DENSITY, MASS AND VOLUME

Density: Density is defined as the mass per unit volume => $p=m/V$
Units: g/cm^3 or kg/m^3

Subtopics to be covered under density:
Finding the density :

- of a liquid
- of a regular solid
- of an irregularly shaped solid
- Predict whether an object will float on density data.

Mass: It is the measure of the quantity of matter in an object at rest relative to the observer
Mass is measured with a spring balance.
It is a scalar quantity

Weight: It is the gravitational force on an object that has mass
Weight= mass x acceleration due to gravity
$W=mg$
Weight is measured with a Newton meter.
Weight is a vector quantity and the unit is Newton(N)
Weights may be compared using a balance

Weight changes from place to place but the mass stays constant.

Gravitational field strength: It is the force per unit mass
$g=W/m$ and this is eqivalent to the acceleration of free fall.

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Finding the density of a liquid:

The density of a liquid can be found by the following method:

- Measure the mass of the empty measuring cylinder.(m_1)
- Pour a fixed volume of water in the measuring cylinder. Note this volume as v cm^3.
- Note the mass of measuring cylinder + water as m_2.
- Find the mass of the water by subtracting m_1 from m_2.
- Find the density of the liquid by using the formula:

$$Density = \frac{mass}{volume} = \frac{m_2 - m_1}{v} \ (g/cm^3)$$

1 Fig. 1.1 shows a side view of a large tank in a marine visitor attraction. **M/J/13-p32**

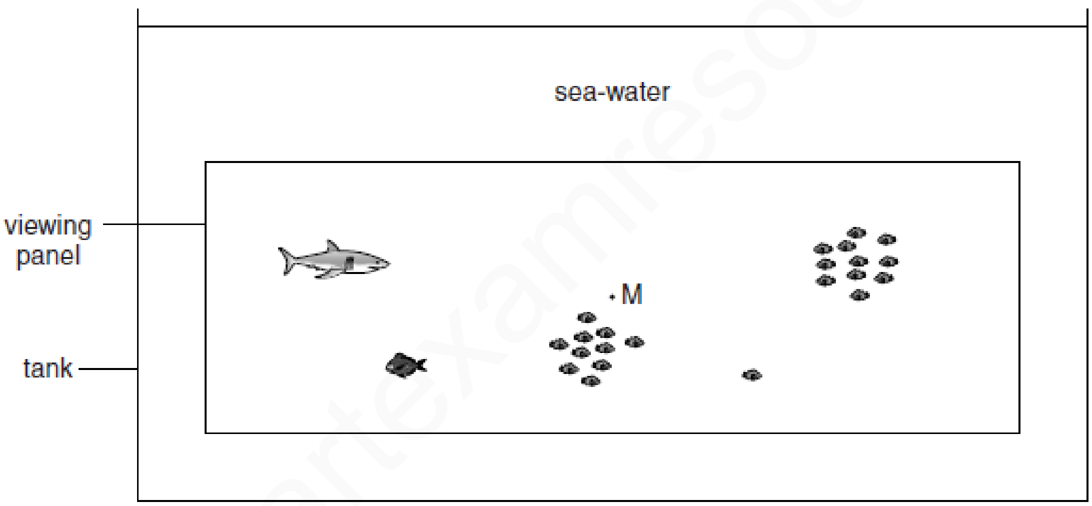


Fig. 1.1 (not to scale)

The tank is 51 m long and 20 m wide. The sea-water in the tank is 11 m deep and has a density of 1030 kg/m^3.

(a) Calculate the mass of water in the tank.

mass = ... [3]

