Model 2 – Atoms

Oxygen		Sulfur		Ratio of numbers of atoms	Ratio of masses of atoms
Number of atoms in the sample	Mass of the sample	Number of atoms in the sample	Mass of the sample		
1	16.00 amu	1	32.00 amu	1:1	1:2
10	160 amu	10	320 amu	1:1	1:2
12 = 1 dozen	192 amu	1 dozen	384 amu	1:1	1:2
1 million	16,000,000 amu	1 million	32,000,000	1:1	1:2
1 mole	16.00 grams	1 mole	32.00 grams	1:1	1:2

Note: The masses shown for oxygen and sulfur have been rounded to make the arithmetic a bit easier.

6. What is the ratio of the mass of an oxygen atom to the mass of a sulfur atom?

1:2

7. Fill in the table in Model 2 in a similar fashion to the eggs table in Model 1. Divide the work evenly among group members. Reduce all ratios to the lowest whole numbers possible.

8. Circle the phrase below that completes the sentence.

When two samples contain the same number of atoms ________________

the masses of the samples will be equal.	the ratio of the sample masses will be equal to the ratio of the atom's masses.	the masses are unrelated.

9. Explain why it is not necessary to know how many atoms are in "1 mole" to finish the last row of the table in Model 2. The mass ratio does not depend on the # ~~Mass is unrelated to~~ of atoms in a sample, as long as the # is the same for both elements.

10. How would the number of oxygen atoms in a 16.00 lbs sample compare to the number of sulfur atoms in a 32.00 lbs sample? The ratio of masses for a mole of oxygen and a mole of sulfur is 1:2, so the ratio of number of atoms in 16- and 32-lb samples will still be 1:1.

11. In the front of the room, there is a bottle that contains a 32.00 g sample of sulfur. This is 1 mole of sulfur. Estimate how many atoms are in the bottle. Your group must reach consensus.

STOP

..... A really big #.

Read This!

A long time ago chemists discovered what you have just discovered: *The relative masses of the elements can be used to "count" atoms.* If you measure out a sample equal to an atom's atomic mass in grams, you always end up with the same number of atoms. Chemists call that quantity the **mole**—a quantity of any sample whose mass is equal to its atomic mass in grams.

Model 3 – Molar Mass

Average Mass of a Single Particle	
1 atom of hydrogen (H)	1.01 amu
1 atom of copper (Cu)	63.55 amu
1 molecule of oxygen (O_2)	32.01 amu
1 molecule of water (H_2O)	18.02 amu
1 formula unit of sodium chloride (NaCl)	58.44 amu

Average Mass of One Mole of Particles (Molar Mass)	
1 mole of hydrogen atoms (H)	1.01 g
1 mole of copper atoms (Cu)	63.55 g
1 mole of oxygen molecules (O_2)	32.01 g
1 mole of water molecules (H_2O)	18.02 g
1 mole of sodium chloride formula units (NaCl)	58.44 g

12. Look at a periodic table. What number in each element box would a chemist use to find the values in the "Average Mass of a Single Particle" column in Model 3?

The average atomic mass values, which are given with amu for a unit.

13. How is the mass of a single particle changed to get the mass of one mole of particles?

Same # from the periodic table, but with grams for a unit

14. Which sample contains more atoms, 18.016 amu of water or 18.016 g of water? Explain.

A gram is a much larger unit than the atomic mass unit, so the 18.016g sample has more atoms. 18.016 amu is the mass of one water molecule!

15. If the formula mass of iron(II) sulfate ($FeSO_4$) is 151.9 amu, what is the molar mass of iron(II) sulfate?

151.9g

16. Use a periodic table to calculate the molar mass of ammonia (NH_3).

17.0g

17. How would the number of atoms in a 1.01 g sample of hydrogen compare to the number of atoms in a 63.55 g sample of copper?

The number of atoms in each sample would be the same.

Read This!

So how many "things" are in a mole? By estimating the size of atoms and taking volume measurements of 1 mole samples scientists can estimate that

1 mole = 6.022 → 10^{23} particles or 602 200 000 000 000 000 000 000 particles

(More than you could count in a lifetime!)

This number is called Avogadro's number, named after Amedeo Avogadro.