

Task 3 — More about Charting

The third task gives further details about charting. In particular some of the many ways in which the appearance of a chart can be improved are explained. On the down-side, some limitations are noted too.

Outline Requirements

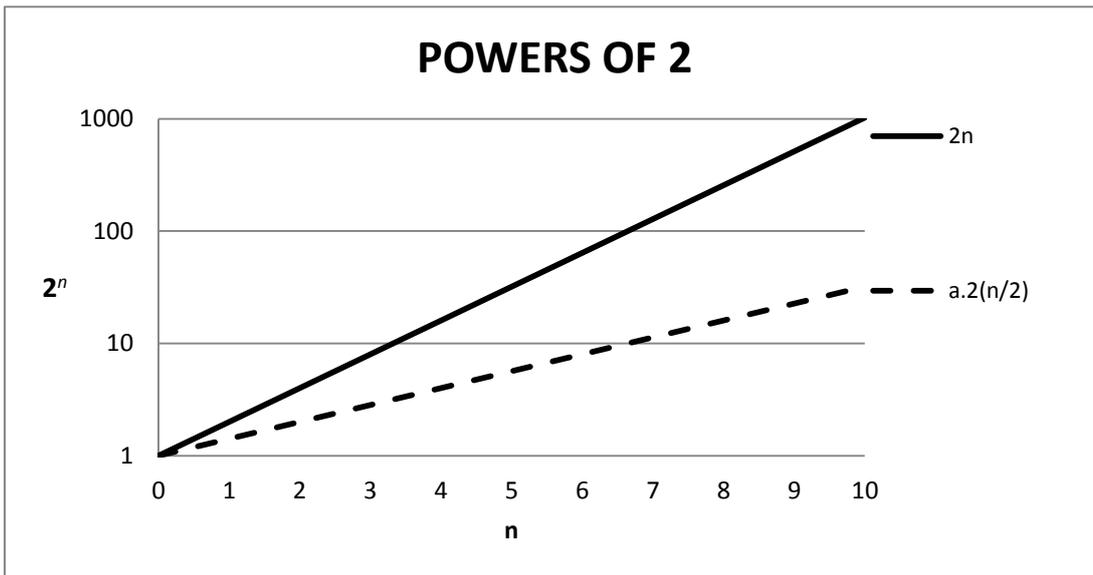
1. Log in to a MCS workstation.
2. Set up, in the Maths folder, an Excel file Powers.xls which contains a single worksheet with an embedded chart whose appearance is roughly as shown overleaf.
3. Use Fill ▾ Series... (Editing group of the Home tab) to set up the first two columns. [Page 3.3 *et seq.*]
4. Use Create from Selection (Defined Names group of the Formulas tab) to associate the name **a** with the value 1. [Page 3.16]
5. Print the result and show the hard-copy to a demonstrator.
6. Work through problem 4: the Bacterial Growth problem.
7. Note the results of the experiments suggested at the end of problem 4.

Check-List

The demonstrator will have the following questions in mind when inspecting your work:

1. Are the four columns of information centred over the embedded chart?
2. Is the entire worksheet centred horizontally?
3. Are the headings right aligned?
4. Are the superscripts in the headings and in the chart as overleaf? [Pages 3.4 and 3.13]
5. Are there always two places shown after decimal points? [Page 3.14]
6. What formula gives rise to the value 1.00? [Page 3.17]
7. Have the tick marks been removed from both axes? [Page 3.9 *et seq.*]
8. Does the chart contain two data series, one shown as a solid line and the other shown as a broken line? [Page 3.14 *et seq.*]
9. Do the two lines in the legend approximately align with the end points of the two data series? [Page 3.15]
10. Are the labels in the legend as overleaf (and so not very satisfactory!)? [Page 3.17 *et seq.*]
11. What happens to the broken line when the value associated with **a** is changed from 1 to 4, then 10, then 32, then 100, then 0.1 in turn? [Page 3.17]
12. Is there a footer showing your name and College?

n	2^n	$a \cdot 2^{(n/2)}$	a
0	1	1.00	1
1	2	1.41	
2	4	2.00	
3	8	2.83	
4	16	4.00	
5	32	5.66	
6	64	8.00	
7	128	11.31	
8	256	16.00	
9	512	22.63	
10	1024	32.00	



Task 3 — More about Charting

Synopsis: Series. Formatting and Editing Charts. Naming Cells.

Briefing

Task 2 touched on the charting facilities available in Excel. Some more advanced facilities are introduced in this session.

Guided Practical Session

- Log in to a MCS workstation.
- Close the Message of the Day window.
- Start Excel:

 | All Programs | Spreadsheets Maths and Statistics | Microsoft Excel 2010

A Linear Series

The first illustration in this session shows a quick way of putting the values 1 to 10 into cells A1 to A10. Such a sequence is referred to by Excel as a *Series*. Since the values increase at a uniform rate, this is a *linear* series.

- Check that A1 is the active cell. Key in 1 and click the Enter box to confirm.
- Click the Fill button in the Editing group of the Home tab and choose Series... from the sub-menu. (In future this instruction will be written “Select Fill ▾ Series...”.)

The Series dialogue box offers several options but it is simple to see what is required. The series is to be arranged in a column, it is linear and it increases by one at each step until it reaches a final value of 10. Some options are correct by default:

- Click the Columns option button under the heading Series in.
- Check that Linear is selected under Type by default.
- Check that the Step value is 1 by default.
- Click in the Stop value box and key in 10.
- Click OK. The values 1 to 10 should appear in the first *column*.

If the values appear in the first *row* you forgot to click the Columns option button.

