

Elements of a graph

In many experiments, we make measurements to collect data. A graph is a pictorial way of presenting a set of data. It can help analyze the data in the following ways.

- 1 It allows you to easily see how one physical quantity is related to another, e.g. whether they are directly proportional to each other.
- 2 It can be used to determine the constants in an equation relating two physical quantities, e.g. slope and intercepts of a straight-line graph.
- 3 It provides the best way of ‘averaging’ a set of data, thus reducing the effect of the errors of individual measurements.

The following example shows what elements are included in a graph.

Example

In an experiment, a beaker of water is heated by a Bunsen burner. The temperature of the water at different time instants is measured and recorded in the table below. Plot a graph of temperature against time.

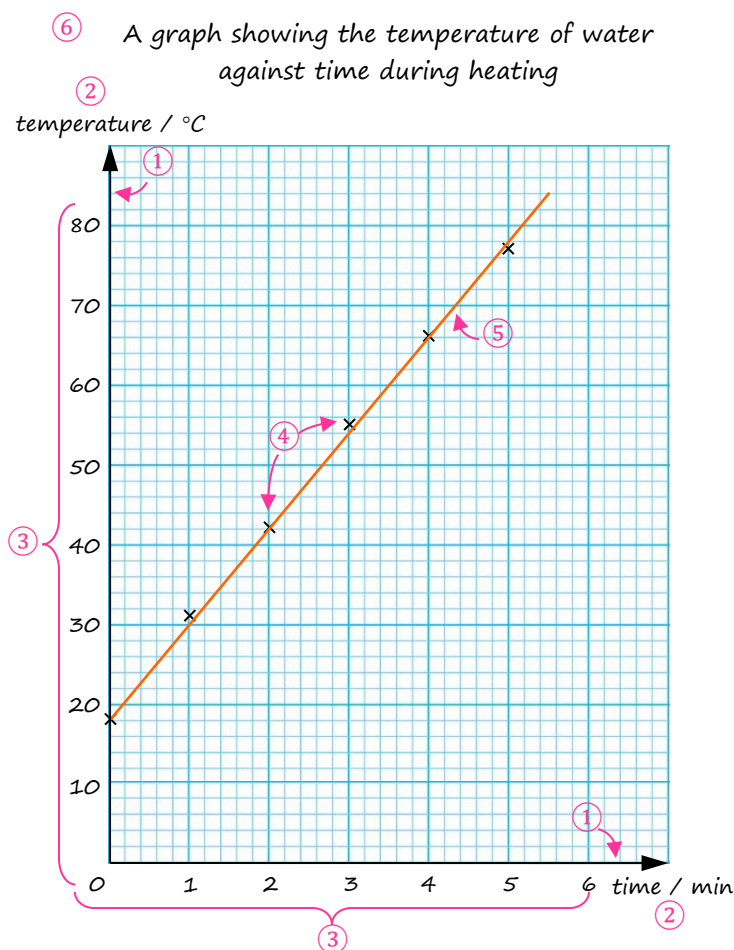
Time / min	0	1	2	3	4	5
Temperature / °C	18	31	42	55	66	77

Solution

Add the following items on graph paper.

- ① **Vertical and horizontal axes**
- ② **Variable and unit for each axis**
- ③ **Scale on each axis:** carefully chosen to let the graph fill most of the graph paper
- ④ **Data points:** usually marked by ‘x’ or ‘•’
- ⑤ **Line showing the trend:** If a straight-line graph is expected, draw a line of best fit. Such a straight line passes through most of the points and those not on the line are evenly spaced about it. If a straight-line graph is not expected, draw a smooth curve.
- ⑥ **Title (if necessary):** describing what the graph is about

* A graph should be drawn with a sharp pencil. All straight lines (the axes and the line of best fit) should be drawn with a ruler.



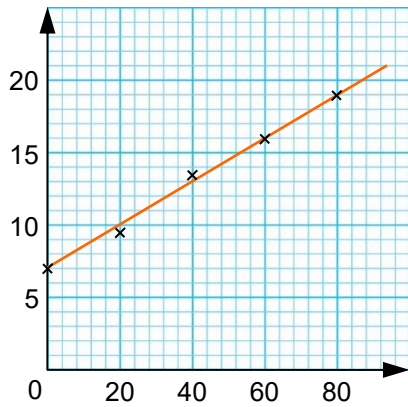
Exercise

1 What is the problem with each of the following graphs? Choose the answer from the box below.

- A The axis scale is not suitably chosen.
- B The axes are not properly labelled.
- C The line of best fit is not correctly drawn.
- D Data points are not accurately marked.

