Important Concepts . . .

Preview Review

Science

Grade 8

W1 - Lesson 1: Mass, Volume, and Density

V5-07

Important Concepts of Grade 8 Science

Materials Required

Textbook:
Science in Action 8

Science Grade 8
Version 5
Preview/Review W1 - Lesson 1

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Preview/Review Concepts
for
Grade Eight Science

W1 - Lesson 1:
Mass, Volume, and Density

OBJECTIVES

By the end of this lesson, you should

- determine the mass of matter
- determine the volume of liquid and of a regularly or irregularly shaped solid
- know units of volume for solids, liquids, and gases
- calculate the density of a substance
- identify an unknown, pure substance from its density
- prepare and use a volume-mass graph

GLOSSARY

density - mass and/or volume; the mass per unit volume of a substance

mass - the amount of matter in a substance

volume - the amount of space occupied by something

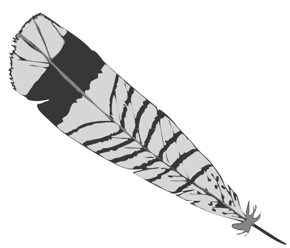
W1 - Lesson 1: Mass, Volume, and Density

Welcome to W1 - Lesson 1. This lesson teaches you about **mass**, **volume**, and **density**. These concepts are needed for other topics throughout this course. This lesson should take about 1.5 hours.

Mass

Mass is the measure of the amount of matter in an object, usually given in grams (g) or kilograms (kg). For example, if you weighed a guinea pig on a **balance scale**, you might find its mass is 250 g.

Mass varies greatly. A feather may have a mass of less than a gram; a semi-truck has a mass of several tonnes.



Activity 1

In the **Item** column list some things that have mass. In the last column write an estimate of the mass of the item/object. Include the units (g, kg, tonnes). The first one is an example.

Number	Item	Estimated Mass
1	cell phone	300 g
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

If you are still unclear about the concept of mass, ask your teacher questions about this.

Volume

You might think of **volume** as that little dial on a stereo that controls the sound. However, for the purposes of this course, volume is an amount of space. The volume of an object is the amount of space it occupies. For solid objects the units are *cubic* such as cubic centimetres (cm^3) or cubic metres (m^3). Liquids volumes are given in units such as millilitres (mL) or litres (L). Gases are measured by both liquid and solid units.

When reporting volume with a unit such as cm^3, that cube (the little ^{3}) means that three things were used to calculate it. This general formula can be used to calculate **volume of a rectangular solid**:

volume = length x width x height

So, if you have a rectangular solid with the dimensions 3 cm x 6 cm x 7 cm, its volume would be 126 cm^3.

Note: 1 cubic centimetre (1 cc) = 1 mL

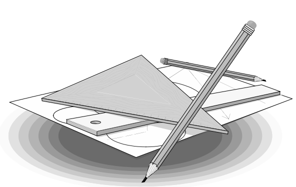
When you calculate the volume of a rectangular solid, length, width, and height must be in the same units. For example, if length is 5 cm, width is 12 cm and height is 2 m, you must convert the metres (m) in the height measurement into centimetres (cm) or the centimetres (cm) in the length and width measurements into metres (m) to have a correct answer. For example, the 2 m converts into 200 cm, so your new dimension for the calculation would be:

5 cm x 12 cm x 200 cm = 12000 cm^3

If you are not sure how to convert metric units, ask your teacher for assistance. Ten millimetres make 1 centimetre; 100 centimetres make 1 metre; 1 000 metres make 1 kilometre.

Conversion Practice

1. 55 mm = ________ cm
2. 1.20 m = ________ cm
3. 230 m = ________ km
4. 0.5 km = ________ cm



Liquid volumes are measured in containers with volume markings. The volume is read at the surface of the liquid. Read the volume section of Toolbox 5 on page 424 of the text.

Activity 2

Using your calculator, calculate volume for the following. Be sure you include the proper units and conversions. The first one has been done for you.

Length	Length unit	Width	Width unit	Height	Height unit	Volume	Volume unit
25	m	13	m	125	cm	4062.5	cm^3
45	m	63	cm	1	cm		
234	cm	45	m	52	m		
68	cm	87	mm	77	mm		
39	cm	21	m	41	m		
23	m	65	cm	63	cm		
479	mm	4	m	12	m		
12	m	10	m	12	m		
91	cm	25	m	235	cm		
27	km	33	km	44	m		

The numbers in the chart are quite large, but they are not out of the ordinary. You may see numbers this large if you calculate the volume of a swimming pool or perhaps determine the amount of top soil on a parcel of land.

The mass of an object (solid, liquid or gas) stays the same regardless of where the object is located. The volume of a solid is also constant. Weight will change with location. The more the gravitational pull on a mass, the greater its weight will be. A cubic metre of anything actually weighs less on a mountain top!

Density

If someone told you they thought you were dense, you probably would not like it at all. However, every object has **density**– some low, some high. What does this mean? For something to have a high density, it must have a small volume compared to its mass. If something has a low density, it has a large volume compared to its mass. Styrofoam has a low density. You could probably lift a piece of styrofoam the size of a car with little effort. However, a piece of gold the size of a car would be very difficult to lift due to its high density.

Density can be calculated. Density is the mass per unit of volume. It is usually measured in grams per millilitre (g/mL) or kilograms per litre (kg/L) for liquids or gases. The units for density of solids are usually grams per cubic centimetre (g/cm^3) or kilograms per cubic metre (kg/m^3).

