Review moles, stoichiometry, exothermic and endothermic reactions

1. How many moles are in 12 g of K_2O?

$n = \frac{m}{mm}$ $\frac{12\text{ g}}{94.203\text{ g/mol}} = 0.13\text{ mol}$

2. How many molecules are in 99 g of $CaCO_3$?

$n = \frac{m}{mm}$ $\frac{99\text{ g}}{100.09\text{ g/mol}} = 0.9891\ldots\text{ mol} \times 6.02\times10^{23}\frac{\text{molec}}{\text{mol}}$

$= 6.0\times10^{23}\text{ molecules}$

3. How many hydrogen atoms are in 24.5 g of $Ca(OH)_2$?

$n = \frac{m}{mm}$ $\frac{24.5}{74.10} = .3306\ldots \times 6.02\times10^{23}\times 2 = 3.98\times10^{23}\text{ H atoms}$

4. Calculate the molarity of a solution by dissolving 250 g of NaCl in water to make a 400.0 mL solution.

$n = \frac{m}{mm} = \frac{250}{58.44} = \frac{4.277\ldots\text{ mol}}{.4000\text{ L}} = 11\text{ M} = 11\text{ mol/L}$

5. There are 10.0 g/ 6.0 L of salt KCl in a Gatorade drink. What is the molar concentration of the drink?

$\frac{10.0\text{ g}}{6.0\text{ L}} = \frac{x}{1\text{ L}} = 1.666\ldots\text{ g}$ $n = \frac{m}{mm} = \frac{1.6666\ldots\text{ g}}{58.44\text{ g/mol}} = 0.029\text{ mol/L}$

6. How many moles of KCl are in 600.0 mL of a 5.2 M solution?

$n = C\times V$ $5.2\frac{\text{mol}}{\text{L}} \times .6000\text{ L} = 3.1\text{ mol}$

7. How many grams of NaCl are in 3.00 L of a 6.2 M solution?

$m = n \times mm$

$18.6\text{ mol} \times 58.44\text{ g/mol} = 1100\text{ g}$

$\frac{6.2\text{ mol}}{\text{L}} = \frac{x}{3.00\text{ L}} = 18.6\text{ mol}$

8. What volume of a 7.0 mol/L solution of H_2O contains 25 g of solute?

$n = \frac{m}{mm}$ $\frac{25\text{ g}}{18.02\text{ g/mol}} = 1.38734\ldots\text{ mol} = \frac{7.0\text{ mol}}{\text{L}} = .20\text{ L}$

9. To neutralize hydrochloric acid (HCl), magnesium hydroxide ($Mg(OH)_2$), a base is added. The neutralization reaction is represented by the following unbalanced equation:

$$HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\,H_2O$$

a- What mass of the $Mg(OH)_2$ is required to neutralize 9.0 g of HCl?

$$9.0\,g\,HCl \times \frac{1\,mol\,HCl}{36.46\,g\,HCl} \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,HCl} \times \frac{58.33\,g\,Mg(OH)_2}{1\,mol\,Mg(OH)_2} = 7.2\,g\,Mg(OH)_2$$

b- How many moles of the $Mg(OH)_2$ is required to neutralize 7.5 g of H_2O?

$$7.5\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,H_2O} = 0.21\,mol\,Mg(OH)_2$$

c- You have 6.0 moles of HCl, what mass of $MgCl_2$ is required to neutralize the 6.0 moles of HCl?

$$6\,mol\,HCl \times \frac{1\,mol\,MgCl_2}{2\,mol\,HCl} \times \frac{95.21\,g\,MgCl_2}{1\,mol\,MgCl_2} = 290\,g\,MgCl_2$$

d- You have 7.0 moles of HCl, how many molecules of $Mg(OH)_2$ is required to neutralize the moles of HCl?

$$7.0\,mol\,HCl \times \frac{1\,mol\,Mg(OH)_2}{2\,mol\,HCl} = 3.5\,mol\,Mg(OH)_2$$

e- If 700.0 g of water was produced, how many molecules of magnesium chloride ($MgCl_2$) must have reacted with the water?

$$3.00\times10^{9}\,molec\,HCl \times \frac{1\,mol\,HCl}{(6.02\times10^{23})\,molec\,HCl} \times \frac{2\,mol\,H_2O}{2\,mol\,HCl} = 4.98\times10^{-15}\,mol\,H_2O$$

~~E.~~ If 3.00×10^9 molecules of HCl are available, how many moles of water would react with it?

