Module 2.1 Homework

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Notice of ADA Accommodation and Methods

I have an ADA accommodation to do my assignment on paper. This document is a utilization of that accommodation. This assignment will utilize questions from the textbook, *Chemistry: Atoms First, 2e*, to practice the skills and learning objectives for this class. As a general statement, the textbook provides an answer key to about half of the provided questions. For ease of grading on behalf of Dr. Moulder, I will do approximately every other question with provided answers. Any comments or concerns can be forwarded to my email at `ryott.glayzer@mines.sdsmt.edu`.

Learning Objectives for Module 2.1

Recognize the different types of chemical transformations: acid-base, precipitation, combination, decomposition, single-replacement, oxidation-reduction, double replacement, and combustion. (Chapter 4,5)

1. Describe the basic properties of solutions (11.1)
2. Distinguish electrolyte and nonelectrolyte solutions (chapter 11.1, 11.2)
3. Identify common acids and bases (chapter 7.2)
4. Derive chemical equations from narrative descriptions of chemical reactions.(chapter 7.1)
5. Write and balance chemical equations in molecular, total ionic, and net ionic formats. (7.1)
6. Define three common types of chemical reactions (precipitation, acid-base, and oxidation reduction) (chapter 7.2)
7. Classify chemical reactions as one of these three types given appropriate descriptions or chemical equations (7.2)
8. Predict the solubility of common inorganic compounds by using solubility rules. (chapter 7.2)
9. Define oxidation, reduction, oxidizing agents, reducing agents, and oxidation numbers (chapter 7.2)
10. Balance equations for oxidation-reduction reactions in acidic or basic solutions (chapter 7.2)
11. Describe the reaction with oxygen of organic compounds, metals, and nonmetals (?)
12. Explain the activity series of metals and use it to predict the product of a redox reaction involving a metal

11.1: The Dissolution Process

Q.1: How do solutions differ from compounds? From other mixtures?

Compounds follow the law of Definite Proportions and will always be comprised of a specific ratio of elements, while solutions can differ wildly in their concentration. A solution is a subset of mixtures that is necessarily homogeneous.

Q.5: Indicate the most important types of intermolecular attractions in each of the following reactions.

5.a. The solution in Figure 11.2:

$$K_2Cr_2O_7\,(s) \longrightarrow 2\,K^+\,(aq) + Cr_2O_7^{2-}\,(aq)$$

Ion-Dipole attraction

5.b. NO (l) in CO (l)

Isn't this only possible below like 75K?
Dipole-Dipole Attraction

5.c. Cl_2 (g) in Br_2 (l)

Dispersion

5.d. HCl (g) in benzene C_6H_6 (l)

Dispersion

5.e. CH_3OH (l) in H_2O (l)

I'm not sure.

11.2: Electrolytes

Q.9: Explain why the ions Na^+ and Cl^- are strongly solvated in water but not in hexane, a solvent composed of nonpolar molecules

Sodium Chloride is a highly polar molecule and thus dissolves readily in polar solvents, like water. This occurs because of the polar electronegativity attractions between constituent ions. The nonpolar solvent does not act on the polarity of the sodium chloride and thus does not readily dissolve it.

Q.13: What is the expected electrical conductivity of the following solutions?

NaOH (aq)	HCl (aq)	$C_6H_{12}O_6$ (aq)	NH_3 (aq)
high	high	zero	low

7.1: Writing and Balancing Chemical Reactions

Q.1: What does it mean to say on equation is balanced? Why is it important for an equation to be balanced?

An equation is balanced when the number of reactants and products for each element is equal. It is important because the reaction would not otherwise adhere to the law of conservation of energy and matter.

Q.5: Write a balanced molecular equation describing each of the following chemical reactions.

a: Solid calcium carbonate is heated and decomposes to solid calcium oxide and carbon dioxide gas.

$CaCO_3\,(s) \longrightarrow CaO\,(s) + CO_2\,(g)$

b: Gaseous butane, C4H10, reacts with diatomic oxygen gas to yield gaseous carbon dioxide and water vapor.

$2\,C_4H_{10}\,(g) + 13\,O_2\,(g) \longrightarrow 8\,CO_2\,(g) + 10\,H_2O\,(g)$

c. Aqueous solutions of magnesium chloride and sodium hydroxide react to produce solid magnesium hydroxide and aqueous sodium chloride.

$MgCl_2\,(aq) + 2\,NaOH\,(aq) \longrightarrow Mg\,(OH)_2\,(s) + 2\,NaCl\,(aq)$

d. Water vapor reacts with sodium metal to produce solid sodium hydroxide and hydrogen gas.

