Mole and Stoichiometry Worksheet

Reminders:

- **Molarity and molar concentration unit is mol/L or M**
- **Volume unit is L**
- **Atom or molecule question use 6.02 x 10²³**

1. What is the volume of a 1.5 mol/L KOH solution that contains 2.24 g of solute?

$$n = \frac{m}{mm} = \frac{2.24g}{56.11g/mol} = \frac{0.03992583 mol}{x} = \frac{1.5 mol}{L} = \boxed{0.027 L}$$

2. What mass of solute is required to prepare 350 mL of NaOH at a concentration of 0.75 mol/L?

$$M = n \times mm$$
$$0.2625 \text{ mol} \times 40.00 g/mol$$
$$= \boxed{11 g}$$

$$n = C \times V$$
$$\frac{0.75 mol}{L} \times 0.35 L = 0.2625 \; mol \; \swarrow$$

3. What is the volume of a 0.25 M solution of Na₂SO₄ that contains 35.5 g of sodium sulfate?

$$n = \frac{m}{mm} \quad \frac{35.5g}{142.05 g/mol}$$
$$\frac{0.249912003 mol}{x} = \frac{0.25 mol}{L} = \boxed{1.0 L}$$

4. What is the molar concentration of the water in an aquarium that contains 100.0 L of salt water prepared with 2.8 kg of sodium chloride (NaCl)?

$$n = \frac{m}{mm} \quad \frac{2800 g}{58.44 g/mol} = \frac{47.91238877 mol}{100.0 L} = \boxed{0.48 \; mol/L}$$

5. Explain the procedure involved in preparing 250 mL of a 3.0 mol/L solution of CaCO₃.

$$M = n \times mm$$
$$0.75 mol \times 100.09 g/mol \quad \Big| \quad \frac{3.0 mol}{L} = \frac{x}{.25 L} = 0.75 mol$$
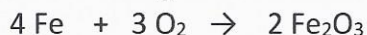$$= 75 g \quad \swarrow$$

1. Weigh 75 g of solute
2. Put solute in volumetric flask
3. Add water & swirl
4. Add water to line
5. Check meniscus.

6. What is the molarity of a 10.0 L solution of HCl that contains 0.36 g of solute?

$$n = \frac{m}{mm} \qquad \frac{0.36\,g}{36.46\,g/mol} = 0.0098 73 84\,mol = \frac{0.0098 73 84\,mol}{10.0\,L} = 0.00099\,mol/L$$

$$9.9 \times 10^{-4}\,mol/L$$

7. Iron rusts according to the following equation:

$$4\,Fe + 3\,O_2 \rightarrow 2\,Fe_2O_3$$

If 10.0 g of iron rust in the presence of oxygen, what mass of Fe_2O_3 will be produced?

$$10.0\,g\,Fe \times \frac{1\,mol\,Fe}{55.85\,g\,Fe} \times \frac{2\,mol\,Fe_2O_3}{4\,mol\,Fe} \times \frac{159.70\,g\,Fe_2O_3}{1\,mol\,Fe_2O_3} = \boxed{14.3\,g\,Fe_2O_3}$$

8. Consider the following unbalanced equation:

$$C_2H_4 + 3\,O_2 \rightarrow 2\,CO_2 + 2\,H_2O$$

How many moles of carbon dioxide will be produced when 5.0 moles of oxygen react?

$$5.0\,mol\,O_2 \times \frac{2\,mol\,CO_2}{3\,mol\,O_2} = \boxed{3.3\,mol\,CO_2}$$

9. Aspirin ($C_9H_8O_4$) is produced from salicylic acid ($C_7H_6O_3$) according to the equation below:

$$2\,C_7H_6O_3 + C_4H_6O_3 \rightarrow 2\,C_9H_8O_4 + H_2O$$

What mass of water is produced when 5.40×10^{12} molecules of aspirin are produced?

$$5.4 \times 10^{12}\,molec\,C_9H_8O_4$$
$$\times \frac{1\,mol\,C_9H_8O_4}{(6.02 \times 10^{23})\,molec\,C_9H_8O_4} \times \frac{1\,mol\,H_2O}{2\,mol\,C_9H_8O_4} \times \frac{18.02\,g\,H_2O}{1\,mol\,H_2O} = \boxed{8.08 \times 10^{-11}\,g\,H_2O}$$

10. How many oxygen atoms are 350 g of H_2SO_4?

$$n = \frac{m}{mm} = \frac{350.\,g}{98.09\,g/mol} = 3.568 15 16 97\,mol \times 6.02 \times 10^{23} \times 4$$

$$= \boxed{8.6 \times 10^{24}\,atoms}$$

11. A student prepared 1 250 mL of solution by using 17.1 g of aluminum sulfate, $Al_2(SO_4)_3$. What is the molar concentration of the solution?

$$n = \frac{m}{mm} \qquad \frac{17.1\,g}{342.17\,g/mol} = 0.049975159\,mol = \frac{0.049975159\,mol}{1.25\,L} = 0.0400\,M$$

12. The label of a juice drink indicates the concentration of fructose, $C_6H_{12}O_6$ to be 18.0 g/200 mL. What is the molar concentration of the sugar in the juice?

