

# 19 Scale Drawing

## 19.1 Measuring Lengths

In this section we consider which units to use when measuring lengths, estimating lengths, and the errors made when measuring.

$$1 \text{ cm} = 10 \text{ mm}$$

$$1 \text{ m} = 100 \text{ cm}$$

$$1 \text{ km} = 1000 \text{ m}$$



### Example 1

Which unit of length is the most appropriate to measure:

- (a) your height,
- (b) the height of a block of flats,
- (c) the length of your foot,
- (d) the thickness of your maths book,
- (e) the distance between your school and the nearest other school?



### Solution

- (a) cm
- (b) m
- (c) cm
- (d) mm
- (e) probably km



### Example 2

Estimate the lengths of each of the following:

- (a) a car,
- (b) the width of your thumbnail,
- (c) the length of your pen.



### Solution

- (a) This will depend on the type of car, but answers between 2 m and 4 m are reasonable.

- (b) Between 1 cm and  $1\frac{1}{2}$  cm (or between 10 mm and 15 mm).
- (c) 15 cm.



### Example 3

A line is measured to the nearest centimetre as 12 cm.

- (a) What is the *shortest* possible length of the line?
- (b) What length must the actual length of the line be *less than*?



### Solution

- (a) 11.5 cm, as this is the shortest length that rounds to 12 cm.
- (b) 12.5 cm, as this is the shortest length that rounds to 13 cm, rather than to 12 cm.

The answers in Example 3 are called  
*upper and lower bounds*

*Note:* the answer to Example 3 (a) is called the *lower bound* of the length;  
the answer to Example 3 (b) is called the *upper bound*.



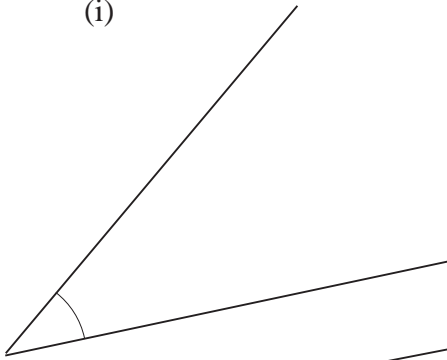
### Exercises

- Which unit of length would be the most appropriate if you were measuring:
  - the distance between two towns,
  - the height of your classroom,
  - the length of a calculator,
  - the thickness of a dictionary,
  - the height of your desk?
- Choosing suitable units estimate the following distances:
  - the length of your classroom,
  - the height of your teacher,
  - the height of your classroom,
  - the length of your little finger,
  - the width of your desk.

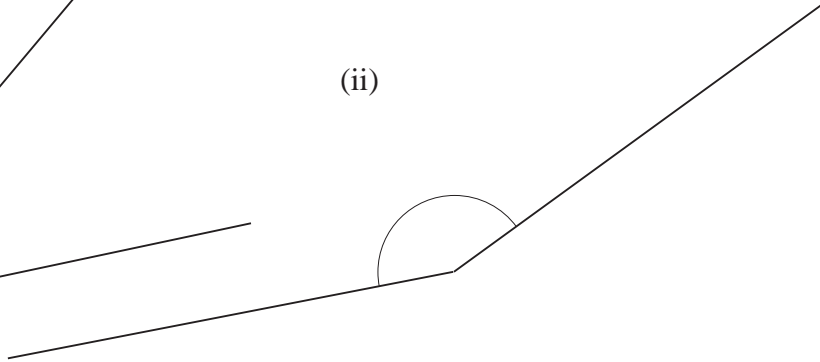
3. Are each of the following statements likely to be *true* or *false*?
- (a) John's height is 242 cm.
  - (b) The height of a desk is 1.2 m.
  - (c) The height of a door is 190 cm.
  - (d) The length of a football pitch is 800 m.
  - (e) The length of a finger is 8 cm.
  - (f) The thickness of a sheet of paper is 1 mm.
4. The length of a line is measured as 10 cm, to the nearest cm. What are the upper and lower bounds of its actual length?
5. The length of a pen is measured as 16 cm, to the nearest cm. What is the minimum possible length of the pen?
6. The distance between 2 airports is 1700 km, correct to the nearest 100 km.
- (a) What are the upper and lower bounds of the actual distance?
  - (b) What would be your answers to (a) if the information was correct to the nearest 10 km?
7. The end of Andy's tape measure is broken, and all the distances that he measures are 1 cm shorter than he thinks. Is this error significant when he measures:
- (a) 5 cm,
  - (b) 5 m,
  - (c) 20 cm,
  - (d) 1 m?
8. (a) Estimate the lengths of each of these lines to the nearest cm:
- (i) \_\_\_\_\_
  - (ii) \_\_\_\_\_
  - (iii) \_\_\_\_\_
  - (iv) \_\_\_\_\_
  - (v) \_\_\_\_\_
  - (vi) \_\_\_\_\_
- (b) Measure the lengths of each line, correct to the nearest cm.
- (c) Explain why you would get more sensible results if you measured the lines to the nearest mm.

