ST. LAWRENCE HIGH SCHOOL

A JESUIT CHRISTIAN MINORITY INSTITUTION

Sub: Physical Science **Class: 8** **Date: 05.05.20**

STUDY MATERIAL: CH 2 PHYSICAL QUANTITIES AND MEASUREMENT (PHYSICS)

Important Formulae

- Density (D) =[Mass (M)]/[Volume (V)]
- 1000 Kg/m^3 = 1 g/cm^3
- $D = \frac{M}{V_1 - V_2}$
- $D * = \frac{m_2 - m_1}{m_3 - m_1}$
- $D = \frac{m_2 - m_1}{V}$
- $RD = \frac{\text{Density of the liquid}}{\text{Density of water at } 4°C}$

$$= \frac{(\text{Mass of the liquid}) \div \text{Volume}}{(\text{Mass of water}) \div \text{Volume}}$$

$$= \frac{\text{Mass of a certain volume of liquid}}{\text{Mass of the same volume of water}}$$

$$D = \frac{m_2 - m_1}{m_3 - m_1}$$

- RD = Density of a substance ÷ Density of water at 4 ° C
- RD= Mass of a substance ÷ Mass of same volume of water at 4°C
- RD = Weight of a substance ÷ Weight of same volume of water at 4°C

Concepts

Measurement is the comparison of an unknown physical quantity with a known physical quantity of the same kind to find out how many times of the known physical quantity it is. So we have a standard against which any quantity must be compared. We call this fixed measure as a unit.

So Unit is a known physical quantity against which all unknown quantities are compared to find quantitatively how many times of the known quantity it is. Quantity is important in Physics. This quantity, given as a numerical value is referred to as the magnitude of the measurement.

Measurement=(numerical value) x (unit)

Short answer Questions

1. Define volume.
   A: The space occupied by matter is called volume.

2. Define density.
   A: The density of a substance is defined as mass per unit volume of the substance.
   Density (D) =[Mass (M)]/[Volume (V)]

3. State the CGS and SI unit of density.
   A: The CGS unit of density if g/cm^3 and the SI unit of density is Kg/m^3.

4. What is Eureka can?
   A: A beaker with a spout used in the experimental verification of Archimedes principle is called a Eureka can or an overflow jar.

5. Name the liquid that can be used to measure the density of a lump of sugar.
   A: Kerosene oil.

6. What is a density bottle?
   A: Density bottle is a specially designed bottle to measure the density of liquids with a capacity of generally 50 ml. It is a glass bottle with a ground glass stopper at its neck.

7. Define relative density.
   A: The relative density of a substance is defined as the ratio of the density of the substance to the density of water at 4^oC.

8. How does temperature generally affect the density of a substance?
   A: The density of a substance generally decreases with a rise in temperature.

9. What is anomalous expansion of water?
   A: The property of water whereby it contracts when heated from 0^oC to 4^oC is called anomalous expansion of water?

10. What is the value of the highest density of pure water and at what temperature does it occur?
    A: The density of pure water is highest at 4^oC which is 1 gm/cm^3 or 1000 Kg/m^3.

11. What are convection currents?
    A: Circular movements or currents within a fluid (liquid or gas) due to different densities of hotter and cooler parts are called convection currents.

12. Give an example of natural convection currents.
    A: Land breeze and sea breeze are examples of natural convection current.

13. Why is it easier to swim in sea water as compared to fresh water?
    A: The density of sea water is greater than the density of freshwater due to dissolved salts, making swimming easier.

14. Define Plimsoll line.
    A: The Plimsoll line is a reference mark on the hull of a ship which indicates the maximum depth up to which a ship may be safely immersed in water when loaded with cargo.

15. How does ice float on water?
    A: The density of ice is less than water making it possible for it to float on water.

16. Which process is mainly responsible for the transfer of heat in a fluid?
    A: Convection

17. How relative density is related to the CGS values of density?
    A: The relative density is numerically equal to the CGS unit of density but without any unit as it is a pure ratio.

