

Test yourself

- a) False 2, a) 1000 ml
- b) False b) volume
- c) True c) kg m^{-3}
- d) True d) 1000 kg m^{-3}
- e) False e) 1000 kg m^{-3}
- f) False f) more
- g) True g) less
- h) False h) more
- i) True i) equal to
- j) True j) zero

- 3a) $\text{kg m}^{-3} \rightarrow$ iv, density
- b) no unit \rightarrow i, relative density
- c) relative density \rightarrow v, density bottle
- d) iron \rightarrow ii, sinks in alcohol
- e) wood \rightarrow iii, floats on water

4a) = ii, Mass - Density \times volume

b) ii, 800 kg m^{-3}

c) iii, 48g

d) ~~ii~~ iii, the mass of a certain volume of brass is more than the mass of equal volume of aluminium.

e) ii, The density bottle will store 25ml of any light liquid in it.

f) ~~iii~~ iii, The buoyant force on a body is equal to the weight of the liquid displaced by it.

g) ~~iii~~ iii, The buoyant force is equal to the weight of the wood piece.

h) v, sink

Numericals:

i. The density of air is $1.28 \text{ g litre}^{-1}$. Express it in:

a) g cm^{-3}

Ans, It is \rightarrow The density of air is 1.28 g/litre
If it is in $\text{g cm}^{-3} = \frac{1.28}{1000} = 0.00128 \text{ g cm}^{-3}$

b kg m^{-3}

Ans, The density of air is 1.28 g/litre

$$\frac{1.28 \text{ g}}{1 \text{ litre}} = \frac{1.28}{1000} \times 1000 = 1.28 \text{ kg/m}^3$$

2, The dimensions of a hall are $10 \text{ m} \times 7 \text{ m} \times 5 \text{ m}$. If the density of air is 1.18 kg/m^3 , find the mass of air in the hall.

Ans, The dimension of the hall is $10 \text{ m} \times 7 \text{ m} \times 5 \text{ m}$ which is $V = 350 \text{ m}^3$

$$\text{Density of air (D)} = 1.18 \text{ kg/m}^3$$

$$M = V \times D = 350 \times 1.18 = 413 \text{ kg}$$

3, The density of aluminium is 2.7 g/cm^3 . Express it in kg/m^3 .

Ans, Density of aluminium = 2.7 g/cm^3
In kg/m^3 it will be = $\frac{2.7 \times 1000}{10}$

$$= 2700 \text{ kg/m}^3$$

4, The density of alcohol is 600 kg/m^3 . Express it in g/cm^3 .

Ans, Density of alcohol = 600 kg/m^3
In g/cm^3 density of alcohol will be

$$\frac{600}{1000} = 0.600 \text{ g/cm}^3$$

5, A piece of zinc of mass 438.6 g has a volume of 86 cm^3 . Calculate the density of zinc.

Ans, Mass of zinc = 438.6 g (M)

Volume of zinc = 86 cm^3 (V)

$$\text{Density} = \frac{M}{V} = \frac{438.6}{86} = 5.1 \text{ g/cm}^3$$

6, A piece of wood of mass 150 g has a volume of 200 cm^3 . Find the density of wood in

a, C.G.S unit

Ans, Mass of the wood = 150 g (M)

Volume of the wood = 200 cm^3

$$\text{Density in C.G.S unit} = \frac{M}{V} = \frac{150 \text{ g}}{200 \text{ cm}^3}$$

$$= \frac{0.75 \text{ g}}{\text{cm}^3}$$

b, S.I unit

Ans, In S.I system the density of wood
= 0.75×1000
= 750 kg/m^3

7 Calculate the volume of wood of mass 6000g if the density of wood is 0.8 g/cm^3

Ans, ~~Volume of wood~~ (V) - Volume = (V)
 Mass of wood = 6000g (M)

Density of wood = 0.8 g/cm^3 (D)

$$D = \frac{M}{V} \text{ so, } V = \frac{M}{D} = \frac{6000}{0.8}$$

$$0.8 \text{ g/cm}^3 = 0.8 \times 1000 = 800 \text{ kg/m}^3$$

$$D = \frac{M}{V} \text{ so, } V = \frac{M}{D} = \frac{6000 \text{ g}}{800 \text{ kg/m}^3} = 7.5 \text{ m}^3$$

