**CHE1031 Module 4 examples: Stoichiometry of chemical reactions**

These are the problems I’ll have you work during lecture. While the problems are presented on lecture slides you may find it useful to print them in this format and bring them to class. The problem number is shown in a green circle in the upper right of slides.

**4.1: Writing & balancing chemical equations**

1. Nitrogen and oxygen gas combine to form dinitrogen pentoxide.

1. Use formulas to create a chemical equation.
2. Add coefficients to balance the equation.

2. Ammonium nitrate decomposes to form nitrogen and oxygen gases and water.

1. Use formulas to create a chemical equation.
2. Add coefficients to balance the equation.

3. Hexane (C6H14) is combusted. Write a balanced chemical equation.

4. Predict the products & balance this exchange reaction:

K2S(aq) + Mg3N2(aq) 🡪

5. When carbon dioxide gas is dissolved into aqueous sodium hydroxide, aqueous sodium carbonate and liquid water are produced.

1. Write a balanced chemical equation.
2. Write complete & net ionic equations.

6. Diatomic chlorine and sodium hydroxide are mass produced by the electrolysis of brine; running electricity through salt water.

1. Write a balanced chemical equation.
2. Write complete & net ionic equations.

**4.2: Classifying chemical reactions**

7. What makes this bright yellow precipitate when aqueous solutions of potassium iodide and lead (II) nitrate are mixed?

1. Write a balanced chemical equation.
2. Write complete & net ionic equations.

8. Which of these reactions will produce a precipitate?

*Write complete ionic equations for those that do form ppt.*

1. potassium sulfate + barium nitrate 🡪
2. lithium chloride + silver (I) acetate 🡪
3. lead (II) nitrate + ammonium carbonate 🡪

9. The weak acid hydrogen hypochlorite reacts with water.

*Write a balanced chemical equation.*

10. A solution of barium hydroxide is neutralized with nitric acid.

1. *Write a balanced chemical equation.*
2. *Write complete & net ionic equations.*

11. Assign oxidation numbers to all elements in these:

1. H2S
2. SO3-2
3. Na2(SO4)

12. Assign oxidation numbers to all elements:

1. K(NO3)
2. AlH3
3. NH4+1
4. H2(PO4)-1

13. Solid rocket fuel is combusted by this reaction.

*Assign oxidation numbers to see which element is oxidized & which reduced?*

10Al(s) + 6(NH4)(ClO4)(s) 🡪 4Al2O3(s) + 2AlCl3(s) + 12H2O(g) + 3N2(g)

14. Assign oxidation numbers to identify redox reactions, & determine what’s oxidized & what’s reduced.

(a) Zn(CO3)(s) 🡪 ZnO(s) + CO2(g)

(b) 2Ga(l) + 3Br2(l) 🡪 2GaBr3(s)

(c) 2H2O2(aq) 🡪 2H2O(l) + O2(g)

(d) BaCl2(aq) + K2(SO4)(aq) 🡪 Ba(SO4)(s) + 2KCl(aq)

(e) C2H4(g) + 3O2(g) 🡪 2CO2(g) + 2H2O(l)

15. Write a balanced equation for this redox reaction in an aqueous acidic solution using the half-equation method:

Cr2O7-2 + Fe+2 🡪 Cr+3 + Fe+3

16. Write a balanced equation for this redox reaction in an aqueous acidic solution using half-equations:

H2O2(aq) + 2H+1 + 2Fe+2 🡪 2H2O + 2Fe+2

**4.3: Reaction stoichiometry**

17. How many moles of each diatomic gas would be needed to make 100 moles of ammonia?

18. How many moles of I2 are required to react with 0.429 mole of Al? 2Al(s) + 3I2(s) 🡪 2AlI3(s)

19. What mass of sodium hydroxide is required to produce 16 g of milk of magnesia, Mg(OH)2?

MgCl2(aq) + 2Na(OH)(aq) 🡪 Mg(OH)2(s) + 2NaCl(aq)

20. What mass of oxygen gas is consumed when 702 g of octane are combusted?

2C8H18 + 25o2 🡪 16CO2 + 18NH2O

21. How many carbon dioxide molecules are produced when 0.75 mol of propane (C3H8) are combusted?

C3H8 + 5O2 🡪 3CO2 + 4H2O

22. How many NH3 molecules are produced by the reaction of 2.4 E24 molecules of Ca(OH)2?

(NH4)2(SO4) + Ca(OH)2 🡪 2NH3 + Ca(SO4) + 2H2O

23. A mass of ammonium sulfate that contains 3.14 E25 atoms of hydrogen is used to produce calcium sulfate. If the volume of the reaction is 2500 mL, what is the molar concentration of calcium sulfate?

(NH4)2(SO4) + Ca(OH)2 🡪 2NH3 + Ca(SO4) + 2H2O

**4.4: Reaction yields**

24. What mass of HCl can be produced when 3.0 moles of H2 are reacted with 2.0 moles of Cl2?

H2(g) + Cl2(g) 🡪 2HCl(g)

25. Silicon nitride is a hard, high-temperature-resistant ceramic used to make turbines for jet engines. It’s made from Si and N2:

3Si(s) + 2N2(g) 🡪 Si3N4(s)

*How many grams of ceramic are made when 2.00 g of Si are reacted with 1.50 g of N2?*

26. How many g of water are made when 5.00 g of H2 reacts with 10.0 g of O2:

2H2(g) + O2(g) 🡪 2H2O(g)

27. When 1.274 g of copper sulfate is reacted with excess Zn metal, 0.392 g of copper metal is produced. *What’s the percent yield?*

Cu(SO4)(aq) + Zn(s) 🡪 Cu(s) + Zn(SO4)(aq)

28. What is the percent yield of a reaction that produces 12.5 g of Freon gas (CF2Cl2) from 32.9 g of CCl4 and excess HF?

CCl4 + 2HF 🡪 CF2Cl2 + 2HCl

**4.5: Quantitative chemical analysisy**

29. The endpoint of titration of a 50.00-mL sample of aqueous HCl is reached after adding 35.23 mL of 0.250 M Na(OH) titrant.

*What is the molarity of the HCl?*

HCl(aq) + Na(OH)(aq) 🡪 NaCl(aq) + H2O(l)

30. A 20.00-mL sample of aqueous oxalic acid, H2C2O4, was titrated with a 0.09113 M solution of permanganate, (MnO4)-1. A volume of 23.24 mL was required to reach the end point.   
*What was the molarity of the oxalic acid?*

5H2C2O4 + 2(MnO4)-1 + 6H+1 🡪 10CO2 + 2Mn+2 +8H2O

31. A 0.4550-g solid mixture containing Mg(SO4) is dissolved in water and reacted with excess Ba(NO3)2, causing precipitation of 0.6168 g of Ba(SO4).

*What was the percentage of Mg(SO4) in the original mixture?*

Mg(SO4)(aq) + Ba(NO3)2(aq) 🡪 Ba(SO4)(s)🡻 + Mg(NO3)2(aq)

32. What is the percent of chloride ion in a sample of 1.1324 g of the sample produces 1.0881 g of AgCl when treated with excess silver ions?

Ag+1(aq) + Cl-1(aq) 🡪 AgCl(s)🡻

33. Polystyrene is a hydrocarbon polymer used to make transparent but brittle products. A combustion analysis of a 0.00215-g sample of polyethylene yields 0.00726 g of CO2 and 0.00148 g of H2O.

*What is the empirical formula of polystyrene?*