

WKS
Mole Conversions

Name Answer Key
Period _____

PART I: Find the Molar Masses (MM) for the following substances. (*Look up the mass of each element on the periodic table and add them all up.*) Write all molar masses with at least 4 sig figs.

- a) MM of Al = 26.98 g/mol
b) MM of PCl_3 = $30.97 + 3(35.45) = 137.3$ g/mol
c) MM of Na_2SO_4 = $2(22.99) + 32.06 + 4(16.00) = 142.1$ g/mol
d) MM of $\text{Mg}(\text{NO}_3)_2$ = $24.31 + 2(14.01) + 6(16.00) = 148.3$ g/mol

For the Rest of the WKS: Use the dimensional analysis/factor label method. Every number must have units. Write answers with correct number of sig figs.

PART II: Conversions between grams and moles. (*All molar mass values must have at least 4 sig figs.*)

Use: grams $\xleftarrow{\text{Molar Mass (? g/mol)}}$ moles

- 1) 45.0 g of Ca = ? moles of Ca

$$? \text{ mol Ca} = 45.0 \text{ g Ca} \times \frac{1 \text{ mol Ca}}{40.08 \text{ g Ca}} = \boxed{1.12 \text{ mol Ca}}$$

- 2) 0.0190 moles MgO = ? grams of MgO

$$\text{MM MgO} = 24.31 + 16.00 = 40.31 \text{ g/mol}$$

$$? \text{ g MgO} = 0.0190 \text{ mol MgO} \times \frac{40.31 \text{ g MgO}}{1 \text{ mol MgO}} = \boxed{0.766 \text{ g MgO}}$$

- 3) 7.32 g of $\text{Ba}(\text{OH})_2$ = ? moles of $\text{Ba}(\text{OH})_2$

$$\text{MM Ba}(\text{OH})_2 = 137.33 + 2(16.00) + 2(1.008) = 171.35 \text{ g/mol}$$

$$? \text{ mo Ba}(\text{OH})_2 = 7.32 \text{ g Ba}(\text{OH})_2 \times \frac{1 \text{ mol Ba}(\text{OH})_2}{171.35 \text{ g Ba}(\text{OH})_2} = \boxed{0.0427 \text{ mol Ba}(\text{OH})_2}$$

PART III: Conversions between moles and atoms or molecules

REMEMBER: moles $\xleftarrow{\text{Avogadro's \#}}$ atoms or molecules
(6.022×10^{23} atoms or mlcls/mol)

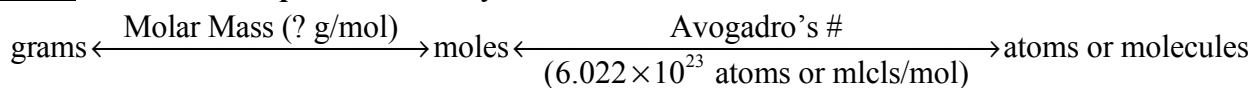
- 4) 4.87×10^{23} atoms of H = ? moles of H

$$? \text{ mol H} = 4.87 \times 10^{23} \text{ atoms H} \times \frac{1 \text{ mol H}}{6.022 \times 10^{23} \text{ atoms H}} = \boxed{0.810 \text{ mol H}}$$

- 5) 0.56 moles of PCl_5 = ? molecules of PCl_5

$$? \text{ mlcl PCl}_5 = 0.56 \text{ mol PCl}_5 \times \frac{6.022 \times 10^{23} \text{ mlcl PCl}_5}{1 \text{ mol PCl}_5} = \boxed{3.4 \times 10^{23} \text{ mlcl PCl}_5}$$

PART IV: Combination questions. Use your flow chart!!