8, Calculate the density of a solid from the following data:

a) Mass of solid = 72g

b) Initial volume of water in measuring cylinder = 24ml

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

Ans, Mass of solid = 72g

Initial volume $V_1 = 24 \text{ ml}$

Final volume $V_2 = 42 \text{ ml}$

Volume of solid (V) = $V_2 - V_1$

$$= 42 - 24 = 18 \text{ cm}^3$$

$$\text{Density of solid} = \frac{M}{V} = \frac{72 \text{ g}}{18 \text{ cm}^3} = \frac{72}{18} \text{ g/cm}^3 = 4.0 \text{ g/cm}^3$$

10, From the

9, The mass of an empty density bottle is 21.8g when filled completely with water it is 41.8g and when filled completely with liq. liquid it is 40.6g Find:

a) The volume of the density bottle.

Ans, Mass of empty density bottle - $M_1 = 21.8 \text{ g}$

Mass of bottle + water = $M_2 = 41.8 \text{ g}$

Mass of water completely in the density bottle = $M_2 - M_1 =$

$$= 41.8 - 21.8$$

$$= 20 \text{ g}$$

Mass of 20g of water volume = 1cc

Mass of volume of bottle (density bottle)

= volume of water = 20cc = 20ml

b, The relative density of liquid.
 Ans, Mass of 20cc. of liquid = (mass of density bottle + mass of 20cc. of liquid - mass of density bottle)
 $= 40.6 - 21.8$
 $= 18.8g$

Mass of 20cc. of water = 20g

$$R.D = \frac{\text{Mass of 20 cc. of liquid}}{\text{Mass of 20cc of water}}$$

$$= \frac{18.8}{20} = \frac{1.88}{2} = 0.94$$

19 From the following observation / calculation calculate the den. density and relative density of a brine solution.

Mass of empty density bottle = 22g

Mass of bottle + water = 50g

Mass of bottle + brine solution = 54g

Ans, Mass of water = $M_2 - M_1$
 $= 50 - 22$

$$= 28g$$

Mass of brine solution = $M_3 - M_1$
 $= 54 - 22$
 $= 32g$

Density of brine solution = $\frac{\text{Mass of brine solution}}{\text{Mass of water}}$
 $= \frac{32}{28} = 1.14g/cm^3$

Rel. Relative density = 1.14.

11, The mass of an empty density bottle is 30g, it is 75g when filled completely with water and 65g when filled completely with a liquid. Find:

a, Volume of density bottle.
 Ans, Mass of empty density bottle (M_1)
 $= 30g$

Mass of bottle + water (M_2) = 75g

Mass of liquid + Liquid (M_3) = 65g

Mass of water = $M_2 - M_1 = 75 - 30 = 45g$

Volume of density bottle = mass of 45g = 45ml

b, density of liquid, and
 Ans, Mass of empty density bottle (M_1) = 30g
 Mass of bottle + water

Ans $M_1 = 30g$

$M_2 = 75g$

$M_3 = 65g$

Mass of ~~density bottle~~ liquid - density bottle
 $= 30g - 65g - 30g$

Mass of water $= M_2 - M_1 = 75 - 30 = 45g$

$D = \frac{35}{45} = 0.777 \text{ g/cm}^3$

c, Relative density of liquid.

Ans, ~~Mass of empty density bottle (M_1) = 30g~~
~~Mass of bottle + water~~

Ans $M_1 = 30g$

$M_2 = 75g$

$M_3 = 65g$

mass of water $= M_2 - M_1 = 75 - 30 = 45g$

Mass of the density bottle = 45g

Volume of the density bottle = 45cc

Mass of equal volume of liquid in density bottle $65 - 30 = 35g$

R.D of liquid $= \frac{35}{45} = \frac{7}{9} = 0.77$

B, Short / Long Answer Question

1, Define the term density of a substance.

Ans, Density of a substance is defined as 'Mass per unit volume'.

Density (d) = $\frac{\text{Mass of the substance}}{\text{Volume of the substance}}$

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

2, Name the S.I unit of density. How is it related to g/cm^3 ?

