MEASUREMENT ERROR

Length, time and weight can never be measured absolutely precisely even with the most accurate scientific instruments. When a scale is used correctly, the maximum possible error in the measurement is half the measurement unit used. It could be smaller or larger.

> Therefore all measurements are approximations, and calculations involving measurements should be rounded off.

Example: The sides of a rectangle are measured as 7 cm and 4 cm. If these measurements are given to the nearest centimetre, what are the possible errors involved, and the upper and lower limits of the perimeter?

Solution: A measurement of 7 cm could lie between a minimum of 6.5 cm and a maximum of 7.5 cm. i.e. 7 ± 0.5

A measurement of 4 cm could lie between a minimum of 3.5 cm and a maximum of 4.5 cm. i.e. 4 ± 0.5

$\therefore$ Lower limit of perimeter $= 2 \times (6.5 + 3.5)$
$= 20$ cm

$\therefore$ Upper limit of perimeter $= 2 \times (7.5 + 4.5)$
$= 24$ cm

NOTE: In most questions, you will usually be asked to round off the final answer to a given number of decimal places or significant figures.

PERCENTAGE ERROR

$$\text{Percentage error} = \frac{\text{error}}{\text{actual size}} \times 100\%$$

Example: Calculate the percentage error in the **length** of the rectangle in the example above.

Solution: The error is 0.5 cm

The actual size is 7 cm

$$\text{Percentage error} = \frac{0.5}{7} \times 100\%$$

$$= 7.14\,\%$$

SCALE DRAWING

Scale drawings are used in many professions including: Architects, Draftsmen, Engineers, Town Planners, Builders and Designers of Machinery. It is necessary and important for these people to first prepare a detailed scaled drawing of their particular design before the construction of the real structure or building is started.

> A scaled drawing has exactly the same shape as the object it represents, but a different size (usually very much smaller).
>
> Scale = length on drawing : real length

The scale can be expressed in two different ways:

Using different units 1cm : 1 m
or **ratio form** 1 : 100

Example (i): Write the following scales in ratio form: (a) 1 cm : 5 m
(b) 1 mm : 1 km

Solution: (a) 1 cm : 5 m = 1 cm : 500 cm (make units the same)
= 1 : 500

(b) 1 mm : 1 km = 1 mm : 1 000 000 mm
= 1 : 1 000 000

Example (ii) The scale on a map is given as 1 : 100 000. Find the actual distance between the two towns which are 5.6 cm apart on the map.

Solution: 1 cm on the map = 100 000 cm in real life

$\therefore$ 5.6 cm on map = $5.6 \times 100\,000$ cm
= 560 000 cm

$\therefore$ The distance between the two towns is 5.6 km.

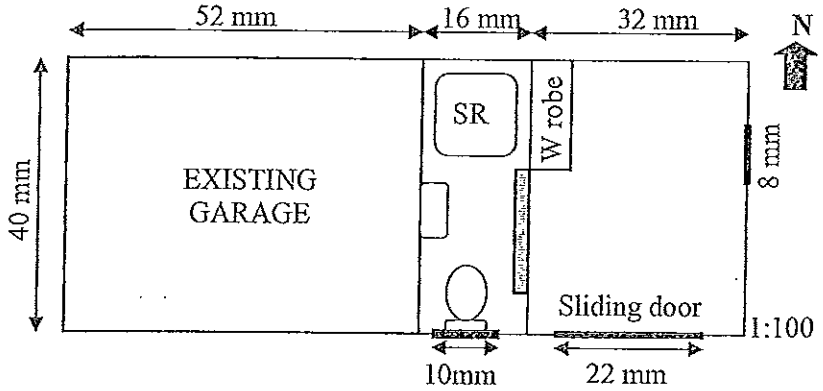
Example (iii): A scale drawing is to be made of a truck. If the truck is 8.5 m long and the model is to be 25 cm long, what scale must be used?

Solution: model : truck = 25 cm : 8.5 m
= 25 cm : 850 cm obtain same units
= 1 : 34 divide by 25

FLOOR PLANS

A plan is a scale drawing of a building (as it would appear from above) that shows the main features of the building. The plan is drawn to a given scale (usually shown at the bottom of the scale drawing) as it is not possible to display all measurements on the drawing.

Example: Barry draws up plans for a teenage retreat at the back of his garage. His design plan is shown below using a scale of 1 mm to 10 cm.



(a) What is the real size of the teenage retreat?

(b) What is the width of the bedroom window?

(c) What are the dimensions of the wardrobe next to the sliding door leading into the bathroom?

(d) What is the area of the bathroom?

Solution: Scale is 1 mm to 10 cm or 1 : 100

(a) Scaled length and width of teenage retreat are (16 + 32) mm long and 40 mm wide.

Real length is $48 \times 10 = 480$ cm $= 4.8$ m long.

Real width is $40 \times 10 = 400$ cm $= 4.0$ m wide.

(b) Scaled width of bedroom window is 8 mm.