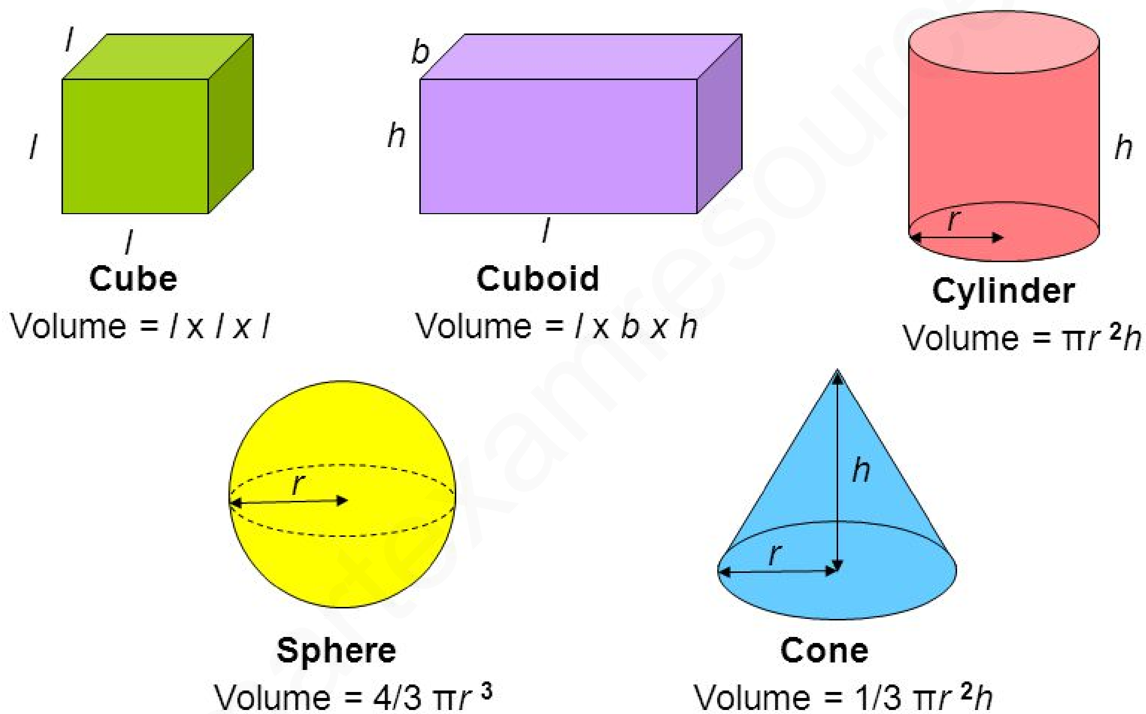
Finding the density of an irregular solid:

The density of a regular soild can be found by the following method:

- Note the dimensions of a regular solid and use them to find the volume. Record the volume in v cm^3.
- Place the solid on a weighing pan and record its mass as m gm

  Use the formula: $Density = \frac{mass}{volume} = \frac{m}{v}$ (g/cm^3)

Following are the formulae of some regular shapes:



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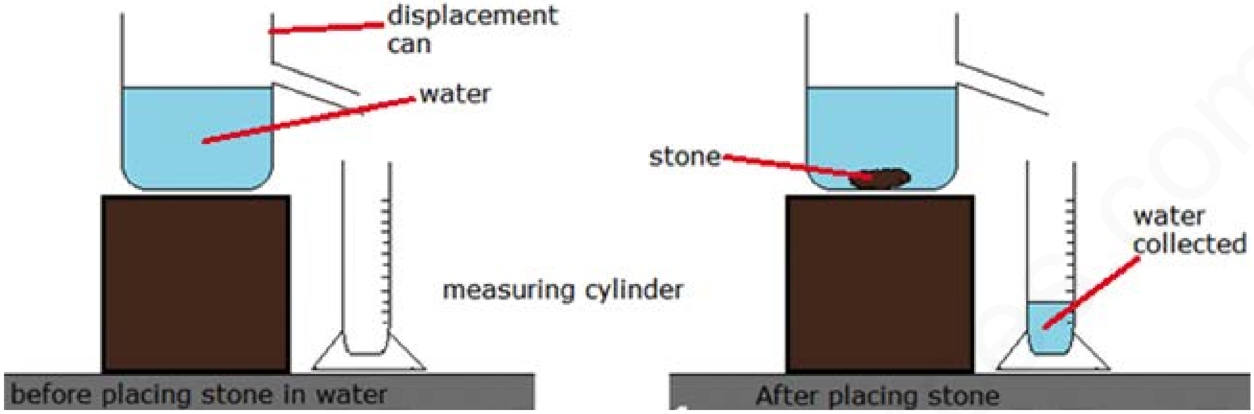
Finding the density of an irregular solid by displacement method:



Suppose you have to find the density of an irregular object like a stone. It can be found in the following way.

- Weigh the stone and record its mass(m_1) in gm.
- Take water in a displacement can . Fill the can to the point which is exactly upto the lower level of the spout.
- Now immerse the stone in the can.
- Water will be displaced by the stone into the measuring cylinder. This volume of the displaced water in the measuring cylinder is actually the volume of the stone. Note this volume as v cm^3.
- Use the formula $Density = \frac{mass}{volume} = \frac{m}{v}$ (g/cm^3)

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APPLICATION BASED QUESTION:-EXTENDED THEORY

2 A student is given the following apparatus in order to find the density of a piece of rock.

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100 g mass
metre rule
suitable pivot on which the rule will balance
measuring cylinder that is big enough for the piece of rock to fit inside
cotton
water

The rock has a mass of approximately 90 g.

