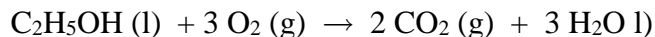


REVIEW QUESTIONS

Chapter 4

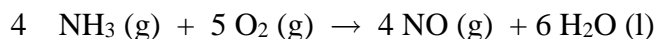
1. The alcohol in “gasohol” burns according to the equation shown below:



How many grams of CO_2 are produced when 3.00 g of $\text{C}_2\text{H}_5\text{OH}$ burns according to this reaction? (Assume excess oxygen)

$$3.00 \text{ g } \text{C}_2\text{H}_5\text{OH} \times \frac{1 \text{ mol}}{46.08 \text{ g}} \times \frac{2 \text{ CO}_2}{1 \text{ C}_2\text{H}_5\text{OH}} \times \frac{44.01 \text{ g}}{1 \text{ mol}} = 5.73 \text{ g CO}_2$$

2. Ammonia burns in air according to the reaction shown below:



- a) How many grams of NO form when 1.50 g NH_3 react with 1.85 g of O_2 react with one another.

$$1.50 \text{ g } \text{NH}_3 \times \frac{1 \text{ mol}}{17.04 \text{ g}} \times \frac{4 \text{ NO}}{4 \text{ NH}_3} \times \frac{30.01 \text{ g}}{1 \text{ mol}} = 2.64 \text{ g NO}$$

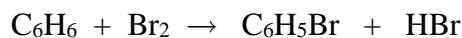
$$1.85 \text{ g } \text{O}_2 \times \frac{1 \text{ mol}}{32.00 \text{ g}} \times \frac{4 \text{ NO}}{5 \text{ O}_2} \times \frac{30.01 \text{ g}}{1 \text{ mol}} = 1.39 \text{ g NO} \leftarrow \text{LR (correct answer)}$$

- b) After the reaction above has completed, which reactant, and how much of it remains unreacted?

$$1.85 \text{ g } \text{O}_2 \times \frac{1 \text{ mol}}{32.00 \text{ g}} \times \frac{4 \text{ mol } \text{NH}_3}{5 \text{ mol } \text{O}_2} \times \frac{17.04 \text{ g}}{1 \text{ mol}} = 0.788 \text{ g NH}_3$$

$$\text{Excess NH}_3 = 1.50 \text{ g} - 0.788 \text{ g} = 0.71 \text{ g}$$

3. When 30.0 g of benzene (C₆H₆) and 65.0 g of bromine are reacted together as shown below, 56.7 g of bromobenzene (C₆H₅Br) is formed. What is the percent yield of this reaction?



$$30.0 \text{ g } \text{C}_6\text{H}_6 \times \frac{1 \text{ mol}}{78.12 \text{ g}} \times \frac{1 \text{ mol } \text{C}_6\text{H}_5\text{Br}}{1 \text{ mol } \text{C}_6\text{H}_6} \times \frac{157.01 \text{ g}}{1 \text{ mol}} = 60.3 \text{ g } \text{C}_6\text{H}_5\text{Br} \leftarrow \text{Theoretical Yield}$$

$$65.0 \text{ g } \text{Br}_2 \times \frac{1 \text{ mol}}{159.80 \text{ g}} \times \frac{1 \text{ mol } \text{C}_6\text{H}_5\text{Br}}{1 \text{ mol } \text{Br}_2} \times \frac{157.01 \text{ g}}{1 \text{ mol}} = 63.9 \text{ g } \text{C}_6\text{H}_5\text{Br}$$

$$\% \text{ Yield} = \frac{56.7}{60.3 \text{ g}} \times 100 = 94.0\%$$

4. How many grams of solute are present in 50.0 mL of 1.33 M CuSO₄ solution?

$$50.0 \text{ mL} \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{1.33 \text{ mol } \text{CuSO}_4}{1 \text{ L}} \times \frac{159.61 \text{ g}}{1 \text{ mol}} = 10.6 \text{ g } \text{CuSO}_4$$

5. How many mL of 1.50 M Na₃PO₄ solution contains 5.00 g of solute?

$$5.00 \text{ g} \times \frac{1 \text{ mol}}{163.94 \text{ g}} \times \frac{1 \text{ L}}{1.50 \text{ mol}} \times \frac{10^3 \text{ mL}}{1 \text{ L}} = 20.3 \text{ mL}$$

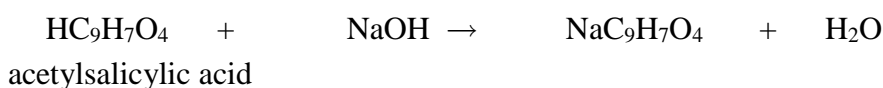
6. What volume of 1.50 M solution of sucrose solution is required to prepare 425 mL of 0.100 M solution?

