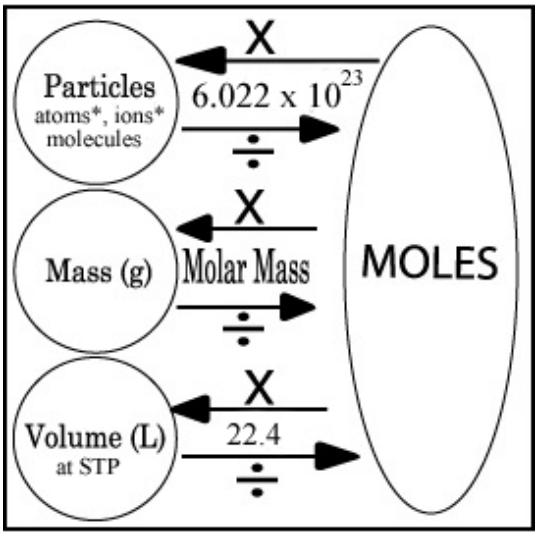
Name: _____ **Honors Chemistry** ____/____/____

Mole Conversions

When converting between moles and mass or volume or representative particles (atoms, ions, formula units or molecules) you will use the mole chart to the right (it is also on the back of your periodic table).



Since I have this extra space here…due to that chart over there, I thought I would fill this space with bad mole jokes.

Q: What was Avogadro's favorite element?
A: Mole-lybdenum

Q: Which tooth did Avogadro have to have pulled?
A: His mole-r.

Q: Why did Avogadro stop going to a chiropractor on October 24th?
A: He was only tense to the 23rd.

Note: it is important that you input the number 6.022 x 10^{23} correctly into your calculator. The chart below gives the correct way to enter the following information into your TI-83/84/etc.

Keystroke	Calculator output	What it means
6.022 ,23	6.022E23	6.022 x 10^{23}

Part I: Moles to Particles

Example: How many fluoride ions are there in 1.8 moles of aluminum fluoride?

Description of Action	Action
1. Determine what you are given. This will always be a number, unit and formula. Write the given over 1.	**1.** $\frac{1.8 \text{ moles of } AlF_3}{1}$
2. According to our chart, when going from **moles to particles** we must **multiply** our given number and 6.02 x 10^{23} particles of the given substance over 1 mole of the substance	**2.** $\frac{1.8 \text{ moles of } AlF_3}{1} \times \frac{6.022 \times 10^{23} \text{ particles } AlF_3}{1 \text{ mole of } AlF_3}$ = **1.08396 x 10^{24} particles AlF_3** Notice how **moles of AlF_3** cancel out. This leaves you with **particles of AlF_3**, your unit in your answer.
3. Because we are solving for **ions**, we have one more step. **This step is only necessary when solving for ions or atoms.** In this step, we take our result and multiply it by the number of that specific ion or atom as indicated by the subscript following the symbol.	**3. In our example we are solving for fluoride ions. There are 3 fluoride ions in the formula, AlF_3. 1.08396 x 10^{24} X 3 = 3.25188 x 10^{24}**
4. Put your answer in significant figures. When multiplying, your answer must have the same amount of significant figures as the number with the fewest number of significant figures in your problem.	**4. Since 1.8 has 2 significant figures and 6.022 x 10^{23} has 4 significant digits and we multiplied, our answer can only have 2 significant figures. Alas, we have to change 3.25188 x 10^{24} to 3.3 x 10^{24} Answer: 3.3 x 10^{24} fluoride ions**

Practice Problems:

1. How many molecules are there in 4.35 moles of calcium sulfate?

2. How many atoms are in 0.75 mol of tungsten?

Part II: Particles to Moles

Example: Convert 2.4088 x 10^{24} formula units of sodium chloride to moles.

Description of Action	Action
1. Determine what you are given and write it down over 1.	**1.** $\frac{2.4088 \times 10^{24} \text{ molecules of NaCl}}{1}$
2. According to our chart, when going from **particles to moles**, we **divide** by 6.02 x 10^{23} molecules of the substance. Because we had set our given value to 10^{23}, both 10^{23} will cancel out.	**2.** $\frac{2.4088 \times 10^{24} \text{ molecules NaCl}}{1} \times \frac{1 \text{ mole of NaCl}}{6.022 \times 10^{23} \text{ molecules NaCl}}$ = 4 moles NaCl
3. Put your answer in significant figures.	**3.** Since 24.088 has 5 significant figures and 6.022 has 4 significant figures, our answer must have 4 significant figures. So we must change 4 to **4.000 moles of NaCl**

Practice Problems:

1. How many moles are in 1.204 x 10^{24} formula units of barium chloride?

2. How many moles are 1.2 x 10^{21} atoms of francium?

Part III: Moles to Grams

Example: Calculate how many grams are in 0.700 moles of magnesium oxide?