Long Answer Questions

1. Obtain a relationship between SI unit and CGS unit of density.

$$\frac{1\text{Kg}}{1\ \text{m}^3} = \frac{1000\ \text{g}}{1000000\ \text{cm}^3} = \frac{1\ \text{gm}}{1000\ \text{cm}^3}$$

Or, 1000 Kg/m^3 = 1 g/cm^3

2. How can you measure the density of a regular solid?

Ans: To measure the density of a regular solid we follow the subsequent procedure:

1. Measure the three dimensions of each regular object, repeating each measurement at two or more places. Depending on the size of the measurement, use the ruler, vernier callipers or a micrometer.
2. Calculate the volume, V, of the object.
3. Measure the mass, m, of the object, using the balance.
4. Calculate the density, D, of each sample, using D = m/V.
5. Compare your results with the accepted values for each material.

3. How can you measure the density of irregular solids?
   A: The density of an irregular solid is found out by dividing the mass of the solid by its volume. The mass, M, is found out using a beam balance. The volume is found out using a measuring cylinder or eureka can.
   The measuring cylinder is filled with a liquid in which the solid does not dissolve. The level of the liquid is noted before and after immersion of the solid as V_2 and V_1 respectively. The difference in level is equal to the volume of the irregular solid.

$$D = \frac{M}{V_1 - V_2}$$

   When using eureka can to measure the volume, eureka can is filled till it overflows. The irregular solid is immersed in the liquid which leads to a volume of liquid overflowing. That liquid is collected and its volume is measured which gives the volume of the solid, V.

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

4. How can you measure the density of a liquid using a density bottle?
   A: To measure relative density of liquid by density bottle

ü Find mass of empty bottle –m_0
ü Find mass of bottle and liquid-m_1
ü Empty the bottle and rinse it with water
ü Fill the bottle with water and find mass m_2

Mass of liquid= (m_1-m_0)g
Mass of equal volume of water= (m_2-m_0)g

Relative density=$\frac{mass\ of\ any\ volume\ of\ substance}{mass\ of\ an\ equal\ volume\ of\ water}$

Relative density=$\frac{m_1-m_0}{m_2-m_0}$

Since comparison of density is done with water (referenced substance) the other name of the ratio is specific gravity of a given substance. Because the density of water is 1g/cm³.Relative density has no units it is simply a number or ratio.

5. How can you measure the density of a liquid using a measuring cylinder?
   A: The mass of the empty measuring cylinder (m1) is found using a beam balance. A certain volume of the liquid (V) is poured into the cylinder and the mass of the measuring cylinder is found out with the liquid in it (m2). Thus density is obtained as:

$$D = \frac{m_2 - m_1}{V}$$

6. How can you measure the relative density of a liquid using a density bottle?

   A: To find the mass of a liquid, first the mass of the clean, dry and empty density bottle is measured using a beam balance (m_1). Mass of the bottle completely filled with the liquid is measured using the beam balance (m_2). To measure the mass of water of the same volume the mass of the bottle completely filled with water is found out (m_3). Thus relative density is obtained as:

$$RD = \frac{\text{Density of the liquid}}{\text{Density of water at 4°C}}$$
$$= \frac{(\text{Mass of the liquid}) \div \text{Volume}}{(\text{Mass of water}) \div \text{Volume}}$$
$$= \frac{\text{Mass of a certain volume of liquid}}{\text{Mass of the same volume of water}}$$
$$D = \frac{m_2 - m_1}{m_3 - m_1}$$

7. How does the density of a substance determine floatation?
   A: If the density of a body is more than that of the liquid in which it is immersed then the body sinks. If the density is less than that of the liquid the body floats with only a portion of its volume immersed in the liquid. If the density is equal to the liquid then the body floats with its entire

volume submerged in the liquid.

8. How can you express relative density in terms of mass?

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

So mathematically,

1. RD = Density of a substance ÷ Density of water at 4 ° C
2. RD= Mass of a substance ÷ Mass of same volume of water at 4°C
3. RD = Weight of a substance ÷ Weight of same volume of water at 4°C

9. Compare the density of a substance in the solid liquid and gaseous states.

Ans: Solids are typically going to be denser; the molecules are more tightly packed together than in a liquid or a gas. Solids have a higher density. Liquids are more free-moving and the molecules do not hold on so tightly to each other, hence the lower density. Gases are completely free-moving and have a much lower density than the other two. Between solids and liquids water along with a rare few substances exhibit an anomalous behaviour where liquid states have higher density than the solid state.