(a) **(i)** In the space below, draw a labelled diagram of apparatus from this list set up so that the student is able to find the mass of the piece of rock.

(ii) State the readings the student should take and how these would be used to find the mass of the rock.

....

....

....
[5]

(b) Describe how the volume of the rock could be found.

....

....

....[2]

(c) The mass of the rock is 88 g and its volume is 24 cm^3.
Calculate the density of the rock.

density of rock = ... [2]

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(ii) Describe what the student does to find the volume of the piece of wood, stating the measurements that she makes and any calculations required.

....

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....

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.... [4]

Predict whether an object will float or sink based on density data:

- If the body is less dense than the fluid, it will float.
- If the body is denser than the fluid, it will sink.

For two immiscible liquids

The one with the lesser density will float on the top of the other and vice-versa.Example: Oil floats on water

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(b) To find the volume of the piece of wood, the student has a measuring cylinder, a supply of water and the brass object in **(a)**. The piece of wood and the brass object are small enough to be placed in the measuring cylinder.

(i) The piece of wood does not sink in water.

Suggest why.

.... [1]

APPLICATION BASED CONCEPTS:-MCQ

1 A scientist needs to determine the volume of a small, irregularly shaped rock sample. Only a rule and a measuring cylinder, partially filled with water, are available.

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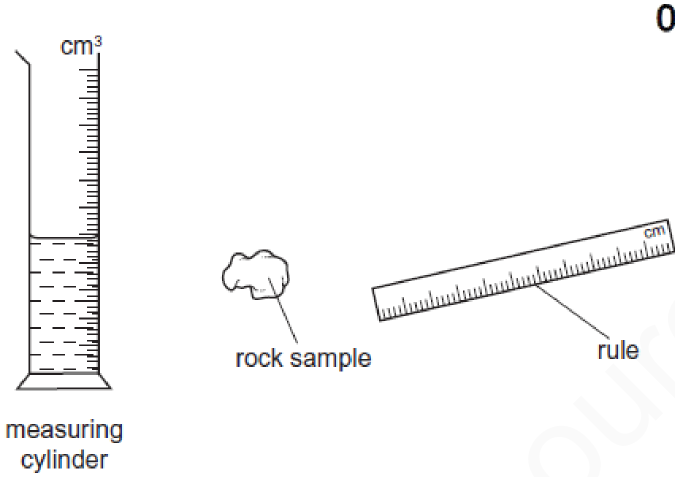


To determine the volume, which apparatus should the scientist use?

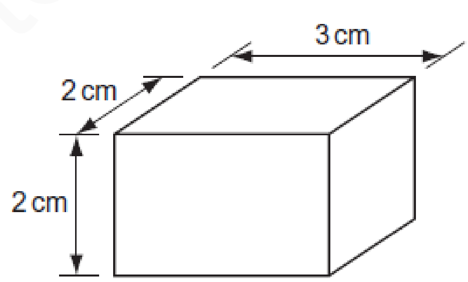
A both the measuring cylinder and the rule

B neither the measuring cylinder nor the rule

C the measuring cylinder only

D the rule only

7 The diagram shows a rectangular block of density $2\,g/cm^3$. **0625/11/M/J/10**



What is the mass of the block?

A 2 g **B** 6 g **C** 14 g **D** 24 g

6 A stone has a volume of 0.50 cm^3 and a mass of 2.0 g.

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What is the density of the stone?

A 0.25 g / cm^3

B 1.5 g / cm^3

C 2.5 g / cm^3

D 4.0 g / cm^3

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4 A student wishes to measure accurately the volume of approximately 40 cm^3 of water. She has two measuring cylinders, a larger one that can hold 100 cm^3, and a smaller one that can hold 50 cm^3. The water forms a meniscus where it touches the glass.