$$V_2 = \frac{M_1 V_1}{M_2} = \frac{(0.100 \text{ M})(425 \text{ mL})}{1.50 \text{ M}} = 28.3 \text{ mL}$$

7. Glacial acetic acid has a density of 1.049 g/mL at 25°C. What is the molarity of a solution of acetic acid prepared by dissolving 10.00 mL of glacial acetic acid at 25°C in enough water to make 100.0 mL of solution?

$$10.00 \text{ mL} \times \frac{1.049 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{60.06 \text{ g}} \times \frac{1}{0.1000 \text{ L}} = 1.747 \text{ M}$$

8. The acetylsalicylic content of aspirin can be determined by reaction of the acid with sodium hydroxide as shown below:



23.0 mL of 0.0770 M NaOH solution was used to completely react with the acid present in a 500-mg aspirin tablet. What is the percent of acetylsalicylic acid in the aspirin tablet?

$$23.0 \text{ mL NaOH} \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{0.0770 \text{ mol}}{1 \text{ L}} \times \frac{1 \text{ mol HC}_9\text{H}_7\text{O}_4}{1 \text{ mol NaOH}} \times \frac{180.17 \text{ g}}{1 \text{ mol}} \times \frac{10^3 \text{ mg}}{1 \text{ g}} = 319 \text{ mg HC}_9\text{H}_7\text{O}_4$$

$$\% \text{ Acid} = \frac{319 \text{ mg}}{500 \text{ mg}} \times 100 = 63.8\%$$

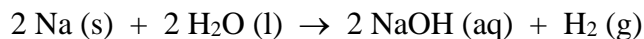
9. Concentrated nitric acid has a density of 1.41 g/mL and contains 70.0% HNO₃ by mass. What is the molarity of this solution?

Assume 1.00 L of solution

$$1.00 \text{ L sol'n} \times \frac{10^3 \text{ mL}}{1 \text{ L}} \times \frac{1.41 \text{ g}}{1 \text{ mL}} \times \frac{70.0 \text{ g acid}}{100 \text{ g sol'n}} \times \frac{1 \text{ mol}}{63.02 \text{ g}} = 15.7 \text{ mol HNO}_3$$

$$\text{molarity} = \frac{15.7 \text{ mol}}{1 \text{ L}} = 15.7 \text{ M}$$

10. How many grams of Na must react with 155 mL of water to produce a solution that is 0.175 M NaOH, as shown below. (Assume a final solution volume of 155 mL)



$$155 \text{ mL} \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{0.175 \text{ mol NaOH}}{1 \text{ L}} \times \frac{2 \text{ mol Na}}{2 \text{ mol NaOH}} \frac{22.99 \text{ g}}{1 \text{ mol}} = 0.624 \text{ g Na}$$

11. A sample of limestone (containing CaCO_3) weighing 438 mg is treated with oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$), as shown below:



The mass of CaC_2O_4 produced in this reaction was found to be 472 mg. Based on this information, what is the mass percent of calcium carbonate in limestone?

$$472 \text{ mg } \text{CaC}_2\text{O}_4 \times \frac{1 \text{ g}}{10^3 \text{ mg}} \times \frac{1 \text{ mol}}{128.10 \text{ g}} \times \frac{1 \text{ mol CaCO}_3}{1 \text{ mol CaC}_2\text{O}_4} \frac{100.09 \text{ g}}{1 \text{ mol}} \times \frac{10 \text{ mg}}{1 \text{ g}} = 0.369 \text{ g CaCO}_3$$

$$\% = \frac{369 \text{ mg}}{438 \text{ mg}} \times 100 = 84.2\%$$

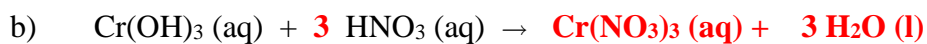
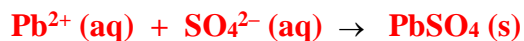
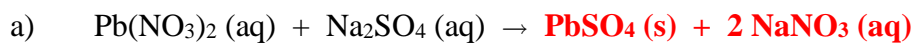
12. Identify each of the following substances as a non-electrolyte (NE), weak electrolyte (WE), or strong electrolyte (SE):

- | | | | | | |
|----|-----------------------------------|-----------|----|----------------------------------|-----------|
| a) | HF | <u>WE</u> | b) | C ₂ H ₅ OH | <u>NE</u> |
| c) | LiOH | <u>SE</u> | d) | HClO ₃ | <u>SE</u> |
| e) | Cu(NO ₃) ₂ | <u>SE</u> | f) | H ₃ PO ₄ | <u>WE</u> |