A Growth Series

Go back a step before embarking on the second illustration:

- Click the Undo button () on the Quick Access Toolbar at the top of the Excel window. All but cell A1 should be cleared.
- Check that A1 is the active cell and has the value 1.
- Drag from cell A1 to cell A11 to select the first *eleven* cells in column A.
- Select Fill ▾ Series...
- Check that the Columns option is still selected and for this second illustration...

- Click the Growth option button under Type.
- Change the Step value to 2. Leave the Stop value blank.

With a linear series, a step value of 2 would mean that the values increased by 2 at each step as in 1,3,5,7,... With Growth selected the values are *multiplied* by 2 at each step as in 1,2,4,8,...

There are two ways of determining how far a series will run. You can *either* specify an explicit Stop value *or* you can select a range of cells to be filled before you embark on the Fill ▾ Series... command.

Given, this time, that the range A1:A11 has been selected, the doubling will continue until a value has been calculated for cell A11:

- Click OK and the series appears in the first 11 cells in column A. These values are powers of 2 running from 1 (2^0) to 1024 (2^{10}) so 2^n will be used as a heading...
- Click row label 1 to select the whole of row 1.
- With the pointer somewhere in this row, click the *right-hand* mouse button.
- From the pop-up menu choose Insert. A blank row appears at the top.
- Make A1 the active cell and key 2^n (we'll convert this to 2^n in a moment) into this cell. Click the Enter box to confirm and then click the Align Text Right button () in the Alignment group of the Home tab to align 2^n with the values below it.

To turn 2^n into 2^n takes two steps: n is made italic and then made a superscript...

- Check that A1 is still the active cell and *in the Formula Bar* drag across the letter n only. This selects the letter n as can be seen by the highlighting.
- With the n selected, click the Format button in the Cells group of the Home tab and choose Format Cells... Note the Font style heading in the Format Cells dialogue box.
- Click Italic in the list box under Font style.
- Click the Superscript checkbox under Effects.
- Click OK and then click the Enter box to complete the process. You should see something like 2^n in cell A1 (but the version in the Formula Bar is unchanged).
- Click the  button in the Font group of the Home tab to make the heading bold.

A Graph

The powers of two can be plotted on a graph:

- Select the range A1:A12 (include the heading).
- Click the word Insert in the list of tabs at the top of the Ribbon to change to the Insert tab:



- Click the Line button  in the Charts group on the Insert tab.

- From the sub-menu that appears click on the *first entry of the second row* under 2-D Line:



(This is described as Line with Markers.)

Excel inserts a line chart into the worksheet and selects the chart. (Note also that a series of Chart Tools tabs have been added to the Ribbon.) There are a couple of problems with this chart, however:

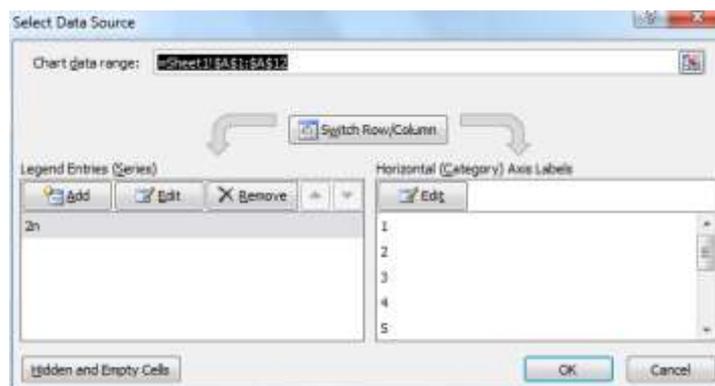
1. The vertical scale has to accommodate values up to 1024 even though the majority of the values plotted are less than a tenth of this maximum. The left-hand half of the plot is not very useful. A logarithmic plot would be better and this alternative will be explored shortly.
2. The numbers against the horizontal axis are not very sensible. You should be able to read 1 to 11 (though 10 may be missing its second digit). Since the series runs from 2^0 to 2^{10} it would be better if the labels ran from 0 to 10.

The sensible way to proceed now is to see whether we can alter the chart's Design or Layout to produce a more useful chart:

- On the Layout tab from the Chart Tools tabs, click the Axes button in the Axes group. (You will probably have to click on the word Layout at the top of the Ribbon to bring up the Layout tab.) This will produce a sub-menu.
- Click on Primary Vertical Axis ► on the sub-menu and choose Show Axis with Log scale. The chart changes to a straight line plot, which is what you should expect.

The chart now looks better but there is still the problem with the numbers against the horizontal axis. Before dealing with this issue, it is instructive to explore where the chart gets its data from, in case you ever need to change this:

- Click on the word Design at the top of the Ribbon to bring up the Design tab, then click the Select Data button in the Data group on that tab. The Select Data Source dialogue box is displayed:



Below the Chart data range: box you should see a box headed Legend Entries (Series) and another headed Horizontal (Category) Axis Labels as in the picture above. If not, click the  icon at the far right of the Chart data range: box and these should appear.

- Under Legend Entries (Series) click on the Edit button. This will bring up the Edit Series dialogue box.

In the **Edit Series** dialogue box, the **Series name** text box shows that the name of the chart has been taken from cell **Sheet1!\$A\$1** and the **Series values** text box shows that the values have been taken from the range **Sheet1!\$A\$2:\$A\$12\$**.

- Now click the **Cancel** button to return to the **Select Data Source** dialogue box.
- Under **Horizontal (Category) Axis Labels** click on the **Edit** button. This will bring up the **Axis Labels** dialogue box.

