Unit 3
Measurement of Area & Volume

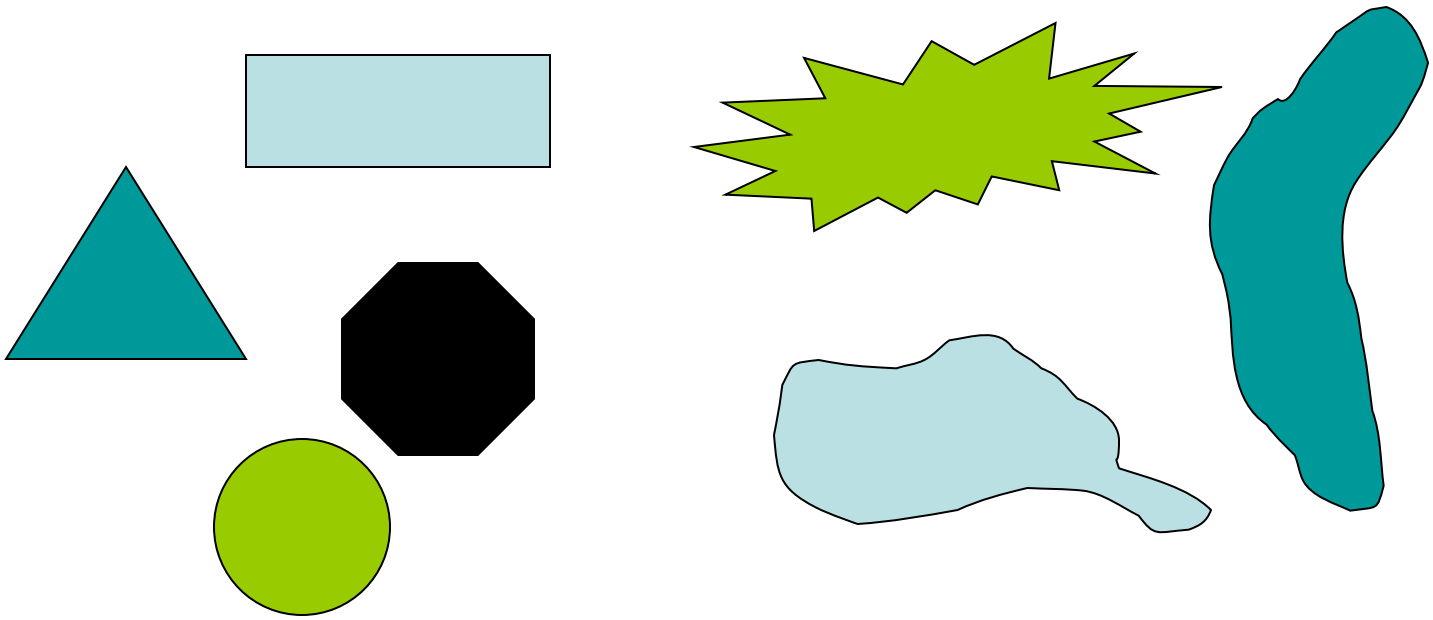
Measurement of area

SI unit for area: m^2

- There are two kinds of figures:

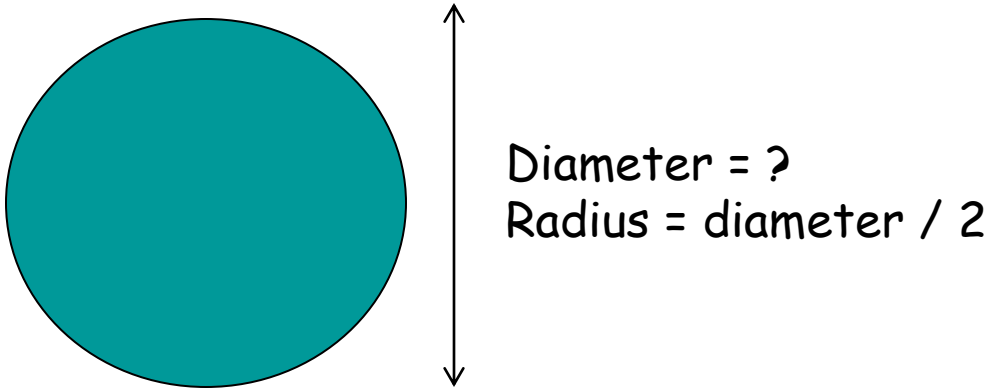
  - regular figures

  - irregular figures



Regular figures

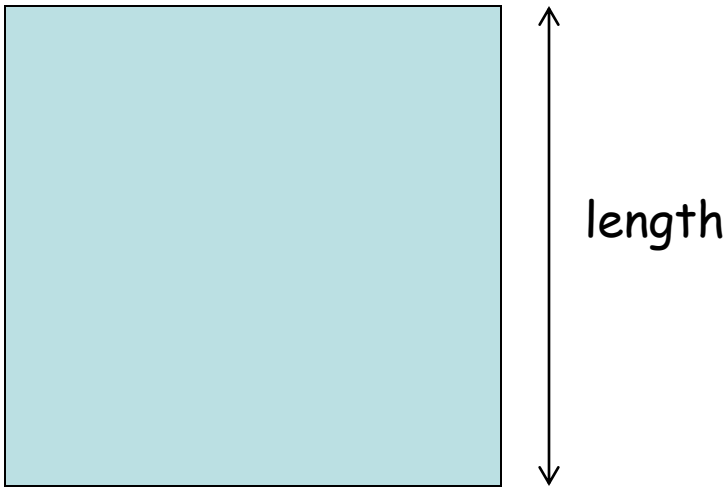
- For regular figures, we must first obtain the formula for the calculation of the area. (e.g. πr^2)
- Next, we measure the physical quantity (e.g. length) required to calculate the area.
- Finally we perform the calculation.



