Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:

Generate points and plot graphs of functions

Use, read and write, spelling correctly:
coordinates, coordinate pair/point, x-coordinate…
grid, origin, axis, axes, x-axis…
variable, straight-line graph, equation (of a graph)…

Generate and plot pairs of coordinates that satisfy a simple linear relationship. For example:

- $y = x + 1$
  (0, 1), (1, 2), (2, 3), (3, 4), (4, 5), …
- $y = 2x$
  (0, 0), (1, 2), (2, 4), (−1, −2), (−2, −4), …
- $y = 10 - x$
  (0, 10), (1, 9), (2, 8), …

Complete a table of values, e.g. to satisfy the rule $y = x + 2$:

x	−3	−2	−1	0	1	2	3
$y = x + 2$	−1	0	1	2	3	4	5

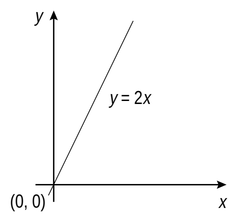
Plot the points on a coordinate grid. Draw a line through the plotted points and extend the line. Then:
- choose an intermediate point, on the line but not one of those plotted;
- read off the coordinate pair for the chosen point and check that it also fits the rule;
- do the same for other points, including some fraction and negative values.

Try this for other graphs.

Recognise that all points on a line will fit the rule.

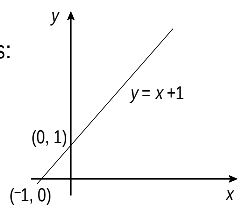
Begin to consider the features of graphs of simple linear functions, where y is given explicitly in terms of x. For example, construct tables of values then use paper or a **graph plotter** to:

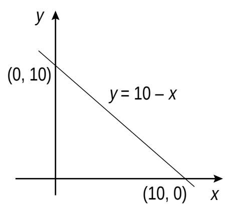
- Plot and interpret graphs such as:
  $y = x$, $y = 2x$, $y = 3x$, $y = 4x$, $y = 5x$



Note that graphs of the form $y = mx$:
– are all straight lines which pass through the origin;
– vary in steepness, depending on the function;
– match the graphs of multiples, but are continuous lines rather than discrete points.

- Plot graphs such as:
  $y = x + 1$, $y = 10 - x$





Note the positive or negative slope of the graph and the intercept points with the axes. Make connections with the value of the constant term.

As outcomes, Year 8 pupils should, for example:

Use vocabulary from previous year and extend to:
linear relationship…
intercept, steepness, slope, gradient…

Generate coordinate pairs and plot graphs of simple linear functions, using all four quadrants. For example:

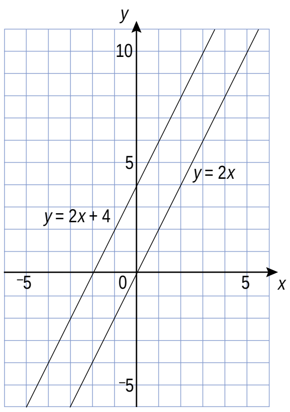
- $y = 2x - 3$
  $(^{-}3, ^{-}9)$, $(^{-}2, ^{-}7)$, $(^{-}1, ^{-}5)$, $(0, ^{-}3)$, $(1, ^{-}1)$, $(2, 1)$, …
- $y = 5 - 4x$
  $(^{-}2, 13)$, $(^{-}1, 9)$, $(0, 5)$, $(1, 1)$, $(2, ^{-}3)$, …

Plot the points. Observe that the points lie in a straight line and draw the line. Read other coordinate pairs from the line (including fractional values) and confirm that they also fit the function.

Recognise that a graph of the form $y = mx + c$:
- corresponds to a straight line, whereas the graph of a linear sequence consists of set of discrete points lying on an 'imagined straight line';
- represents an infinite set of points, and that:
  - the values of the coordinates of each point satisfy the equation represented by the graph;
  - any coordinate pair which represents a point not on the graph does not satisfy the equation.

