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Class 8 Physics

Chapter 2: Physical Quantities and Measurement

Instructions

1. Study the content provided and Answer related Questions
2. Write all Questions and their answers in your notebook

Assignment 2.1

Density:

1. Equal masses of different substance have different volumes.
   Example: the volume of cotton is much larger than the volume of iron of same mass.
2. Equal volume of different substances have different masses.
   Example: the mass of iron is much larger than mass of an equal volume of wood.

Density is defined as mass per unit volume. i.e.

$$\text{Density of a Substance} = \frac{\text{Mass of the Substance}}{\text{Volume of the Substance}}$$

$$d = \frac{M}{V}$$

Unit of density $= \frac{\text{unit of mass}}{\text{unit of volume}}$

In SI System, kg/ m^3

In CGS System, g/cm^3

Relation between SI and CGS Units

$1\ kg\ m^{-3} = \frac{1\ kg}{1\ m^3} = \frac{1000\ g}{(100\ cm)^3}$

$= \frac{1}{1000} g\ cm^3$

Thus,

$1\ kg\ m^{-3} = 10^{-3}\ g\ cm^{-3}$

Or $1\ g\ cm^{-3} = 1000\ kg\ m^{-3}$

So, if certain substance is said to have density of 200 kg/m^3 than we may say that each 1m^3 volume of substance will have a mass of 200 kg.

Note:

1. The density of substance does not change with any change in its shapes or size.
2. Density may change due to heating, on heating in general, substance expands that means it volume increases but mass remain same hence density decreases and with decrease in temperature substance contracts hence density decreases.

Answer the following questions:

Que 1. Define the term density of a substance.

Que 2. Name the SI unit of density. How is it related to g/cm^3?

Que 3. The density of brass is 8.4 g cm^{-3}. What do you mean by this statement?

Que 4. A given quantity of a liquid is heated. Which of the following quantity will vary and how?

(a) Mass (b) volume and (c) density

Que 5. How does the density of a liquid vary with temperature?

Que 6: The density of air is 1.28 g $litre^{-1}$. Express it in: (a) g cm^{-3} (b) kg m^{-3}

[*hint: use relation 1 litre = 100 cm^3 and 1 litre= 0.001 m^3]*

Que 7: The density of aluminium is 2.7 g cm^{-3}. Express it in kg m^{-3}.

[hint: use relation between SI and CGS units]

Que 8: The dimension of a hall are 10 m X 7 m X 5 m. If the density of air is 1.11 kg m^{-3}, find the mass of the air in the hall.

[hint: use V=10X 7 X 5 m^3; d=M/V]

Assignment 2.2

Determination of density of a regular solid

Steps to be followed

1. Measure mass M of the given regular solid by using beam balance.
2. Now find the volume V of the regular solid by using the formula,

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useful formulas to calculate volume of regular solids

Volume of cube = (one side)^3

Volume of cuboid = length X breadth X height

Volume of sphere = $\frac{4}{3}\ \pi$ (radius)^3

Volume of cylinder = π (radius)^2 (height)

3. Knowing mass and volume find the density by using the given formula,
   Density = M/V

Example:

if mass (M) of a solid spherical iron ball of radius 5 cm is 4095g

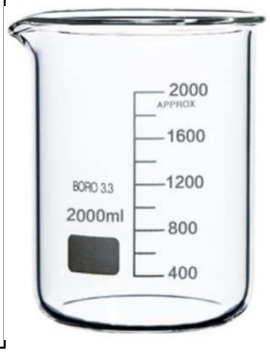
Then, Volume (V) = $\frac{4}{3}\pi \times 5^3$ =525.95 $\approx$ 526 cm^3

Density d= $\frac{M}{V} = \frac{4095}{526}\,\mathrm{g}cm^{-3} \approx 7.78\mathrm{g}cm^{-3}$

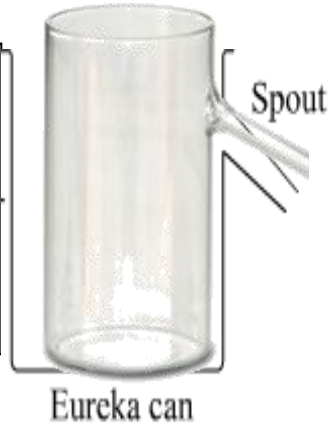
Vessels for measuring Volume

1. Measuring cylinder:
Measuring cylinders (graduated cylinders) are graduated glass cylinders with a capacity from 2 mL to 2 L.

2. Measuring beaker:
A beaker is generally a cylindrical container with a flat bottom. Most also have a small spout (or "beak") to aid pouring. Beakers are available in a wide range of sizes, from one millilitre up to several litres.



