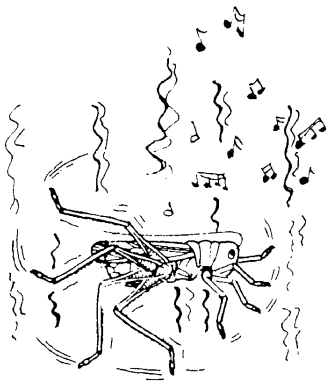
UNIT 14 *Straight Line Graphs* Activities

Activities

ACTIVITY 14.1 *Chirping Crickets*



In forests in many warm and humid parts of the world, crickets can be heard making chirping sounds. The rate at which they chirp varies according to the temperature; the warmer it is, the more quickly they chirp (maybe because they are happy!).

A suggested formula that connects the temperature in degrees Fahrenheit, y, and the number of chirps made in one minute, x, is

$$y = \frac{1}{4}x + 40$$

1. What is the temperature when the number of chirps per minute is

   (a) 60 (b) 80 (c) 100 ?

2. Using axes $0 \le x \le 120$, $0 \le y \le 100$, plot the graph of the function

$$y = \frac{1}{4}x + 40$$

3. Use your graph to predict

   (a) the temperature when there are 71 chirps per minute,

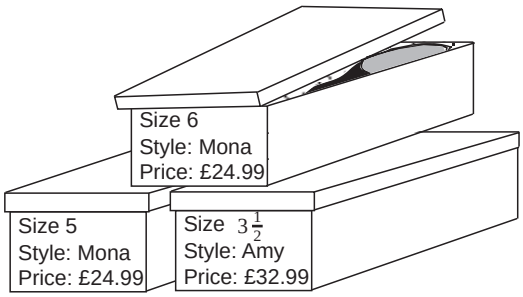
   (b) the number of chirps per minute when the temperature is $67\,^{\circ}\mathrm{F}$.

Extension

What is the relationship between the temperature in degrees Celsius and the number of chirps per minute?

ACTIVITY 14.2 *Shoe Size*

Correct shoe size is important; your feet need room for growth until they are full-size, but not so much room that the shoes will become sloppy and provide inadequate support.



For adults, there is a simple relationship between the length of the foot, x inches, and the adult shoe size, y. This is given by

$$y = 3x - 25$$

(Note that if y is not a whole number, then you must take the next whole number *larger* than the value.)

1. Use the formula to determine the suitable shoe size when

   (a) $x = 9$ inches (b) $x = 11$ inches (c) $x = 11\frac{1}{2}$ inches.

2. With axes $0 \le x \le 15$ and $0 \le y \le 20$, draw the graph of $y = 3x - 25$.

3. Use the graph to estimate the required shoe size when

   (a) $x = 9\frac{1}{2}$ inches (b) $x = 10$ inches (c) $x = 10\frac{1}{2}$ inches.

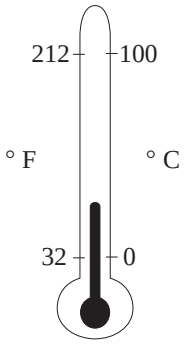
4. Design a ready reckoner that summarises the range of foot lengths suitable for each adult shoe size from 2 to 13.

Extension

(a) Repeat questions 1 and 3, using half-sizes as well as whole number sizes.

(b) Find out about the relationship between the European Shoe Size (Paris Points) and UK sizes.

ACTIVITY 14.3 *Temperature Conversion*



There are two scales for measuring temperatures in common use in the UK:

degrees Fahrenheit (°F), devised by a German physicist, *G D Fahrenheit* (1686–1736),

and

degrees Celsius (°C), devised by a Swedish astronomer, *Anders Celsius* (1701–1744).

The second of these scales was originally known as the 'centigrade' scale, as it uses the $0° - 100°$ range to correspond to the Fahrenheit scale's $32°$ (the temperature at which pure water freezes) to $212°$ (the temperature at which it boils). Temperatures do, of course, exist outside these ranges: for example, temperatures at the polar caps (North and South Poles) *never exceed* 0 °C, while the temperature inside a blast furnace is about 1000 °C. Although the Celsius scale is now used for most purposes, you will find that the Fahrenheit scale is still also in common usage.