Plot the graphs of linear functions in the form $y = mx + c$, on paper and using ICT, and consider their features. For example:

- Construct tables of values.
  Plot and interpret graphs such as:
  $y = 2x$, $y = 2x + 1$, $y = 2x + 4$, $y = 2x - 2$, $y = 2x - 5$



  Describe similarities and differences.
  Notice that:
  - the lines are all parallel to $y = 2x$;
  - the lines all have the same gradient;
  - the number (constant) tells you where the line cuts the y-axis (the intercept).

As outcomes, Year 9 pupils should, for example:

Use vocabulary from previous years and extend to:
quadratic function, cubic function…

Plot the graphs of linear functions in the form $ay + bx + c = 0$, on paper and using ICT, and consider their features. For example:

Recognise that linear functions can be rearranged to give y explicitly in terms of x. For example:

- Rearrange $y + 2x - 3 = 0$ in the form $y = 3 - 2x$.
  Rearrange $y/4 - x = 0$ in the form $y = 4x$.
  Rearrange $2y + 3x = 12$ in the form $y = \frac{12 - 3x}{2}$.
- Construct tables of values.
  Plot the graphs on paper and using **ICT**.
  Describe similarities and differences.
- Without drawing the graphs, compare and contrast features of graphs such as:
  $y = 3x$ $y = 3x + 4$ $y = x + 4$
  $y = x - 2$ $y = 3x - 2$ $y = ^{-}3x + 4$

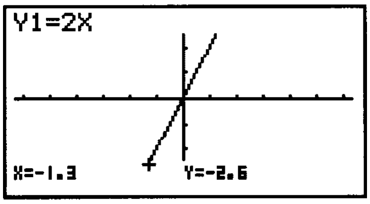
Pupils should be taught to:

Generate points and plot graphs of functions (continued)

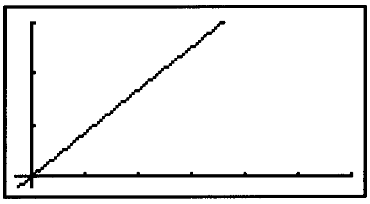
As outcomes, Year 7 pupils should, for example:

Recognise that equations of the form $y = mx$ correspond to straight-line graphs through the origin.

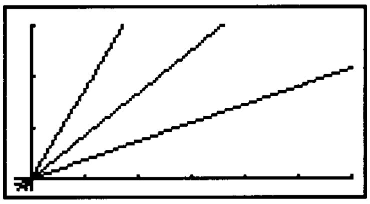
- Use a **graphical calculator** to plot a straight-line graph through the origin, trace along it, and read off the coordinates. Describe the relationship between the values for *x* and the values for *y*.



- Draw the graph of $y = x$.



Draw the graph of a line that is steeper.
Draw the graph of a line that is less steep.



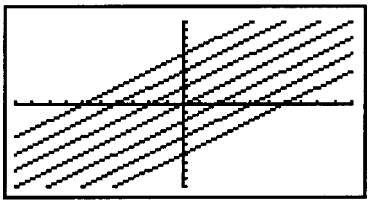
Recognise that equations of the form $y = c$, where c is constant, correspond to straight-line graphs parallel to the *x*-axis, and that equations of the form $x = c$ correspond to straight-line graphs parallel to the *y*-axis.

As outcomes, Year 8 pupils should, for example:

Recognise that equations of the form $y = mx + c$ correspond to straight-line graphs.

Use a **graphical calculator** to investigate the family of straight lines $y = mx + c$.

- Draw the graphs of:
  $y = x + 1$ $y = x + 2$ $y = x + 3$
  $y = x - 1$ $y = x - 2$ $y = x - 3$
  Describe what the value of m represents.
  Describe what the value of c represents.