Ans, S.I unit of density is kg/m^3 in C.G.S system unit of mass is gram and unit of volume is cm^3 , so C.G.S unit of density is g/cm^3 (gram per cubic centimeter)

Relationship between S.I and C.G.S units.

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

Thus, $1 \text{ kg/m}^3 = 10^{-3} \text{ g/cm}^3$ or $1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$

3, The density of brass is 8.4 g/cm^3 .
What do you mean by this statement?
Ans, This statement means one cubic centimeter volume of brass has mass of 8.4 g .

4, Arrange the following substances in order of their increasing density:
Iron, Cook Brass, water, Mercury.
Ans, ~~Cook~~ \rightarrow Cook, water, Iron, Brass, Mercury.

5, How does the density of a liquid (or gas) vary with temperature?
Ans, Most of the liquid den increase in volume with increase in temperature, but water shows anomalous behaviour. Water has maximum volume at 4°C and maximum density at 4°C .
Actually, when volume increases density decreases and when volume decreases the density increases.
But water when cooled from a high

temperature, contracts upto 4°C because volume decreases and expands when cooled further below 4°C and hence density of water increases when it is ~~coolt~~ cooled upto 4°C while decreases when cooled further below 4°C . In other words, the density of water is maximum at 4°C equal to 1 g/cm^3 or 1000 kgm^{-3} .

6, A given ~~ex~~ quantity of a liquid is heated. Which of the following quantity will vary and how?
Ans, when a given quantity of a liquid is heated -
a, ~~ex~~ Mass: does not change
b, volume: changes and increases with ~~ex~~ in temperature.
c, density: changes and decreases.
Density = ~~ex~~ Mass/volume
9, what is a density bottle? How is it used to find the density of a liquid?
Ans, The density bottle is a small glass bottle having a glass stopper at its neck.

The bottle can store a fixed volume of a liquid. Generally the volume of bottle is 25ml or 50ml. Stopper has a small hole through it. When bottle is filled with liquid and stopper is inserted the excess liquid rises through the hole and drains out. Thus the bottle will contain the same volume of liquid each time when it is filled. It is used to determine the density of a liquid.

10, Define the term relative density of a substance.

Ans, Relative density is the ratio of density of a substance to the density of water at 4°C .

11, What is the unit of the relative density?

Ans, Unit of relative density is not since it is a pure ratio.

12, Distinguish between density and relative density.

Ans, Density - It is ratio of mass to volume.

$$D = \frac{m}{V}$$

Units are g cm^{-3} or kg m^{-3}

Density in $\text{kg m}^{-3} = \text{RD} \times 1000$

Relative density - It is the ratio of density of substance to density of water.

It is a pure quantity. It has no units.

13, Explain the meaning of the statement 'Relative density of aluminium is 2.7'.

Ans, The statement 'Relative density of aluminium is 2.7' means a piece of aluminium of any volume has mass 2.7 times that of an equal volume of water.

14, How does the density of a body and that of a liquid determine whether the body will float or sink into that liquid?

Ans, If the density of a body is less than the density of liquid, the body will

float on the surface of liquid.
If the density of a body is more than the density of liquid, the body will sink in a liquid.

15) A cork piece floats on water surface while an iron nail sinks in it. Explain the reasons.

Ans, Cork floats on water means density of cork is less than density of water. Iron nail sinks in water means density of iron nail is more than density of water.

17/18, State the law of floating? floatation?
Ans, 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 i.e. while floating. Weight of the floating body = weight of the liquid displaced by its immersed part.

20) For a floating body, how is its weight related to the buoyant force?

Ans, 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.

21) Why does a piece of ice float on water?
Ans, Floation of ice on water: Density of 0.9 g/cm^3 is less than density of water 1 g/cm^3 . Hence, ice floats on water.

22) Explain why an iron needle sinks in water, but a ship made of iron floats on water.

Ans, Density of iron is more than density of water, weight of iron nail is more than wt. of water displaced by it and nail sinks. While shape of iron ship is ~~not~~ made in such a way that it displaces more weight of water than its own weight. Secondly the ship is hollow and the empty space contains air which makes the average density of ship less than that of water and hence a ship floats on water.