The **Axis Labels** dialogue box shows where the **Horizontal (Category) Axis Labels** (i.e. the labels for the points on the x -axis of the chart) have come from and this box is blank. This matter will be attended to later.

- Now click the **Cancel** button to return to the **Select Data Source** dialogue box.
- Click the **Cancel** button again to get rid of the **Select Data Source** dialogue box.

We need to change the chart's title and it would be useful to add titles to the horizontal and vertical (x - and y -) axes. First let's change the chart's title:

- Click on the chart title (currently **2n**) shown on screen. You should find that a box has appeared around the title. Move the mouse cursor over this box until it changes into a vertical line and then click on the box. You should now be able to edit the chart title.
- Change **2n** to **POWERS OF TWO**. When you've finished editing the title click anywhere else on the worksheet to indicate to **Excel** that you are finished and it should accept your changes.

Now let's add a title for the **Horizontal (Category) Axis** (the x -axis):

- Click on the chart. Click the **Axis Titles** button in the **Labels** group of the **Layout** tab. A sub-menu will appear. Click on **Primary Horizontal Axis Title** ► and choose **Title Below Axis** from the sub-menu. A small box with **Axis Title** in it appears below the **Horizontal (Category) Axis** (the x -axis). Move the mouse cursor over this box until it changes into a vertical line and then click on the box. You should now be able to edit the axis title.
- Change **Axis Title** to **n**. When you've finished editing the axis title click anywhere else on the worksheet to indicate to **Excel** that you are finished and it should accept your changes.

Now let's add a title for the **Vertical (Value) Axis** (the y -axis):

- Click on the chart. Click the **Axis Titles** button in the **Labels** group of the **Layout** tab. A sub-menu will appear. Click on **Primary Vertical Axis Title** ► and choose **Rotated Title** from the sub-menu. A small box with **Axis Title** (on its side) in it appears to the left of the **Vertical (Value) Axis** (the y -axis). Move the mouse cursor over this box until it changes into a vertical line and then click on the box. You should now be able to edit the axis title.
- Change **Axis Title** to **2n** (which will eventually be converted to 2^n). When you've finished editing the axis title click anywhere else on the worksheet to indicate to **Excel** that you are finished and it should accept your changes.

Next let's take a look at some of the other buttons on the **Layout** tab:

- Click on the chart. Click the **Axes** button in the **Axes** group of the **Layout** tab. Click on **Primary Horizontal Axis** ► on the sub-menu and choose **None**. Notice that the numbers

against the horizontal (x -) axis disappear, as does the axis itself. Click the Undo button (↶) on the Quick Access Toolbar at the top of the Excel window to undo this change.

- Once again click the Axes button in the Axes group of the Layout tab. Click on Primary Vertical Axis ▶ on the sub-menu and choose None. Notice that the numbers against the vertical (y -) axis disappear, as does the axis itself. Click the Undo button (↶) on the Quick Access Toolbar to undo this change. (Notice that there are other options you can try as well as None and you should feel free to experiment – use the Undo button (↶) to undo your changes afterwards.)
- Now click the Gridlines button in the Axes group of the Layout tab. A sub-menu allowing you to modify the Primary Horizontal Gridlines or the Primary Vertical Gridlines will appear. The *gridlines* on a chart take the form of horizontal or vertical lines which run the full width or height of the chart. At the moment there are probably no Horizontal (Category) Axis (the x -axis) gridlines but, on the Vertical (Value) Axis (the y -axis), there are Major Gridlines. You should experiment with the different options for the gridlines until you are clear what they do. Use the Undo button (↶) to undo your changes afterwards
- Click the Legend button in the Labels group of the Layout tab. Choose None from the sub-menu to make the legend disappear. (Feel free to try some of the other options before finally choosing None.)
- Now click the Data Labels button in the Labels group of the Layout tab and choose Above from the sub-menu. Notice that each marked point on the plot shows the value associated with that point above the point.
- Now click the Data Labels button again and choose More Data Label Options... In the Format Data Labels dialogue box that appears you can change many aspects of the data labels appearance. Click the Label Options category in the left hand part of the dialogue box. The right hand part of the dialogue box should now be headed Label Options. Under Label contains deselect the Value option and select the Category name option. Click the Close button. Notice that each marked point on the plot shows the (ill-chosen) value on the x -axis.
- There seems no good reason this time for having any data labels, so click the Data Labels button again and choose None.
- Now click the Data Table button in the Labels group of the Layout tab and choose Show Data Table from the sub-menu. A table appears below the x -axis showing the data in tabulated form.
- Click the Data Table button again and choose None from the sub-menu. The data table disappears.

Now move on to the last step:

- Use the drag handles on the chart border to make the chart exactly fill the region D1:K15.

This chart will be improved in several ways but first save the worksheet...

Saving the Worksheet

You can use the **Save** button () in the Quick Access Toolbar with a new workbook because Excel will automatically behave as though the **Save As...** command had been given:

- Click the **Save** button () in the Quick Access Toolbar. The list box in the **Save As** dialogue box shows your top-level folders including **Notes**.
- Double-click the **Notes** folder and check that the list box shows the folders contained in **Notes** including **Maths**.
- Double-click the **Maths** folder. It is likely that no files are shown in the list box because you probably have no **Excel** files in the **Math** folder yet.
- In the **Save as type** list box choose **Excel 97-2003 Workbook**.

The native file format of **Excel 2010 (Excel Workbook)** is not compatible with previous versions of **Excel** older than **Excel 2007**. Since some people (and some computers elsewhere in the University) are still using earlier versions of **Excel**, it is probably a good idea to get into the habit of saving your **Excel** files in a format that can be understood by earlier versions of **Excel**, namely as **Excel 97-2003 Workbooks**.