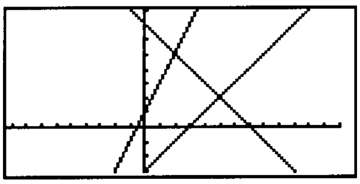


- Use a **graphical calculator** and knowledge of the graph of $y = mx + c$ to explore drawing lines through:
  (0, 5)
  ($^{-}7$, $^{-}7$)
  (2, 6)
  ($^{-}7$, 0) and (0, 7)
  ($^{-}3$, 0) and (0, 6)
  (0, $^{-}8$) and (8, 0)

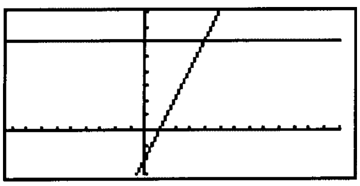
Know and explain the reasons for these properties of functions of the form $y = mx + c$:
- they are all straight lines;
- for a given value of c, all lines pass through the point (0, c) on the y-axis;
- all lines with the same given value of m are parallel.

Use knowledge of these properties to find the equations of straight-line graphs.
For example, use a **graphical calculator** to:

- Find the equations of these straight-line graphs.



- Find some more straight lines that pass through the point (4, 6).



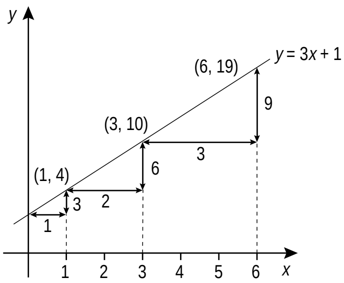
As outcomes, Year 9 pupils should, for example:

Given values for m and c, find the gradient of lines given by equations of the form $y = mx + c$.

Compare changes in y with corresponding changes in x, and relate the changes to a graph of the function. For example:

- $y = 3x + 1$

x	0	1	2	3	4	5
y	1	4	7	10	13	16
Difference	3	3	3	3	3	

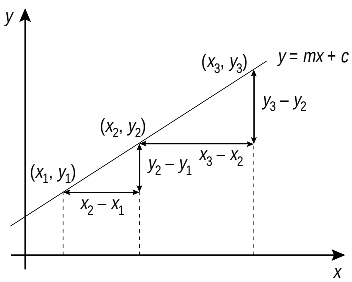


$$\frac{\text{change in } y}{\text{change in } x} = \frac{4-1}{1-0} = \frac{10-4}{3-1} = \frac{19-10}{6-3} = 3$$

Recognise that:
- the change in y is proportional to the change in x;
- the constant of proportionality is 3;
- triangles in the diagram are mathematically similar, i.e. enlargements of a basic triangle.

Know that for any linear function, the change in y is proportional to the corresponding change in x. For example, if A (x_1, y_1), B (x_2, y_2) and C (x_3, y_3) are any three points on the line $y = mx + c$, then

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{y_3 - y_2}{x_3 - x_2} = m$$



Know that for the straight line $y = mx + c$:
- $m = \dfrac{\text{change in } y}{\text{change in } x}$;
- m is called the gradient of the line and is a measure of the steepness of the line;
- if y decreases as x increases, m will be negative;
- lines parallel to the x-axis, e.g. $y = 3$, have gradient 0, and for lines parallel to the y-axis, e.g. $x = 7$, it is not possible to specify a gradient.

Link to properties of linear sequences (pages 148–9), proportionality (pages 78–81), enlargements (pages 212–15), and trigonometry (pages 242–7).