9. (a) Estimate the size of each of these angles:

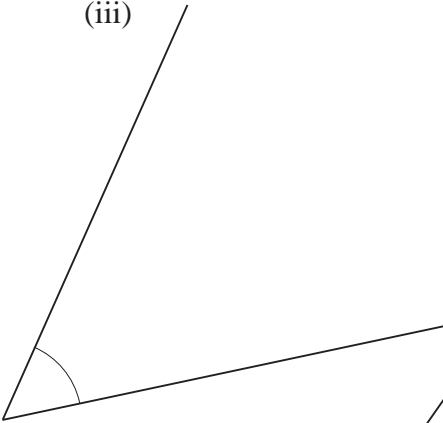
(i)



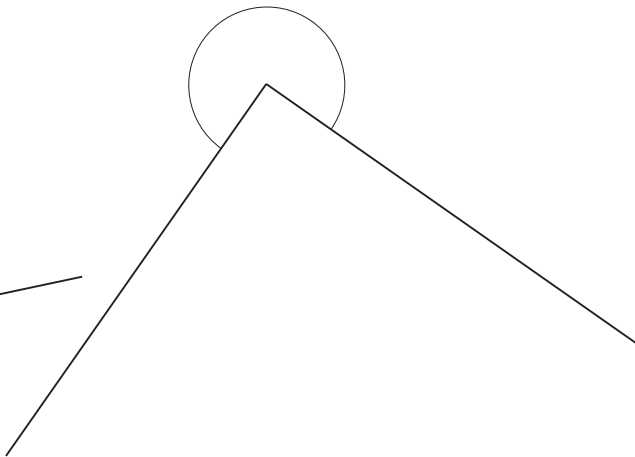
(ii)



(iii)

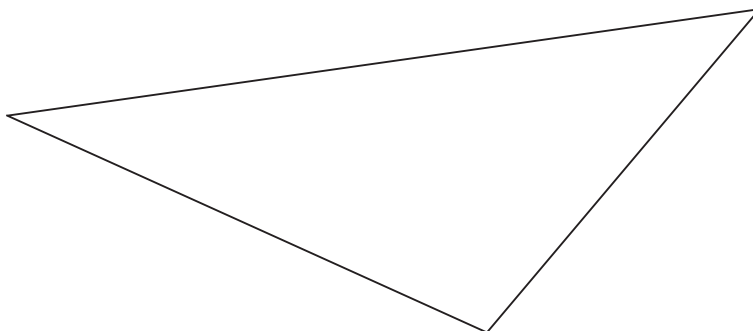


(iv)



- (b) Measure the size of each angle to see how good your estimates were.

10. (a) Measure the 3 angles in this triangle:



- (b) Check that they add up to  $180^\circ$ .