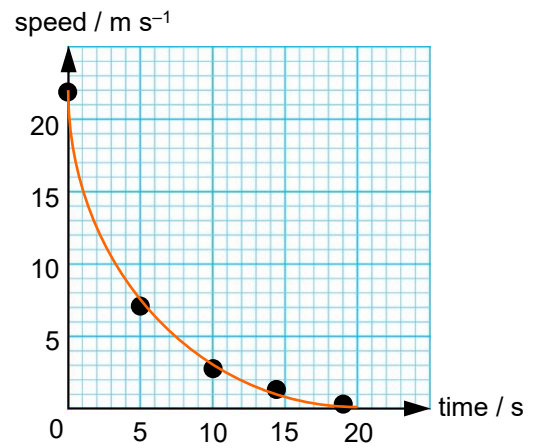
(a)

A graph of length of the liquid column in an alcohol-in-glass thermometer against temperature



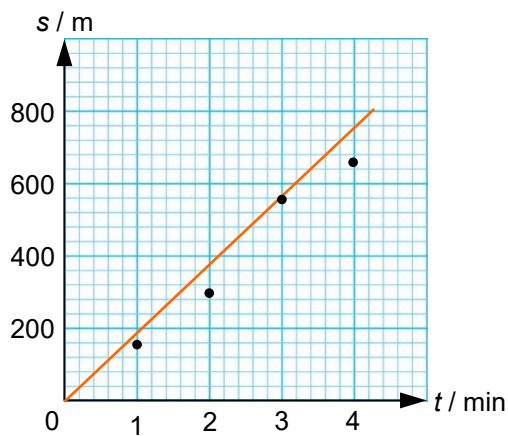
(b)

A graph showing the speed of a car against time



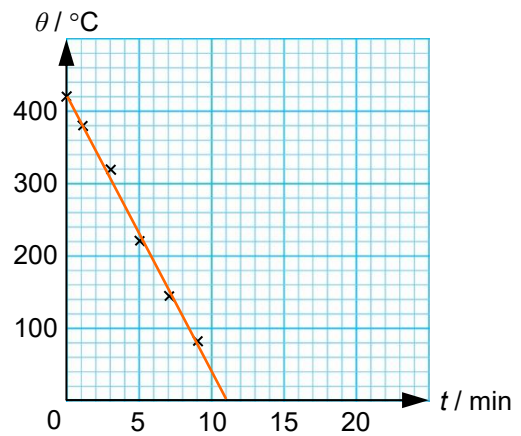
(c)

A graph showing the distance travelled s against time t



(d)

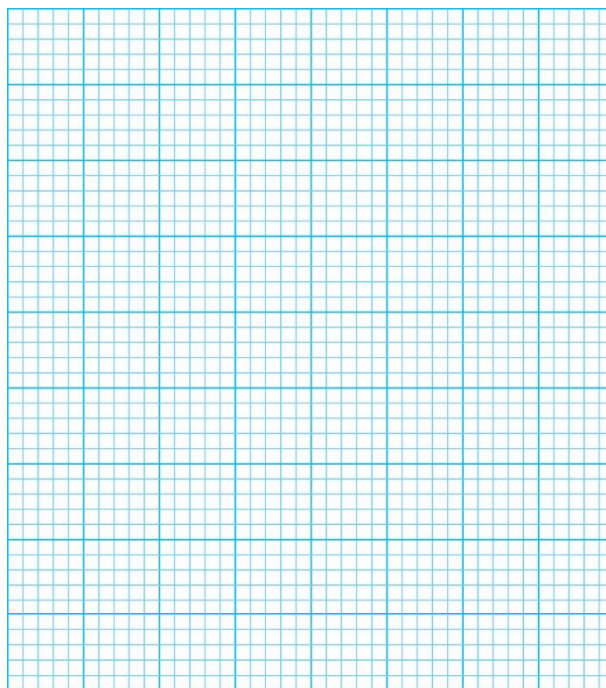
A graph showing the temperature θ of a metal block against time t



- 2 A hot object is allowed to cool at a constant rate. The temperature θ of the object at different time instants t is recorded in the table below.

t / min	0	10	20	30	40	50	60	70
$\theta / ^\circ\text{C}$	78	72	68	58	49	44	40	34

- (a) (i) Plot a graph of θ against t on the graph paper provided below.



- (ii) Is the graph a straight line or a curve?

- (b) Estimate the temperature of the object at $t = 45$ min.