- Click in the **File name** text box and overwrite whatever is in it with **Powers** and click **Save**. This saves the file, and **Book1** in the **Title bar** changes to **Powers**.

Chart Items — Terminology

The different parts of a chart are referred to as *chart items* and it is useful to rehearse some of the terminology before looking at a few of the many facilities for formatting and editing charts.

The three most important chart items are the two axes and the line of the plot. The horizontal axis is variously referred to as the *Horizontal (Category) Axis* or the *x-axis* and the vertical axis is variously referred to as the *Vertical (Value) Axis* or the *y-axis*. The line is formally called a *data series* and note that this has a *marker* (a diamond-shaped blob) at each point.

The two axes form the left-hand and lower boundaries of the *Plot Area*, the central region of the chart. The *Plot Area* lies within the *Chart Area* which is delimited by the outermost boundary of the chart.

Each axis has an *Axis Title* (n and $2n$ at the moment) and the *Chart Title* is at the top. Both axes also carry *labels* (the values 1 to 11 and 1 to 10000).

The *x-axis* has obvious *tick marks*, little lines which dangle down from the axis near the labels. The *y-axis* also has tick marks which stick out to the left of the axis but, as noted earlier, it also has gridlines which run across the full width of the *Plot Area*. The *major* gridlines are associated with the labels 10, 100 and so on. It is possible to have *minor* gridlines too which indicate sub-divisions.

A chart can also have a legend but this item was deselected earlier.

- Click on the chart. Move the pointer to the various items in the chart and notice that, after a one-second wait, an advisory notice appears close to the pointer. The notice usually indicates what the item is. When you point at a marker on the data series the notice even gives the value at that point.

- Next, (single-)click on the various items in the chart. In most cases this action selects the item and it is highlighted in some obvious way. Try selecting the main title, the *x*-axis and the data series in turn.
- Click in the Chart Area, anywhere just inside the surrounding border. When the Chart Area is selected, the selection is indicated by the appearance of the eight drag handles that were present when the chart first appeared.
- Notice the Chart Tools tabs (Design, Layout and Format) in the Ribbon. Click an arbitrary cell *outside* the chart. This deselects the chart (all evidence of selection disappears) and the Chart Tools tabs disappear.

Formatting a Chart — The Format tab and Right-Clicking

The Chart Tools tabs are for changing various aspects of the chart. It is possible to make additional refinements to a chart using the Format tab. In general terms, one selects some chart item which one wants to adjust and then clicks on the Format tab. This tab will know which item has been selected.

As an illustration, consider the vertical axis. It seems silly to have tick marks as well as gridlines and it would be as well to remove them. It also seems silly to extend the axis as far as 10000 when the maximum value (1024) is only a little above 1000. The Format tab can be used as follows:

- First, select the Vertical (Value) Axis (the *y*-axis) by clicking one of its labels (for example, click 1000). [One could also select the axis by clicking a tick mark or the axis itself.] Notice that a rectangular box with blobs at each corner appears around the axis and its labels to indicate selection.
- Click the word Format in the list of tabs at the top of the Ribbon to change to the Format tab. Notice that there is a Current Selection group at the far left of the Format tab. The top of this group is a list box that currently says Vertical (Value) Axis. Below this is the Format Selection button. Click the Format Selection button to open the Format Axis dialogue box.
- Ensure that Axis Options is selected in the left hand column of this dialogue box; click it if it is not. One of several sets of list boxes in the right hand column of the box specifies that the Major tick mark type: is Outside the axis. Change from Outside to None. This will clear the tick marks.
- Note that also in the right hand column of the dialogue box is a ticked checkbox which indicates that a Logarithmic scale is being used for this axis. Note also that the Maximum: is Auto and the text box across from Maximum: is greyed-out and has 10000.0 in it.
- Change the Maximum: setting from Auto to Fixed, and change the value in the previously greyed-out box to 1000.0. Click Close. This closes the tab dialogue box, the chart has its tick marks removed from the vertical axis and the maximum value on the vertical axis is now 1000.

The next step is to remove the tick marks from the horizontal axis. One could go through the same procedure of selecting the axis, bringing up the Format tab and then clicking the Format Selection button, but there is a quicker way:

- First, select the Horizontal (Category) Axis by clicking one of its labels. Again, a box with a blob at each corner appears around the axis and its labels to indicate selection.

- Next, *right* click on the label. This action brings up a sub-menu, at the bottom of which is Format Axis... Selecting Format Axis... will take you to the Format Axis dialogue box. It was unnecessary to do the single-click to select but that action is recommended so you can verify that you have chosen the right item.
- Almost certainly **Axis Options** is selected in the left hand column of this dialogue box; click it if it is not. The right hand column of the dialogue box has a rather different appearance now because the horizontal axis is linear rather than logarithmic. Leave most of the entries in this tab alone. The only thing you should do is change the **Major tick mark type**: to **None** as before and click **Close**.

The tick marks are removed from the horizontal axis of the chart. The labels 1 to 11 still need changing but the Format Axis dialogue box is not the place to make such a change.