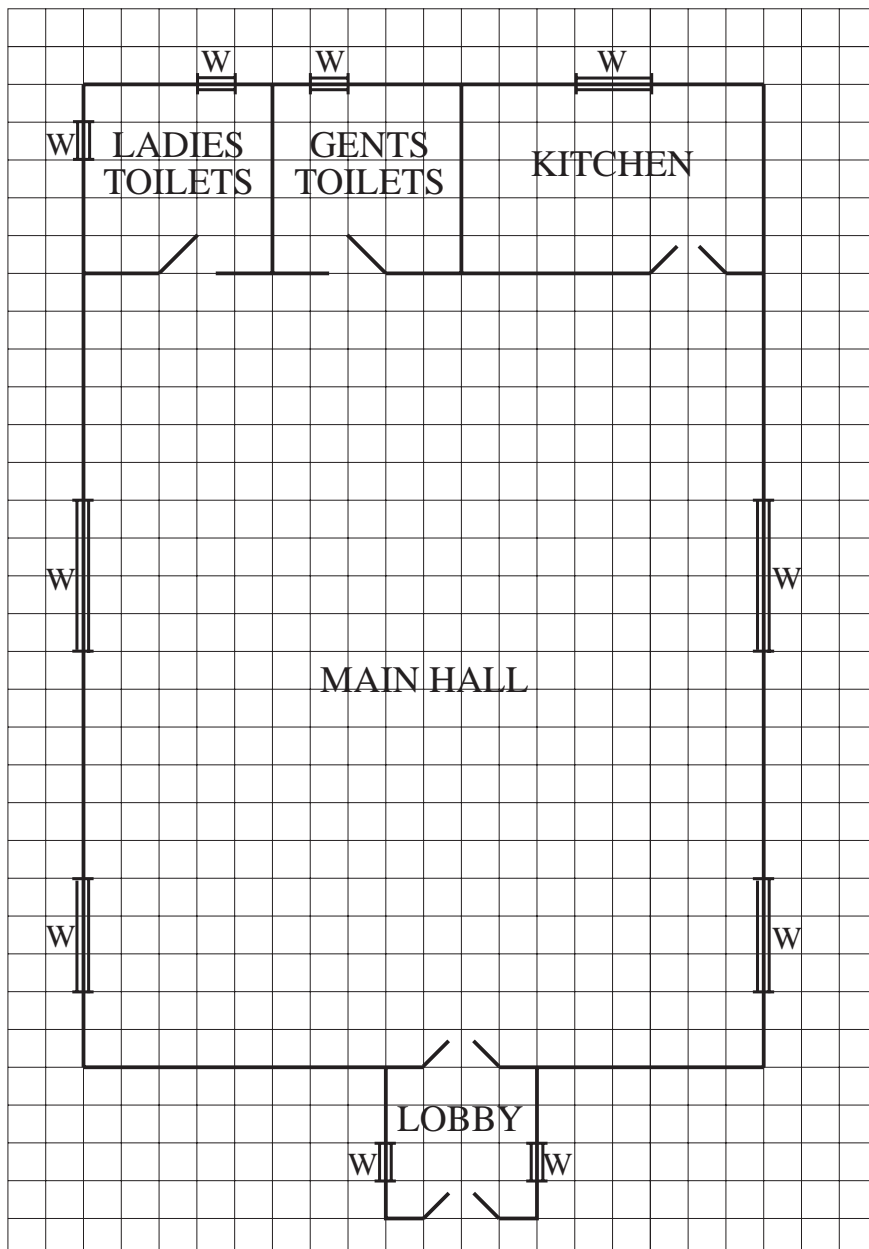
## 19.2 Plans

Plans are drawn using a scale such as 1 : 100. This means that 1 cm on the plan represents 100 cm, or 1 m, in real life. In this section we consider how to take measurements from plans and how to draw plans.



### Example 1

The diagram shows the plan of a village hall, on a scale of 1 : 100.



What are the 'real life' measurements for:

- the dimensions of the kitchen,
- the dimensions of the gents toilet,

- (c) the length of the main hall,  
 (d) the area of the lobby,  
 (e) the length of the kitchen window?