6) 51 g of S = ? atoms of S (g → moles → atoms)

$$? \text{ atoms S} = 51 \text{ g S} \times \underbrace{\frac{1 \text{ mol S}}{32.06 \text{ g S}}}_{\substack{1.59 \text{ mol S}^* \\ *1 \text{ extra sig fig}}} \times \frac{6.022 \times 10^{23} \text{ atoms S}}{1 \text{ mol S}} = \boxed{9.6 \times 10^{23} \text{ atoms S}}$$

7) 8.34 × 10²³ molecules of Fe₂(CO₃)₃ = ? g of Fe₂(CO₃)₃ (molecules → moles → grams)

$$\text{MM Fe}_2(\text{CO}_3)_3 = 2(55.85) + 3(12.01) + 9(16.00) = 291.73 \text{ g/mol}$$

$$? \text{ g Fe}_2(\text{CO}_3)_3 = 8.34 \times 10^{23} \text{ mlcl Fe}_2(\text{CO}_3)_3 \times \underbrace{\frac{1 \text{ mol Fe}_2(\text{CO}_3)_3}{6.022 \times 10^{23} \text{ mlcl Fe}_2(\text{CO}_3)_3}}_{\substack{1.385 \text{ mol Fe}_2(\text{CO}_3)_3^* \\ *1 \text{ extra sig fig}}} \times \frac{291.73 \text{ g Fe}_2(\text{CO}_3)_3}{1 \text{ mol Fe}_2(\text{CO}_3)_3} = \boxed{404 \text{ g Fe}_2(\text{CO}_3)_3}$$

8) 3.20 g of Ag₂SO₄ = ? molecules of Ag₂SO₄

$$\text{MM Ag}_2\text{SO}_4 = 2(107.87) + 32.06 + 4(16.00) = 311.80 \text{ g/mol}$$

$$? \text{ mlcl Ag}_2\text{SO}_4 = 3.20 \text{ g Ag}_2\text{SO}_4 \times \underbrace{\frac{1 \text{ mol Ag}_2\text{SO}_4}{311.80 \text{ g Ag}_2\text{SO}_4}}_{\substack{0.01026 \text{ mol Ag}_2\text{SO}_4^* \\ *1 \text{ extra sig fig}}} \times \frac{6.022 \times 10^{23} \text{ mlcl Ag}_2\text{SO}_4}{1 \text{ mol Ag}_2\text{SO}_4} = \boxed{6.18 \times 10^{21} \text{ mlcl Ag}_2\text{SO}_4}$$

PART V: Mixed review (all types of mole conversions) with a few complications.

9) Which of the following has a greater mass: 2 atoms of lead or 5.1 × 10⁻²³ moles of helium? (Show work.)

$$? \text{ g Pb} = 2 \text{ atoms Pb} \times \frac{1 \text{ mol Pb}}{6.022 \times 10^{23} \text{ atoms Pb}} \times \frac{207.2 \text{ g Pb}}{1 \text{ mol Pb}} = \boxed{6.881 \times 10^{-21} \text{ g Pb}} \text{ *Greater Mass}$$

$$? \text{ g He} = 5.1 \times 10^{-23} \text{ mol He} \times \frac{4.003 \text{ g He}}{1 \text{ mol He}} = \boxed{2.0 \times 10^{-22} \text{ g He}}$$

10) A 25.0 g sample of Cu₂S, has... MM Cu₂S = 2(63.55) + 32.06 = 159.16 g/mol

a) ... how many molecules of Cu₂S?

$$? \text{ mlcl Cu}_2\text{S} = 25.0 \text{ g Cu}_2\text{S} \times \underbrace{\frac{1 \text{ mol Cu}_2\text{S}}{159.16 \text{ g Cu}_2\text{S}}}_{\substack{0.1571 \text{ mol Cu}_2\text{S}^* \\ *1 \text{ extra sig fig}}} \times \frac{6.022 \times 10^{23} \text{ mlcl Cu}_2\text{S}}{1 \text{ mol Cu}_2\text{S}} = \boxed{9.46 \times 10^{22} \text{ mlcl Cu}_2\text{S}}$$

b) ... how many atoms of copper?

$$? \text{ atoms Cu} = 9.46 \times 10^{22} \text{ mlcl Cu}_2\text{S} \times \frac{2 \text{ atom Cu}}{1 \text{ mlcl Cu}_2\text{S}} = \boxed{1.89 \times 10^{24} \text{ atoms Cu}}$$

11) How many moles of Br₂ are in a 22.5 mL sample of liquid Br₂? Density of liquid Br₂ = 3.12 g/mL