Formatting a Chart — Changes to a Data Series

The next step is to format the data series to remove the markers:

- Click somewhere on the line of the plot between two markers. This *selects the data series*. Notice that large blobs appear on all the markers to highlight the selection.
- Click the word **Format** in the list of tabs at the top of the Ribbon to change to the **Format** tab. Click the **Format Selection** button to open the **Format Data Series** dialogue box.
- Immediately click **Close** to close the box. Open it again the quicker way...
- Click somewhere outside the chart and then *right-click* somewhere on the line of the plot. This opens a sub-menu from which you should choose Format Data Series... to open the **Format Data Series** dialogue box.
- In the left hand column of the dialogue box, click **Line Color**. Under the **Line Color** heading in the right hand column of the box, the **Automatic** option has been selected by default. This gives a solid coloured line.
- Select the **Solid line** option. We can now choose the colour of the line. Click the  button next to **C**olor:. This opens a drop-down palette of colours.
- Click the black square in the palette. This will change the colour of the line. If there isn't a black square (or if you wanted a colour not shown) choose the **More Colors...** option at the bottom of the drop down palette and then choose the colour you want from the **Colors** tab dialogue box.
- In the left hand column of the dialogue box, click **Line Style**. Under the **Line Style** heading in the right hand column of the box, there are various options you can change to affect the appearance of the line. Click the  button next to **D**ash type:. This opens a drop-down list box which shows various styles of line. You could select long dashes or short dashes and so on. The default solid line seems a good choice so click the  button again to get rid of the drop-down list box.
- In the left hand column of the dialogue box, click **Marker Options**. Under the **Marker Options** heading in the right hand column of the box, the **Automatic** option has been selected by default. This gives the diamond-shaped markers that are not needed, so choose **None**.
(If you wanted to change the colour of the markers, you would click on **Marker Fill** in the left hand column of the dialogue box and then under in the right hand column you

would select the **Solid fill** option. You would then choose the colour you wanted by clicking the  button next to **C**olor: and choosing from the drop-down palette of colours.)

- Click **Close**. This closes the dialogue box. The markers appear still to be present but this is an illusion. What you see is a highlighting effect to show that the data series is still selected.

Changing the Chart Type to XY (Scatter)

The labels on the x -axis currently run from 1 to 11 rather than from 0 to 10. No information has been supplied in the worksheet to specify what the labels ought to be and Excel simply noted that there were eleven values and naïvely used 1 to 11 for the labels.

The difficulty stems from choosing a **Line** chart. The proper choice would have been to use an **XY (Scatter)** chart, in which one set of values is plotted against another and both sets of values are specified explicitly:

- Click on the chart. Click the word **Design** in the list of tabs at the top of the Ribbon to change to the **Design** tab. Click on the **Change Chart Type** button in the **Type** group.
- In the left hand column of the **Change Chart Type** dialogue box, select **X Y (Scatter)**.
- In the right hand column of the dialogue box, under **X Y (Scatter)**, choose the second chart sub-type **Scatter with Smooth Lines and Markers**:



- Click **OK**.

One consequence of this change is that the markers reappear on the data series. This feature is still unwanted and a little revision is in order:

- Assuming the markers have reappeared on the data series remove them.

The labels on the x -axis now run from 0 to 12. Excel still doesn't know what the values should be and the **Select Data Source** dialogue box will give a clue as to what is happening:

- Click on the chart if it (or some part of it) is not already selected. Click on the **Select Data** button in the **Data** group on the **Design** tab.
- Click the **E**dit button under **Legend Entries (S**eries). This brings up the **Edit Series** dialogue box.

The text boxes record the way the Excel interpreted your original selection on the worksheet when you first created the chart.

The **S**eries name of the data series is taken from the first cell A1. The *full address* of this cell includes the sheet name which is **Sheet1**. This name is separated from the *cell identifier* by an exclamation mark. The full address of the first cell is therefore **Sheet1!\$A\$1**.

The values which constitute the data series, the **S**eries Y values, are in a range whose full address is **Sheet1!\$A\$2:\$A\$12**.

On the other hand, the **S**eries X values: box is waiting for an appropriate range and this means making a temporary excursion:

- Click **Cancel** to close the dialogue box, and then click **Cancel** to close the **Select Data Source** dialogue box.
- Select cell A1. This is outside the chart so the **Chart Tools** tabs disappear.
- Click the ▼-sign on the **Insert** button in the **Cells** group of the **Home** tab and choose **Insert Sheet Columns** from the sub-menu that appears. A new blank column appears on the left. The data series and the chart move to the right.

(Note that if you click the picture  above the word **Insert** then a blank row is inserted and no sub-menu appears. If you've done this use the **Undo** button () to undo this action and then click the ▼-sign on the **Insert** button.)

- Make A2 the active cell. Key 0 into cell A2.
- Click the Enter box to confirm.
- Select **Fill ▼ Series...**
- Select the **Columns** option. Leave the **Type** as **Linear** and leave the **Step** value as 1.
- Set the **Stop** value to 10.
- Click **OK**.

This should put the values 0 to 10 in cells A2 to A12. Check this.

- Make A1 the active cell. Key in n and click the Enter box to confirm.
- Right-align this n and make it bold and italic.

This has incorporated into the worksheet the values which are suitable labels for the x -axis. You can now pay attention to the chart again:

- Click anywhere in the chart. Note that the **Chart Tools** tabs appear.
- Click on the **Select Data** button in the **Data** group on the **Design** tab. Click the **Edit** button under **Legend Entries (Series)** to bring up the **Edit Series** dialogue box.
- Click in the **Series X values:** box and be prepared for an unusual window which appears when you drag out a region of the worksheet...
- Check that the insertion point is in the **Series X values:** box then, in the worksheet, drag from cell A2 to cell A12 to select the values 0 to 10 which are required as labels for the x -axis. A curious window with a single text box indicates how the dragging process is proceeding. When the mouse button is released the range **Sheet1!\$A\$2:\$A\$12** should appear in the **Series X values:** box.
- Click **OK**. Click **OK** again in the **Select Data Source** dialogue box.