Some examples of regular figures

SQUARE

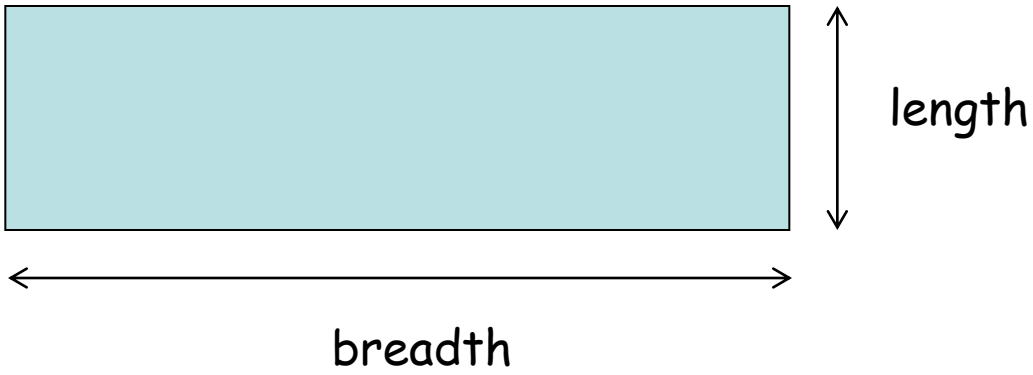
Formula for area = length^2 (l^2)



Some examples of regular figures

RECTANGLE

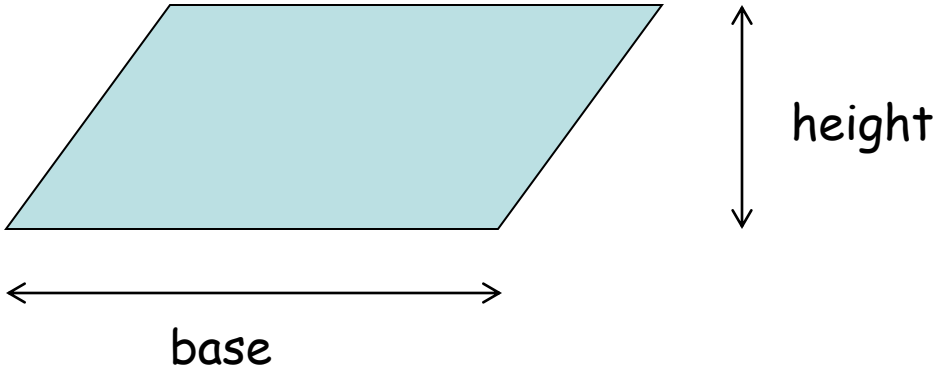
Formula for area = length x breadth ($l$xb)



Some examples of regular figures

PARALLELOGRAM

Formula for area = base x height (bxh)

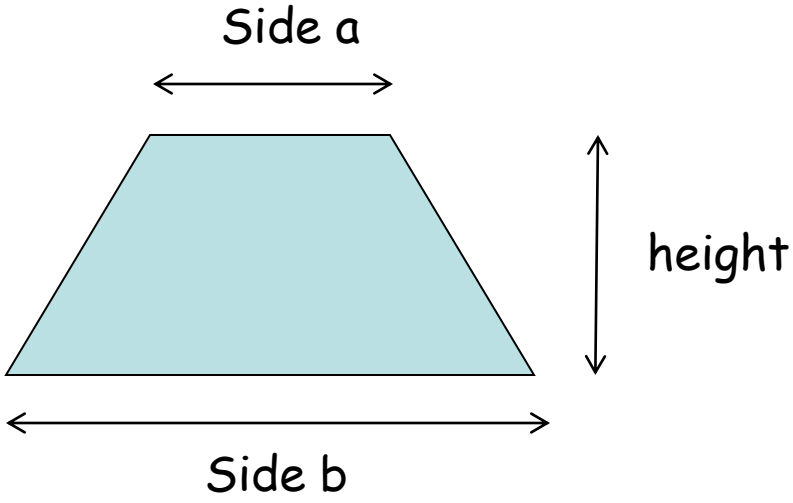


Some examples of regular figures

TRAPEZIUM

Formula for area = $\frac{1}{2}$ x sum of parallel sides x height

$= \frac{1}{2}(a+b)h$

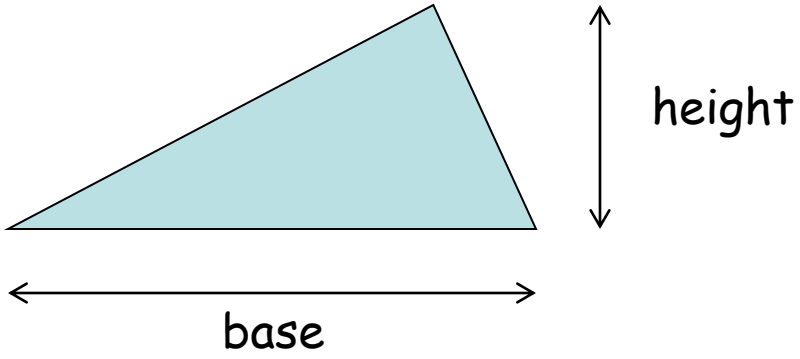


Some examples of regular figures

TRIANGLE

Formula for area

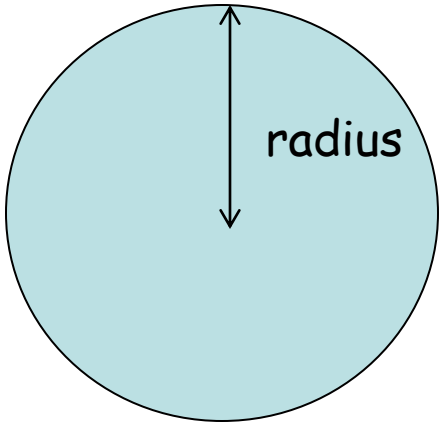
= $\frac{1}{2}$ x base x height ($\frac{1}{2}$bh)



Some examples of regular figures

CIRCLE

Formula for area = π x radius^2 (π r^2)