$700.0\text{g}H_2O \times \frac{1\text{mol}H_2O}{18.02\text{g}H_2O} \times \frac{1\text{mol}MgCl_2}{2\text{mol}H_2O} \times \frac{6.02\times10^{23}\text{molec}MgCl_2}{1\text{mol}MgCl_2} = 1.169\times10^{25}\text{ molec } MgCl_2$

g- If 10.5×10^7 molecules of HCl are available, how many grams of $MgCl_2$ would react with it?

$10.5\times10^7\text{molec}HCl \times \frac{1\text{mol}HCl}{(6.02\times10^{23})\text{molec}HCl} \times \frac{1\text{mol}MgCl_2}{2\text{mol}HCl} \times \frac{95.21\text{g}MgCl_2}{1\text{mol}MgCl_2} = 8.30\times10^{-15}\text{g } MgCl_2$

10. 100 mL of HCl is used to produce $CaCl_2$. If 5.0 g of $CaCl_2$ is made, what is the concentration of the HCl used? The following equation represents the reaction:

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

$5.0\text{g}CaCl_2 \times \frac{1\text{mol}CaCl_2}{110.98\text{g}CaCl_2} \times \frac{2\text{mol}HCl}{1\text{mol}CaCl_2} = \frac{.09010635\text{mol}}{.1\text{L}} = .9\text{M}$

11. What is the volume of a 6.5 M solution of CH_4 are needed to react with 5.4 g of H_2O?

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

$5.4\text{g}H_2O \times \frac{1\text{mol}H_2O}{18.02\text{g}H_2O} \times \frac{1\text{mol}CH_4}{2\text{mol}CH_4} = \frac{.14833518\text{mol}}{x} = \frac{6.5\text{mol}}{1\text{L}}$

0.023L

12. Kim neutralizes 700.0 mL of HCL at a concentration of 5.5mol/L using $Ca(OH)_2$ according to the following equation:

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

$n = CV \quad 5.5\text{mol/L} \times .700\text{L} = 3.9\text{mol}$

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

$3.9\text{mol}HCl \times \frac{1\text{mol}CaCl_2}{2\text{mol}HCl} \times \frac{110.98\text{g}CaCl_2}{1\text{mol}CaCl_2} = 220\text{g}CaCl_2$

13. When 900mL of HCl is mixed with $NaHCO_3$, 16 g of CO_2 is produced. What was the concentration of the HCl solution used to produce this much gas?

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

$16\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.0\,g\,CO_2} \times \frac{1\,mol\,HCl}{1\,mol\,CO_2} = 0.363553738\,mol \div .9\,L$ = .4 mol/L

14. Molten iron and carbon monoxide are produced in a blast furnace by the reaction of iron oxide and carbon. If 25.0 g of Fe_2O_3 are used, how many grams of iron can be produced?

The unbalanced reaction is: $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$

$25\,g\,Fe_2O_3 \times \frac{1\,mol\,Fe_2O_3}{159.70\,g\,Fe_2O_3} \times \frac{2\,mol\,Fe}{1\,mol\,Fe_2O_3} \times \frac{55.85\,g\,Fe}{1\,mol\,Fe} = 17.5\,g\,Fe$

15. The average human requires 120.0 grams of glucose ($C_6H_{12}O_6$) per day. How many molecules of CO_2 are required for this amount of glucose to be produced?

The balanced reaction is: $6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$

$120.0\,g\,C_6H_{12}O_6 \times \frac{1\,mol\,C_6H_{12}O_6}{180.18\,g\,C_6H_{12}O_6} \times \frac{6\,mol\,CO_2}{1\,mol\,C_6H_{12}O_6} \times \frac{6.02\times10^{23}\,molec\,CO_2}{1\,mol\,CO_2} = 2.406\times10^{24}\,molec\,CO_2$

16. 50 mL of a 0.5 mol/L solution of NaI reacts to produce how many moles of PbI_2? /6

The balanced reaction is: $Pb(NO_3)_2 + 2\,NaI \rightarrow PbI_2 + 2\,NaNO_3$

$n = C \times V$

$\frac{.5\,mol}{L} \times .05\,L = .025\,mol$

$.025\,mol\,NaI \times \frac{1\,mol\,PbI_2}{2\,mol\,NaI} = 0.01\,mol\,PbI_2$

17. To ensure crops have the proper nutrients to promote growth, many farmers use fertilizers such as diammonium phosphate, $(NH_4)_2HPO_4$. Farmer Mac has been given 175 g sample of $(NH_4)_2HPO_4$, to apply to his crops. How many atoms of hydrogen are there in 175 g of diammonium phosphate, $(NH_4)_2HPO_4$?

