

Measuring Mass

CONTENT STANDARD: Measurement

CONTENT TOPIC: Physical Science

CONCEPT: Quantitative attributes of matter such as mass, weight, volume, and length can be described.

CONTENT OBJECTIVE: To understand the concept of mass and weight measurements.

INSTRUCTIONAL OBJECTIVES: The learner will:

- Define and measure mass.
- Define and measure weight.
- Explain the difference between mass and weight.

OUTLINE OF CONTENT:

- I. All matter has mass
- II. All matter has weight if gravity is present
- III. Mass is independent of location, weight is dependent on location (you weigh more on Earth than on the Moon)

GOAL: To enable students to acquire scientific knowledge by applying concepts, theories, principles and laws from science.

STANDARD(S): The learner will understand that:

Everything is constantly changing; rates of change vary over a wide scale with a great variety in patterns of change.

BENCHMARK: Some things may stay constant while others change.

Cycles of change can be extended in scales of time, space, and material.

BENCHMARK: Changes occur in various ways and may be altered by controlling some variables.

INFORMATION:

For K and 1st grade emphasize *all matter* (everything around us) *has mass*. *Weight is dependent on location*.

Mass and weight are two different ways to measure matter. **Mass is a measure of the amount of matter (“stuff”) in an object.** Mass does not change. **Weight is dependent on location and can vary depending on where it is measured.** Weight will be less if you are on the moon compared to the earth. Some students are confused about the difference between mass and weight. Mass is a property of all matter, weight depends on gravity. If there is no gravity, there can be no weight, but mass still exists.

Most people think that there is hardly any difference between "weight" and "mass" and it wasn't until we started our exploration of space that it was possible for the average person to experience, even indirectly, what it must mean to be "weightless". Now that Astronauts regularly seem to be demonstrating "weightlessness", (yet we know they still have all of the matter or mass they had when they were on earth,) more of us are beginning appreciate the weight - mass confusion. Like many confusing concepts, after they are finally understood, they are still difficult to explain to others who don't understand. We hope we can explain the difference between mass and weight so that you will have no trouble explaining the difference to your students.

Mass: This concept is so basic that, like length and time, it is really impossible to define. Isaac Newton called mass the **quantity of matter**. Some say mass is the amount of matter in something (and hope that no one asks: What is matter?). Better minds than ours have been confused over the meaning of the concept "mass" and even today, better minds than ours contemplate what mass really means. Our way of giving up on the impossible task of defining mass is to say: **mass is the measure of the amount of "stuff" in something.** This definition is properly confusing and you can work on the meaning of "stuff"! In the metric system mass is measured in kilograms and grams and these will be the units we will most often use. (The more mass something has, the harder it is to move or, the more sluggish it is.)

Weight: If you can finally accept the concept of mass even if we have been unable to define it, weight is easy: **The weight of a mass is the force that the earth pulls on the mass.** We hope you have a feeling for what force means. The entire idea of weight can be understood as the force of gravity on something. Usually we spend most of our time on Earth so our weight is the force that the earth pulls on us. If we get further away from the earth, the force the earth pulls on us is less and we weigh less. If you lived on Mars, the above definition would probably change to: "The weight of a mass is the force that Mars pulls on the mass." The whole idea of weight is related to the force of gravity. It would be correct to say, no matter where you might be in the universe that **"the weight of a mass is the force of gravity on the mass."** In the metric system force is measured in newtons hence weight is also measured in newtons. On the surface of the earth, a mass of 1 kilogram weighs 9.8 newtons. The pound is the US unit of force hence the US unit of weight is also the pound. We will use newtons for the unit of force (and weight) almost always in the discussions that follow.

Remember that measurement is an important skill that students begin developing in the earliest years. It begins with non-standard units of length, volume, and mass. An important concept is that any *measurement is an estimation* to the nearest unit being used (inches, centimeters, pounds, grams, etc). The measurement tool and the unit will be determined by the attribute being



measured and the purpose of the measurement. Students must be able to select and use a balance to measure mass and measuring cups or graduated cylinders for volume. When measuring matter, *students should understand that all measurements have error* because one must always estimate the last reported digit. All instruments have limitations on their ability to measure.

CLASSROOM CONNECTORS

TIME REQUIRED: 30 minutes

MATERIALS: Balance scale, spring scale, weights, and density spheres. Paper and pencil to record findings.

SET: Raise your hand if you know how much you weigh. Do you weight the same here on Earth as you do on the Moon? Why or why not? Today you will learn about **mass and weight**.

SUPERVISED PRACTICE:

1. Make sure your balance is “zeroed” (level)
2. Using the balance scale compare the weights of different objects in the room
3. Using the density spheres and gram weights:
 - a. put one sphere on the scale
 - b. using the weights find out the mass of the sphere
 - c. compare the mass of different types of spheres
4. Using the spring scale measure the amount of weight of different objects
5. Using the density spheres and weights:
 - a. put one sphere on the scale
 - b. using the scale find out the weight of the sphere
 - c. compare the mass of different types of spheres

CLOSURE:

1. You have an object and you want to know if it will float in water. To answer the question: "will it float?" do you need to know the objects mass, weight or density?
2. A student's mass on Earth is 50 kilograms. If this student went to the Moon, would her mass be more, less, or the same?
3. A student's weight on Earth is 100 pounds. If this student went to the Moon, would he weigh more, less, or the same?
4. A block of wood easily floats on water when on the Earth. If the same block of wood were taken to the Moon, would it float on water? (Really give this some careful thought, most people can not answer this question. The answer is easy, mass and volume does not change because of location. The wood will float in water on the moon just like Earth)

