The National
Orthodox School
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Subject: Science/ Physics   **Title: Density**

Name: Answer Key   **Grade-Section: ……CS**

Objectives:

1- **Define Density**
2- **Learn how to calculate density**
3- **Differentiate between the density of regular and irregular solids**
4- **Examine how to calculate the density of liquids**

What is Density?

Density is defined as the **mass** (amount of matter) of a substance that is found in a certain **volume.**

How do we calculate density?

$$DENSITY = \frac{MASS}{VOLUME} = kg/m^3$$

In our course we will use two units for density:

1- kg/m^3

2- g/cm^3

To solve density problems, list the known and unknown values, then use one of the following.

▸ When a problem requires you to calculate density, use the density equation, $\boxed{D = \dfrac{M}{V}}$

▸ You can solve for mass by multiplying both sides of the density equation by volume.

$$D\,V = \frac{M\cancel{V}}{\cancel{V}} \quad \text{or} \quad \boxed{M = D\,V}$$

▸ You can solve for volume by dividing both sides of the equation above by density.

$$\frac{M}{D} = \frac{\cancel{D}\,V}{\cancel{D}} \quad \text{or} \quad \boxed{V = \frac{M}{D}}$$

Exercise:

1) A metal cylinder has a mass of 6.20g and a volume of 124 cm^3. What is the density of the cylinder?

$$D = \frac{m}{v} = \frac{6.2}{124} = 0.05 \ g/cm^3$$

2) What is the mass of an object that has a density of $8 g/cm^3$ and a volume of 64 cm^3?

$$m = D \times V = 8 \times 64 = 512 g$$

3) A piece of tin has a mass of 16.52 g and a volume of 2.26 cm^3. What is the density of tin?

$$D = \frac{m}{V} = \frac{16.52}{2.26} = 7.31 \ g/cm^3$$

4) A man has a 50.0 cm^3 bottle completely filled with 163 g of a slimy green liquid. What is the density of the liquid?

$$D = \frac{m}{V} = \frac{163}{50} = 3.26 g/cm^3$$

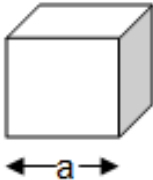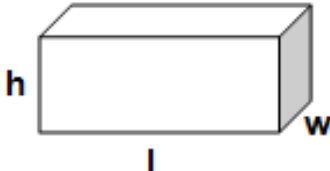5) What is the volume of 325 g of metal with a density of 9.0 g/cm^3?

$$V = \frac{m}{D} = \frac{325}{9} = 36.11 \; cm^3$$

6) You have a box that has a volume of 412 cm^3 and weighs 42g. What is its density?

$$D = \frac{m}{V} = \frac{42}{412} = 0.102 \; g/cm^3$$

Volume of a rectangular shaped object/cube

To find the volume we use the following rule: Length x Width x Height (L x W x H).

Figure	Formula	Variables
Cube	a^3	a = length of edge
Rectangular prism	l × w × h	l = length w = width h = height

Example:

Find the **volume** in each of the following:

1)   A cube has a length of 3 cm. (Note – a cube has six equal

     sides).

     Solution: V = 3 x 3 x 3 = 27 cm^3.

2)   A piece of wood has a length of 10 cm, width of 18 cm, and

     height of 3 cm.

     Solution: V = 10 x 18 x 3 = 540 cm^3

Check you understanding:

1)   A rectangular fish tank is 60.00 cm long, 200.00 mm wide,
     and 200.00 m deep.

     (a) What volume of water can it hold?

$$V = l \times w \times d$$

$$length = 60cm$$

$$width = \frac{200mm}{10} = 20\ cm$$

$$depth = 200m \times 100 = 20{,}000\ cm$$

$$V = 60 \times 20 \times 20000 = 24000000\ cm^3$$

     (b) What is the mass of the water?

$$m = D \times V = 1 \times 24000000 = 24000000\ g$$

2) Calculate the density of a 500 g rectangular block with the following dimensions:

length=8 cm, width=6 cm, height=5 cm.

$$V = l \times w \times h = 8 \times 6 \times 5 = 240 \ cm^3$$

$$D = \frac{m}{V} = \frac{500}{240} = 2.08 \ g/cm^3$$

3) A gold cube is 150.00 mm long, 10.00 cm wide, and 0.95 m thick. If gold has a density of 19.3 g/ cm^3, calculate the mass of the gold cube.

$$l = \frac{150mm}{10} = 15 \ cm$$

$$w = 10 \ cm$$

$$t = 0.95m \times 100 = 95 \ cm$$

$$V = l \times w \times t = 15 \times 10 \times 95 = 14{,}250 \ cm^3$$

$$m = D \times V = 19.3 \times 14250 = 275{,}025 \ g$$

Volume of an irregularly shaped object

Use a graduated cylinder filled with a fluid.

a) Record the beginning amount of fluid.

b) Drop the object into the graduated cylinder.

c) Record the level of the fluid with the object.

To determine the volume:

Level of fluid with object – beginning amount of fluid

Example:

A graduated cylinder is filled to the 30mL mark with water. You drop in a rock. The water level rises to 48mL.

Solution: V = 48mL – 30mL = 18mL= 18 cm³

Check your understanding:

1) A bead weighs 15 g. You place it in a graduated cylinder that has 20mL of water in it.
   After placing the bead in the cylinder, the water level is now at 30mL. What is its density?

$$V_{bead} = V_2 - V_1 = 30 - 20 = 10ml = 10cm^3$$

$$D = \frac{m}{V} = \frac{15}{10} = 1.5 \ g/cm^3$$

2) An irregular object with a mass of 118 g **displaces** 25mL of water when placed in a graduated cylinder. Calculate the density of the object.

$$D = \frac{m}{V} = \frac{118}{25} = 4.72 \ g/cm^3$$

3) A graduated cylinder is filled with water to a level of 40.0 mL. When a piece of copper is lowered into the cylinder, the water level rises to 63.4 mL. Find the volume of the copper sample. If the density of the copper is 8.9 g/cm3, what is its mass?

$$V_{copper} = V_2 - V_1 = 63.4 - 40 = 23.4ml = 23.4cm^3$$

$$m = D \times V = 8.9 \times 23.4 = 208.26 \ g$$

Density of Liquids:

- Just like solids, liquids also have their own characteristic density.
- The volume of a liquid can be measured directly with a graduated cylinder.
- To measure the mass of the liquid we do the following:
  - An empty measuring cylinder is put on a balance and its mass is found (M1)
  - The liquid is poured into the measuring cylinder and the mass is found on the balance as (M2)
  - Thus Mass= M2-M1