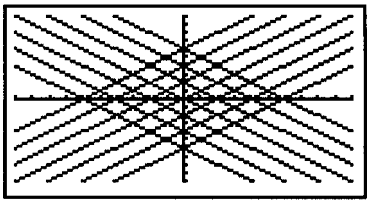
Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Generate points and plot graphs of functions (continued)	

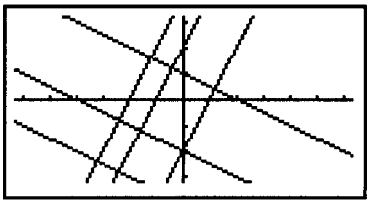
As outcomes, Year 8 pupils should, for example:

As outcomes, Year 9 pupils should, for example:

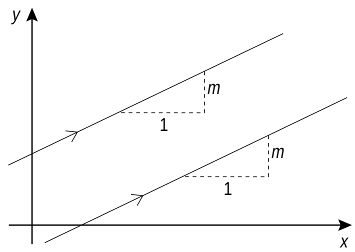
Investigate the gradients of parallel lines and lines perpendicular to the lines. *For example:*

- *Look at pairs of lines $y = m_1x + c_1$ and $y = m_2x + c_2$. Use a* ***graphical calculator*** *to investigate the relationship between m_1 and m_2 when the two lines are parallel and the two lines are perpendicular.*

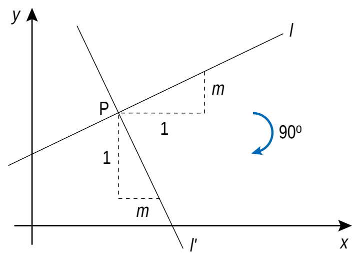




Recognise that any line parallel to a given line will have the same gradient:

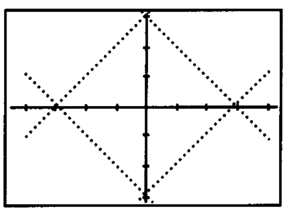
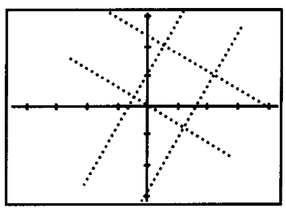


Let l be a line of gradient m, where l is not parallel to either axis. Let l' be a line perpendicular to l. Explain why the gradient of l' is $1/m$.



Use a ***graphical calculator*** *to solve problems such as:*

- *Draw these squares.*

Pupils should be taught to:	As outcomes, Year 7 pupils should, for example:
Generate points and plot graphs of functions (continued)	

As outcomes, Year 8 pupils should, for example:

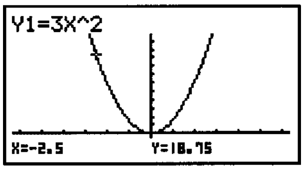
As outcomes, Year 9 pupils should, for example:

Generate points and plot the graphs of simple quadratic or cubic functions, *on paper or using* ***ICT****. For example:*

Construct tables of values, including negative values of x, and plot the graphs of these functions:

- $y = x^2$
- $y = 3x^2 + 4$
- $y = x^3$

Use a ***graphical calculator*** *to plot the graph of, for example,* $y = 3x^2$*. Trace along it. Read coordinates. Describe the relationship between the values for x and the values for y.*



Use a ***graphical calculator*** *to explore the effect of changing the values of the parameters a and c in the following functions:*

- $y = x^2 + c$
- $y = x^3 + c$
- $y = ax^2$

Construct a table of values and plot the graph of a general quadratic function. For example:

- $y = 2x^2 - 3x + 4$

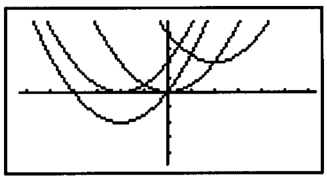
x	-2	-1	0	1	2	3	4
x^2	4	1	0	1	4	9	16
$2x^2$	8	2	0	2	8	18	32
$-3x$	6	3	0	-3	-6	-9	-12
+4	4	4	4	4	4	4	4
y	18	9	4	3	6	13	24

Recognise that (1, 3) is not the lowest point on the graph. Identify the axis of symmetry.