### Solution

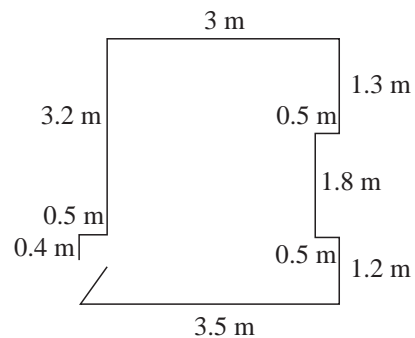
- (a) On the plan the kitchen is 4 cm by 2.5 cm. In reality these distances are 100 times larger, that is,  $4 \times 100 = 400$  cm by  $2.5 \times 100 = 250$  cm, or 4 m by 2.5 m.
- (b) On the plan the gents toilet is 2.5 cm by 2.5 cm. In reality it is 250 cm by 250 cm, or 2.5 m by 2.5 m.
- (c) The length of the main hall is 10.5 cm on the plan. In reality it will be 1050 cm, or 10.5 m.
- (d) On the plan the lobby is 2 cm by 2 cm. This corresponds to actual dimensions of 2 m by 2 m, so
- $$\begin{aligned} \text{area} &= 2 \times 2 \\ &= 4 \text{ m}^2 \end{aligned}$$
- (e) The length of this window on the plan is 1 cm. The actual length will be 100 cm, or 1 m.



### Example 2

Veronica makes a rough sketch of her bedroom and measures the lengths of the walls.

Draw an accurate plan of Veronica's bedroom, using a scale of 1 : 50.



### Solution

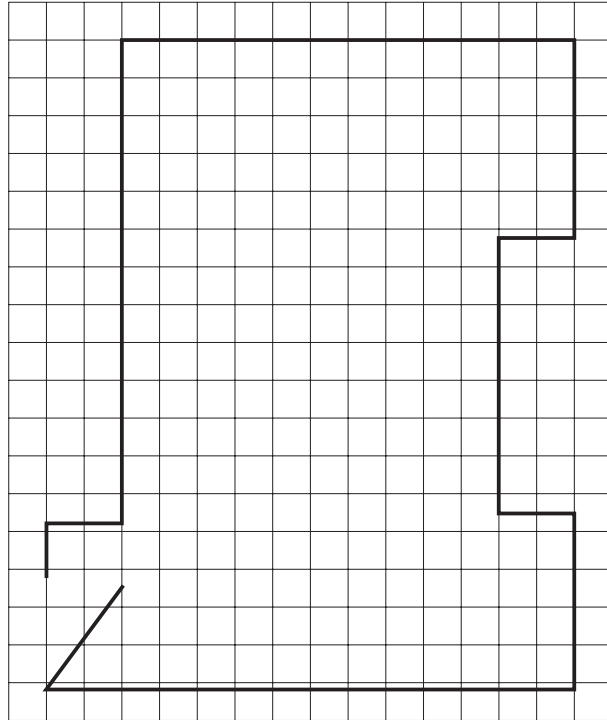
A scale of 1 : 50 means that 1 cm on the plan will represent an actual distance of 50 cm.

All the distances on the sketch must be divided by 50 to find the distances that should be used on the plan.

The table shows these distances:

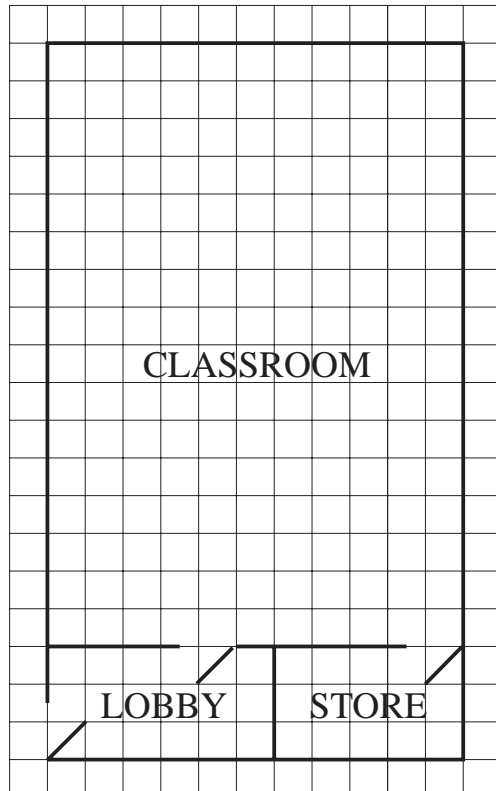
Actual Size in m	Actual Size in cm	Size on Plan in cm
3	300	$300 \div 50 = 6$
1.3	130	$130 \div 50 = 2.6$
1.8	180	$180 \div 50 = 3.6$
1.2	120	$120 \div 50 = 2.4$
3.5	350	$350 \div 50 = 7$
0.4	40	$40 \div 50 = 0.8$
0.5	50	$50 \div 50 = 1$
3.2	320	$320 \div 50 = 6.4$

The plan can then be drawn accurately, as shown in the diagram.

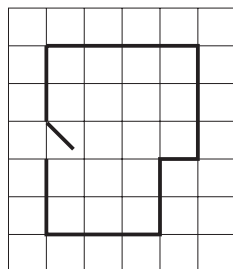


### Exercises

- This is a plan of a temporary building at a school. It is drawn using a scale of 1 : 100.  
 What are the actual measurements of:
  - the length of the classroom,
  - the width of the classroom,
  - the dimensions of the lobby,
  - the dimensions of the store?

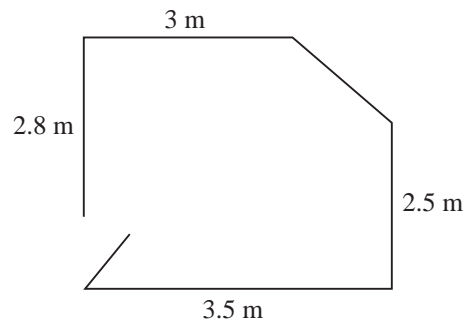


- Adam draws a plan of his bedroom using a scale of 1 : 200. Find the actual lengths of the walls in his bedroom.



3. Jai's garage is 3 m wide and 8 m long. What would be the dimensions of this garage on a plan with a scale of:
- 1 to 100,
  - 1 to 200,
  - 1 to 50,
  - 1 to 10,
  - 1 to 20?
4. On a plan with a scale of 1 : 50, the floor of a rectangular cupboard is shown with dimensions 2.5 cm by 3.6 cm. What are the actual dimensions of the floor? Give your answers in metres.

5. Alice draws this sketch of her bedroom.  
The doorway is 0.7 m wide.

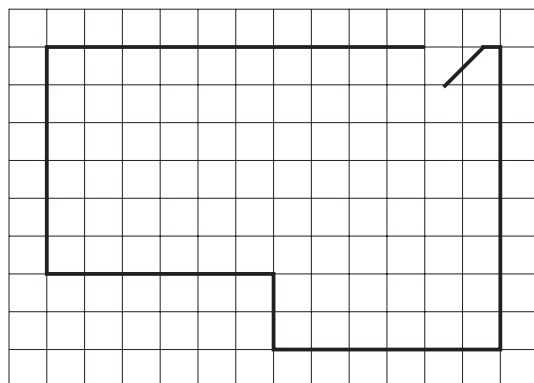


- Draw a plan of this room using a scale of 1 : 50.
  - Calculate the actual length of the wall that is *not* at right angles to the other walls.
6. On a plan, an actual length of 5 m is represented by 25 cm. What is the scale of the plan?
7. A rectangular room has dimensions 4 cm by 5 cm on a plan with a scale of 1 : 120.
- What are the actual dimensions of the room in metres?
  - What is the floor area of the room?
  - What is the length of the longest straight line that could be drawn on the floor of the room?

8. This diagram shows the plan of a room, drawn using a scale of 1 : 200.

Calculate:

- the perimeter of the room,
- the total floor area of the room,
- the length of the longest straight line that could be drawn on the floor of the room.