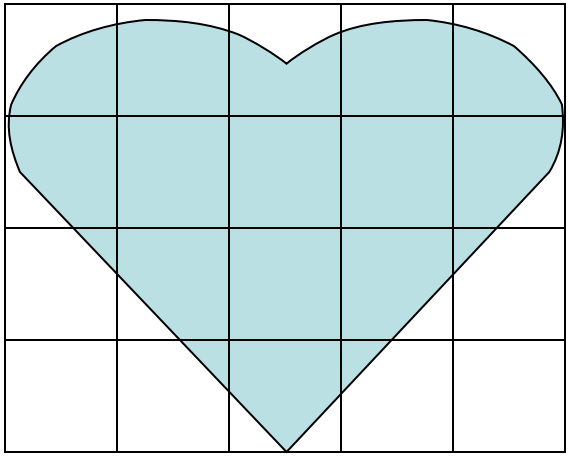


Example

- How do you calculate the **cross-sectional area** of a piece of wire?

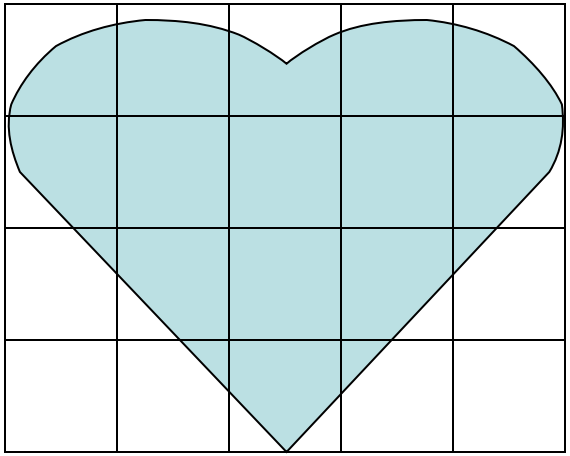
- For an irregular figure:
- Step 1:

  Draw a square grid over the figure (or trace the figure over a square grid depending on which is possible.)



- For an irregular figure:
- Step 2:

  Count the number of squares that are at least half-covered by the figure.

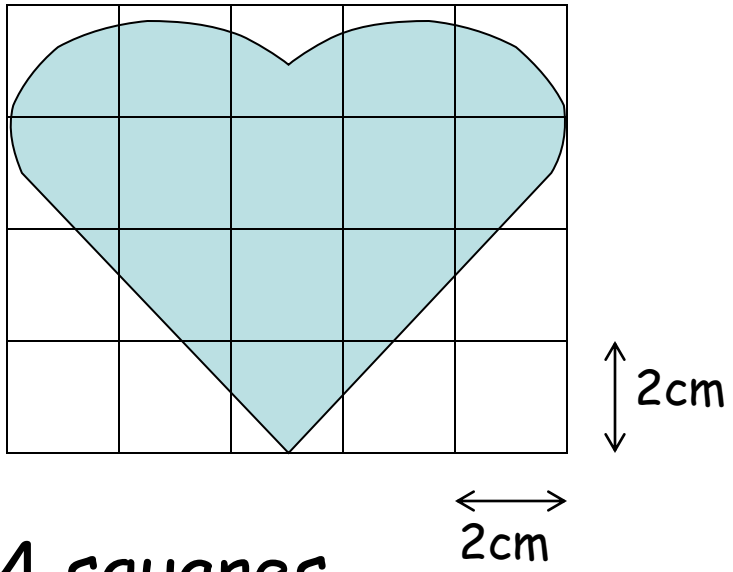


14 squares

- For an irregular figure:
- Step 3:

  Calculate the area of one square

Area of 1 square = 4 cm²



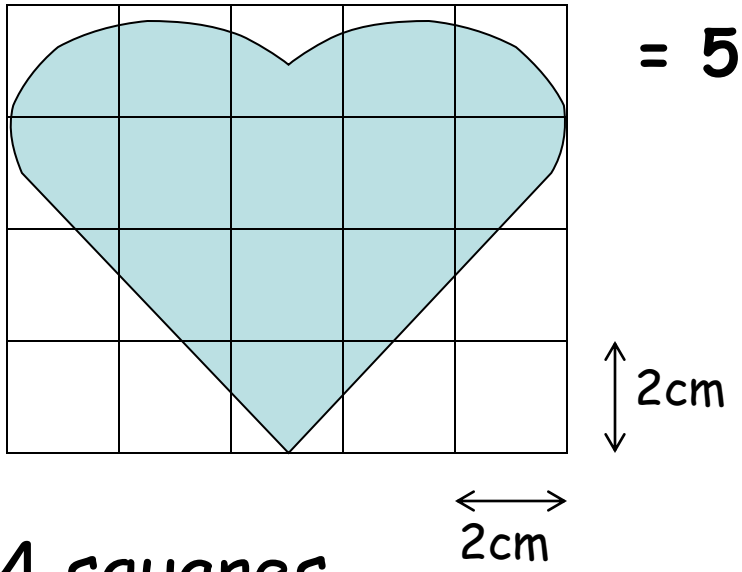
14 squares

- For an irregular figure:
- Step 4:

  Multiply the area of 1 square and the number of filled-squares to get the area of the figure.

4 cm^2 x 14 squares

= 56 cm^2

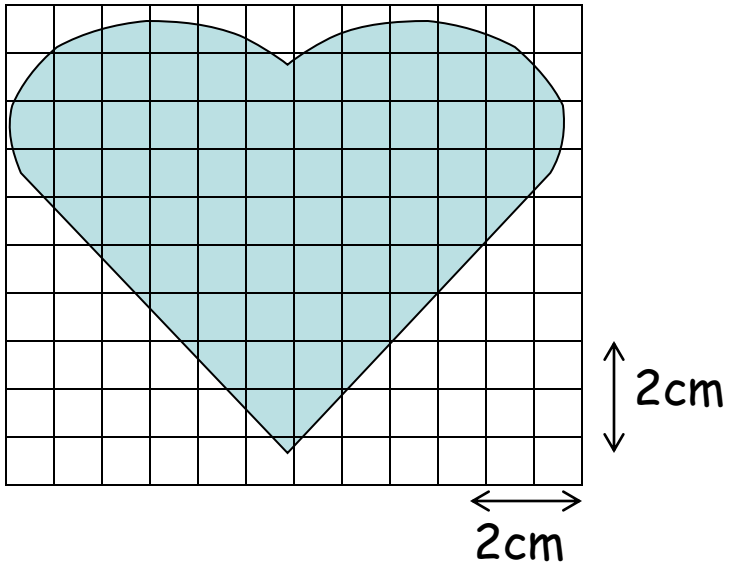


14 squares

- IQ Test

  How do you get a more accurate calculation of the irregular figure?