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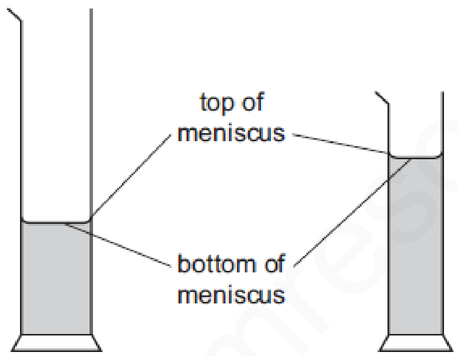

Which cylinder should the student use and which water level should she use to ensure an accurate result?

	cylinder	water level
A	larger one	bottom of meniscus
B	larger one	top of meniscus
C	smaller one	bottom of meniscus
D	smaller one	top of meniscus

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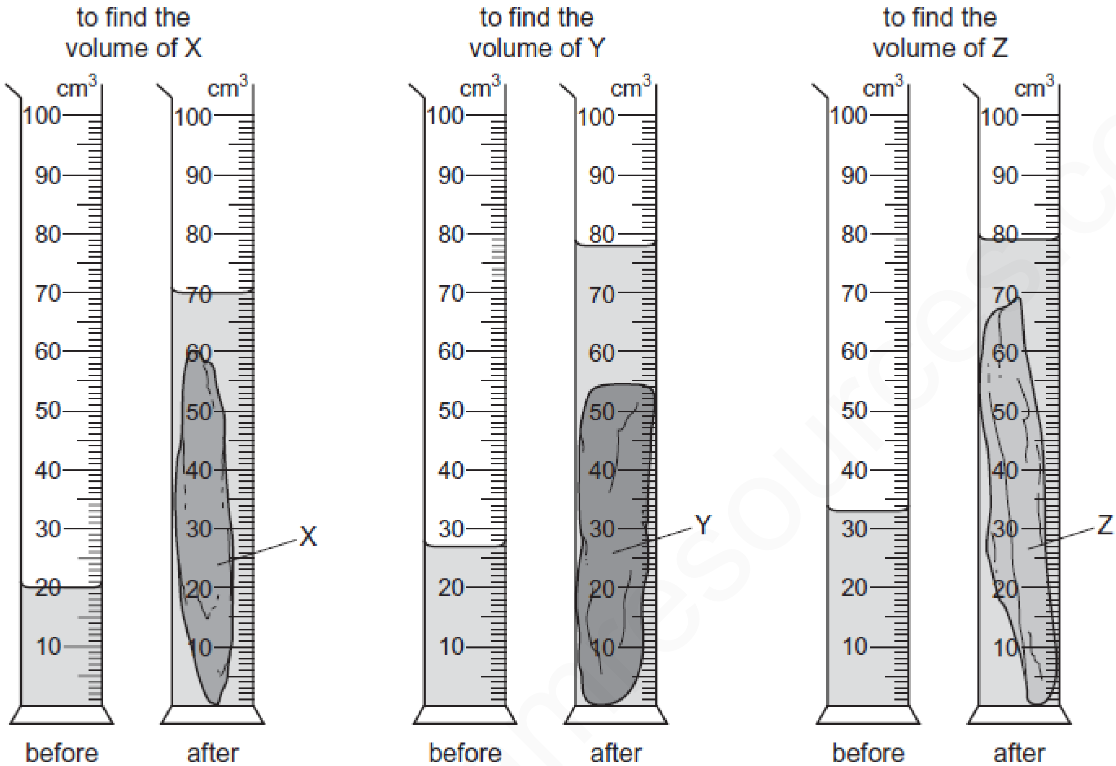
1 A geologist compares the volumes of three rocks, X, Y and Z. Three measuring cylinders contain different volumes of water. He places each rock into one of the measuring cylinders.

The diagrams show the measuring cylinders before and after the rocks are put in.



Which row shows the volumes of X, Y and Z in order, from largest to smallest?

	largest volume	→	smallest volume
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	Y	X

4 Diagram 1 shows a piece of foam rubber that contains many pockets of air. Diagram 2 shows the same piece of foam rubber after it has been compressed so that its volume decreases.

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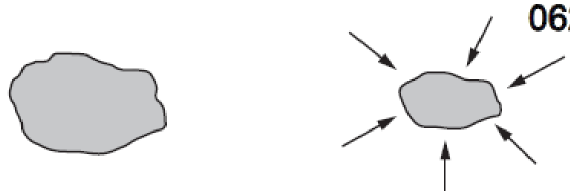

diagram 1 (before compression) diagram 2 (after compression)

What happens to the mass and to the weight of the foam rubber when it is compressed?

	mass	weight
A	increases	increases
B	increases	no change
C	no change	increases
D	no change	no change

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