UNIT 13 *Graphs* Activities

Activities

ACTIVITY 13.1 *Correlation*

The table opposite gives the complete set of football Premier League results for Saturday/Sunday 8/9 November 1997.

Home team	*Goals scored*	*Away team*	*Goals scored*
Blackburn	3	Everton	2
Coventry	2	Newcastle	2
Crystal Palace	1	Aston Villa	1
Leeds	4	Derby	3
Liverpool	4	Tottenham	0
Sheffield Wednesday	5	Bolton	0
Southampton	4	Barnsley	1
Arsenal	3	Manchester United	2
Chelsea	2	West Ham	1

Plot the number of goals scored by each team on a scatter diagram, using

x-axis – home team score
y-axis – away team score

Problem 1 Describe the type of correlation produced by this scatter plot.

Problem 2 Repeat the exercise with a more recent set of results.

Does this show the same type of correlation?

For the next problem you will need a football annual, giving a summary of the results for a complete year (or see the internet address http://www.soccernet.com).

Problem 3 (a) For last year's Premiership League champions, construct a scatter plot, using, for each of their matches,

x – winning team's score

y – opponent's score

What type of correlation is observed?

(b) What type of correlation would you expect to find if you were to undertake the same exercise with the club at the bottom of the league?

Check your predictions by constructing the scatter plot.

Problem 4 Draw scatter plots for the first 10 clubs in the league table for the year, against factors such as

(a) transfer money spent on the team,

(b) number of foreign players on the team,

(c) length of service of current manager, etc.

For each scatter plot, predict the type of correlation and then check your prediction.

ACTIVITY 13.2 *Line of Best Fit*

The data opposite give

- the average midday temperature (in November) for a number of UK cities,
- the position of each city in degrees of latitude, which is a measure of their distance from the equator. ('N' indicates that the position is *north* of the equator.)

City	*Average Temperature* (° C)	° *Latitude (to nearest* 30′)
Aberdeen	9	57° N
Birmingham	11	52° 30′ N
Cardiff	11	51° 30′ N
Edinburgh	10	55° 30′ N
London	12	51° 30′ N
Manchester	11	53° 30′ N
Newcastle	12	55° N
Southampton	13	51° N

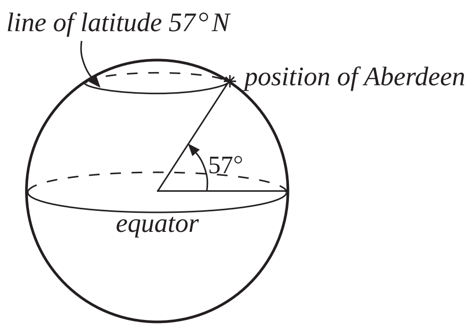


Diagram to show position of Aberdeen at 57° *N*

Problem 1

Using the x-axis for the average temperature and the y-axis for the ° latitude, plot the data points in a scatter diagram. What type of correlation is shown by these data?

Data that show either strong positive or strong negative correlation can often be modelled by a linear type of relationship, that is, the data fit reasonably well on a *straight* line.

Problem 2

Draw a line of best fit for the data points on a scatter diagram. (In drawing your straight line, try to minimise the total distance of all the points from your line; it is also useful find to the mean value of all the x-values, say $\bar{x}$, and the same for y-values, say $\bar{y}$. The line of best fit should pass through the point $(\bar{x}, \bar{y})$).

Problem 3

Use your line to predict

(a) the average temperature at Milton Keynes which is at latitude 52° N.

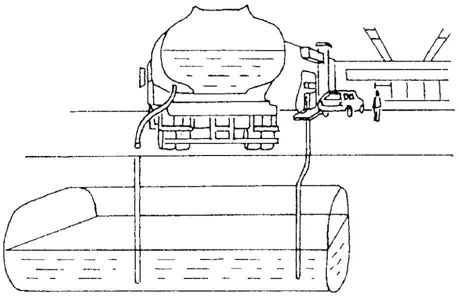
(b) the latitude of Middlesbrough, which had an average temperature of 11 °C.

Problem 4

Why does your line of best fit not give accurate data for all the points on its path?

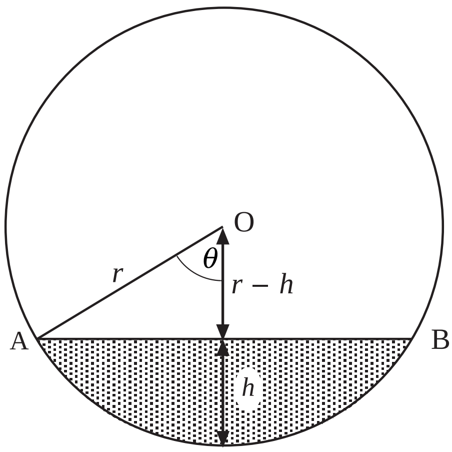
ACTIVITY 13.3 *Dipstick Problem*

Petrol stations very rarely run out of fuel. This is due partly to efficient deliveries but also to precise stock control.



Each type of fuel (4 star and unleaded petrol, and diesel) is stored in an underground tank and the amount in each tank is carefully monitored using some form of dipstick.

It is easy to measure the *height*, say h, of fuel in the tank. However, the volume will be proportional to the *cross-sectional area* – not the height. Suppose the cross-section is a circle (it is, in fact, usually elliptical, but a circle is a good approximation). You need to find the relationship between area, A, and height, h, and so provide a ready reckoner to convert height to area.



For simplicity, take $r = 1\,\text{m}$. For values of h from 0 to 1, you need to find the angle θ and the area of fuel.

Problem 1 Show that $\cos\theta = 1 - h$.

Problem 2 Show that the area of the sector OAB is given by

$$\frac{\pi\theta}{180}$$

Problem 3 Show that the area of the triangle OAB is

$$(1 - h)\sin\theta$$

Problem 4 Deduce the area of the cross-section of fuel and express this as a fraction, A', of the complete cross-sectional area of the tank.

Problem 5 (a) Using the equation in *Problem 1*, find the value of θ for each value of h in the table opposite.

(b) Use the formula deduced in *Problem 4* to find the area fractions.

h	$\theta°$	*Area fraction*
0	0	0
0.1	25.84	0.019
0.2	...	...
...	...	...
...	...	...
1.0	90.00	0.500

Problem 6 Plot a graph of A' (vertical axis) against height h (horizontal axis).

Problem 7 Use your graph to estimate the height that corresponds to an area fraction of

(a) 0.05 (b) 0.10

Extension

Construct a dipstick for this problem, from which you can read off the area fraction against every height value.