  Ans: Use a grid of smaller squares!



- ACTIVITY NO 5

Unit Conversion for AREA

- $1\ cm^2$ = _____ m^2

  $1\ cm^2$ = 1 cm x 1 cm

  = 0.01 m x 0.01 m

  = $0.0001\ m^2$

Unit Conversion for AREA

- $20\ m^2$ = _____ cm^2

  $20\ m^2$ = 20 m x 1 m

  = 2000 cm x 100 cm

  = $200000\ cm^2$

Unit Conversion for AREA

- $0.05\ km^2$ = _____ m^2

  $0.05\ km^2$ = 0.05 km x 1 km

  = 50 m x 1000 m

  = $50000\ m^2$

Try this Yourself!

Complete the following conversion of units.

$1\ cm^2 = 1\ cm \times 1\ cm = \_\_\_\_\_\ m \times \_\_\_\_\_\ m$

$= \_\_\_\_\_\ m^2$

$4.9\ km^2 = \_\_\_\_\_ km \times \_\_\_\_\_ km = \_\_\_\_\_\ m \times \_\_\_\_\_\ m$

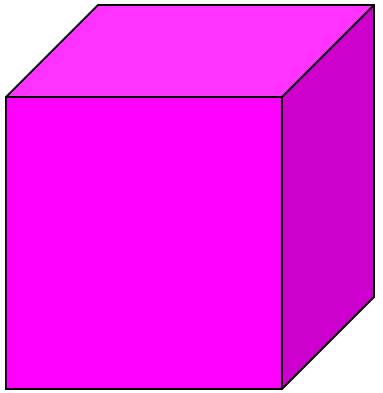
$= \_\_\_\_\_\ m^2$

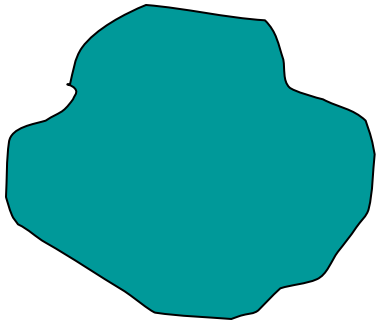
Measurement of Volume

Volume of objects

SI unit for volume: m^3

- Two kinds of objects where we can measure the volume
  - Regular shaped objects
  - Irregular shaped objects

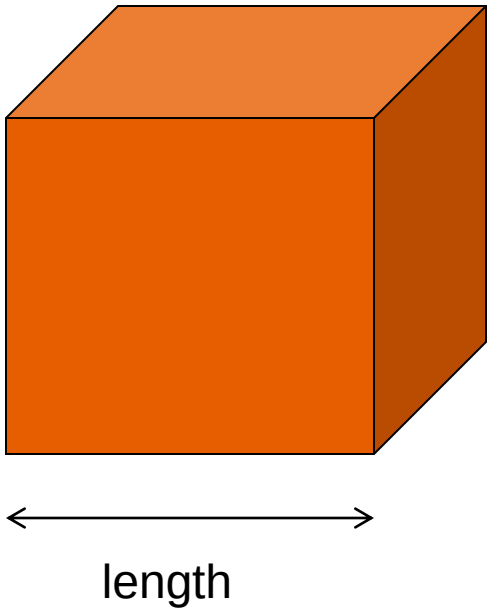




Regular shaped objects

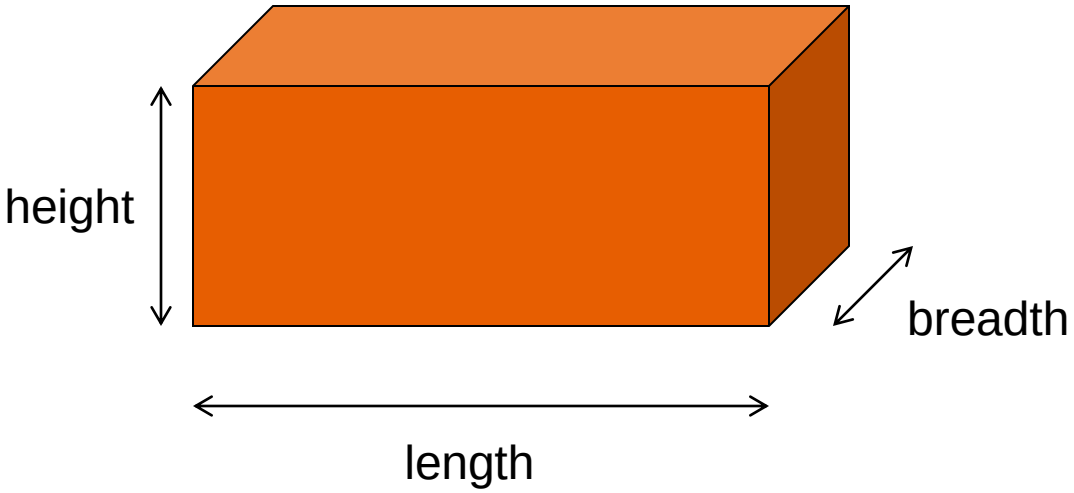
CUBE

Volume = length^3 (l^3)



CUBOID

Volume = length x breadth x height ($l$xbxh)