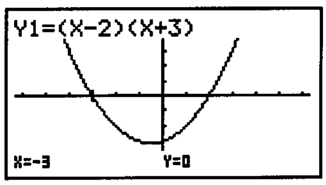
Use a ***graphical calculator*** *to investigate graphs of functions of the form* $y = ax^2 + bx + c$*, for different values of a, b and c.*

- *Investigate families of curves such as:*

  $y = ax^2$
  $y = (x + b)^2$
  $y = x^2 + c$
  $y = (x + b)^2 + c$



$y = (x + a)(x + b)$



Link to properties of quadratic functions (pages 162–3).

Pupils should be taught to:

Construct functions arising from real-life problems, and plot and interpret their corresponding graphs

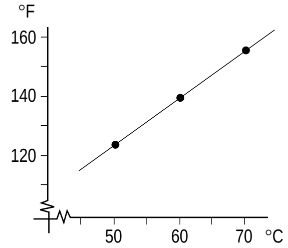
As outcomes, Year 7 pupils should, for example:

Begin to plot the graphs of simple linear functions arising from real-life problems.

In plotting such graphs:

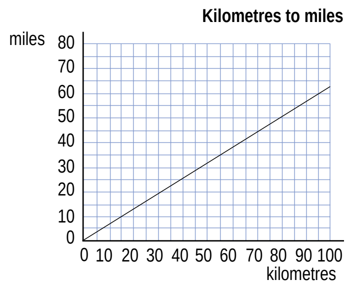
- know that scales are usually marked with multiples of the value (or variable) at equal spaces along the axis and often, but not always, start at zero;
- suggest suitable scales for the axes, based on the range of values to be graphed;
- decide how many points need to be plotted in order to draw an accurate graph;
- when appropriate, construct a table of values;
- know conventions for giving a title and labelling the axes;

- know the conventions for marking axes when scale(s) do not start from 0, e.g.

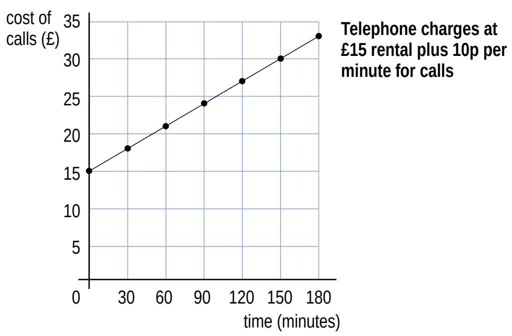


For example:

- Plot a conversion graph, e.g. converting from metric to imperial units or from degrees Fahrenheit to degrees Celsius.



- Plot a graph of charges, e.g. for fuel or mobile telephone calls, based on a fixed charge and a charge per unit consumed.



Use **ICT** to generate graphs of real data.

As outcomes, Year 8 pupils should, for example:

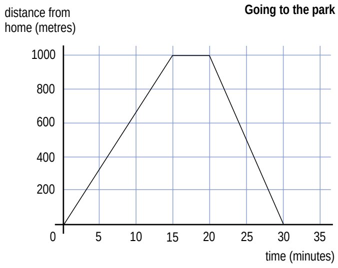
Construct linear functions arising from real-life problems and plot their corresponding graphs.

In plotting such graphs:

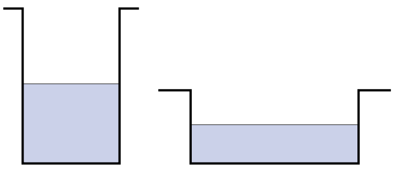
- write the appropriate formula;
- decide how many points to plot;
- construct a table of values;
- choose suitable scales for the axes;
- draw the graph with suitable accuracy;
- provide a title and label the axes.

For example:

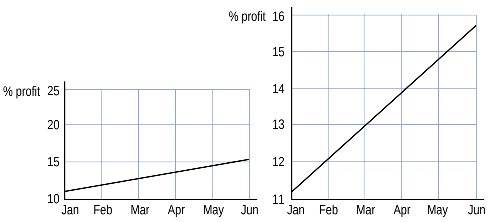
- Plot a simple distance–time graph.