The data series now runs through the point (0,1) and the labels are appropriate: it is now more obvious that 2^6 has the value 64. Next, shorten the axis:

- Right-click on a label on the **Horizontal (Category) Axis** (the x -axis) and choose **Format Axis...** from the sub-menu to open the **Format Axis** dialogue box.
- Click on **Axis Options** in the left hand column of the dialogue box.

- Under **Axis Options** in the right hand column of the dialogue box, change the **Maximum** to 10.0 (first you'll need to select **Fixed**) and change the **Major unit** to 1.0 (first you'll need to select **Fixed**).
- Click **Close**. At last the x -axis labels are as required.

Formatting a Chart — Changes to Titles

- Click, in turn, the n , the $2n$ and the **POWERS OF TWO** titles. Whenever titles are selected in this way a border with blobs at the corners appears highlighting the item.
- With **POWERS OF TWO** selected, drag across the word **TWO** from left to right. This highlights the word. Key in 2 so the chart title changes to **POWERS OF 2**.
- Right-click $2n$ and choose **F**ont... to open the **Font** tab dialogue box.
- Select the **F**ont tab and change the **S**ize to 11 points. Click **OK**.
- Right-click $2n$ and choose **F**ormat Axis Title... from the sub-menu to open the **Format Axis** dialogue box. In the left hand column of the dialogue box, click on **A**lignment. In the right hand column, under **T**ext layout, choose **H**orizontal in the **T**ext direction: list box. Make sure the **C**ustom angle: is set to 0° .
- Click **Close**. The $2n$ axis title should now be horizontal.
- With $2n$ still selected, drag across the n to highlight that letter.
- Right-click the n and choose **F**ont...
- In the **Font** tab, select **I**talic in the list box under **F**ont style and click the **S**uperscript checkbox under **E**ffects. Click **OK**. The axis title should now look more like 2^n .
- Change the other axis title from n to n .

Formatting a Chart — Changes to the Plot Area

- Click somewhere in the **Plot Area** but not too close to the line on the plot or to a gridline or to an axis. This selects the **Plot Area**. Several handles appear which you could use to change the size and shape of the **Plot Area**.
- Right-click somewhere in the **Plot Area** and choose **F**ormat Plot Area... from the sub-menu to open the **Format Plot Area** dialogue box.

The **Format Plot Area** dialogue box is relatively simple. Click **B**order Color in the left hand column of the dialogue box, and you will see that under **B**order Color in the right hand column the **A**utomatic option has been selected by default. This is a grey line. You haven't seen it because it is covered by the two axes and the topmost and rightmost gridlines:

- Select the **N**o line option under the **B**order Color heading.
- Click **F**ill in the left hand column of the dialogue box and ensure that the **N**o fill option is selected under the **F**ill heading in the right hand column of the dialogue box. There is no need for a fancy background.
- Click **Close**. The chart now has a clean and uncluttered appearance.

Editing a Chart — Incorporating a new Data Series

The alterations which have been made so far are described as *formatting* actions in the Excel documentation. They are to be contrasted with *editing* actions which include adding new points to a data series or adding a new data series to a chart.

To add a second data series to the chart, a new series must be entered into the worksheet:

- Click cell C2 and thereby make C2 the active cell.
- Key in the formula =SQRT(B2) and click the Enter box to confirm.
- Check that C2 is still the active cell complete with its emphasised border indicating selection. Notice the little black square at the bottom right-hand corner of the border. This is the *Fill handle*.
- Point to the Fill handle and notice that the pointer changes to a +-sign.
- Drag the Fill handle downwards to cell C12 and release the mouse button. This is the standard short-cut way of filling and is known as *AutoFill*.

Each cell in the C column takes on the square root of the value of its neighbour in the B column. The default **Format Category** is **General** and the result is a mixture of whole numbers and numbers taken to several decimal places. This looks messy:

- Check that the range C2:C12 is still selected, and click the **Format** button in the **Cells** group on the **Home** tab and choose **Format Cells...** from the sub-menu.
- Select the **Number** tab and select **Number** as the **Format Category**. Check that the number of **Decimal places** is shown as 2.
- Click **OK**. The values in the C column look much tidier.
- Make C1 the active cell and key $2^{(n/2)}$ into the cell and click the Enter box to confirm.
- Make this entry look as much like $2^{(n/2)}$ as you can (only the *n* is italic). Right-align the entry and make it bold.

In versions of Excel prior to Excel 2010 one way to incorporate a new data series into a chart was to use a technique known as *drag and drop* – unfortunately, **you cannot use drag and drop to add a new data series to a chart in Excel 2010**. In Excel 2010 this is how you add a new data series to a chart:

- Click on the chart. Now click on the **Select Data** button in the **Data** group on the **Design** tab.
- Click the **Add** button under **Legend Entries (Series)** to bring up the **Edit Series** dialogue box.
- Click in the **Series name:** text box and then click on cell C1. The text in this box should now read =Sheet1!\$C\$1 (i.e. worksheet Sheet1, cell C1).
- Click in the **Series X values:** box. If there is anything already in this box, delete it. Be prepared for an unusual window which appears when you drag out a region of the worksheet...
- Check that the insertion point is in the **Series X values:** box then, in the worksheet, drag from cell A2 to cell A12 to select the values 0 to 10 which are required as labels for the *x*-axis. A curious window with a single text box indicates how the dragging process is

proceeding. When the mouse button is released the range `Sheet1!A2:A12` should appear in the **Series X values:** box.

