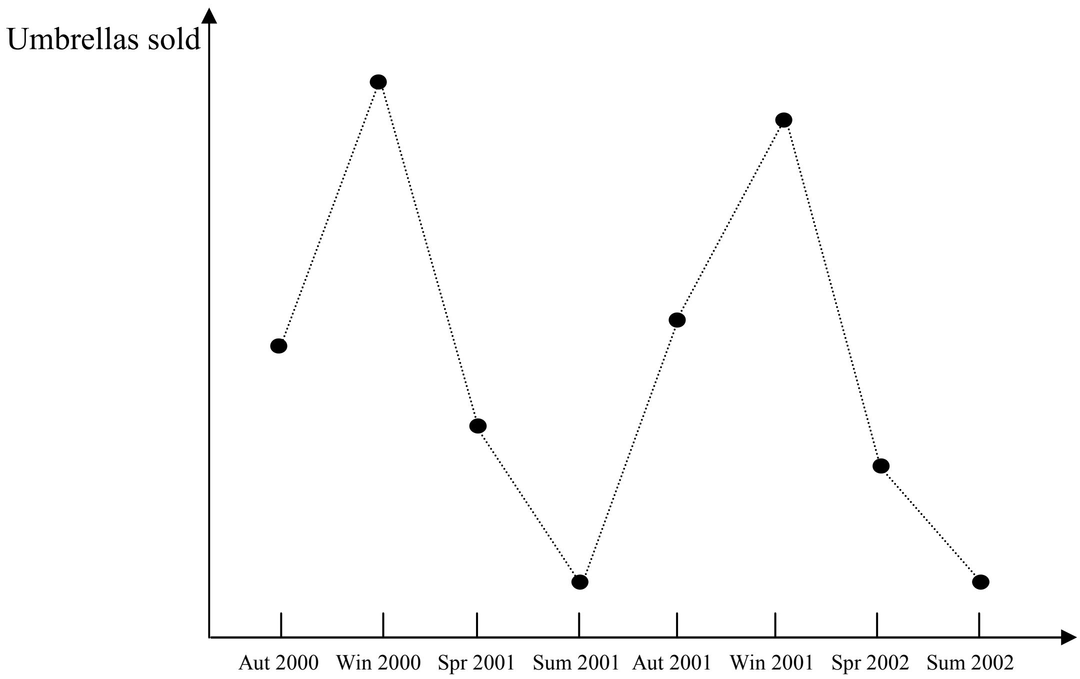
GCSE MATHEMATICS topic sheet.
MOVING AVERAGES

Many sets of data display **trends** which depend upon the time of year or the particular month or even the time of day etc.

For example, we would expect that sales of umbrellas would peak during the winter months and then tail off during the summer months etc.

In fact, if we were to plot a graph showing sales of umbrellas against the seasons of the year (autumn, winter etc.) we would expect some wildly fluctuating graph as follows:



This is called a **time series graph**.

In attempting to glean meaningful information from such graphs, we really need to isolate the different seasons, each of which exerts its own seasonal influence.

One way of doing this is to use what are termed **moving averages**, which are designed to *level* out the large fluctuations which can occur in a set of data that varies over time.

The following questions (and their solutions!) illustrate the basic ideas and detail what are typical GCSE questions.

1. A college records the number of people who sign up for adult education classes each term.
The table shows the numbers from Autumn 2000 to Summer 2002.