Q19. Differentiate between density and relative density.

ANS. DENSITY	**RELATIVE DENSITY**
i. Mass per unit volume of a substance is called density. ii. Density = mass/volume iii. SI unit of density is Kg/m^3 CGS unit of density is g/cm^3	i. The ratio between density of a substance and density of water is called relative density. ii. Relative density = Density of the substance/density of water at 4^0C iii. Units: Relative density has no units because it is the ratio between the similar physical quantities (density).

Explanation

1. 1. When is a cargo ship said to be fully loaded?
   A: When the ship's waterline (where the hull of the ship meets the surface of the water) equals the ship's Plimsoll line.
2. How does an iron ship float while an iron nail sinks?
   Ans: Because density of iron nail is more than the density of water so it sinks. While determining the density of the iron ship we take into consideration the density of air within the ship which is much less than But density of iron ship is less than density of nail as it's volume is more than nail and volume is inversely proportional to density. Thus the ship floats
3. How does an iceberg float on water?
   Ans: Icebergs float because as water freezes, it ex- pands and becomes less dense than the water it sits in. Only one tenth of an iceberg is above the surface, depending on the age of the iceberg.
4. Why is it easier to swim in sea water than in fresh water?
   Ans: It is easier to swim in sea water than in a river because, the sea water contains salt which increases the density of water and also increases its upthrust so, the body sinks less in it and

we swim easily. Easy to swim in sea water than in river water: Seawater contains a large number of dissolved salts

5. There is a fine hole in the stopper of a density bottle. Why?
   Ans. The function of the fine hole in a stopper is that, when the bottle is filled and the stopper is inserted, the excess liquid rises through the hole and runs down outside the bottle, by this way the bottle will always contain the same volume of whatever the liquid is filled in provided the temperature remains constant.
6. Explain anomalous expansion of water.

Ans: The anomalous expansion of water is an abnormal property of water whereby it expands instead of contracting when the temperature goes from 4oC to 0oC and it becomes less dense.The density becomes less and less as it freezes because molecules of water normally form open crystal structures when in solid form

7. How is convection currents formed in a liquid or a gas?
   A: When a fluid is heated it expands. Hence their density decreases. The warmer fluid being less dense rises up and the cooler portion being denser move downward to take its place. That fluid is then heated and consequently moves up. The cooler fluid moves down to take its place. The process continues till the entire fluid is at the same temperature. Thus the convection current is set up.
8. How are sea breezes and land breezes formed?

Ans: The land and sea breezes are convection currents set up in air due to the difference in heating and cooling rates of land and water. The circulation is composed of two opposing flows; one at the surface (called the sea breeze) and one aloft (which is a return flow). These two flows are a result of the difference in air density between the land and sea caused by the sun's heating.

The sun warms both the ground and ocean at the same rate. However, since the ground's heat remains confined to the top few inches of soil it radiates back into the atmosphere warming the air. Over the adjacent water the cooler, more dense air, being pull down by gravity, begins to spread inland.

The opposite is seen in case of land breeze at night. Where ground retains less heat than the water.

Solved Numericals

Example 1.

A block of ice with volume $5.5m^3$ has a mass of 5060kg find the density of ice.

Solution

Volume of block=$5.5m^3$

Mass of block=5060kg

Density=mass /volume

=$5060/5.5m^3$.

=$920kg/m^3$.

The density of ice is $920kg/m^3$.

Example 2.

A silver cylindrical rod has a length of 0.5m and radius of 0.4m, find the density of the rod if its mass is 2640kg.

Solution

Mass of cylinder=2640kg

Volume of cylinder= $\pi r^2 h$

=3.14 x 0.4 2 x 0.5

$=0.2512m^3$

Density=mass/volume

$=10509kg/m^3$.

Example3.

A stone has a mass of 112.5g.when the stone totally immersed in water contained in measuring cylinder displaced water from 50cm3 to 95cm3.find the density of the stone.

