Handout - The Mole

- The mole is a scientist's way of expressing ***an amount***. This is often done by non-scientists as well.

  Ex. -

- Technically, the mole is the number of carbon atoms in exactly $12\ g$ of carbon.

- So, if individual atoms have different weights how can I equally react them? Well, if we use the example above, we know that gas B is 16 times heavier I need 16 times as much of gas B for them to react equally, IF THE ATOMS OF BOTH GASES WERE BOTH A MASS OF 1. However, we know that different atoms weigh different amounts because the protons and neutrons are different. Hmmmm, we seem to be stuck.

- We know that carbon has 6 protons and 6 neutrons which equal 12 atomic mass units (amu). If we compare this to magnesium which is 12 protons and 12 neutrons which equal 24 amu. So it looks like magnesium is twice the weight of carbon when we look at the atoms. Couldn't we just change the units from amu to g. If we do it for all elements then the RATIO of the masses of the elements won't change. Yah!

- We can now say that $12\ amu$ is equal to $12\ grams$!

- Putting a g beside atomic mass allows us to use masses from the periodic table.

  *** Therefore – $12\ g\ of\ C\ = 1\ mol$ Carbon

- So what we're saying is that 1 mole of an element has a mass equal to the atomic mass in GRAMS!

- The mass of one mole is referred to as the _____.

- Avogadro's hypothesis –

  Ex. –

- Avogadro's discovery of gases allows us to connect the moles of a gas to an actual amount of atoms found in the mole.

- Avogadro found that in $1\ mole$ of any element there is $6.022 \times 10^{23}\ molecules$.

  Ex. – Fluorine has an atomic mass of $19.0\ amu$ so that means in $19\ g$ of fluorine or $1\ mole$ of fluorine there is $= 6.022 \times 10^{23}\ molecules$ of fluorine.

- What is the molar mass of water?

$$H_2O \quad = \quad \frac{2\times H}{1\times O} \quad = \quad \frac{2\times 1.01}{1\times 16.00} \quad = \quad \frac{2.02}{+\,16.00} \quad = \quad 18.0\ grams$$

- Calculate the molar mass of . . . .

  Ex. - CO_2 = $(1 \times C) + (2 \times O) = (1 \times 12.01) + (2 \times 16.00) = 44.01\ g$

  Ex. 2 - NH_4Cl =

  Ex. 3 - $CaBr_2$ =

  Ex. 4 - $Al(OH)_3$ =

- Now that we can find out how many grams equal $1\ mole$ for each element we can use this value to calculate the amount of particles (atoms or molecules) that make up that mass.

- Using Avogadro's number (6.022×10^{23}) will allow us to do this.

  1.)

  2.)

  *****DON'T FORGET – WHEN IN DOUBT AT WHAT TO DO, CHANGE TO MOLES!!!!!*****

  Ex. - How many grams of CCl_4 is in $2.5\ moles$ of CCl_4?

  Answer –

Ex. 2 – How many moles are there in $39.6\ grams$ of NaCl?

Answer -

Ex. 3 – How many atoms of Carbon are in $16.2\ g$ of Carbon?

Answer -

Ex. 4 – How many atoms are in $16.4\ g$ of Li_2SO_4?

Answer -

Ex. 5 – How many grams of Nitrogen in $4.16 \times 10^{24}\ molecules$ NO_2?

Answer -

Ex. 6 – How many molecules of N_2O_4 do you have if there are $12.4\ g$ of Nitrogen?

Answer -