3.Eureka Can:
It is a glass (or polythene or metal) beaker with a side opening near its mouth which is known as spout. As liquid in can reaches upto spout it starts overflowing, hence eureka can hold only certain fixed volume in it.



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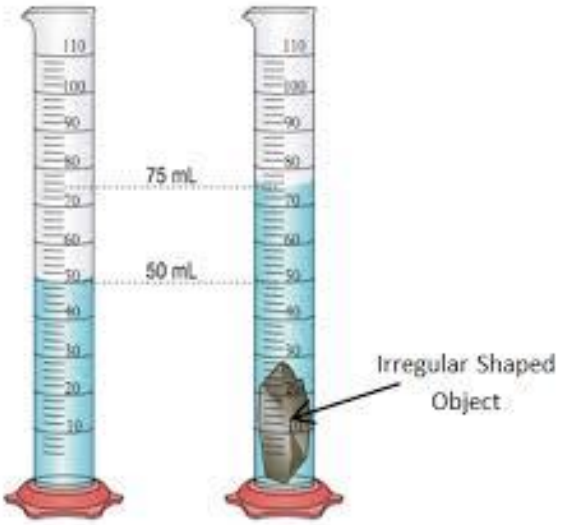
Determination of Density of an irregular Solid:

1.Using measuring cylinder

1. Measure the mass (M) of solid using beam balance.
2. Measure volume (V) of solid using measuring cylinder,
   (i) Take reading of liquid before putting solid in cylinder (say V_1).
   (ii) Next take reading after putting solid in cylinder (say V_2).
3. Calculate V= $V_2 - V_1$ cm^3 (1mL = 1 cm^3)
4. Density $d = \frac{M}{V}$



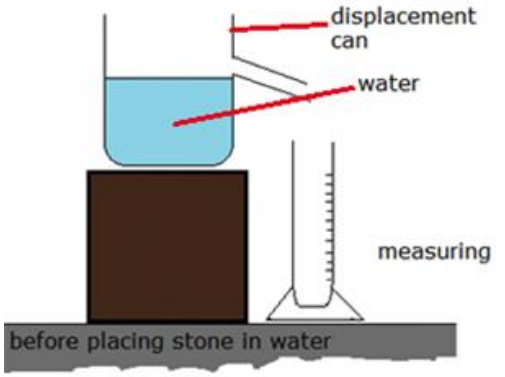
2. Using Eureka Can

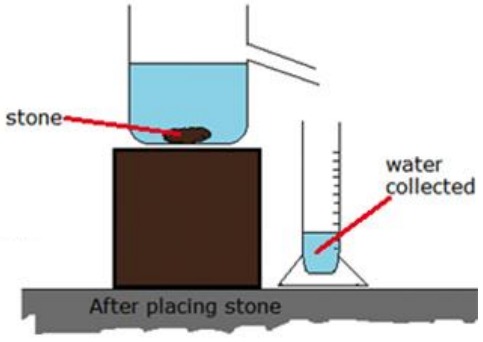
Eureka can is also known as displacement can.

1. Measure mass(M) of solid using beam balance.
2. To calculate Volume (V) follow these steps:
   (i) Pour water into can until it starts overflowing through the spout.
   (ii) When water has stopped dripping out empty the measuring cylinder and place again at same place near spout.
   (iii) Now put stone slowly into Eureka Can some water will start overflowing and gets collected in measuring cylinder.

The amount of water stored in cylinder will give volume(V) of irregular solid.

$$Density, d = \frac{M}{V}$$





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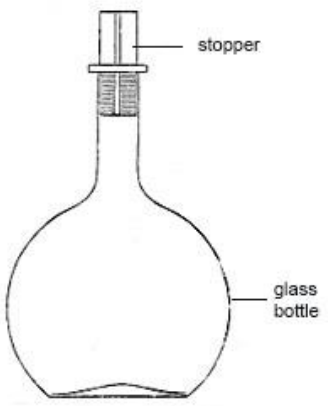
Determination of density of liquid Using Density bottle

A density bottle is a specially designed bottle which is used to determine the density of a liquid. The bottle can store fixed volume of liquid. The stopper of bottle has narrow hole through it.



To determine the density of the liquid using density bottle

1. First, wash the bottle and dry it. Then measure the mass of the empty bottle using a beam balance. Let the mass be M_1 g.
2. Remove the stopper of the bottle and fill it with water. Replace the stopper. Wipe the outside of the bottle dry. Measure its mass again. Let the mass be M_2 g.
3. Empty the bottle and dry it. Now fill the bottle with the given liquid. Replace the stopper. Wipe the outside of the bottle dry. Measure its mass again (M_3g)
4. Calculate the mass of water ($M_2 - M_1$) and mass of liquid ($M_3 - M_1$). Since the density of water is 1g/cm^3, the mass of water contained in the bottle gives the volume of the bottle.