Hint: mL → g → moles

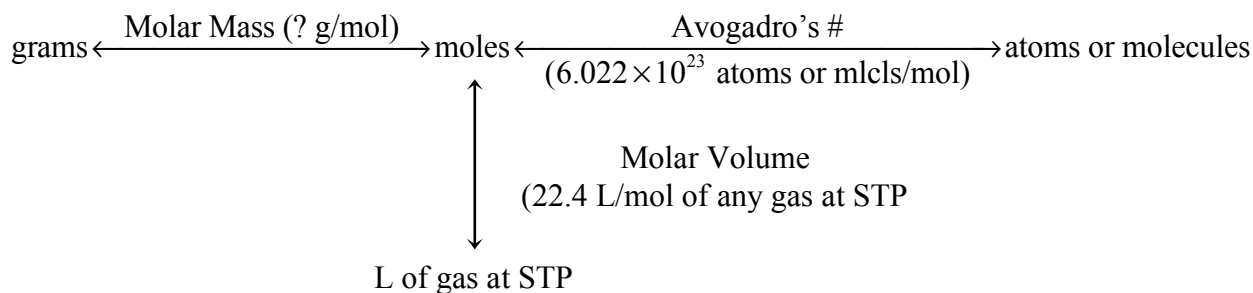
$$? \text{ mol Br}_2 = 22.5 \text{ mL Br}_2 \times \underbrace{\frac{3.12 \text{ g Br}_2}{1 \text{ mL Br}_2}}_{70.2 \text{ g Br}_2} \times \frac{1 \text{ mol Br}_2}{159.81 \text{ g Br}_2} = \boxed{0.439 \text{ mol Br}_2}$$

PART VI: Molar Volume of Gases

Concept:

- Avogadro's Hypothesis states that "Equal volumes of gases at the same temperature and pressure have the same number of particles.
- Thus, at any one set of temperature and pressure conditions, all gases have the same volume.
- It is conventional to define a standard set of conditions which is called **Standard Temperature and Pressure** or STP. At STP, $T = 0^\circ\text{C}$ and $P = 1\text{ atm}$
- It is known that at STP, 1 mole of any gas has a volume of 22.4 L

Flow chart:



Calculations using molar volume: Use the dimensional analysis/factor label method to make the following conversions. Show all work. Every number written must have units and answers need correct # of sig figs.

1) 2.5 moles of O_2 gas at STP = ? L

$$? \text{ L O}_2 = 2.5 \text{ mol O}_2 \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = \boxed{56 \text{ L O}_2}$$

2) 3.56 L of H_2 gas at STP = ? moles of H_2

$$? \text{ mol H}_2 = 3.56 \text{ L H}_2 \times \frac{1 \text{ mol H}_2}{22.4 \text{ L H}_2} = \boxed{0.159 \text{ mol H}_2}$$

3) A clown fills up his balloon with helium gas until it has a volume of 18.5 L at STP. How many atoms of helium are in his balloon?

$$? \text{ atoms He} = 18.5 \text{ L He} \times \frac{1 \text{ mol He}}{22.4 \text{ L He}} \times \frac{6.022 \times 10^{23} \text{ atoms He}}{1 \text{ mol He}} = \boxed{4.97 \times 10^{23} \text{ atoms He}}$$

0.8259 mol He*
*1 extra sig fig

4) What would be the volume of an 84.0 g sample of nitrogen gas, N_2 , at STP?

$$? \text{ L N}_2 = 84.0 \text{ g N}_2 \times \frac{1 \text{ mol N}_2}{28.02 \text{ g N}_2} \times \frac{22.4 \text{ L N}_2}{1 \text{ mol N}_2} = \boxed{67.2 \text{ L N}_2}$$

2.998 mol N₂*
*1 extra sig fig

5) What is the density of CO_2 gas at STP? *Hint: Assume you have a 1 mole sample of CO_2 gas at STP.*

$$D = \frac{\text{mass}}{\text{vol}} = \frac{44.01 \text{ g CO}_2 / \text{mol CO}_2}{22.4 \text{ L CO}_2 / \text{mol CO}_2} = \boxed{1.96 \text{ g/L}}$$

6) **Fun with trying to grasp the enormous amount of particles in a mole.** Assume that one can count 100 molecules per minute. How many years would be required to count a mole of molecules?

$$? \text{ yr} = 6.022 \times 10^{23} \text{ molecules} \times \frac{1 \text{ min}}{100 \text{ mlcl}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ yr}}{365.25 \text{ day}} = \boxed{1.145 \times 10^{16} \text{ yr}}$$

This is 11.45 million billion years, or over $814,000 \times$ the age of the universe!