74E-28
X Variable	0.03951883	0.000411256	96.09302	5.32E-27

The RESIDUAL OUTPUT table lists the *y* values given by the trendline for the given x values and also the difference between each of these values and your initial data values. These differences are called the *Residuals*. This may be useful information. You can see looking down the residuals that the 9th observation differs much more from the trendline than any other point. You can see this even more easily by looking at the graphs. One shows the plot of the residuals against the x values. The residuals aren't quite spread around at random as much as you might expect so you might be tempted in real life to look and see if your calibration had some systematic defects in the procedure. The second plot shows the given data and the predicted values from the trendline. You already have this from the trendline exercise above but you could alternatively get the same graph by knocking this one into shape. The labelling of these graphs needs improving, they need stretching and the scales need tweaking if you were going to keep them.

Being able to find the regression statistics is very useful and if you are analysing data 'for real' in future, remember to do this.

Descriptive Statistics Function

This is a useful little function. It allows you to determine quickly a deal of information about a series of numbers - values like the mean, the standard deviation, the median, the mode, etc.



We'll try this on the figures in column D of the calibration spreadsheet (which are actually the residuals from the previous fitting exercise). Once again, go into the *Tools* menu, select *Data Analysis* and then select *Descriptive Statistics*. Choose the input range by clicking on the *Input Range* box and then highlighting the data (in this case the D2 to D22). Select *Output Range* and then click on the white box to the right and then a spreadsheet cell where you want the results to start appearing. Tick *Summary statistics* and *Confidence Level for Mean* and, finally, *OK*. You will then get the descriptive statistics shown below.

Column1	
Mean	0
Standard Error	0.004854
Median	-0.00352
Mode	#N/A
Standard Deviation	0.022246
Sample Variance	0.000495
Kurtosis	7.467604
Skewness	2.175335
Range	0.110849
Minimum	-0.03244
Maximum	0.078409
Sum	0
Count	21
Confidence Level(95.0%)	0.010126

You can see that the mean is zero, which is one of the criteria for the 'best fit' regression line. The standard deviation tells you that on average the measured voltages differ from the trendline by 22 mV. The skewness term suggests that the residual distribution is leaning towards negative values and the kurtosis that it is not a normal distribution. However, all this gets us into statistical interpretation, which isn't part of the lab.

Conclusion

You should now be pretty good at basic scatterplots. It is easy to plot more than one quantity on a graph, if need be. Regression is a very useful tool to know about and one that is often used to find a trend in data that is much more spread around than our calibration line, which is an example of 'very good' data that lies tightly around a line.

JSR

Astronomy Assessed Assignment

Letter from Afar

Imagine yourself living on another planet or moon in our solar system in the year 2109. Assume that you live in environmentally protected quarters but from time to time have to venture outside on missions. Write a 1-page letter home (Dear...) describing life as you find it.

You should look up the textbook or web pages to find the physical conditions at your chosen base, such as gravity, temperature, atmosphere (if any), nature of the surface, distance from the Sun and so on. Make notes. Locate the names of some real places, if your planet or moon has been named. Look for further details of your location on the web, using as a start our astronomy course links page or sites of your own choice. (Our page: http://www.abdn.ac.uk/physics/astro/astlinks.html).

Here are some issues you can address. There won't be room to cover them all.

- What are you there for? (everyone should say something about this)
- What is your job in the team? (ditto)
- Who went with you or is living with you?
- How are you coping with the problem of staying with the same people all the time in cramped conditions?
- What is your food source?
- How is water obtained?
- What do you do in your free time?
- Is there any entertainment?
- What do you miss most from home?
- How is electricity generated?
- How much natural light is there?
- How are you protected from the local conditions of temperature, pressure (or near vacuum) and composition of any atmosphere?
- How do you get around?
- What effect does reduced gravity have?
- What protection have you from the Sun's UV and high energy solar particles?
- For long-term missions, how is sustainability maintained or planned for?

Send your letter via e-mail as a **Word attachment in .doc format** to homebase, aka p.bonifacio@abdn..ac.uk with the words 'letter from afar' as the e-mail subject. Length: 1 A4 page, 12 pt Times New Roman (interplanetary e-mails are expensive!). **Include your full name somewhere on the document**. Assessment will be based on the factual accuracy of what you say about your site (judged against today's knowledge!), the plausibility of your reason for being there and the imaginative content of your letter. Remember that there are serious survival problems everywhere in the solar system except on Earth - too hot, too cold, no atmosphere, no water, no indigenous food, etc. The final two computing session have been reserved for this activity so you can be sure of a reserved seat at a terminal and scheduled time to do it. That will give you four hours, which should be plenty. You can do this exercise outside the classroom if you prefer. Everyone is recommended to obtain **confirmation that your message has been received and read** for this and any other exercise sent as class-work by e-mail. Most other mailers have an equivalent function.

At the first session you should at least choose a place and make notes about conditions there, thinking about what you might tell your recipient. **You should aim to e-mail the letter by the end of the final session, although the absolute deadline isn't until a week later**. Are you seeing red over your mission, having a jovial time or a titanic struggle? I may put the best ones on a page on the web, linked from the astronomy homepage.

Footnote: If you plan to be at one of the 'gas giants' then you can't land on a solid surface and you can't gravitationally orbit the planet within the atmosphere. The reason is that the orbital speed at the distance of the outer atmosphere is much greater than the rotational speed of the atmosphere and hence atmospheric drag would slow you down, heat you up and gravity would pull you inwards, trying to speed you up as it did so. The result: cinders floating in the atmosphere. This is the same reason why Earth satellites must orbit outside our atmosphere. You can find out more about how satellites and orbits work in our level 2 *Space Science and Remote Sensing* course. What you can do at the gas giants is float in their atmosphere if the density of your capsule, bubble, module or whatever is made equal to the density of the atmosphere outside. Then you will just circulate around the planet with the atmosphere around you, like a balloon. Alternatively, you can land on one of the many moons of the gas giants.

JSR