Thus, mass of liquid = ($M_3 - M_1$) g ; volume of liquid = ($M_2 - M_1$) cm^3

Therefore, **density of liquid** $= \frac{mass\ of\ liquid}{volume\ of\ liquid} = \frac{(M_3 - M_1)}{(M_2 - M_1)} g\ cm^{-3}$

Answer the following questions:

Que 9. Describe an experiment to determine the density of the material of a coin.
[hint: Coin is a regular shape object]

Que 10. Name three vessel used for measuring volume.

Que 11. What is a density bottle?

Que 12. Describe an experiment to determine the density of a liquid.

Que 13. Calculate the density of solid from the following data:

(a) Mass of solid = 72g

(b) Initial volume of water in measuring cylinder =24mL

(c) Final volume of water when solid is completely immersed in water = 42mL.

[hint: follow technique used for irregular solid using measuring cylinder]

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Assignment 2.3

Relative Density (R.D.)

The relative density of a substance is defined as the ratio of the density of the substance to the density of water at 4^0 C. Relative density is also known as specific density.

$$\text{relative density of substance} = \frac{\text{density of the substance}}{\text{density of water at } 4^0\text{C}}$$

Note: Density of Water at 4^0 C = **1 g cm^{-3} = 1000 kg m^{-3}**

Unit of relative density

Relative density is a ratio of same quantities. It is just a number. It has no unit. It is a dimensionless quantity.

Example: density of iron is 7.8 g cm^{-3} and density of water is 1 g cm^{-3}.

Hence, relative density of iron = $\frac{7.8\ g\ cm^{-3}}{1\ g\ cm^{-3}}$ = 7.8

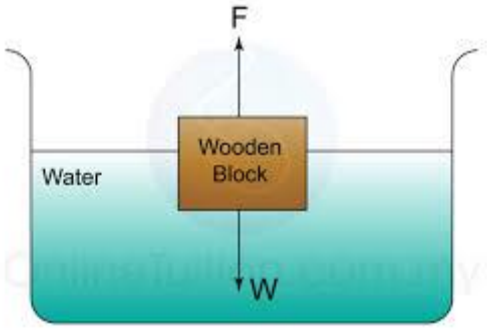
Density of a substance in its different states

A substance can exist in three states

i) Solid : Molecules in solid are tightly packed, so solids will be highly dense.
ii) Liquid : Molecules in liquid are loosely packed, so liquids will be less denser than solid.
iii) Gas : Molecules in gas are very loosely packed, so gas will be least denser.

Density in soild is most, less in Liquid and least in gas.

Floating and Sinking



Principle of flotation

When a body is immersed in a liquid, the **following two forces act on it**:

1. The **weight** of the body **W** acting vertically downwards. This force tends to sink the body
2. The **buoyant force** (upthrust) of the liquid **F** acting vertically upwards. The buoyant force is equal to the weight of the of the liquid displaced by the immersed part of the body. This force tends to move the body in an upward direction.

Due to this buoyant force object inside liquid appears to have less weight than actual.

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Law of floatation

When a body floats in a liquid, the weight of the liquid displaced by its immersed part is equal to the total weight of the body. This is the law of floatation.

The weight of the floating body = Weight of the liquid displaced by its immersed part.

Some applications of floatation

1. **Floatation of iron ship**

As the density of an iron nail is more than that of water, the nail sinks in water. This is understandable. But a huge ship made of iron floats. This is because of its shape. A ship is hollow in the middle. When the ship is in water the entire volume of the ship, including the hollow portion, displaces water to make space for itself. The volume of water displaced is much greater than the volume of the iron ship. Hence, according to Archimedes' principle, the up thrust is more than the weight of the ship. That is why the iron ship floats in water.

In short, we can say that the shape of the ship makes its overall density less than that of water and hence the ship floats.

2. **Floatation of ice on water**

A substance floats if it is less dense, or has less mass per unit volume, than other components in a mixture.
Ice floats because it is less dense than the water.
The fact that ice floats in water are a bit strange because most substances are denser when they're solids. Water, however, reaches its maximum density at 4 ^{0}C. As the water cools and freezes, it becomes less dense due to the unique nature of hydrogen bonds.

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Answer the following questions:

Que14. Define the term relative density. What is its unit?

Que 15. Explain the meaning of statement "Relative density of aluminium is 2.7".

Que 16. Distinguish between density and relative density.

Que 17. A cork piece floats on water surface while an iron nail sinks in it. Explain the reason.

Que 18. State the law of floatation?

Que 19: Why does a piece of ice float on water?

Que 20. Explain why it is easier to lift a stone under water than in air. [*hint: upthrust*]