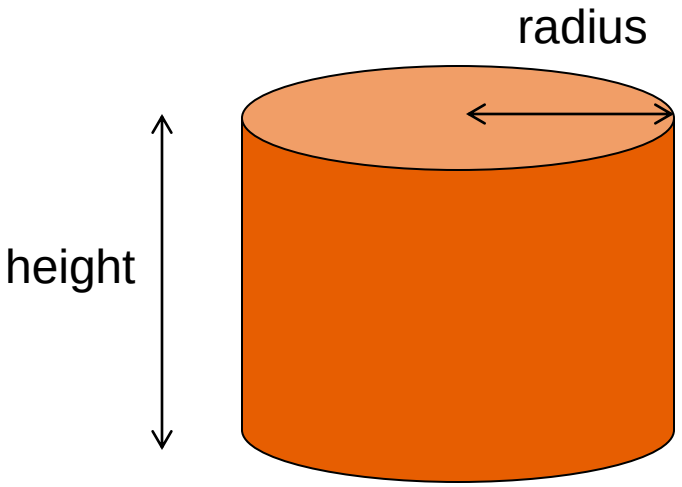


Regular shaped objects

CYLINDER

Volume = area of circular base x height

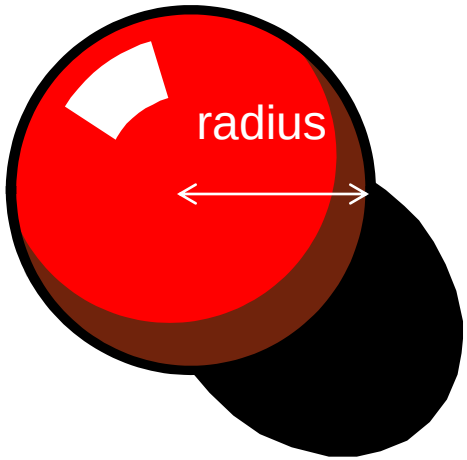
= πx radius^2 x height (πr^2 h)



Regular shaped objects

SPHERE

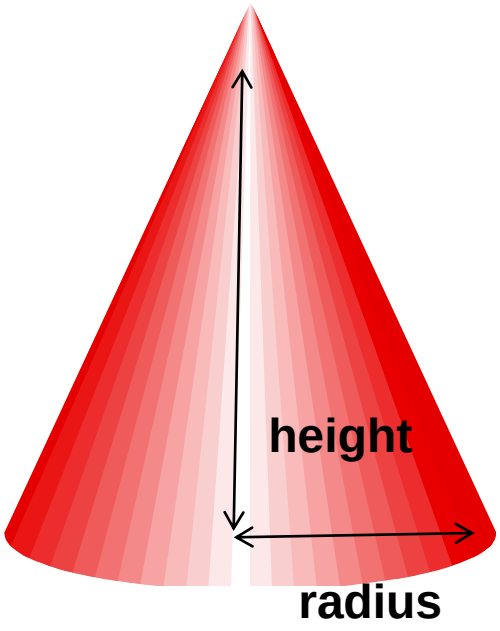
Volume = 4/3 πx radius^3 = $\frac{4}{3}\pi r^3$



Regular shaped objects

CONE

Volume = 1/3 πx radius^2 x height = $\frac{1}{3}\pi r^2 h$



Examples

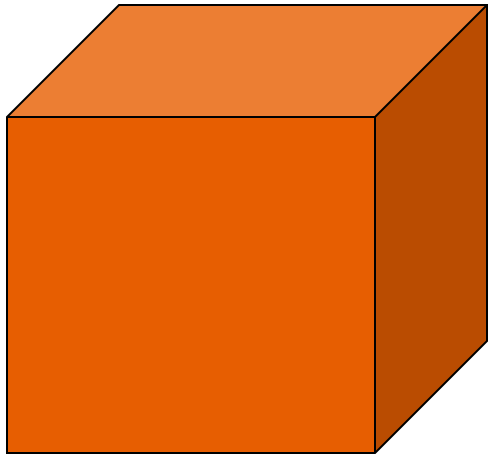
- Find the volume of a cube with length 2cm.

  Ans:

  Volume $= l^3$

  $=2^3$

  $= 8\ cm^3$



Examples

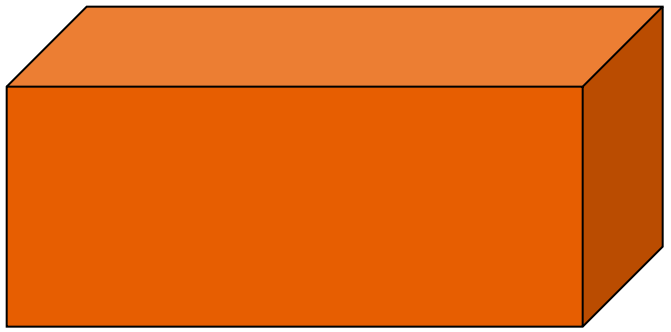
- Find the volume of a cuboid with length 2cm, width 3cm and height 2cm.

  Ans:

  Volume $= l \times w \times h$

  $= 2 \times 3 \times 2$

  $= 12\ cm^3$



Examples

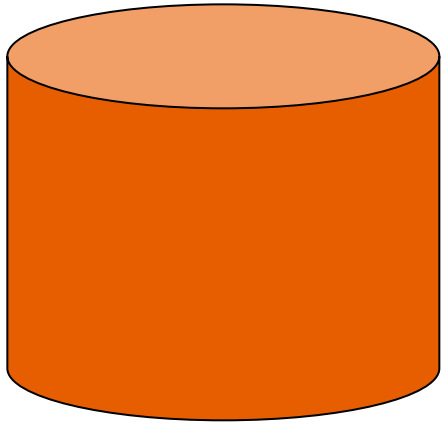
- Find the volume of a cylinder if the radius of its base is 3cm and height is 5cm.

  Ans:

  Volume $= \pi \times r \times r \times h$

  $= \pi \times 3 \times 3 \times 5$

  $= 141.4\ cm^3$



Examples

- Find the volume of a sphere if its diameter is 4cm.