- Sketch a line graph to show the depth of water against time when water runs steadily from a tap into these jars.

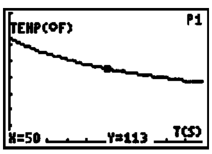


Begin to recognise that the choice of different scales and starting points can have a significant effect on the appearance of a graph, and can mislead or leave data open to misinterpretation. For example:



Use **ICT** to generate graphs of real data. For example:

- Use a **temperature probe** and **graphical calculator** to plot a cooling curve.



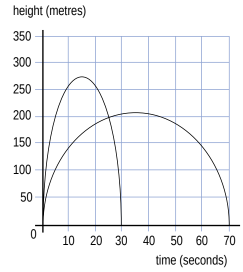
Link to line graphs (pages 264–5).

As outcomes, Year 9 pupils should, for example:

Construct functions arising from real-life problems and plot their corresponding graphs.

Draw and use graphs to solve distance–time problems. For example:

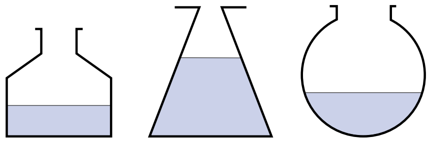
- This graph shows how high two rockets went during a flight. Rocket A reached a greater height than rocket B.



  Estimate how much higher rocket A reached than rocket B.
  Estimate the time after the start when the two rockets were at the same height.
  Estimate the number of seconds that rocket A was more than 200 m above the ground.

Sketch a line graph for the approximate relationship between two variables, relating to a familiar situation. For example:

- Sketch a graph of the depth of water against time when water drips steadily from a tap into these bottles.

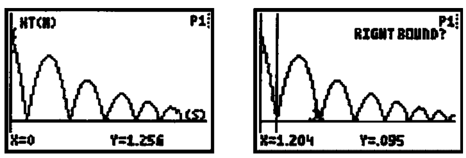


  Sketch graphs for other shapes of bottle.
  Predict the bottle shape from the shape of a graph.

- Sketch a graph of the number of hours of daylight at different times of the year.

Use **ICT** to generate graphs of real data. For example:

- Use a **motion detector** and **graphical calculator** to plot the distance–time graph of a bouncing ball.



Link to line graphs (pages 264–5).

Pupils should be taught to:

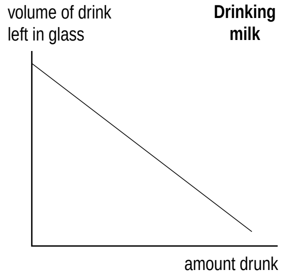
Construct linear functions arising from real-life problems, and plot and interpret their corresponding graphs (continued)

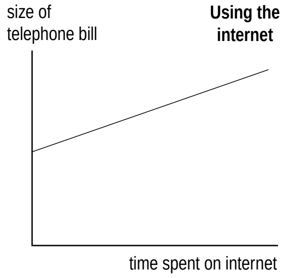
As outcomes, Year 7 pupils should, for example:

Discuss and begin to interpret graphs of linear functions, including some drawn by themselves and some gathered from other sources, such as a newspaper or the **Internet**.

For example:

Explain graphs such as:





In interpreting the graphs of functions:

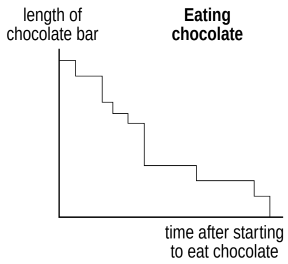
- read values from a graph;
- say whether intermediate points have any practical significance;
- say how the variables are related, e.g. they increase together.