Real width of bedroom window is $8 \times 10 = 80$ cm wide.

(c) By measurement the scaled dimensions of wardrobe are 16 mm long by 6 mm wide.

Real dimensions are $16 \times 10 = 160$ cm long by $6 \times 10 = 60$ cm wide.

(d) Real length of bathroom is $40 \times 10 = 400$ cm $= 4.0$ m
Real width of bathroom is $16 \times 10 = 160$ cm $= 1.6$ m

Area of bathroom = length × width
= $4 \times 1.6 = 6.4$ m^2

REVIEW EXERCISE – LEVEL 1

1. Convert these measurements into the units indicated:

(a) 4.3 m = cm (b) 8 cm = m

(c) 750 m^2 = cm^2 (d) 1800mm^2 = cm^2

(e) 5.8 ha = m^2 (f) 85 cm^3 = L

(g) 9.7 tonne = kg (h) 80 g = kg

2. (a) A car averages 76 km/h for 2½ hours. How far does it travel?

(b) How long, in minutes and seconds, does it take light, travelling at 3×10^5 km/s, to go from the Sun to Earth, a distance of 1.5×10^8 km?

(c) A bowler bowls the ball the length of the pitch (20 metres) in 0.45 seconds. Calculate the speed of the ball in km/h.

3. Reduce these ratios to their simplest form

(a) 15 : 18 (b) 27 : 18 (c) 4 : 6 : 8 (d) $5\frac{1}{2} : 3\frac{1}{7}$

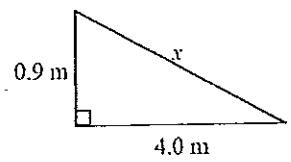
4. (a) Divide 120 marbles in the ratio 3 : 5

(b) Divide 60 kg in the ratio 3 : 4 : 5

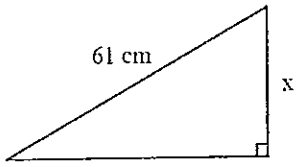
(c) Divide $35 in the ratio 3 : 7

5. Use Pythagoras' Theorem to calculate the unknown side:

(a)

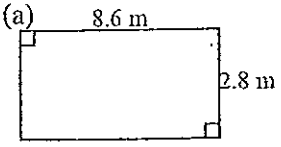


(b)

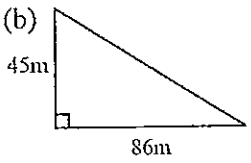


6. Find, correct to 1 decimal place, the perimeter of the following:

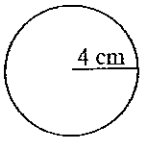
(a)



(b)



(c)



7. Two rectangles are similar. The smaller has dimensions 12 cm by 4 cm. If the larger rectangle has its longer side 18 cm long, calculate the length of its smaller side.

REVIEW EXERCISE – LEVEL 2

1. Simplify the following ratios

   (a) \$2 : 50 cents (b) 1 kg : 300 grams

   (c) 5 cm : 20 mm (d) 3 days : 12 hours

2. (a) Jenny contributes \$600 and Alex \$800 to set up a business. If they make a profit of \$490, how much should each get?

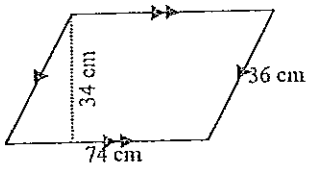
   (b) The ratio of petrol to oil in a two-stroke mixture is 25 : 1. How much oil should there be in 3.9 litres of the mixture?

   (c) The ratio of girls to boys in a year is 8 : 7. If 4 more boys join the year, there will be the same number of boys and girls. How many girls are there?

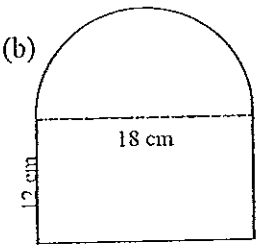
3. A police radar unit detects a passing motorist travelling at 11 m/s in a school zone. Convert this speed to km/h and determine if the motorist is pulled over for exceeding the 40 km/h limit.

4. Calculate the perimeter of these shapes:

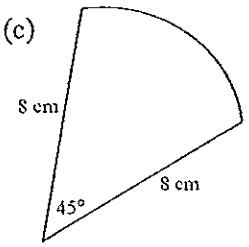
   (a)



   (b)



   (c)

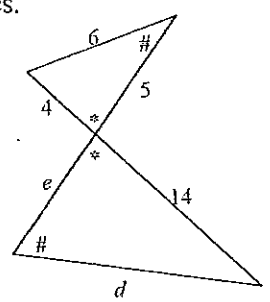


5. Use the Theorem of Pythagoras to calculate, to 3 significant figures, the diagonal length of a square of side 14.8 m.

6. A building casts a shadow 18 m long on level ground. At the same time a nearby fence post 1.6 m high casts a shadow 0.8 m. Calculate the height of the building.

7. Calculate the values of d and e in the following diagrams involving similar triangles.

   (a)



   (b)