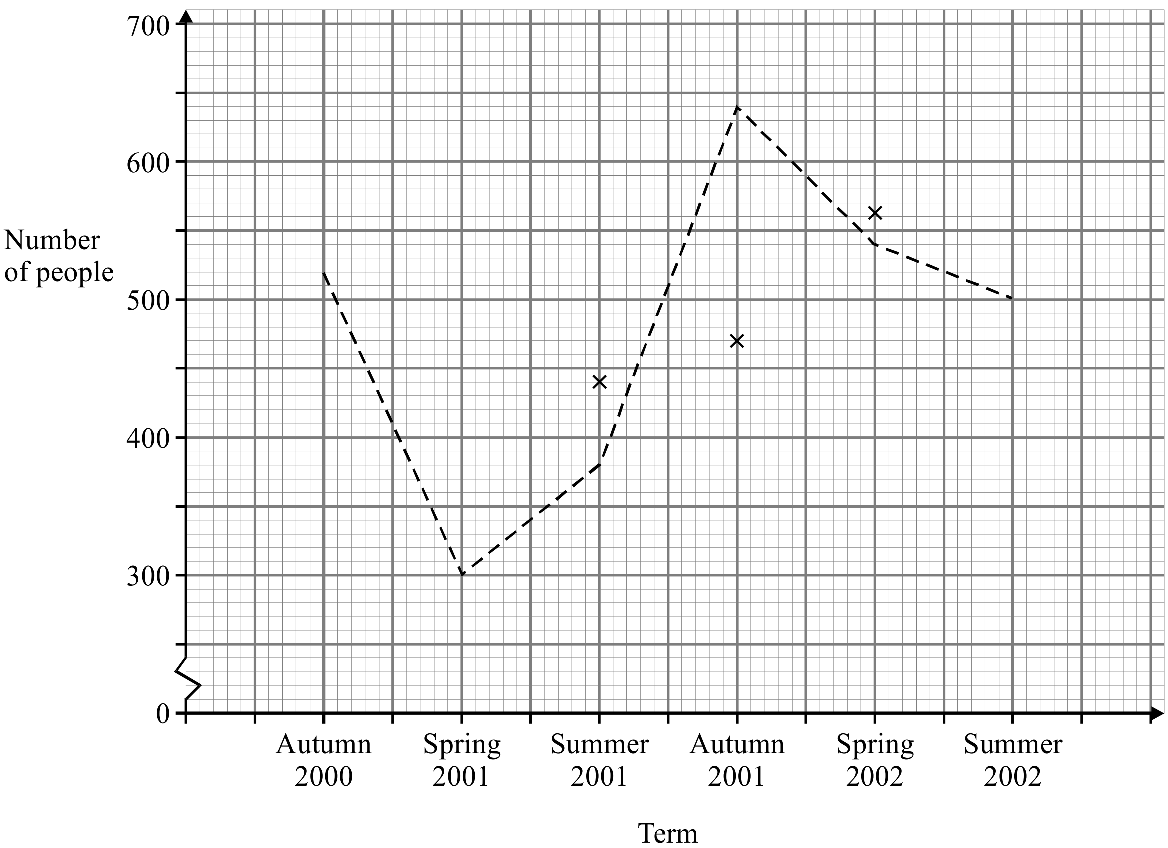
Term	Autumn 2000	Spring 2001	Summer 2001	Autumn 2001	Spring 2002	Summer 2002
Number of people	520	300	380	640	540	500

(a) Calculate the first value of the three-point moving average for these data.

(b) Explain why a three-point moving average is appropriate.

The time series graph shows the original data.

The remaining values of the three-point moving average are also plotted (as crosses).



(c) Plot the value from part (a) on the graph.

(d) Use the trend to estimate the three-point moving average that would be plotted at Summer 2002.

(e) Use the value from part (d) to calculate a prediction of the number of people who will sign up for adult education classes in Autumn 2002.

2. The table shows the amounts of Jenny's gas bills from September 2001 to December 2002.

Date	September 2001	December 2001	March 2002	June 2002	September 2002	December 2002
Amount of bill (£)	28.70	32.40	29.10	7.80	30.30	38.60

(a) Explain why a four-point moving average is appropriate for these data.

(b) Show that the first value of the four-point moving average is £24.50

(c) Calculate the second value of the four-point moving average for these data.

3. The table shows the amount of water used every 6 months over a period of 4 years.

Year	**1998**		**1999**		**2000**		**2001**	
Month	**Mar**	**Oct**	**Mar**	**Oct**	**Mar**	**Oct**	**Mar**	**Oct**
Water used (cubic metres)	36	45	29	43	38	45	52	46
Average	☒	36.7	39				47.7	☒

