**More Than a Trillion**

(Adapted from Living By Chemistry’s “More Than a Trillion”)

Purpose: In this lesson, you will explore how to count using a new unit called the mole.

**Part I: 1 Mole = 6.02 × 1023 Particles**

1. Look at the patterns and fill in the missing data.

|  |  |  |  |
| --- | --- | --- | --- |
| Substance | # of Moles | # of Particles | Total # of Atoms |
| He (g) | 1.0 | 6.02 × 1023 | 6.02 × 1023 |
| He (g) | 0.5 | 3.01 × 1023 | 3.01 × 1023 |
| He (g) | 2.0 | 1.20 × 1024 |  |
| H2 (g) | 1.0 | 6.02 × 1023 | 1.20 × 1024 |
| H2 (g) | 0.5 | 3.01 × 1023 |  |
| H2 (g) |  |  | 2.41 × 1024 |
| Cu (s) | 1.0 |  |  |
| Cu (s) | 0.1 | 6.02 × 1022 |  |
| H2O (l) | 1.0 |  | 1.81 × 1024 |
| H2O (l) | 0.5 | 3.01 × 1023 |  |

2. How many particles are in 2.00 moles of a substance?

3. How many particles are in 10.0 moles of a substance?

4. How many particles are there in 2.00 moles of water? How many atoms?

5. Why do you think moles are useful as a counting unit for chemists?

6. Which has more mass, 1 mole of He (g) or 1,000,000,000 atoms of He (one trillion)? Explain your reasoning.

**Part II: Counting Molecules vs. Atoms**

1. CH2O is the chemical formula for formaldehyde.

 a) How many carbon atoms are there in 1 molecule of CH2O?

 b) How many carbon atoms are there in 1 mole of CH2O?

 c) How many hydrogen atoms are there in 1 molecule of CH2O?

 d) How many hydrogen atoms are there in 1 mole of CH2O?

 e) How many oxygen atoms are there in 1 molecule of CH2O?

 f) How many oxygen atoms are there in 1 mole of CH2O?

To answer the following questions, label 24 small pieces of paper with “1 mole CHHO.”

2. How many moles of CH2O are needed to have the same number of atoms as 1 mole of C6H12O6? (use the pieces of paper labeled “1 mole of CHHO” to check your answer)



Formaldehyde

clear liquid

smells putrid

Glucose

white solid

tastes sweet

3. Which has more mass: 1 mole of CH2O (formaldehyde) or 1 mole of C6H12O6 (sugar)? Explain your thinking.

4. Suppose you have a container with 24 moles of CH2O and another container with 4 moles of C6H12O6. (Use the pieces of paper labeled 1 mole of CHHO” to check your answers)

1. Is the total number of atoms in the two containers the same? Why or why not?
2. Explain why 24 moles of CH2O weigh the same as 4 moles of C6H12O6.
3. Which has more molecules, 24 moles of CH2O or 4 moles of C6H12O6?

**Making Sense:**

A company has a history of releasing NO2 gas into the atmosphere, which forms smog. In order to reduce their pollution, they figure out how to release N2O4 instead. For every 1.0 mole of NO2, they now release 0.75 moles of N2O4 instead.

▪Are there fewer gas particles with the release of 0.75 moles of N2O4 instead of 1.0 moles of NO2? Explain.

▪Are there fewer N atoms being released? Explain.

▪If the amount of smog depends on the number of N atoms, has the company reduced the amount of smog that will be produced?

**If you finish early…**

How many moles of acetic acid (C2H4O2) are equivalent to 4 moles of C6H12O6?

|  |  |  |  |
| --- | --- | --- | --- |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |

|  |  |  |  |
| --- | --- | --- | --- |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |
| **CHHO** | **CHHO** | **CHHO** | **CHHO** |