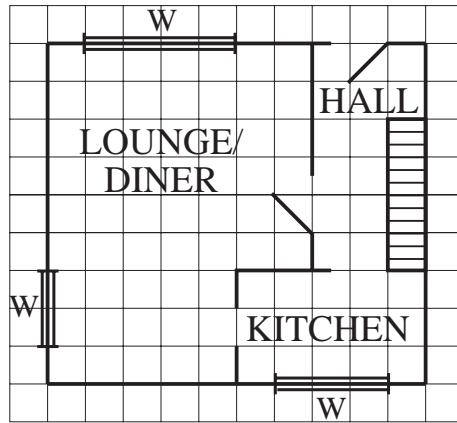




9. The diagram shows the plan of the ground floor of a house, using a scale of 1 : 120.

Calculate the following:

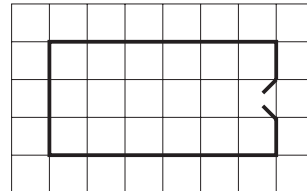
- (a) the total length of the two windows in the lounge/diner,
- (b) the floor area of the kitchen,
- (c) the total floor area of the lounge/diner,
- (d) the floor area of the hall, excluding the stairs.



10. The diagram shows the plan of a workshop.

The area of the workshop floor is 72 m<sup>2</sup>.

- (a) What actual area does each small square on the grid represent?
- (b) What length does 5 mm on the plan represent?
- (c) What is the scale of the plan?



## 19.3 Maps

Scales are used on maps in the same way that they are used in plans. A scale of 1 : 50 000 is used on many Ordnance Survey maps. This means that 1 cm on the map represents an actual distance of 50 000 cm (or 500 m or 0.5 km).

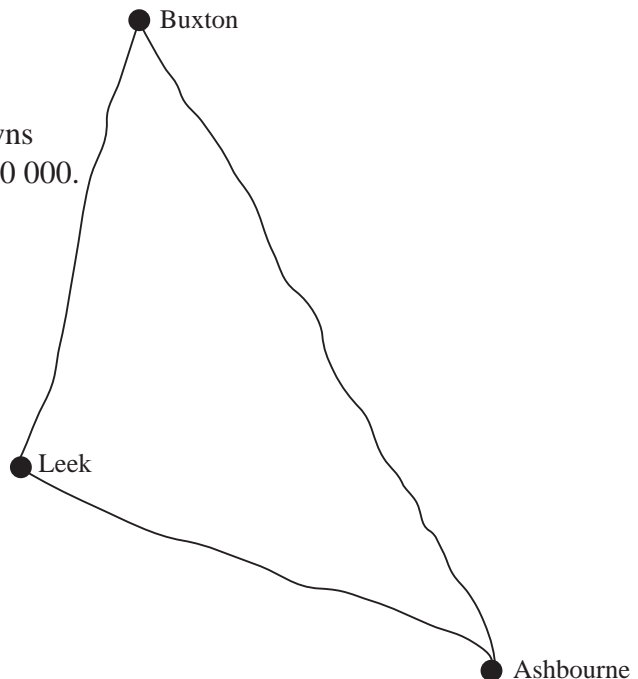


### Example 1

This map shows roads linking 3 towns and is drawn using a scale of 1 : 300 000.

What is the actual distance on a straight line between:

- (a) Buxton and Ashbourne,
- (b) Buxton and Leek?





## Solution

- (a) The distance between Buxton and Ashbourne is 9.8 cm on the map.

$$\begin{aligned} \text{Actual distance} &= 9.8 \times 300\,000 \\ &= 2\,940\,000 \text{ cm} \\ &= 29\,400 \text{ m} \\ &= 29.4 \text{ km} \end{aligned}$$

- (b) The distance between Buxton and Leek on the map is 6.1 cm.

$$\begin{aligned} \text{Actual distance} &= 6.1 \times 300\,000 \\ &= 1\,830\,000 \text{ cm} \\ &= 18.3 \text{ km} \end{aligned}$$



## Example 2

The distance between two towns is 3.5 km. How far apart would these towns be on a map with a scale of 1 : 50 000 ?