$$\frac{18.0g}{.2L} = \frac{x}{L} = 90g \qquad n = \frac{m}{mm} \quad \frac{90g}{180.18g/mol} = \boxed{\frac{.5mol}{L}}$$

13. Which of the following solutions has the highest concentration in g/L?
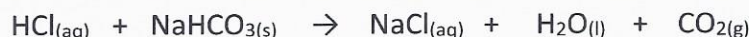   Solution 1- 3.5 moles of NaOH in 3.0 litres of solution
   Solution 2- 2.5 moles of HCl in 2.0 litres of solution

$$m = n \times mm$$
$$3.5mol \times 40.00g/mol =$$
$$\frac{140g}{3.0L} = \boxed{47g/L}$$

$$m = n \times mm$$
$$2.5mol \times 36.4g/mol =$$
$$\frac{91.15g}{2.0L} = \boxed{46g/L}$$

14. When 200mL of HCl is mixed with $NaHCO_3$, 22×10^{14} molecules of CO_2 is produced. What was the concentration of the HCl solution used to produce this much gas?

$$HCl_{(aq)} + NaHCO_{3(s)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

$$2.2 \times 10^{14} \text{ molec } CO_2 \times \frac{1 mol CO_2}{(6.02 \times 10^{23}) molec CO_2} \times \frac{1 mol HCl}{1 mol CO_2} = \frac{3.6544800 \times 10^{-10}}{.2L}$$
$$= \boxed{2 \times 10^{-9} M}$$

15. How many atoms are in 63 g of H_3PO_4?

$$n = \frac{m}{mm} \quad \frac{63g}{98.00g/mol} = .642857143 mol \times 6.02 \times 10^{23} \times 8 =$$
$$\boxed{3.1 \times 10^{24} \text{ atoms}}$$

16. Fred neutralizes 250mL of HCL at a concentration of 4.5 mol/L using $Ca(OH)_2$ according to the following equation:

$$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2 H_2O$$

After the neutralization, she allows the water from the beaker to evaporate. What is the mass of the $CaCl_2$ that will be left in the beaker?

$$\frac{4.5mol}{L} = \frac{x}{.25L} =$$
$$1.125 mol$$

$$1.125 mol HCl \times \frac{1 mol CaCl_2}{2 mol HCl} \times \frac{110.98g CaCl_2}{1 mol CaCl_2}$$
$$= \boxed{62g CaCl_2}$$

17. How many grams of solute are there in 350.0 mL of a solution of NH₄OH with a
    concentration of 0.65 mol/L

$$M = n \times mm$$
$$.2275 \, mol \times 35.06 \, g/mol \qquad \frac{.65 \, mol}{L} = \frac{x}{.350 \, L} = .2275 \, mol$$

$$\boxed{8.0 \, g}$$

18. How many molecules are in 55 g of NaCl?

$$n = \frac{m}{mm} = \frac{55 \, g}{58.44 \, g/mol} = 0.94136208 \, mol \times 6.02 \times 10^{23} \, molec$$

$$\boxed{5.7 \times 10^{23} \, molecules}$$

19. A student dissolves 25.0 g of calcium carbonate, CaCO₃, in water to obtain a 550 mL
    solution. What is the molar concentration of this solution?

$$n = \frac{m}{mm} \qquad \frac{25.0 \, g}{100.09 \, g/mol} = .249775202 \, mol \qquad \frac{.249775202 \, mol}{.55 \, L} = \boxed{.45 \, mol/L}$$

20. You must prepare 50.0 mL of an aqueous solution of sodium nitrate (NaNO₃) that will
    have a concentration of 0.40 mol/L. What mass of NaNO₃ is required?

$$M = n \times mm$$
$$.020 \, mol \times 85.03 \, g/mol$$

$$\boxed{1.7 \, g}$$

$$n = C \times V$$
$$\frac{.40 \, mol}{L} \times .050 \, L = .020 \, mol$$

21. What is the volume when a 4.0 M solution of HCl are needed to react with 4.85 g of
    Ca(OH)₂? The equation that represents the reaction follows.
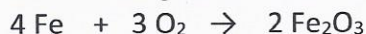 $$2 HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2 H_2O$$

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$$4.85 \, g \, Ca(OH)_2 \times \frac{1 \, mol \, Ca(OH)_2}{74.10 \, g \, Ca(OH)_2} \times \frac{2 \, mol \, HCl}{1 \, mol \, Ca(OH)_2} = \frac{.130904184 \, mol}{x} = \frac{4.0}{L}$$

$$\boxed{0.033 \, L}$$

22. Iron rusts according to the following equation:
    $$4 \, Fe + 3 \, O_2 \rightarrow 2 \, Fe_2O_3$$
    If 10.0 g of iron rust in the presence of oxygen, how many molecules of Fe₂O₃ will be
    produced?

$$10 \, g \, Fe \times \frac{1 \, mol \, Fe}{55.85 \, g \, Fe} \times \frac{2 \, mol \, Fe_2O_3}{4 \, mol \, Fe} \times \frac{6.02 \times 10^{23} \, molec \, Fe_2O_3}{1 \, mol \, Fe_2O_3} = \boxed{5.39 \times 10^{22} \, molec \, Fe_2O_3}$$