Solution

Mass of the stone=112.5g

Volume of stone=$95cm^3-50cm^3=45cm^3$

Density=mass/volume

$=2.5g/cm^3$.

Example 4.

Beaker contain $262.5cm^3$ of a certain liquid weigh 410g,if the mass of an empty dry beaker is 200g,find the density of the liquid.

Solution

Mass of liquid=410g-200g=210g

Volume of liquid=$262.5cm^3$.

Density=mass/volume

$=0.8g/cm^3$.

Example 5

A 30ml density bottle was filled with kerosene and found to weigh 86g.if the mass empty dry bottle was 62g, find the density of kerosene.

Solution

Mass of empty bottle=62g
Mass of bottle and kerosene=86g
Mass of kerosene only=86g-62g=24g
Density= mass /volume
=24g/30ml
=0.8g/cm^3.

Example 6
Given the data below find the density of granules
Mass of empty dry density bottle =18g
Mass of density bottle and granules=131g
Mass of density bottle and granules together with water on top =171g

Mass of density bottle full of water=68g

Solution

Density of sand=$\frac{m_1 - m_0}{(m_1 + m_3)+(m_0 + m_2)}$g/$cm^3$

Where m_0=18g,m_1=131g,m_2=171g,m_3=68g.

Density of sand=$\frac{131-18}{(131+68)-(18+171)}$g/$cm^3$

=11300kg/m^3.

Example 7
A globe of steel has a mass of 12g and a volume of 15.2cm^3,find its relative density.
Solution

Relative density=$\frac{mass\ of\ any\ volume\ of\ substance}{mass\ of\ an\ equal\ volume\ of\ water}$

Mass of 15.2cm^3 of water is 1g/cm^3 x 15.2cm^3
Mass=15.2g
Relative density =$\frac{12g}{15.2g}$
=0.79.

Example 8
The mass of density bottle is 19g when dry and empty, 45g when filled with water and 40g when full of liquid x. calculate the density of the liquid x.

Solution

Relative density$=\frac{m_1-m_0}{m_2-m_0}$

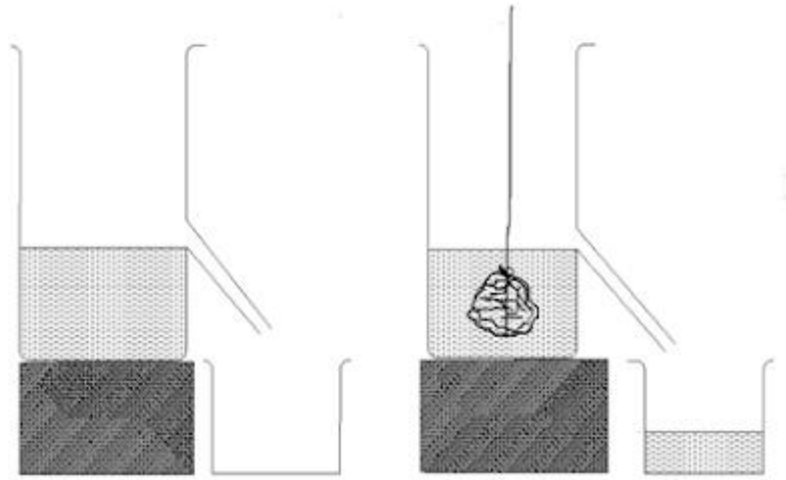
$=\frac{(40-19)g}{(45-19)g}$

$=0.81$

The density of liquid x is $0.81 g/cm^3$.

Determinations of relative density by eureka can method

- ü Find the mass m_0 g of solid
- ü Fill the eureka can and let water overflow until last drop
- ü Place under the spout of overflow can a clean dry beaker of mass m_1 g.
- ü Lower the solid slowly with thin thread until it is totally immersed
- ü Obtain the mass of water that overflow from the eureka can and the beaker itself m_2 g.



The volume of water overflows into a beaker is equal to the volume of solid
Mass of solid = m_0 g
Mass of beaker and water=m_2 g
Mass of beaker=m_1g.
Mass of water only = (m_2-m_1)g

Relative density$=\frac{mass\ of\ any\ volume\ of\ substance}{mass\ of\ an\ equal\ volume\ of\ water}$

$=\frac{m_0}{m_2-m_1}$

EXAMPLE 9
A certain piece of metal has a mass of 282.5 g,if when the block was totally immersed in overflow can displaced water in a beaker of mass 20 g.if the mass of water and the beaker was 45 g,find the relative density of the metal.