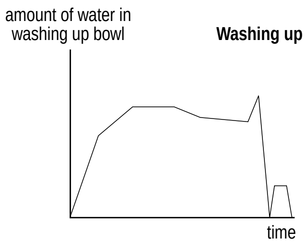
As outcomes, Year 8 pupils should, for example:

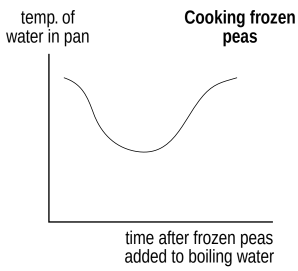
Discuss and interpret graphs of functions from a range of sources.

For example:

Give plausible explanations for the shape of graphs such as:







In interpreting the graphs of functions:

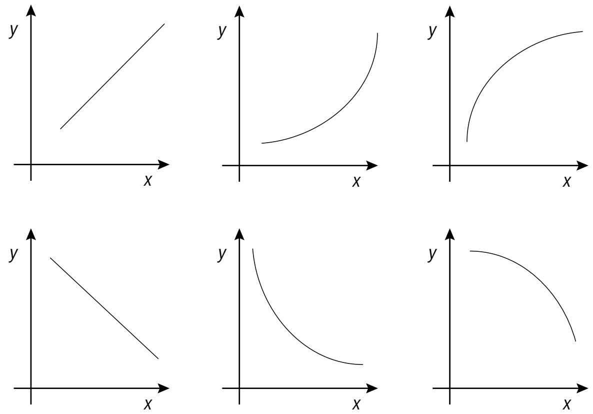
- read values from a graph;
- discuss trends, the shape of the graph and how it is related to the variables and the context represented.

As outcomes, Year 9 pupils should, for example:

Discuss and interpret a range of graphs arising from real situations.

For example:

For each of the situations below, suggest which sketch graph has a shape that most accurately describes it:



- the distance (y) travelled by a car moving at constant speed on a motorway, plotted against time (x);
- the number (y) of litres of fuel left in the tank of a car moving at constant speed, plotted against time (x);
- the distance (y) travelled by an accelerating racing car, plotted against time (x);
- the number (y) of dollars you can purchase for a given amount in pounds sterling (x);
- the temperature (y) of a cup of tea left to cool to room temperature, plotted against time (x);
- the distance (y) you run, plotted against time (x), if you start by running flat out, gradually slowing down until you collapse from exhaustion;
- the amount (y) of an infection left in the body as it responds to treatment, slowly at first, then more rapidly, plotted against time (x).

Choose phrases from these lists to describe graphs such as those above.

a. When x is large:
y is large;
y is small;
y becomes zero.

b. When x is small:
y is large;
y is small;
y becomes zero.

c. As x increases by equal amounts:
y increases by equal amounts;
y increases by increasing amounts;
y increases by decreasing amounts;
y decreases by equal amounts;
y decreases by increasing amounts;
y decreases by decreasing amounts.

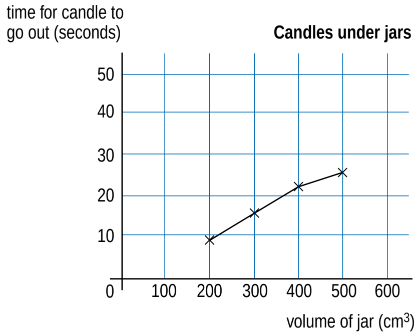
Pupils should be taught to:

Construct linear functions arising from real-life problems, and plot and interpret their corresponding graphs (continued)

As outcomes, Year 7 pupils should, for example:

Discuss and interpret straight-line graphs from science or geography. For example:

- Some pupils put a lighted candle under jars of different sizes. The jars varied from 200 cm³ to 500 cm³ in volume. They timed how long the candle took to go out.



Discuss features of the graph. For example:

Can we join the points up?
How many points (experiments) are needed to give an accurate picture?
Should the points be joined by straight lines?

How long do you think the candle would take to go out under a jar of 450 cm³? Of 600 cm³?
Suppose you wanted the candle to burn for 20 seconds. Under which jar would you put it?