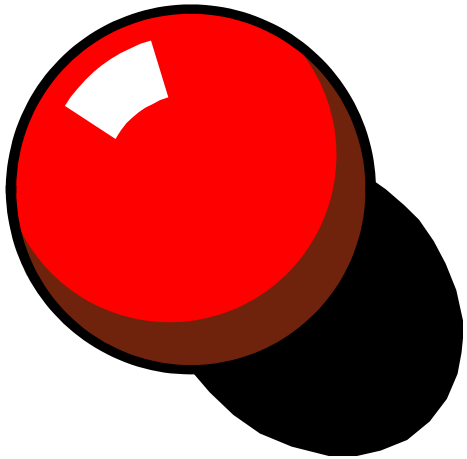
  Ans:

  Radius = 2 cm

  Volume $= 4/3 \times \pi \times r^3$

  $= 4/3 \times \pi \times 2^3$

  $= 33.5\ cm^3$



Examples

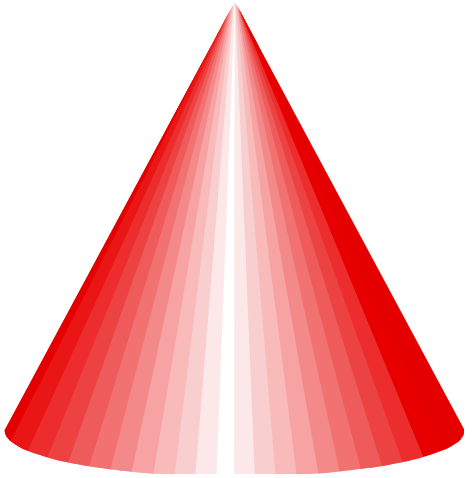
- Find the volume of a cone which has a height of 5cm and the radius of its base is 4cm.

  Ans:

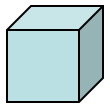
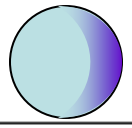
  Volume $= 1/3 \times \pi \times r^2 \times h$

  $= 1/3 \times \pi \times 4^2 \times 5$

  $= 83.8\ cm^3$

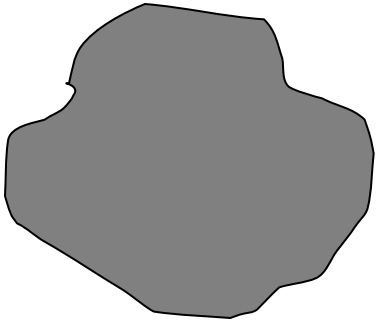


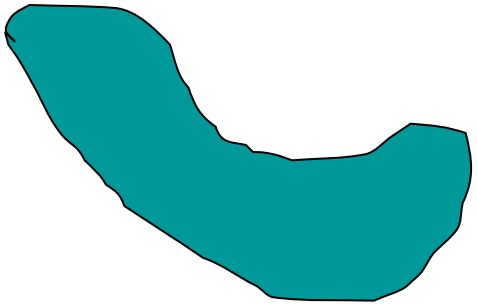
Volume of regular figures

Types of shape	Formula for volume
Cube 	$V = \ell^3$
Cylinder 	$V = \pi r^2 h$
Cuboid 	$V = \ell b h$
Sphere 	$V = \frac{4}{3} \pi r^3$
Cone 	$V = \frac{1}{3} \pi r^2 h$

Irregular objects

- Two kinds of irregular objects
  - Liquids
  - Irregular solids





Volume of liquids

- Volume of liquids
  - Some common laboratory instruments used:
    - Measuring cylinder

      (accuracy = 1 cm^3)