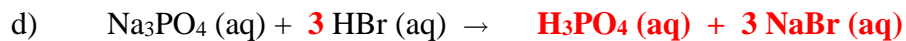
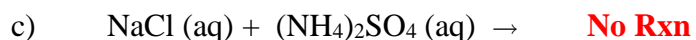
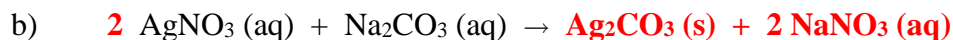
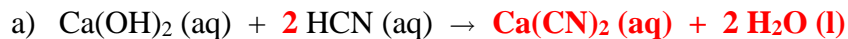
13. Complete each equation shown below:

- a) $\text{AlCl}_3 (\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Al}^{3+} (\text{aq}) + 3 \text{Cl}^- (\text{aq})$
- b) $\text{Na}_3\text{PO}_4 (\text{s}) \xrightarrow{\text{H}_2\text{O}} 3 \text{Na}^+ (\text{aq}) + \text{PO}_4^{3-} (\text{aq})$
- c) $(\text{NH}_4)_2\text{CO}_3 (\text{s}) \xrightarrow{\text{H}_2\text{O}} 2 \text{NH}_4^+ (\text{aq}) + \text{CO}_3^{2-} (\text{aq})$

14. Complete the molecular equations shown below, and write balanced net ionic equations for each:

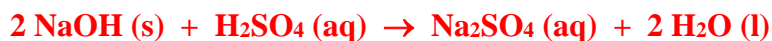


15. For each reaction shown below, determine if a reaction occurs. If so, write a balanced net ionic equation. If not, write "No Rxn".

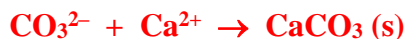


16. Write balanced net ionic equations for each reaction described below:

a) Solid sodium hydroxide pellets are dropped in solution of sulfuric acid.



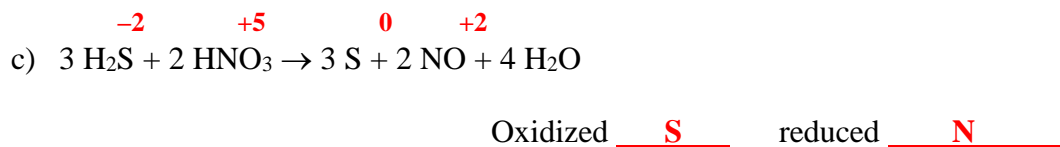
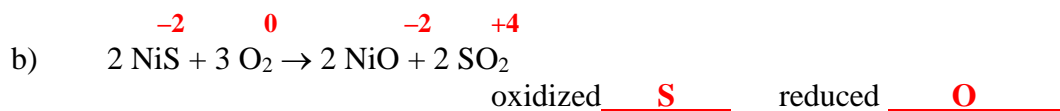
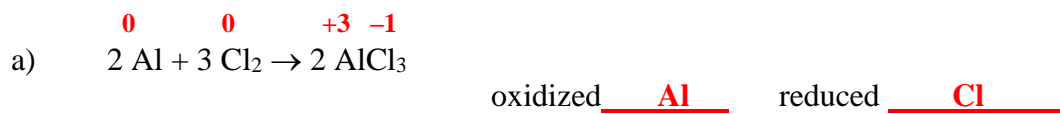
b) Aqueous solutions of ammonium carbonate and calcium chloride are mixed together.



17. In the compounds below, assign oxidation numbers to the underlined element:

- a) $\text{H}_3\underline{\text{P}}\text{O}_2$ +1 d) $\text{H}_2\underline{\text{C}}\text{O}$ 0
 b) $\text{Na}_2\underline{\text{C}}_2\text{O}_4$ +3 e) $\underline{\text{C}}\text{IF}_4^-$ +3
 c) $\text{Mn}\underline{\text{S}}\text{O}_4$ +6 g) $\text{Al}\underline{\text{H}}_3$ -1

18. Identify which substance is oxidized and which substance is reduced in each of the following redox reactions.



19. A solution is prepared by mixing 0.10 L of 0.12 M NaCl and 0.23 L of 0.18 M MgCl₂ solutions. What volume of 0.25 M AgNO₃ is required to precipitate all the chloride ions in the solution above? (Answer = 0.38 L)



$$0.10 \text{ L NaCl} \times \frac{0.12 \text{ mol}}{1 \text{ L}} \times \frac{1 \text{ mol Cl}^-}{1 \text{ mol NaCl}} = 0.012 \text{ mol Cl}^-$$

$$0.23 \text{ L MgCl}_2 \times \frac{0.18 \text{ mol}}{1 \text{ L}} \times \frac{2 \text{ mol Cl}^-}{1 \text{ mol MgCl}_2} = 0.0828 \text{ mol Cl}^-$$

