WPMS Science

Name:
Date:

Observation and Measurement

Introduction

Your skills in observing, measuring, and describing your world are, and always will be, very important to you. The activities you'll do in these investigations help you improve your abilities.

You observe the world using your five **senses**: **sight, hearing, touch, smell,** and **taste**. Sometimes you want to know more about an object than you can learn only through your senses, so that's where measuring becomes important. You're making a measurement when you decide what size clothing to buy, or even how old you are.

Often, you use **instruments** to extend your sense and make more accurate measurements. In the blank spaces, write the name of each instrument that you might use to measure each "variable".

Length:

Mass (weight):

Liquid volume:

Temperature (heat):

Time:

All of these measurements are **direct**-this means that you find the value by comparing it with a know amount, such as the distance between lines on the ruler. Examples of variables you often measure directly are your height and weight (mass.) Other measurements are **indirect**—they are found by measuring something related and then using a mathematical equation to calculate what you want. For example, to find the area of a flat surface, you'd measure the length and width, and then multiply them to find the area. To find the volume of a rectangular solid, such as a block, you'd multiply the length times the width times the thickness.

One of the most important variables you will study this year is **density.** This describes the amount of a substance in a certain volume. For example, if you had the same volume of a solid, such as a rock, and a gas, such as air, the solid would have a greater mass, so we say it is "more dense." After you measure the volume and use a **balance scale** to find the mass, you can determine the density using the relationship:

Density = (mass) / (volume)

That is, you divide the mass by the volume. If you know any two of these three variables, you could find the other through their relationships:

Mass = (density) x (volume   Volume = (mass) / (density)

Some examples of how density is important in our world are that weather, volcanic eruptions, and even the slow movements inside the Earth that move continents over vast periods of time are driven by differences in density.

Finally, you need to consider the **accuracy** of your measurements. All instruments have slight errors—the bathroom scale you use is not precise, nor is any ruler completely accurate. So we commonly use two mathematical techniques to help understand more about accuracy. One is **finding the average**, which you probably already know. The other is finding the **percent deviation from the accepted value**, which you will learn more about later in this activity.

Activity 1 –Making Measurements

1. Length

Measure the objects given to the **nearest 0.1 cm** and record your answers.

Block	Length (longest side)	Width (middle side)	Thickness (shortest side)
Code			

Cylinder	Length (longest side)	Diameter (across the top)	Circumference (around the middle)
Code			

Ball	Diameter (across the top)	Circumference (around the middle)

2. Area

The area means how much space an object covers on a surface.

Area of a rectangle

The side of a block is rectangular, so we can find its area using the relationship:

Area = length x width (or length x thickness, or width x thickness)

Complete the table of areas for the side of your block. You need to record your answers to the **nearest 0.1 cm^2** (that is, **rounded to one decimal place**.)

Largest side	Medium side	Smallest side

Area of a circle

The area of a circle is found using the relationship: **Area = πr^2**

The symbol **"π"** is pronounced "pie" and spelled out "pi." It comes from the number one always gets by dividing the circumference of a circle by its diameter. It is approximately equal to 3.14.

Calculate and record the area of the top of the cylinder, rounded to the nearest 0.1 **cm^2**:

Area of a sphere

The area of a sphere, such as the ball, is found using the relationship:

$$\textbf{Area} = 4 \pi r^2$$

Calculate and record the area of the ball, rounded to the nearest 0.1 **cm^2**:

3. **Volume**

The volume of an object means how much space it occupies (takes up.)

Volume of a rectangular solid

The volume of a rectangular solid is found using the relationship:

Volume = (length) x (width) x (thickness)

Calculate and record the volume of the block, rounded to the nearest 0.1 **cm^3**:

Volume of a cylinder

The volume of a cylinder is fond by the relationship:

Volume = (area) x (length)

Calculate and record the volume of the cylinder, rounded to the nearest 0.1 **cm^3**:

Volume of a sphere

The volume of a sphere is found using the relationship:

$$\textbf{Volume} = (4/3) \pi r^3$$

Calculate and record the volume of the ball, rounded to the nearest 0.1 **cm^3**:

4. **Mass**

Use the balance scale to find the mass of each object, to the **nearest 0. 1 g**.

Block	Cylinder	Ball

5. **Irregularly-shaped Objects**

What you have used so far were objects with “regular” shapes that can be described using mathematical equations. But how would you measure an “irregularly-shaped” object, such as a rock?

You can still use a balance scale to determine the mass. We will use **granite** (lighter-colored) and **basalt** (darker-colored) for this activity. Find the masses of your samples and record them to the nearest 0.1 g.

Granite	Basalt

Now you have the problem of finding the volume of the irregularly-shaped object. Many centuries ago, a Greek scientist discovered how to do this using the **water displacement method**. He realized that the volume of the object is equal to the volume of water it displaces (moves up) in a container.

You will use a **graduated cylinder** or **beaker**. First you need to pour in water to any chosen line (the “original” level.) Then carefully put in the object and record the “final” level. When you subtract the original level from the final level, the **difference** is the volume of the object. Liquids are measured in milliliters (mL), but one mL exactly equals 1 cm^3, so record your answer to the nearest 0.1 cm^3.

Granite	Original level	Final level	volume

Basalt	Original level	Final level	volume

Activity 2 – Calculating Densities

In the Introduction, you learned that density is a very important **property** or **characteristic** of many objects making up our world. Once again,

Density = (mass) / (volume)

The unit used to record density is **"grams per cubic centimeter" (g/ cm^3)**, or for liquid, **"grams per milliliters" (g/mL)**.

First, calculate the density of the objects using your measurements and record them in the table below. Then, we will compare the results of al the groups and find the "class average." This will be one way to tell how accurate our results are.

Object	Your group's results	Class average
block		
cylinder		
ball		
granite		
basalt		

Give two or three reasons why your group's results may differ from the class averages:

Activity 3—Finding the "percent deviation from the accepted value."

The Introduction also reminded you that all instruments contain some error because they are not perfect. Often in scientific investigations, we use a technique called finding the **"percent deviation from the accepted value."** The "accepted value" is the real value, and may be given to you in a problem or found in a reference table.

On page 1 of the "Earth Science Reference Tables," the equation to find "percent deviation from the accepted value" is given as

Deviation (%) = [(difference from the accepted value)/(accepted value)] x 100

This means that you:

1. subtract the measured value from the accepted value
2. divide this difference by the accepted value
3. multiply this quotient by 100%

In most cases, it does not matter if the subtraction produces a positive or negative number—all we are interested in is by what percent the answers differ, not if it is more or less.

To learn more about this important equation, we will use the values you obtained in Activity 2 for the density of granite and basalt. From reference sources, we know that

Density of granite = 2.7 g/ cm^3
Density of basalt = 3.0 g/ cm^3

In the space below, calculate the percent deviation for your measurements. Show your work.

Deviation from your group's results for granite =

Deviation from class average for granite =

Deviation from your group's results for basalt =

Deviation from class average for basalt =

Activity 4 – The "Big Challenge" – Finding the Height of a Flagpole

Everything we have done so far involves important skills, but the problems really were not too challenging. So now I give you this: How can you measure the height of something too big to measure directly, the flagpole in front of the school?

You and your group will need to discuss ways to solve the problem, then make notes of what you do as you make your measurements, and present your results. You may want to use simple drawings to help explain things.

In a report attached to these Activity sheets, include your:

Statement of the Problem
Procedures (methods you used)
Results (including proper units)

Final Thoughts

In the space below or on additional paper, briefly write about:

- Five important things you have learned while doing these activities
- What you liked best
- What you found most difficult and why

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