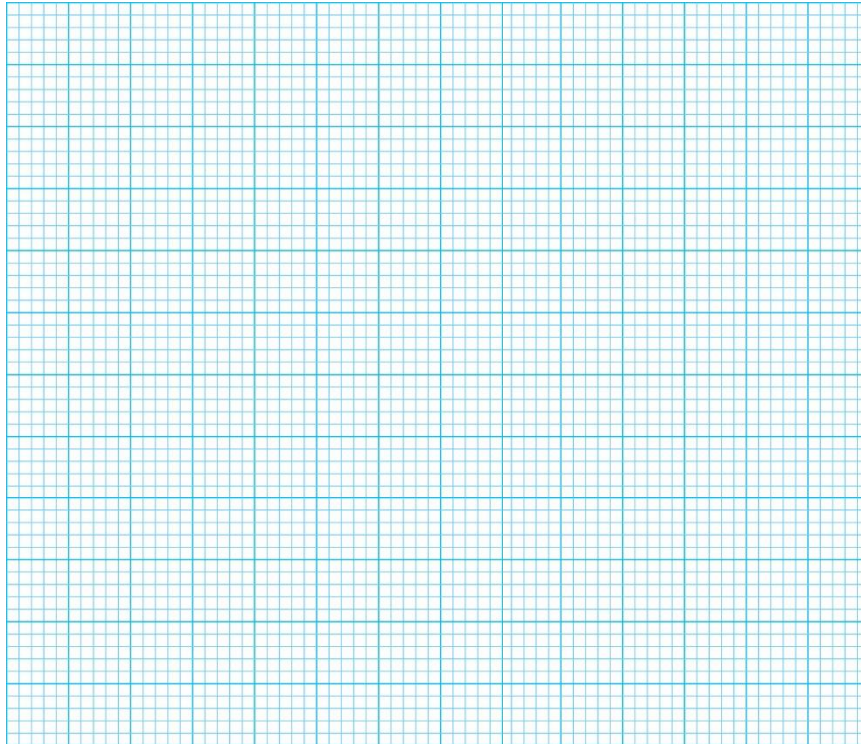
Elements of a graph

3 The resistance of a thermistor in a thermistor thermometer decreases when the temperature increases.

The table below shows the resistance R at various temperatures T .

$T / ^\circ\text{C}$	0	8	16	24	32	40	48	56	64	72	80
R / Ω	900	580	380	250	160	105	70	45	35	22	10

(a) Plot a graph to show how R changes with T .

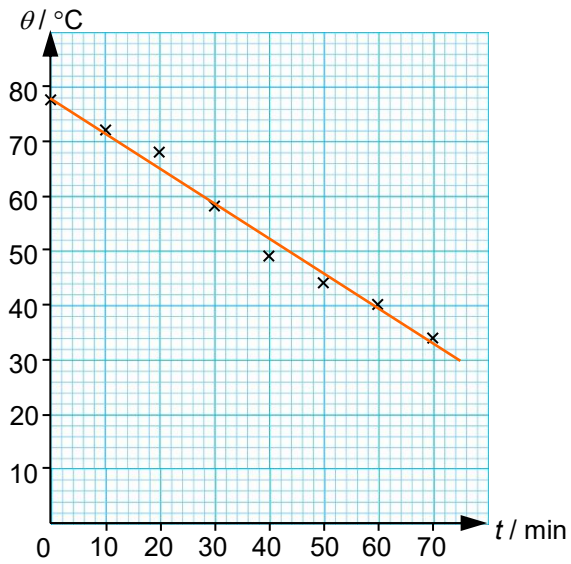


(b) What is the temperature when the resistance is 200Ω ?

Answers

- 1 (a) B
 (b) D
 (c) C
 (d) A

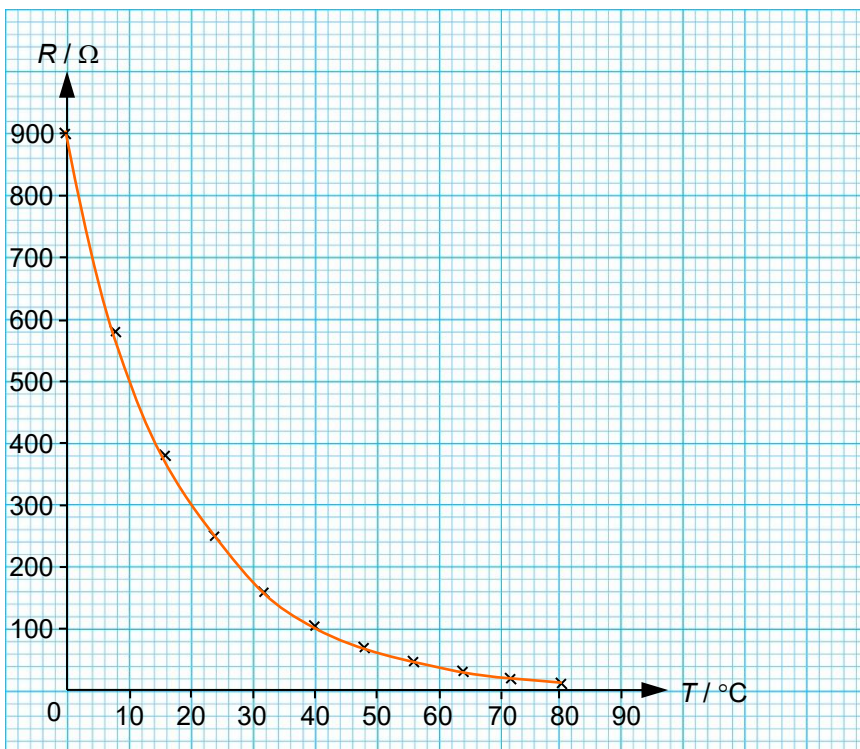
2 (a) (i)



(ii) A straight line

(b) At $t = 45$ min, the temperature is $49\text{ }^{\circ}\text{C}$.

3 (a)



(b) When $R = 200\ \Omega$, the temperature is $28\text{ }^{\circ}\text{C}$.