1. On coordinate axes, with °C as the x-axis $(0° \le C° \le 100°)$ and °F as the y-axis $(0° \le F° \le 220°)$, plot the two points (0, 32) and (100, 212). Draw the line that passes through these two points.
2. What is the gradient of this line?
3. What is the intercept of the y-axis?
4. What is the formula for F in terms of C ?
5. Use your graph to estimate the following temperatures in °F:

   (a) 20 °C (b) 25 °C (c) 52 °C

   Check your answers using the formula.
6. Use your graph to estimate the following temperatures in °C:

   (a) 59 °F (b) 75 °F (c) 98.4 °F
7. Rewrite the formula in the form °C = ...

Extension

An approximate formula for converting between °C and °F is given by

$$F = 2C + 24$$

By drawing this graph on the set of axes used for question 1, estimate when it is a reasonable approximation to use. At which point does the approximation become exact?

ACTIVITY 14.4 *Mozart*

Wolfgang Amadeus Mozart was born in Salzburg, Austria, on 27 January 1756 and died in Vienna on 5 December 1791. He is one of the best known composers in the history of western music.

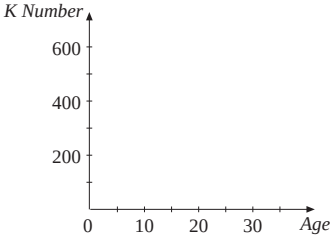
He was a child prodigy and composed a large number of works, using every type of musical composition, and travelling to many countries to perform.

His works were numbered chronologically by a biologist, *Ludwig Ritter von Köchel*, whose catalogue was published in 1862. The following table lists some of Mozart's compositions, each denoted by a 'K' (Köchel) number.

K number	*Date Completed*	*Age* (Years)	*Title*
1	*January 1762*	*6*	*Minuet*
33	*June 1766*	*10*	*Kyrie*
65	*January 1769*		*Dance Music*
123	*April 1770*		*Contredanse*
176	*December 1773*		*Dance Music*
192	*June 1774*		*Missa Brevis (Mass)*
238	*January 1776*		*Piano Concerto No. 6*
271	*January 1777*		*Piano Concerto No. 9*
317	*March 1779*		*Missa (Mass)*
385	*July 1782*		*Symphony No. 35 (Haffner)*
425	*November 1783*		*Symphony No. 36 (Linz)*
470	*April 1785*		*Andante for Strings*
525	*August 1787*		*Serenade (Eine Kleine Nachtmusik)*
551	*August 1788*		*Symphony No. 41 (Jupiter)*
588	*January 1790*		*Opera (Cosi fan tutte)*
620	*September 1791*		*Opera (Die Zauberflote - The Magic Flute)*
626	*December 1791*		*Requiem*

1. Copy and complete the 'Age' column.

2. Plot the data of age (*x*-axis) against K number (*y*-axis), and by eye, draw a line of best fit.



3. Use the graph to estimate Mozart's age when he completed the piano concertos: (a) K453, (b) K491.

4. Estimate how many compositions he had completed by the time he was 30 years old.

5. Estimate the K number for his quartet which was finished on Christmas Day, 1777.

6. Find the equation of your line in question 2, in the form $y = mx + c$, i.e. $\text{K} = m \times \text{age} + c$. Use the equation to answer question 3 and 5 again. Does it give accurate answers?

ACTIVITIES 14.1 - 14.4 Page 1 *Notes for Solutions*

Notes and solutions given only where appropriate.

14.1 1. (a) 55 °F (b) 60 °F (c) 65 °F

2. Graph

3. (a) About 58 °F (b) About 108 per minute

Extension

$$°\text{C} = \frac{5}{36}x + \frac{40}{9}$$

14.2 1. (a) 2 (b) 8 (c) 10 (as the exact vlaue of y is 9.5)

2. Graph

3. (a) 4 (b) 5 (c) 7

4.