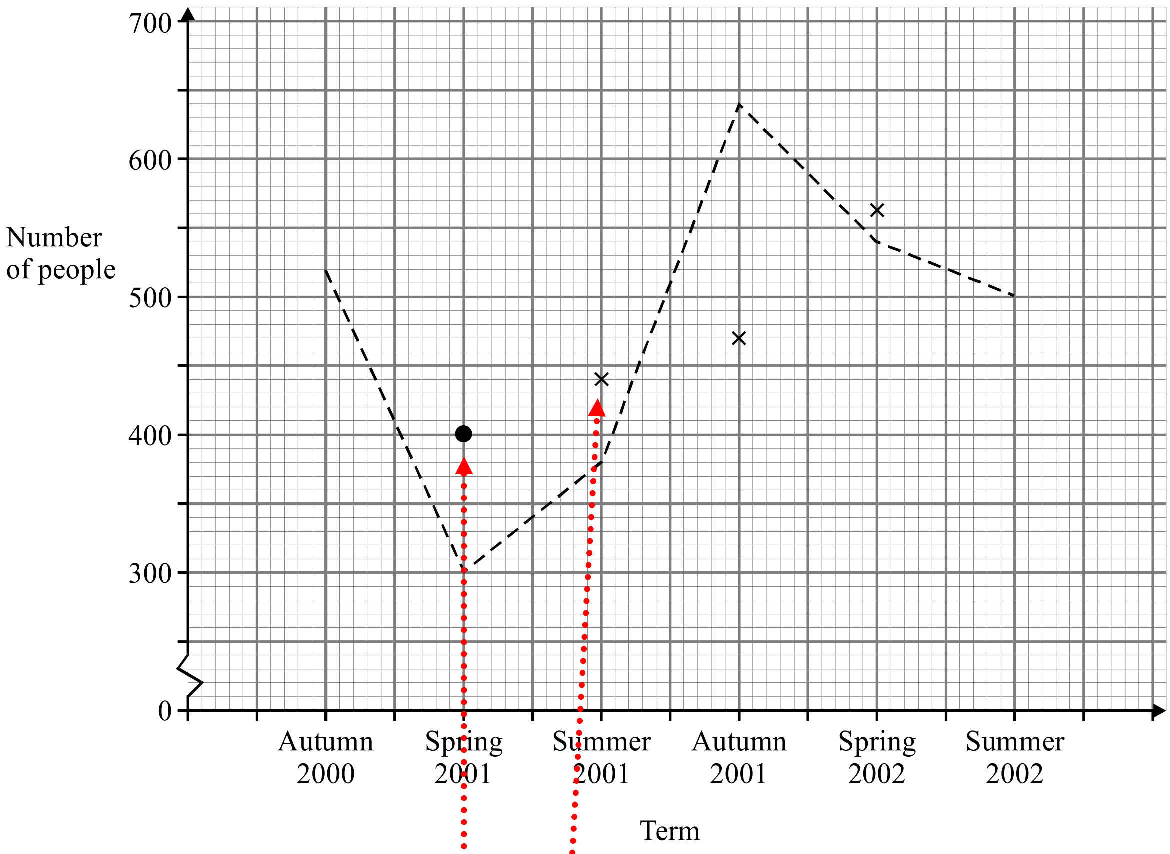
Complete the table to show the three point moving averages.

SOLUTIONS / ANSWERS.

1. (a) The first three-point moving average is $\frac{520 + 300 + 380}{3} = \frac{1200}{3} = 400$.

(b) A three-point moving average is appropriate because there are three terms in the year, each of which could effect the numbers enrolling in a different way. For example, more adults might naturally sign up in the summer term etc.

(c)



