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**- Student Activity - The mole**

**INTRODUCTION**

The mole designates an extremely large number of units, 6.022 × 1023, which is the number of atoms determined experimentally to be found in 12 grams of carbon-12. Carbon-12 was chosen arbitrarily to serve as the reference standard of the mole unit for the International System of Units (SI). The number of units in a mole also bears the name [Avogadro’s number](https://www.britannica.com/science/Avogadros-number), or Avogadro’s constant, in honor of the Italian physicist [Amedeo Avogadro](https://www.britannica.com/biography/Amedeo-Avogadro) (1776–1856). Avogadro proposed that equal volumes of [gases](https://www.britannica.com/science/gas-state-of-matter) under the same conditions contain the same number of molecules, a [hypothesis](https://www.merriam-webster.com/dictionary/hypothesis) that proved useful in determining atomic and molecular weights and which led to the concept of the mole.

**PROCEDURE**

On your table there are two containers with small white marbles in them. One container is labeled **Atom A** and the other is labeled **Atom B**. We are going to assume for this activity that each container holds one mole of atoms (or 6.022 × 1023 atoms). However, please count the number of marbles in each container to prove that there are actually the same number of marbles in both containers. It should be 65 marbles. So we are going to pretend that one mole of atoms is equal to 65 marbles for this activity.

Weigh all of the marbles in the container labeled **Atom A** \_\_\_\_\_\_\_\_\_\_\_\_ grams

Weigh all of the marbles in the container labeled **Atom B** \_\_\_\_\_\_\_\_\_\_\_\_ grams

Look carefully at each container.

Do all of the marbles (atoms) in the container labeled **Atom A** look the same? \_\_\_\_\_\_\_

Do all of the marbles (atoms) in the container labeled **Atom B** look the same? \_\_\_\_\_\_\_

Why not? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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You have already learned that the mass of an atom is found by adding the total number of protons and neutrons contained within it. This mass is called the **Atomic Mass.** It also goes by another name, **Formula Mass**. It is called the formula mass because the symbols we use for atoms and molecules are called formulas. (Later on in the year, when we calculate the mass of molecules, we will call that mass the Molecular Mass or Molecular Weight).

The units we use for atomic mass or formula mass are **amu**. **Amu** stands for *Atomic Mass Units.* This is a relative term for no one can actually weigh an atom.

However, we can weigh a mole of atoms. The mass of a mole of atoms is called **Molar Mass**.Molar mass also goes by other names: **Gram Formula Mass** and **Gram Atomic Mass**.

The units we use for molar mass are in **grams/mole (g/mol)**. However, we often shorten it to just grams (the per mole part is assumed).

So that you don't get confused, follow the simple chart below.

**Mass**  **Names Units used**

Mass of a single atom atomic mass, formula mass, amu formula weight

Mass of a molecule molecular mass, molecular weight amu formula weight

Mass of a mole of atoms molar mass, gram formula mass, grams/mole (or just grams) gram atomic mass

Now let's go back to the atoms you just massed on the digital balance. It turns out that the molar mass of an element and the atomic mass of an atom are the same number! That means that if you want to find the mass of one mole of atoms, all you have to do is look up the atomic mass of that atom from the reference table, and then change the units from amu to grams/mol.

For example, if you weighed exactly one mole of aluminum atoms, the molar mass should be exactly 26.98154 grams/mole. This is because the average mass of one aluminum is 26.98154 amu.

Now go back to the two samples you weighed. Based on their masses, and assuming that each container has exactly one mole of atoms, what element was atom A and B?

Atom A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Atom B \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now let's practice some simple conversions.

First write down the average atomic masses and molar masses for the following elements:

**Name**  **Symbol** **Atomic Mass (amu)** **Molar Mass (g/mol)**

Hydrogen \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Helium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Lithium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Boron \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Carbon \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sodium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Magnesium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sulfur \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Potassium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Calcium \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If you have 2.00 moles of carbon, how many grams would it weigh?

2.00 ~~moles~~ of C x 12.011 grams = **24.0 grams of carbon** (rounded to 3 sig figs) 1 ~~mole~~

If you have 11.5 grams of sodium, how many moles would you have?

11.5 ~~grams~~ of Na x 1 mole = **0.500 moles of sodium** (rounded to 3 sig figs) 22.98977 ~~grams~~

Now you try some. Do the following conversions on the next two pages:

1. How many grams are in 3.00 moles of lithium atoms?

2. How many grams are in 0.500 moles of calcium atoms?

3. How many grams are in 4.75 moles of hydrogen atoms?

4. How many grams are in 5.60 moles of sulfur atoms?

5. How many grams are in 9.34 moles of helium atoms?

6. How many moles of atoms are in 5.41 grams of boron?

7. How many moles of atoms are in 42.0 grams of carbon?

8. How many moles of atoms are in 6.08 grams of magnesium?

9. How many moles of atoms are in 68.4 grams of potassium?

10. How many moles of atoms are in 20.7 grams of sodium?