      Eg. 18.0 cm^3, 18.5 cm^3

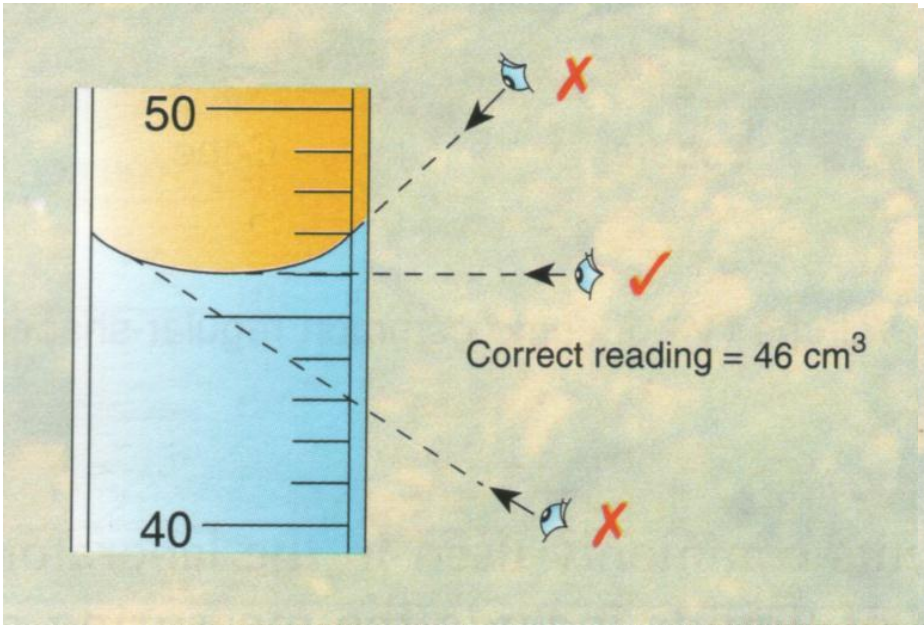
    - Burette

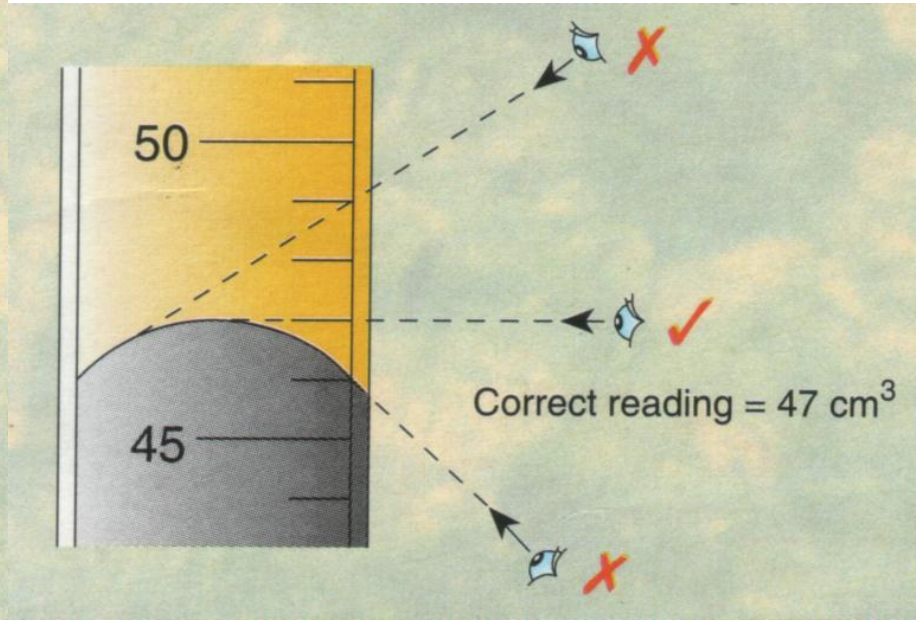
      (accuracy = 0.1 cm^3)

      Eg. 0.20 cm^3 , 0.25 cm^3

Measuring volume of liquids

- Precautions:
  - Parallax error – place eye at level of meniscus while taking reading.
  - Meniscus reading – read the bottom of the meniscus (or top, depending on the liquid)





Measuring the volume of liquid using measuring cylinder

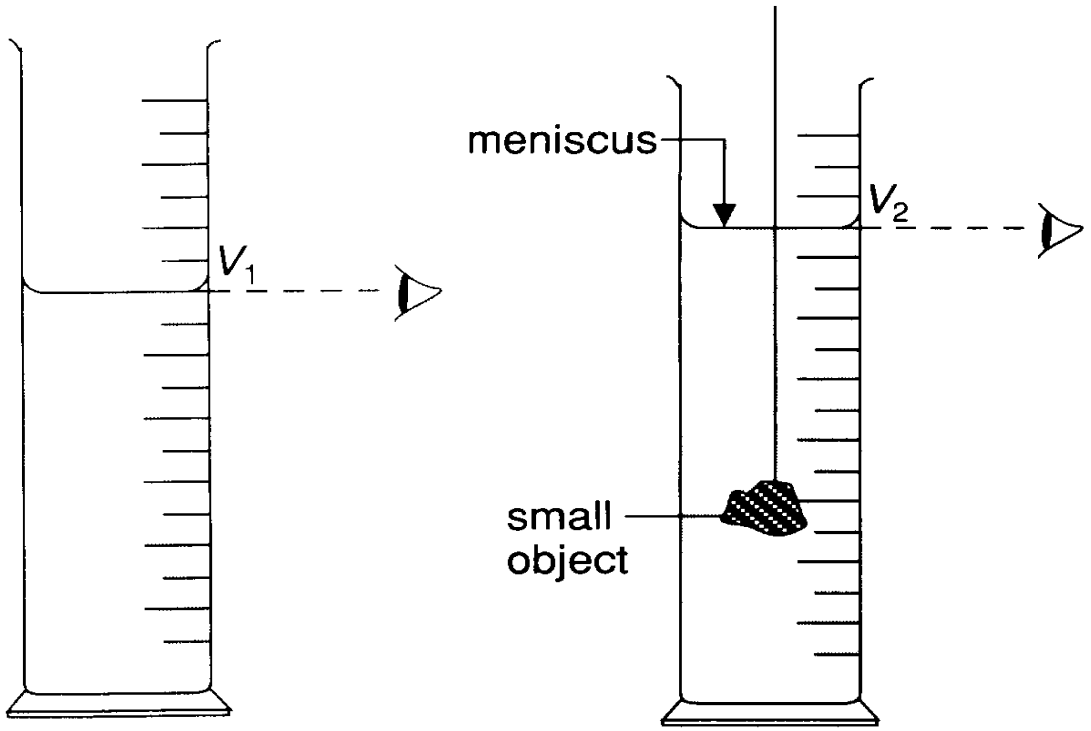
Pour the liquid into the measuring cylinder and read the reading directly from the scale.

Precautions:

- Position the eye at the same level as the meniscus to avoid parallax error.
- Place the measuring cylinder on a flat and horizontal surface.

Irregular solid objects

- Volume of irregular solids
  - Displacement method
    - Using measuring cylinder (for small objects)
    - Using displacement can (for large objects)