## Solution

$$\begin{aligned} \text{Actual distance} &= 3.5 \text{ km} \\ &= 3500 \text{ m} \\ &= 350\,000 \text{ cm} \end{aligned}$$

$$\begin{aligned} \text{Distance on map} &= \frac{350\,000}{50\,000} \\ &= 7 \text{ cm} \end{aligned}$$

*Alternative solution:* a scale of 1 : 50 000 means that 1 cm on the map represents 50 000 cm or 500 m or 0.5 km, in reality.

$$\begin{aligned} \text{Distance on map} &= \frac{3.5}{0.5} \\ &= 7 \text{ cm} \end{aligned}$$

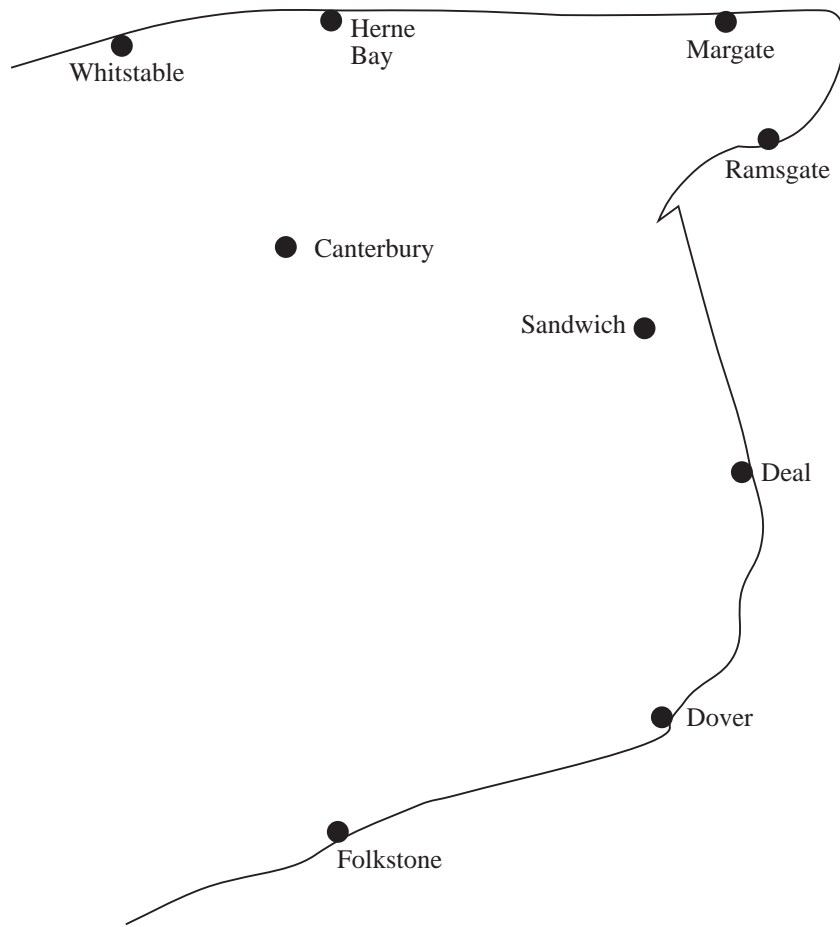


## Exercises

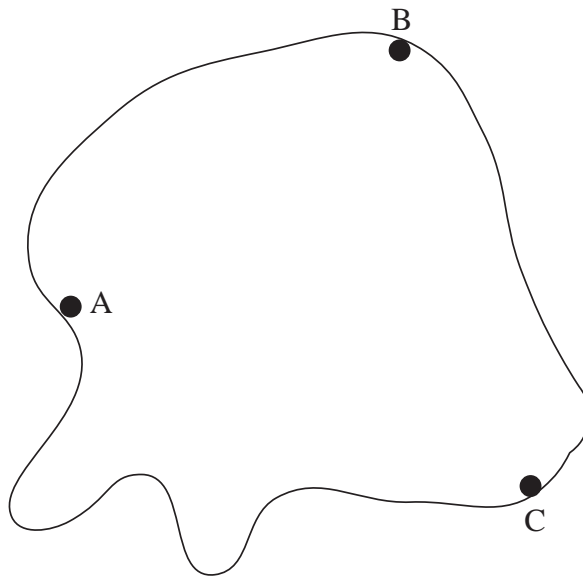
1. The following map shows some places in Kent and is drawn using a scale of 1 : 300 000.