$$\text{Total mol of Cl}^- = 0.012 + 0.0828 = 0.0948 \text{ mol}$$

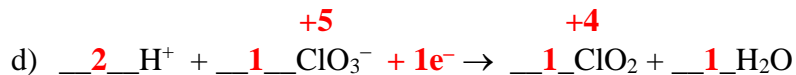
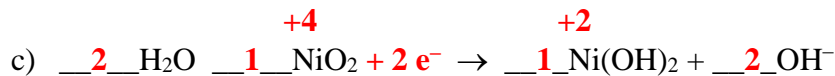
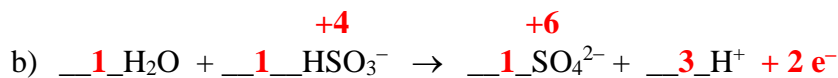
$$0.0948 \text{ mol Cl}^- \times \frac{1 \text{ mol AgNO}_3}{1 \text{ mol Cl}^-} \times \frac{1 \text{ L}}{0.25 \text{ mol}} = 0.38 \text{ L}$$

20. When B₅H₉ reacts with water, it forms boric acid (H₃BO₃) and hydrogen gas. Boric acid combines with sodium oxide to form borate salt Na₂B₄O₇ and water. What mass of B₅H₉ is required to form 151 g of the borate salt by this reaction sequence? (Answer = 37.9 g)

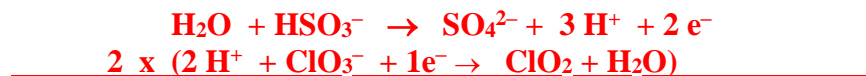


$$151 \text{ g Na}_2\text{B}_4\text{O}_7 \times \frac{1 \text{ mol}}{201.22 \text{ g}} \times \frac{4 \text{ mol B}_5\text{H}_9}{5 \text{ mol Na}_2\text{B}_4\text{O}_7} \times \frac{63.14 \text{ g}}{1 \text{ mol}} = 37.9 \text{ g B}_5\text{H}_9$$

21. Balance each oxidation or reduction half-reaction shown below:



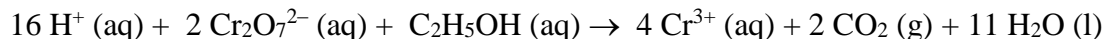
22. What is the overall equation formed from combining half-reactions (b) and (d) above?



Combining the equations above and cancelling electrons, H⁺ and H₂O, results the following overall equation:



23. A person's blood alcohol (C₂H₅OH) can be determined by titrating a sample of blood plasma with a sodium dichromate solution. The balanced equation is:



If 35.46 mL of 0.04961 M Cr₂O₇²⁻ is required to titrate 25.00 g of plasma, what is the mass percent of alcohol in blood? (Answer = 0.1621%)

$$35.46 \text{ mL Cr}_2\text{O}_7^{2-} \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{0.04961 \text{ mol}}{1 \text{ L}} \times \frac{1 \text{ mol C}_2\text{H}_5\text{OH}}{2 \text{ mol Cr}_2\text{O}_7^{2-}} \times \frac{46.08 \text{ g}}{1 \text{ mol}} = 0.04053 \text{ g C}_2\text{H}_5\text{OH}$$

$$\% \text{ C}_2\text{H}_5\text{OH} = \frac{0.04053 \text{ g C}_2\text{H}_5\text{OH}}{25.00 \text{ g blood}} \times 100 = 0.1621\%$$

24. Phosphoric acid can be produced by reaction of aqueous sodium phosphate and sulfuric acid. The other product in the reaction is sodium sulfate.

- a) What volume (in mL) of 1.55 M sulfuric acid is required to completely react with 27.5 mL of 1.20 M sodium phosphate?



$$27.5 \text{ mL Na}_3\text{PO}_4 \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{1.20 \text{ mol}}{1 \text{ L}} \times \frac{3 \text{ mol H}_2\text{SO}_4}{2 \text{ mol Na}_3\text{PO}_4} \times \frac{1 \text{ L}}{1.55 \text{ mol}} \times \frac{10^3 \text{ mL}}{1 \text{ L}} = 31.9 \text{ mL}$$

- b) What is the concentration of the phosphoric acid produced in the final solution?

$$27.5 \text{ mL Na}_3\text{PO}_4 \times \frac{1 \text{ L}}{10^3 \text{ mL}} \times \frac{1.20 \text{ mol}}{1 \text{ L}} \times \frac{2 \text{ mol H}_3\text{PO}_4}{2 \text{ mol Na}_3\text{PO}_4} = 0.0330 \text{ mol H}_3\text{PO}_4$$

$$\text{Total volume of solution} = 27.5 \text{ mL} + 31.9 \text{ mL} = 59.4 \text{ mL} = 0.0594 \text{ L}$$

$$\text{Molarity of H}_3\text{PO}_4 = \frac{0.0330 \text{ mol}}{0.0594 \text{ L}} = 0.556 \text{ M}$$