Shoe Size	*Foot length* (inches)
2	$9 \le x < 9\frac{1}{3}$
3	$9\frac{1}{3} \le x < 9\frac{2}{3}$
4	$9\frac{2}{3} \le x < 10$
5	$10 \le x < 10\frac{1}{3}$
6	$10\frac{1}{3} \le x < 10\frac{2}{3}$
7	$10\frac{2}{3} \le x < 11$
8	$11 \le x < 11\frac{1}{3}$
9	$11\frac{1}{3} \le x < 11\frac{2}{3}$
10	$11\frac{2}{3} \le x < 12$
11	$12 \le x < 12\frac{1}{3}$
12	$12\frac{1}{3} \le x < 12\frac{2}{3}$
13	$12\frac{2}{3} \le x < 13$

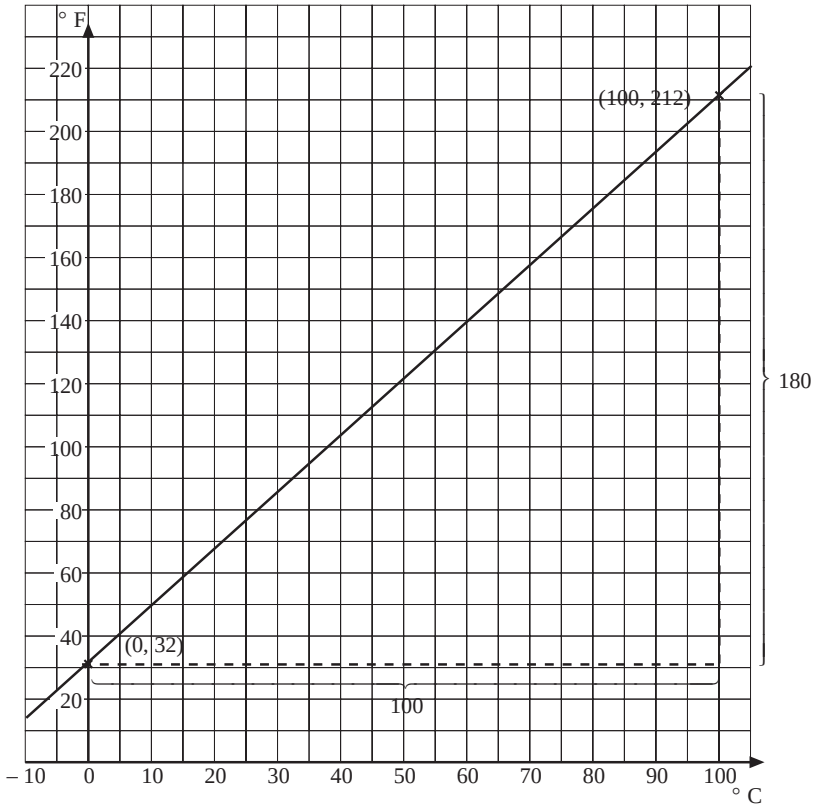
ACTIVITIES 14.1 - 14.4 Page 2 *Notes for Solutions*

14.2 *Extension*

(a) 1. (a) 2 (b) 8 (c) $9\frac{1}{2}$

3. (a) $3\frac{1}{2}$ (b) 5 (c) $6\frac{1}{2}$

14.3 1.



2. $\frac{180}{100} = \frac{9}{5}$

3. 32

4. $F = \frac{9}{5}C + 32$

5. (a) 68 °F (b) 77 °F (c) About 126 °F

6. (a) 15 °C (b) About 24 °C (c) 36.9 °C

7. $°C = \frac{5}{9}(°F - 32)$

ACTIVITIES 14.1 - 14.4 Page 3 *Notes for Solutions*

14.3 *Extension*

Approximation is exact when $2C + 24 = \frac{9}{5}C + 32$, which gives $C = 40$.

14.4 1. *Age Column*

6
10
13
14
17
18
20
21
23
26
27
29
31
32
34
35
35

2. Graph

3. (a) About 28 years (b) About 30 years

4. About 480

5. About K291 $\left(\frac{12}{27} \times 46 + 271\right)$

6. Approximately $K = 24 \times \text{age} - 240$