This formula can be used to calculate density:

$$\textbf{density (d)} = \frac{\textbf{mass (m)}}{\textbf{volume (v)}}$$

Example:
If a 10g object occupies 2.5 cm^3 what is its density?

$$d = \frac{m}{v}$$

$$d = \frac{10\ g}{2.5\ cm^3}$$

$$d = 4\ g/cm^3$$

For calculations of density, all the units you use must be comparable. This means that if the mass is in grams, the volume must be in mL or cm^3. If the mass is in kilograms, the volume must be in L or m^3.

The following is an example of a student's calculation of the density for a small rock. The student used the **water displacement method**. This method works on the theory that when an object is dropped into water, it will displace (move) an amount of water that is equal to its volume. This is shown when you get into a bathtub filled with water and you notice the water level has risen. The parts of your body that are under water have displaced an amount of water equal to their volume. This is the best way to determine the volume of an **irregular object** such as a rock.

Examples

A student used the water displacement method to determine the volume of a rock. First, 50 mL of water were added to a graduated cylinder. Then the rock was dropped in. The water then measured 62 mL. What is the volume of the rock?

62 mL – 50 mL = 12 mL

The rocks volume is 12 mL.

Since 1 mL is the same as 1 cc, the volume of the rock can also be written as 12 cc.

The student found that the volume of the small rock was 47 mL. By using a balance beam scale, the student determined that the rock's mass was 78 g.

Using the above formula for density, the student calculated the following result: d = m/v

$$d = \frac{78 \text{ g}}{47 \text{ mL}}$$

d = 1.659 g/mL

d = 1.66 g/mL

(rounded to 2 decimal places)

Therefore, the rock was 1.66 times more dense than the same volume of water. We know that the density of water is 1 gram per millilitre.

Scientists have used density to help them identify elements such as gold and silver because under the same conditions, density is a constant value. It never changes unless conditions such as temperature change. Pure gold will always have a density equal to 19.3 g/cm^3 at room temperature. If a shiny gold-coloured metal has any other density, the substance is not pure gold. In the following activity, you will calculate the actual densities of some important elements.

Questions

1. What is the volume of an object given the following information? Initial water volume = 25 mL, Final water volume = 35 mL.

____

2. 50 mL of water is added to a measuring container.
After a 30 cc object is added, what volume will the water read?

____

Activity 3

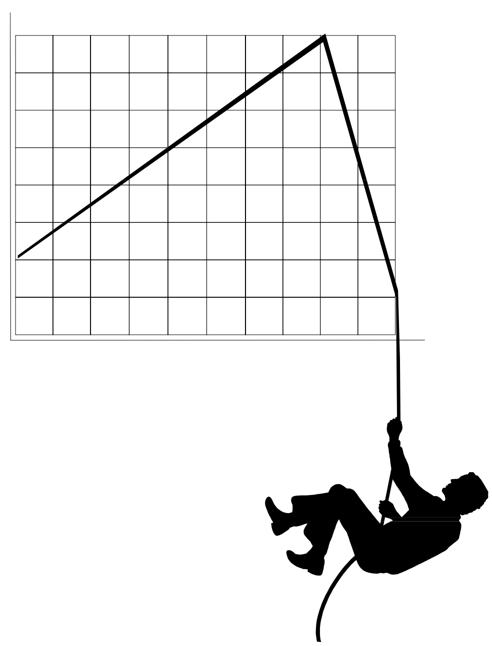
A student took some unknown pure substances and used the water displacement method to determine their volumes. Then, the student found the mass of each sample. Using a calculator, determine the density of the following samples. Then determine the name of each element - using the chart on the next page. The first one has been done for you.

Sample	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Possible name of Element
1	71.77	9.12	**7.87**	**iron**
2	129.40	14.96		
3	168.68	8.74		
4	30.91	3.45		
5	26.68	3.65		
6	114.24	10.88		
7	58.30	6.55		
8	993.05	87.11		
9	26.88	1.25		
10	18.75	2.63		
11	46.75	4.77		

Element	Density (g/cm^3)
Copper	8.96
Cadmium	8.65
Tin	7.31
Iron	7.87
Silver	10.5
Nickel	8.9
Platinum	21.5
Gold	19.3
Lead	11.4
Zinc	7.13
Bismuth	9.8
Americium	13.7
Uranium	19.1
Titanium	4.54
Aluminum	2.7

Activity 4

A student recorded the mass and volume of different amounts of silver. On the grid provided, graph the volume numbers 2, 6, 10, 14, 18, and 20 on the *x* axis (the bottom) and the corresponding mass numbers on the *y* axis, (along the side). This is a line graph; you must label your axis and units. Your graph must include a title (Density of Silver). When your graph is complete, you must answer the questions following it. The data table showing the information the student collected is on the next page.



Volume (cm^3)	Mass (g)	Density (g/cm^3)
2	21	10.5
4	42	10.5
6	63	10.5
8	84	10.5
10	105	10.5
12	126	10.5
14	147	10.5
16	168	10.5
18	189	10.5
20	210	10.5
30	315	10.5
40	420	10.5

Activity 5

1. Is the graphed data in a straight line or a curved line?

 ____

2. What does the shape of the line show you?

 ____

3. Calculate the slope of the line (rise/run).

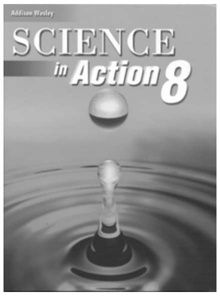
4. What value is the slope equal to? (Hint: Check the density chart.)

 ____

5. Use the graph to complete the blanks on the following chart.

Volume (cm3)	Mass (g)	Density (g/cm3)
3		10.5
7		10.5
19	199.5	

You should now be able to meet all the objectives listed at the beginning of the lesson. Go through the list to see if there is anything you need to spend more time on.



Extended Activity (Homework)

Read pages 47 to 49 in *Science in Action 8*. In your own words explain how the density of a substance can be changed.