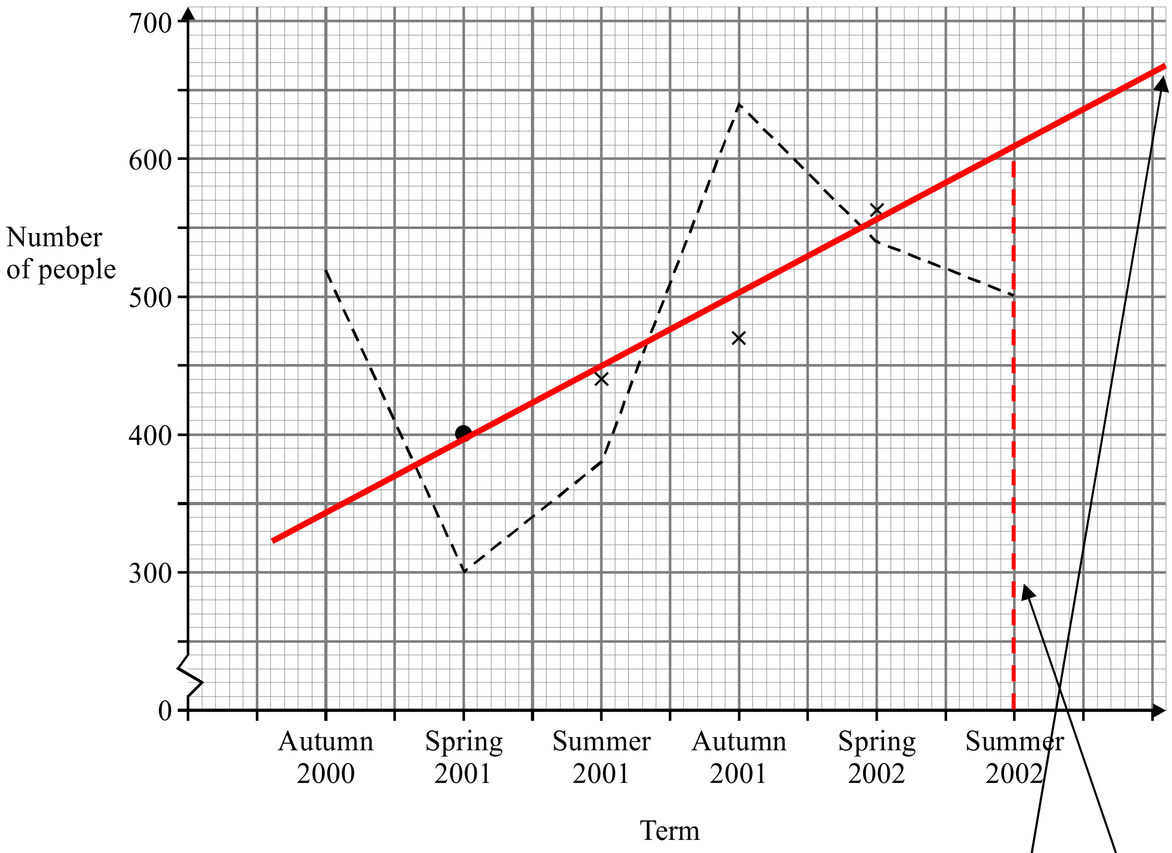
In part (a) we calculated the **moving average** for the terms: autumn 2000, spring 2001 and summer 2001; which came to 400.

We plot this value on the above graph in the middle of the respective terms; i.e. we plot (Spring 2001, 400).

Always plot moving averages in the middle of the respective grouping.

{Note that the second moving average is obtained by averaging out the data for spring 2001, summer 2001 and autumn 2001 etc.}

(d) For the moving average which would result for summer 2002, we simply draw a best fitting trend line through the four plotted moving averages shown below.



We now use the best fit line to estimate the next moving average to be 610.

(e) {Questions very rarely ask for this these days!}

One way of estimating the number enrolling during Autumn 2002 consists of using the above trend line as in part (d) to estimate the moving average, and then making some **seasonal adjustment** based upon the data for the autumn terms only.

First, the trend line gives an estimated moving average of 660 for the autumn 2002 term.

Now, for the autumn seasonal adjustment:
For each autumn, use the trend line on the time series graph to estimate the seasonal effect.

Autumn 2000: actual number enrolling – **estimated** moving average
= 520 – 340
= 180.

Autumn 2001: actual number enrolling – **actual** moving average
= 640 – 520
= 130.

This gives us an average seasonal adjustment for autumn of $\frac{180 + 130}{2} = 155$.

Therefore, our estimated enrolment for autumn 2002 = 660 + 155 = 815.

2. (a) A four-point moving average is appropriate because there are four bills every year and the particular season could effect the amount of the bill.
For example, a winter gas bill would be expected to be higher than a summer bill etc.

(b) First moving average = $\dfrac{28.7 + 32.4 + 29.1 + 7.8}{4}$ = £24.50.

(c) Second moving average = $\dfrac{32.4 + 29.1 + 7.8 + 30.3}{4}$ = £24.90.

3. The table shows the three point moving averages.

Year	**1998**		**1999**		**2000**		**2001**	
Month	**Mar**	**Oct**	**Mar**	**Oct**	**Mar**	**Oct**	**Mar**	**Oct**
Water used (cubic metres)	36	45	29	43	38	45	52	46
Average		36.7	39	**36.7**	**42**	**45**	47.7	

$\dfrac{29 + 43 + 38}{3}$ $\dfrac{43 + 38 + 45}{3}$ $\dfrac{38 + 45 + 52}{3}$