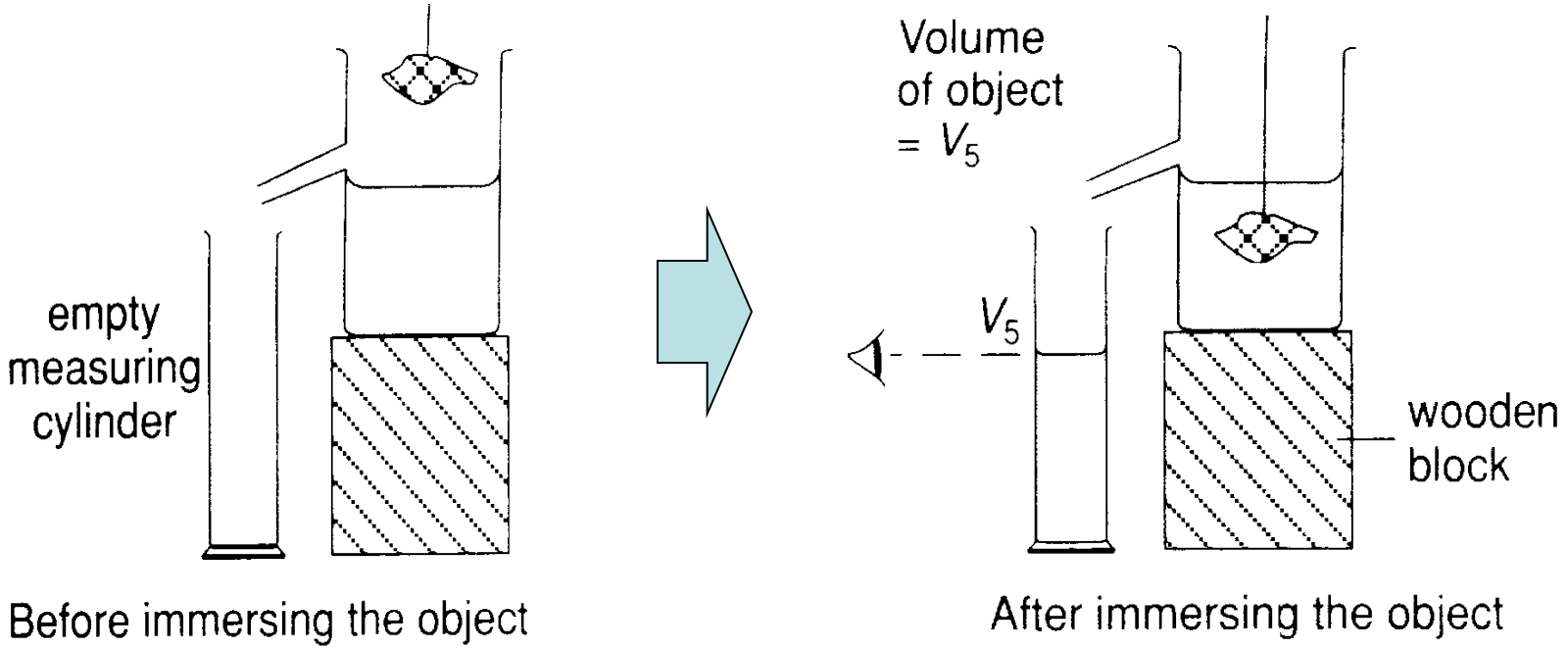
Volume of object is given by

$V = V_2 - V_1$

Volume of irregular solids

Displacement method

- Using displacement can (for large objects)
  - Step 1: Fill the displacement can until excess water flows out of the spout.
  - Step 2: Lower the irregular object with a string into the can
  - Step 3: Collect and measure the displaced water with a measuring cylinder



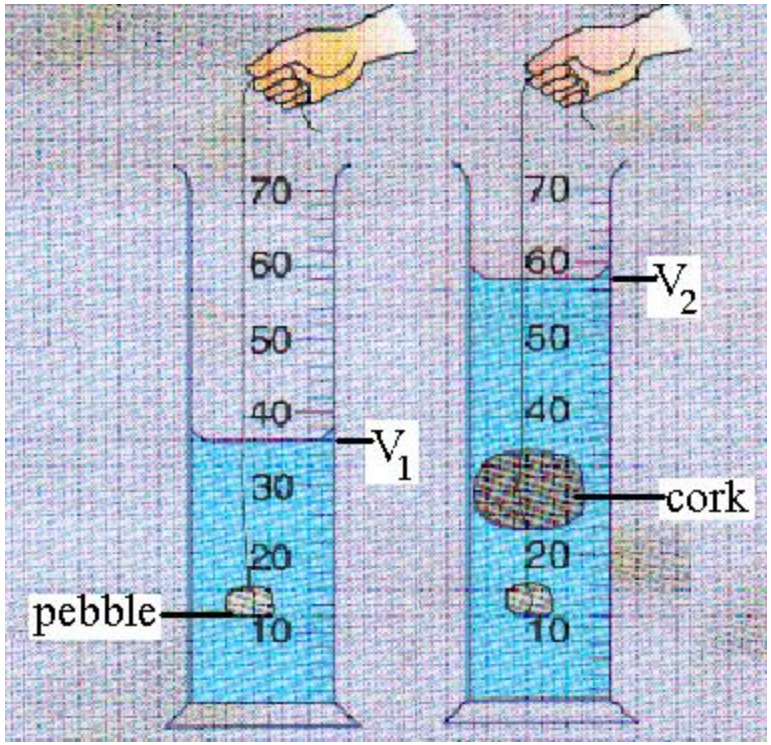
Think about it…

- How would you measure the volume of
  - A lump of plasticine?
  - A piece of cork?

  using the displacement method?

Volume of a floating object

Measurement of volume of a small irregular-shaped object which does not sink in water:



$V_2 = 58\ cm^3$

$V_1 = 36\ cm^3$

Volume of cork = $22\ cm^3$

Unit conversion for volume

- $1\ cm^3 = 1\ ml = 0.001$ litre (l)
- $1\ cm^3 = 1\ cm \times 1\ cm \times 1\ cm$
  $= 0.01\ m \times 0.01\ m \times 0.01\ m$
  $= 0.000001\ m^3$
- 1 litre $= 1000\ cm^3 = 0.001\ m^3$

Unit conversion for volume

- $0.02\ m^3 = \ ?\ cm^3$

  Ans:

  $0.02\ m^3 = 0.02\ m \times 1\ m \times 1\ m$

  $= 2\ cm \times 100\ cm \times 100\ cm$

  $= 20000\ cm^3$

Unit conversion for volume

- $2\ m^3$ = ? litre

  Ans:

  $2\ m^3$ = 2 m x 1 m x 1 m

  = 200 cm x 100 cm x 100 cm

  = $2000000\ cm^3$

  = 2000000 ml

  = 2000 l

Try this Yourself!

Complete the following table:

$1\ m^3 =$	litres
$1\ km^2 =$	m^2
1 dm =	cm
1 litre =	cm^3