What is the actual distance on a straight line, in km, between:

- Canterbury and Dover,
- Whitstable and Margate,
- Sandwich and Deal,
- Herne Bay and Folkstone?



2. The map below shows a small island drawn using a scale of 1 : 25 000. There are three lookout posts, at A, B and C.



A person walks from A to B, from B to C, and from C back to A. He always walks in a straight line between the lookout posts. What is the total distance that the person walks?

3. A map has a scale of 1 : 50 000. What are the actual distances, in km, that are represented by each of these lengths on the map:
- (a) 4 cm,
  - (b) 10 cm,
  - (c) 3.2 cm,
  - (d) 5.1 cm?
4. The distance between two places on a map is 6 cm. If the map has a scale of 1 : 40 000, what is the actual distance between the two places?
5. On a map with a scale of 1 : 3 000 000, the distance between Edinburgh and London is 18 cm. What is the actual distance, in km, between these cities?
6. Two towns are 15 km apart. What would be the distance between the two towns on a map with a scale of 1 : 300 000?
7. A tower is 2 km due north of a church. A windmill is 5 km east of the tower.

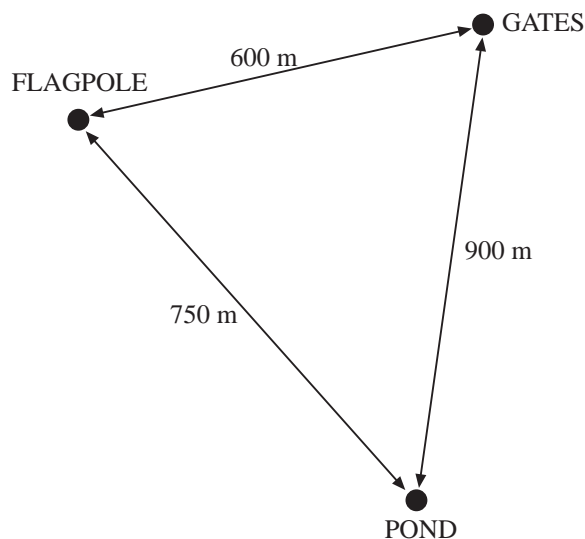
Tower ●

● Windmill

Church ●

- A map is to be drawn with a scale of 1 : 25 000.
- (a) What will be the distance on the map between the church and the tower?
  - (b) What will be the distance on the map between the tower and the windmill?
  - (c) Draw the map, and use it to calculate the actual distance between the church and the windmill.
8. The distance between London and Birmingham is 165 km. What would be the distance between these two cities on a map with a scale of:
- (a) 1 : 500 000,
  - (b) 1 : 1 000 000,
  - (c) 1 : 300 000,
  - (d) 1 : 110 000 ?

9. A student measures the distances between various points shown in her school grounds. The points are shown in the diagram, which is *not* drawn to scale.



- (a) Draw a map to show this information, using a scale of 1 : 10 000.
- (b) A person is exactly halfway between the gates and the pond. How far are they from the flagpole?
- (c) Another student stands at the gates looking towards the flagpole. They turn anticlockwise so that they are looking at the pond. What angle does the student turn through?
10. On a map, a distance of 40 km, is represented by 32 cm. What actual distance would be represented by 14 cm on the map?
11. A map has a scale of 1 : 50 000. A park is shown on the map as a rectangle measuring 6 cm by 4.2 cm. What is the actual area of the park?