132.08

$n = \frac{m}{mm}$ $\frac{175\,g}{132.08\,g/mol} = 1.325757576\,mol \times 6.02\times10^{23}\,molec \times 9$

7.18×10^{24} H atoms

18. How much NaOH is needed to make 45.0 mL of a 0.75 M solution?

$m = n \times mm$

$.03375 \times 40.00$

1.4g

$n = C \times V$

$.75\ \frac{mol}{L} \times .045\ L = .03375\ mol$

19. How many moles of P_2S_3 are in 800.0 mL of a 5.2 M solution?

$n = C \times V \quad 5.2\ \frac{mol}{L} \times .8000\ L = 4.2\ mol$

20. A lab technician is asked to prepare 750 mL of a glucose, $C_6H_{12}O_6$, solution with a concentration of 0.50 mol/L. What is the mass of the glucose?

$m = n \times mm$

$.375\ mol \times 180.18\ g/mol$

68g

$\frac{.50\ mol}{L} = \frac{x}{.75\ L} = .375\ mol$

21. Sodium chloride (NaCl) is the most common ionic compound in sea water. A 300.0 mL sample of sea water contains 7.80 g of sodium chloride. What is the molar concentration of sodium chloride in the sample of sea water?

$n = \frac{m}{mm} \quad \frac{7.80\ g}{58.44\ g/mol} = 0.133470226\ mol \quad \frac{0.133470226\ mol}{.3000\ L} = 0.445\ M$

22. Instant cold packs are used to treat athletic injuries. They contain solid ammonium nitrate, NH_4NO_3, and a bag of water.
When the pack is squeezed, the bag of water breaks and the solid dissolves. This process quickly lowers the temperature of the pack to below 0°C. Which of the following best describes this situation?

A) More energy is released than absorbed during the dissolution of NH_4NO_3.
B) The dissolution of NH_4NO_3 in water is an exothermic reaction.
C) $NH_4NO_{3(s)} + 25.7\ kJ \rightarrow NH_4NO_{3(aq)}$
D) $NH_4NO_{3(s)} \rightarrow NH_4NO_{3(aq)} + 25.7\ kJ$

23. Mario is studying the energy changes of different chemical reactions. He mixes ethanoic acid (CH_3COOH) with sodium carbonate (Na_2CO_3) in a reaction vessel. The balanced chemical equation for this reaction is shown below.

$$2\ CH_3COOH + Na_2CO_3 + \text{energy} \rightarrow 2\ CH_3COONa + H_2O + CO_2$$

Which of the following statements correctly describes what Mario should observe and conclude about the reaction?

A) The temperature of the reaction vessel will increase and therefore the reaction is endothermic.
B) The temperature of the reaction vessel will increase and therefore the reaction is exothermic.
C) The temperature of the reaction vessel will decrease and therefore the reaction is endothermic.
D) The temperature of the reaction vessel will decrease and therefore the reaction is exothermic.

24. Transformations can be chemical or physical changes. Which of the following transformations is an endothermic chemical change?

A) $H_2O_{(s)} + \text{energy} \rightarrow H_2O_{(l)}$

B) $H_2O_{(g)} \rightarrow H_2O_{(l)} + \text{energy}$

C) $2\,H_2O_{(l)} + \text{energy} \rightarrow 2\,H_{2(g)} + O_{2(g)}$

D) $2\,H_{2(g)} + O_{2(g)} \rightarrow 2\,H_2O_{(l)} + \text{energy}$

25. The terms endothermic and exothermic refer to whether heat is absorbed or released during a chemical reaction. Below is a list of endothermic and exothermic reactions. Which of the following correctly identifies the exothermic reactions?

Endothermic and Exothermic Reactions

1.	$CH_{4(g)} + 2\,O_{2(g)} \rightarrow CO_{2(g)} + 2\,H_2O_{(l)} + 891\ kJ$ EXO
2.	When hydrochloric acid, HCl, and sodium hydroxide, NaOH, are combined together in a beaker, the temperature of the water increases by 5 °C. EXO
3.	$N_{2(g)} + O_{2(g)} + \text{energy} \rightarrow 2\,NO_{(g)}$
4.	When ammonium chloride, NH_4Cl, dissociates in water, the temperature of the water drops from 25 °C to 16 °C.