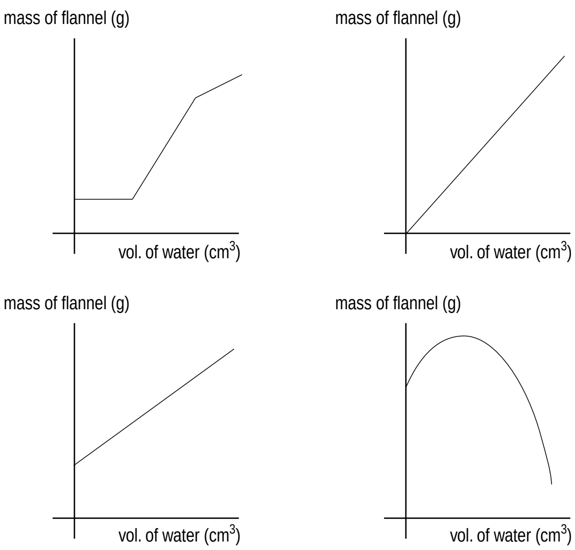
What kind of shape is the graph?
Which of the four sentences below best describes the relationship between the volume of the jar and the time it takes for the candle to go out?

A. The greater the volume, the shorter the time for the candle to go out.
B. The biggest jar kept the candle going longest.
C. As the volume of the jar increases, so the time gets longer.
D. The candle went out most quickly under the smallest jar.

As outcomes, Year 8 pupils should, for example:

Discuss and interpret line graphs from other subjects. For example:

- Some pupils poured different volumes of water on to a small towelling flannel. Each time they found its mass.
  The water was always completely absorbed or soaked up by the flannel.
  Which would be the most likely line for their graph?



- Some very hot water is placed in three test tubes and its temperature recorded over time.
  The first tube has no wrapping.
  The second tube has a wrapping of ice.
  The third tube has a wrapping of plastic foam.
  Sketch the temperature graph for each tube.

Draw and discuss graphs with discontinuities: for example, postal charges for packets of different weights.

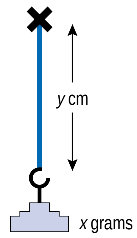
Link to interpreting and discussing results (pages 268–71).

As outcomes, Year 9 pupils should, for example:

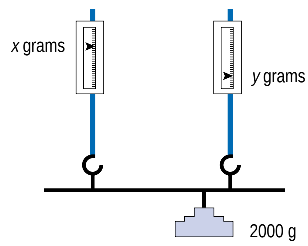
Discuss and interpret linear and non-linear graphs from other subjects. For example:

Think about how *y* will vary with *x* in these situations, and describe and sketch a graph to show each relationship.

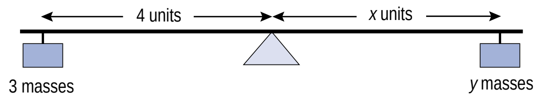
- A mass of *x* grams is suspended from a piece of elastic which stretches to a length of *y* cm.



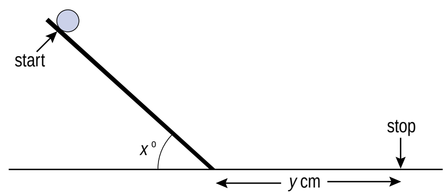
- A thin rod is hung from two spring balances.
  A 2 kg mass is hung from the rod and can be slid along in either direction. The reading on the left-hand balance is *x* grams and on the right-hand balance is *y* grams.



- A balance is arranged so that 3 equal masses are placed on the left-hand side at a distance of 4 units from the pivot. On the right-hand side *y* masses are placed *x* units from the pivot.



- A ball bearing is rolled down a plane inclined at an angle of $x°$. It comes to rest at a horizontal distance of *y* cm from the bottom of the plane.



Draw and discuss graphs with discontinuities: for example, a graph of $[x]$, the greatest integer less than or equal to x.

Link to interpreting and discussing results (pages 268–71).