- Click in the **Series Y values:** box. **If there is anything already in this box, delete it.** Be prepared for an unusual window which appears when you drag out a region of the worksheet...
- Check that the insertion point is in the **Series Y values:** box then, in the worksheet, drag from cell `C2` to cell `C12` to select the values 1.00 to 32.00 which form the new data series for the y-axis. Once again, a curious window with a single text box indicates how the dragging process is proceeding. When the mouse button is released the range `Sheet1!C2:C12` should appear in the **Series Y values:** box.
- Click OK. Click OK again in the **Select Data Source** dialogue box.

The second data series is probably coloured and has markers and data labels. Some further formatting is needed...

Formatting a Chart — Changing the Legend

- Check that the chart is selected. The **Chart Tools** tabs should appear on the Ribbon.
- Click the **Legend** button in the **Labels** group of the **Layout** tab. From the sub-menu, choose **Show Legend at Right** to make the legend reappear. The legend provides a (somewhat unsatisfactory) key to distinguish the two data series.
- Click anywhere inside the legend's border to select the legend. Eight handles (round or square blobs) should appear. By dragging the handles you can change the size and shape of the legend border. By clicking inside the legend area away from a handle or any of the items in the legend and then dragging, you can reposition the legend...
- Stretch the border vertically and reposition the legend so that the two components are roughly in line with the rightmost extremities of the two data series.
- Make sure the legend is selected. Click the word **Format** in the list of tabs at the top of the Ribbon to change to the **Format** tab. Click the **Format Selection** button to open the **Format Legend** dialogue box.
- Select **Border Color** in the left hand column of the **Format Legend** dialogue box.
- Select the **No line** option under the **Border Color** heading in the right hand column of the dialogue box.
- Click **Close**. Any border the legend may have had disappears, but the handles remain to indicate that the legend is still selected.
- Click outside the chart. This action is preparatory to the next illustration but it has the side effect of deselecting the legend so the handles disappear.

Formatting a Chart — Changes to the new Data Series

The next step will be to remove the new data series' data labels, to format it to make it a broken black line and to remove its markers:

- Right-click on one of the data labels of the new data series and choose **Format Data Labels...** from the sub-menu to open the **Format Data Labels** dialogue box. Select **Line Options** in the left hand column of the dialogue box.

- Make sure that all of Series Name, X Value and Y Value under Label contains in the right hand side of the dialogue box do not have a tick (✓) next to them. Untick any which do. Click Close.
- Right-click somewhere on the line of the new plot between two markers (if there are any markers, or just anywhere on the line of the new plot if there aren't) and choose Format Data Series... from the sub-menu to open the **Format Data Series** dialogue box. Select Line Style in the left hand column of the dialogue box.
- Change the Dash type of the line to a simple broken line and change the colour to black.
- Select Line Color in the left hand column of the dialogue box. Under Line Color in the right hand column of the dialogue box, select Solid line. Change the Color: to black.
- Select Marker Options in the left hand column of the dialogue box. Change the Marker Type to None. Click Close.

It is possible that the legend doesn't quite fit into the space available and $2(n/2)$ (which is erroneous anyway) is split over two lines. Whether or not this is the case, give the legend more space...

- Click in the legend so that the eight handles appear. Drag the handle in the middle of the left-hand side leftwards to make the legend wider. Crash into the chart itself, concluding the drag halfway between the 9 and 10 gridlines.
- Click in the Plot Area of the chart to select it. Drag the handle in the middle of the right-hand side to the left to make the chart less wide. The axis labels may turn (or may already have turned) sideways. If this is the case...
- Right-click a label on the axis and choose Format Axis... to open the **Format Axis** dialogue box.
- In the left hand column of the dialogue box, click on Alignment. In the right hand column, under Text layout, choose Horizontal in the Text direction: list box. Make sure the Custom angle: is set to 0° .
- Click Close. Click outside the chart.

Naming Cells

The values in the **C** column are the square roots of the values in the **B** column. Suppose you want these new values to be a factor of 4 larger.

You could simply adjust the formula in cell **C2** to $=4*\text{SQRT}(B2)$ and drag the fill handle downwards to update the other cells in the **C** column.

If you then wish to experiment with other factors, the process of updating cell **C2** and dragging becomes slightly tedious. It is better to set aside some specific cell for the factor and just change the contents of this one cell between experiments:

- Make **D2** the active cell and key 4 into this cell. Click the Enter box to confirm. It seems sensible to give a heading to this factor...
- Make **D1** the active cell. Key in **a** (one character). Click the Enter box to confirm.
- Right-align this **a** and make it bold.

The obvious next steps are to adjust the formula in cell C2 to $=\$D\$2*\text{SQRT}(B2)$ and then drag downwards. Remember the use of dollar-signs to indicate an absolute address? The first \$ isn't strictly needed but it does no harm.

To anyone used to ordinary mathematics, it would be much better if one could write the formula simply as $=a*\text{SQRT}(B2)$ and use *a* as the required reference to the value 4. There is a facility for doing just that:

- Drag downwards from D1 to D2 so as to select the cell containing the name *a* and the cell containing the value 4.
- Click the word Formulas in the list of tabs at the top of the Ribbon to change to the Formulas tab. Click the Create from Selection button in the Defined Names group. The Create Names from Selection dialogue box has the Top row checkbox set. This indicates that the name *a* in the top row of the current selection will be taken as a name which can be used in formulae. Click OK.
- Make C14 the active cell and try a simple experiment...
- Key in the formula $=a+2$ and click the Enter box to confirm. The value 6 is duly calculated for the cell.
- Click the Undo button () on the Quick Access Toolbar to remove the 6.
- Check that C14 is still the active cell. As usual C14 is noted in the Name Box (to the left of the Formula Bar). To the right of the C14 in the Name Box there is a ▼ button...
- Click the ▼ and notice the single entry *a* in the drop-down list box. If you had created several names, they would all be here too.
- Click this *a* and observe that cell D2 becomes the active cell (not cell D1 which has *a* in it). Further, the Name Box doesn't record this cell as D2 but as the name *a*.
- Make C2 the active cell. Modify the formula to $=a*\text{SQRT}(B2)$ and click the Enter box to confirm. The value in C2 changes from 1.00 to 4.00 and this change is reflected in the chart.
- Drag the fill handle of C2 downwards to cell C12. The formulae in the other cells are duly updated and the associated data series on the chart changes too.
- Experiment with different values in D2; try 10, 32, 100 and 0.1 and notice the changes both to the values in the C column and to the chart.
- Check that you understand just why the second plot on the chart changes as it does as the value of *a* is changed.

The heading in cell C1 needs editing. Start by *double-clicking* it:

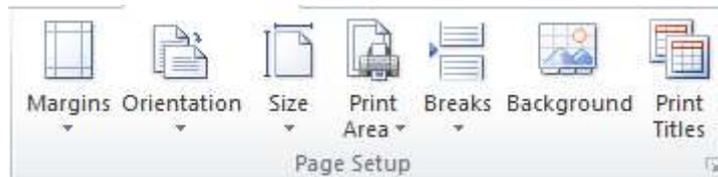
- Double-click cell C1. This not only makes C1 the active cell but it also causes the flashing insertion point to appear in the cell itself.
- Click in front of the 2 to ensure that the insertion point is to the left of the leading 2 in cell C1 and key in *a*. (the dot separates the *a* from the 2 and implies multiplication).
- Click the Enter box to confirm. The change to the heading affects the legend in the chart though this latter still isn't right!
- Change the value in D2 to 1. You then get the values which you originally had for the second data series.

You should by now be able to make most of the adjustments to a worksheet and to a chart that you are likely to want to make. Unfortunately, there seems to be no way of changing $2n$ into 2^n and $a.2(n/2)$ into $a.2^{(n/2)}$ in the legend. The best you can do is to change the headings of columns B and C to something like 2^n and $a.2^{(n/2)}$.

Printing the Worksheet

Preview and print the worksheet:

- Ensure that the chart is *not* selected. Click a cell in the worksheet if it is.
- Click on the word **File** at the top left of the Ribbon to open the **Backstage** view. Then click on **Print**. The appearance of the worksheet in the previewer is not very satisfactory. As with **Flat.xls** it would be better to move the chart below the tabulated values and move these values to the right. Click on the word **Home** at the top of the Ribbon to return to your worksheet and make the appropriate changes, especially to the position of the chart.
- Click on the word **Page Layout** at the top of the Ribbon to bring up the **Page Layout** tab. Click the small arrow () in the lower right corner of the **Page Setup** group:



...to bring up the **Page Setup** tab dialogue box. Centre the entire worksheet horizontally and to add the footer which incorporates your name and College. Preview again.

- When all is well, print the worksheet with the embedded chart.
- Collect the printed worksheet from the printer.
- If the previewer is open, click on the word **Home** at the top of the Ribbon to return to your worksheet. Then click **Save**. Finally, click on the word **File** at the top left of the Ribbon to open the **Backstage** view and click **Close** to close the workbook.

Powers of Two Concluded

This example has introduced a number of formatting and editing features. It also reflects real life in the way that a chart is commonly built up in stages with a certain amount of back-tracking and changing of mind on the way.

With the benefit of hindsight, the end product could have been set up more speedily. In outline, the first step should have been to set up both the n and 2^n columns and then create an **XY Scatter** chart rather than get into the mess that resulted from creating a **Line** chart.

The requirement for a semi-log plot should have been ignored until a complete draft chart had been completed. At that stage, the y -axis could have been selected and then formatted by putting a tick in the **Logarithmic scale** checkbox in the **Format Axis** dialogue box.

Leaving Excel

- Click on the word **File** at the top left of the Ribbon to open the **Backstage** view and then click **Exit**. (If you have any open workbooks with unsaved changes, then a message window will advise that you have made some changes and will ask whether you want to

save these changes. Click **Yes** which saves the recent changes and you will then exit from Excel.)

The workbook is saved in the file **Powers.xls** and you have left Excel.

Logging off

- As at the end of every session, it is important to log off in the approved way:



After a short wait, the screen returns to its idle state presenting the invitation to:

Press **CTRL + ALT + DELETE** to log on

Summary

Here are some of the more important features which were referred to Session 6.

Workbook	A collection of worksheets and chart sheets in a single file.
Chart sheet	A sheet in a workbook occupied by a chart alone.
Series	A sequence of values in which there is some simple relationship between one value and the next.
Data Series	A data series (on a chart) is a sequence of markers which might be joined by a line.
Marker	A blob of some simple geometric shape on a chart indicating a point on a data series.
Legend	A key indicating which markers apply to which data series on a chart.
Plot Area	The area of a chart where a graph (typically) is plotted.
Axis	A horizontal or vertical line on a graph, usually calibrated in such a way that the coordinates of a point on the graph can be specified.
Tick mark	Calibration line on an axis.
Gridline	Tick mark which runs right across a chart.
Chart Title	Text providing a caption to a chart.
Axis Title	Text providing a caption to an axis.
Axis label	Text associated with a tick mark or gridline.
Chart item	Generic term for the components of a chart.
Editing	Adding a new point to a data series or adding a new data series to a chart or simply changing one or more points.
Formatting	Changing the appearance of a chart, usually by making changes to one or more chart items.