$2\,H_2O\,(g) + 2\,Na\,(s) \longrightarrow 2\,NaOH\,(s) + H_2\,(g)$

Q.9: Aqueous hydrogen fluoride (hydrofluoric acid) is used to etch glass and to analyze minerals for their silicon content. Hydrogen fluoride will also react with sand (silicon dioxide).

a: Write an equation for the reaction of solid silicon dioxide with hydrofluoric acid to yield gaseous silicon tetrafluoride and liquid water.

$4\,HF\,(aq) + SiO_2\,(s) \longrightarrow SiF_4\,(g) + 2\,H_2O\,(l)$

b: The mineral fluorite (calcium fluoride) occurs extensively in Illinois. Solid calcium fluoride can also be prepared by the reaction of aqueous solutions of calcium chloride and sodium fluoride, yielding aqueous sodium chloride as the other product. Write complete and net ionic equations for this reaction.

$2\,Na^+\,(aq) + 2\,F^-\,(aq) + Ca^{2+}\,(aq) + 2\,Cl^-\,(aq) \longrightarrow CaF_2\,(s) + 2\,Na^+\,(aq) + 2\,Cl^-\,(aq)$
$2\,F^-\,(aq) + Ca^{2+} \longrightarrow CaF_2\,(s)$

7.2: Classifying Chemical Reactions

Q.13: Indicate what type, or types, of reaction each of the following represents:

$\mathbf{Ca\,(s) + Br_2\,(l) \longrightarrow CaBr_2\,(s)}$

Redox addition

$\mathbf{Ca\,(OH)_2\,(aq) + 2\,HBr\,(aq) \longrightarrow CaBr_2\,(aq) + 2\,H_2O\,(l)}$

Acid-Base Neutralization

C_6H_{12} (l) + 9 O_2 (g) ⟶ 6 CO_2 (g) + 6 H_2O (l)

Redox Combustion

Q.17: Determine the oxidation states of the elements in the compounds listed. None of the oxygen-containing compounds are peroxides or superoxides.

H_3PO_4

H	P	O
+1	+5	-2

Al $(OH)_3$

Al	H	O
+3	+1	-2

SeO_2

Se	O
+4	-2

KNO_2

K	N	O
+1	+3	-2

In_2S_3

In	S
+3	-2

P_4O_6

P	O
+3	-2

Q.21: Complete and balance the following acid-base equations:

HCl (g) + Ca $(OH)_2$ (s)

2 HCl (g) + Ca $(OH)_2$ (s) ⟶ $CaCl_2$ (s) + 2 H_2O (l)

Sr $(OH)_2$ (aq) + HNO_3 (aq)

Sr $(OH)_2$ (aq) + 2 HNO_3 (aq) ⟶ Sr $(NO_3)_2$ (aq) + 2 H_2O (l)

Q.25: Complete and balance the equations for the following acid-base neutralization reactions. If water is used as a solvent, write the reactants and products as aqueous ions. In some cases, there may be more than one correct answer, depending on the amounts of reactants used.

$Mg(OH)_2$ (s) + $HClO_4$ (aq) $\longrightarrow$

$Mg(OH)_2$ (s) + 2 $HclO_4$ (aq) $\longrightarrow$ Mg^{2+} (aq) + 2 $ClO_4{}^-$ (aq) + 2 H_2O (l)

SO_3 (g) + H_2O (l) $\longrightarrow$

SO_3 (g) + 2 H_2O (l) $\longrightarrow$ H_3O^+ (aq) + $HSO_4{}^-$ (aq) + nH_2SO_4 (aq)

SrO (s) + H_2SO_4 (l) $\longrightarrow$

SrO (s) + H_2SO_4 (l) $\longrightarrow$ $SrSO_4$ (s) + H_2O

Q.29: Great Lakes Chemical Company produces bromine, Br2, from bromide salts such as NaBr, in Arkansas brine by treating the brine with chlorine gas. Write a balanced equation for the reaction of NaBr with Cl2.

2 NaBr (aq) + Cl_2 (g) $\longrightarrow$ 2 NaCl (aq) + Br_2 (l)

Q.33: Complete and balance the equations of the following reactions, each of which could be used to remove hydrogen sulfide from natural gas:

Ca$(OH)_2$ (s) + H_2S (g) $\longrightarrow$

Ca$(OH)_2$ (s) + H_2S (g) $\longrightarrow$ CaS 9 S_0 + 2 H_2O (l)

Na_2CO_3 (aq) + H_2S (g) $\longrightarrow$

Na_2CO_3 (aq) + H_2S (g) $\longrightarrow$ Na_2S (aq) + CO_2 (g) + H_2O (l)

Grading

$\frac{35}{36}$ points earned, or 97%