Description of Action	Action
1. Determine what you are given and write it down over 1.	**1.** $\frac{0.700 \text{ moles of MgO}}{1}$
2. Calculate the gram formula mass of the compound.	**2.** Mg: 1 x 24.3 = 24.3 O: 1 x 16.0 = 16.0 24.3 + 16.0 = **40.3 g/mol**
3. According to our chart, when going from **moles to grams**, we must **multiply** the given and the gram formula mass of the substance (in grams) over 1 mole of the substance.	**3.** $\frac{0.700 \text{ moles of MgO}}{1} \times \frac{40.3 \text{ grams of MgO}}{1 \text{ mole MgO}}$ = **28.2 grams of MgO**
4. Put your answer in significant digits.	**4.** 40.3 has 3 significant digits and 0.700 has 3 significant digits, so our answer must have 3 significant digits. In this case, no conversion is necessary. **Answer: 28.2 grams of MgO**

Practice Problems:

1. How many grams are in 0.200 moles of calcium bromide?
2. How many grams are in 0.150 moles of potassium iodide?

Part IV: Grams to Moles

Example: Calculate the number of moles in 25.0 grams of potassium permanganate.

Description of Action	Action
1. Determine what you are given and write it down over 1.	**1.** $\frac{25.0 \text{ grams of } KMnO_4}{1}$
2. Calculate the gram formula mass of the given.	**2.** K: 1 x 39.1 = 39.1 Mn: 1 x 54.9 = 54.9 O: 4 x 16.0 = 64.0 39.1 + 54.9 + 64.0 = **158.0 g/mol**
3. According to the chart, when going from **grams to moles**, we must **divide** the given by the gram formula mass (in grams).	**3.** $\frac{25.0 \text{ grams of } KMnO_4}{1} \times \frac{1 \text{ mole of } KMnO_4}{158.0 \text{ grams of } KMnO_4}$ = **0.1582278 moles of $KMnO_4$**
4. Put your answer in significant figures.	**4.** 25.0 has 3 significant figures and 158.0 has 4 significant figures so our answer can only have 3 significant figures. **Answer: 0.158 moles of $KMnO_4$**

Practice Problems:

1. Calculate the number of moles in 8.76 grams of sodium hydroxide.
2. Convert 100.7 grams of potassium perchlorate to moles.

Part V: Moles to Liters at STP (standard temperature and pressure – 273 K and 1 atm)

Example: What is the volume of 3.3 moles of hydrogen sulfide at STP?

Description of Action	Action
1. Determine what you are given and write it down over 1.	**1.** $\frac{3.3 \text{ moles of } H_2S}{1}$
2. According to our chart, when going from **moles to liters**, we must **multiply** the given by 22.4 liters. 1 mole of any gas is equal to 22.4 liters	**2.** $\frac{3.3 \text{ moles of } H_2S}{1} \times \frac{22.4 \text{ L } H_2S}{1 \text{ mole } H_2S}$ = **73.92 L of H_2S**
3. Put your answer in significant figures.	**3.** 3.3 has 2 significant figures and 22.4 has 3 significant figures. Our answer can only has 2 significant figures. **Answer: 74 L of H_2S**

Practice Problems:

1. What is the volume 16.18 moles of ammonium chloride gas at STP?
2. What is the volume of 2.3 moles of water vapor?

Part VI: Liters to Moles at STP (standard temperature and pressure – 273 K and 1 atm)

Example: How many moles are there in 68.0 liters of fluorine gas at STP?

Description of Action	Action
1. Determine what you are given and write it down over 1.	**1.** $\frac{68.0 \text{ L of } F_2}{1}$
2. According to our chart, when going from **liters to moles**, we must **divide** the given and 22.4. 1 mole of any gas is equal to 22.4 liters	**2.** $\frac{68.0 \text{ L of } F_2}{1} \times \frac{1 \text{ mole } F_2}{22.4 \text{ L } F_2}$ = **3.035714 moles of F_2**
3. Put your answer in scientific notation.	**3.** 68.0 and 22.4 both have 3 significant digits so our answer can only have 3 significant digits. **Answer: 3.04 moles of F_2**

Practice Problems:

1. How many moles are there in 32.3 liters of ammonium bromide gas at STP?
2. Convert 18.3 liters of hydrogen gas to moles at STP.

Homework:
Solve each of the following mole conversion problems. All problems must be set up correctly and you must show all of your work to get credit. Put a box around your final answer and label it with the proper units. Assume all gases are at STP.

1. How many molecules of H_2S are there in 2.0 liters of the substance?

2. How many molecules of nitrogen gas (N_2) are there in 62.0 liters of the substance?

3. What is the mass of 32.0 liters of oxygen gas (O_2)?

4. What is the mass of 19.5 liters of carbon dioxide (CO_2)?

5. What is the volume of 450.0 grams of nitrous oxide (N_2O)?

6. What is the volume of 50.0 grams of fluorine gas (F_2)?

7. How many molecules are there in 500.0 grams of water?

8. How many formula units are there in 850.0 grams of sodium chloride (NaCl)?

9. What is the mass of 3.2×10^{25} atoms of selenium?

10. What is the mass of 2.8×10^{20} formula units of sodium bicarbonate ($NaHCO_3$)?

11. What is the volume of 7.5×10^{24} molecules of sulfur dioxide (SO_2)?

12. What is the volume of 6.1×10^{22} molecules of carbon monoxide (CO)?

13. What is the mass of 2.0 liters of dichlorodifluoromethane (CCl_2F_2)?

14. What is the volume of 42.0 grams of freon ($C_2Cl_4F_2$)?

15. How many freon molecules ($C_2Cl_4F_2$) are there in 3.33 liters of the substance?