Solution

Relative density$=\frac{mass\ of\ any\ volume\ of\ substance}{mass\ of\ an\ equal\ volume\ of\ water}$

$=\frac{m_0}{m_2-m_1}$

$=\frac{282.5g}{(45-20)g}$

$=11.3$

Solution of Previous Years' Question Papers

2019

1st Term

2. Relative density is also known as-

a**. specific gravity** b. convection currents c. density d. sublimation

A reference mark on the hull of the ship is called **Plimsoll line**

1. How does density of liquid vary with temperature?

Ans. In case of liquids there is a large increase in volume with increase in temperature. So density of liquid decreases when they are heated and increases when they are cooked.

2. What happens if relative density of a density of a substance is less than 1?

Ans: If relative density of a substance is less than 1 it will float on water.

2. Why it is easier to swim in sea water than in freshwater? What do you mean by relative density of a substance?

Ans: Relative density of the substance is defined as the ratio of the density of the substance to the density of water at 4 ^oC.

$$\text{Relative density} = \frac{\text{Density of a substance}}{\text{density of water at } 4^0\text{C}}$$

It has no unit.

5. Explain convection currents. Give 2 example of natural convection currents.

Ans: Circular movement of currents within a fluid due to different densities of hotter and cooler part.

Examples: 1. Convectional rain 2. Land and Sea breeze

7. Explain an activity to show that object with less dennty floats on math (with diagram)

Ans : To show that subjects heavily less density float on water. Material Required – a glass beaker, Water, Cooking oil, Cark,

Procedure : Take some water in a glass beaker pour some cooking oil on the top now are cork in the beaker.

Observation : In the first step, we observed that both the liquids will frorm different layers in the beaker, cooking oil being less derse than water will float on it.

In the second step, we observed that the cork being less dense than oil will flat on oil.

Conclusion : Objects heaving less density float on water and those having more density sink in water.

8. State Reason –

Ans. : Reason – Ice floats on water because the density of ice less than the of density of water. Thus, the density of huge mass of ice called iceberg is less than that of water and hence it floats on water.

2nd Term

10. (i)Why does an iron ship float on water but an iron nail sinks in water?

Ans. The army ship floats on water because its average density is less than that of the iron nail which consists of water only iron only.

(ii) A block of aluminum of density 2700kg/m^3 has a volume of 250 cm^3. Find the mass of the block.

Ans: Mass = density x volume= 2700 x 250 / 1000 = 0.675 Kg

Exercise Problems

Question 1

500 grams of sugar occupies a volume of 0.315 liters. What is the density of the sugar in grams per milliliter?

Question 2

The density of a substance is 1.63 grams per milliliter. What is the mass of 0.25 liters of the substance in grams?

Question 3

The density of pure solid copper is 8.94 grams per milliliter. What volume does 5 kilograms of copper occupy?

Question 4

What is the mass of a 450 centimeter^3 block of silicon if the density of silicon is 2.336 grams/centimeter^3?

Question 5

What is the mass of a 15 centimeter cube of iron if the density of iron is 7.87 grams/centimeter^3?

Question 6

Which of the following is greater?

a. 7.8 grams per milliliter or 4.1 μg/μL

b. 3 x 10-2 kilograms/centimeters3 or 3 x 10^{-1} milligrams/centimeter^3

Question 7

Two liquids, A and B, have densities 0.75 grams per milliliter and 1.14 grams per milliliter, respectively.

When both liquids are poured into a container, one liquid floats on top of the other. Which liquid is on top?

Question 8

How many kilograms of mercury would fill a 5-liter container if the density of mercury is 13.6 grams/centimeter^3?

Question 9

How much does 1 gallon of water weigh in pounds?

Given: Density of water = 1 gram/centimeter^3

Question 10

How much space does 1 pound of butter occupy if the density of butter is 0.94 grams/centimeter^3?