Chemistry

Fall Examination Study Questions

1. (Chapter 2) Identify the following properties as physical or chemical properties:
   a) Copper is shiny and orange.
   b) Potassium reacts explosively with fluorine gas to produce potassium fluoride.
   c) Oxygen is a gas at room temperature.
   d) Sodium oxide has a very high melting point.
   e) Sodium chloride dissolves readily in water.
   f) When acid is added to marble chips, bubbles of carbon dioxide are produced.
   g) Lithium reacts with oxygen to form lithium oxide.

2. (Chapter 4) For each of the following compounds, indicate whether it is ionic or covalent and give the correct formula.
   a) diphosphorus pentoxide b) magnesium nitrate c) silver(I)oxide d) potassium hydroxide

3. (Chapter 4) Name the following compounds:
   a) $PbCl_2$ b) Cu_2SO_4 c) CS_2 d) HF e) $NaClO_3$

4. (Chapter 5) How many significant figures are there in the following numbers or answers?
   a) 10.2 b) 0.0030 c) 3.1×10^5 d) 6.382 + 1.2 = ? e) 8.0 x 10.0 = ?

5. (Chapter 6 & 7) Rust is 52.3% Fe, 44.9% O and 2.8% H.
   a) Find the empirical formula for rust.
   b) Rust is an ionic compound. What two ions are present in rust?
   c) Write a balanced equation for the formation of rust from iron(III)oxide and water.

6. (Chapter 6) A sample of aluminum is heated in air and completely converted to aluminum oxide. Use the data below to calculate the simplest formula of aluminum oxide.
   Mass of crucible = 29.00 g
   Mass of crucible + aluminum (before heating) = 30.62 g
   Mass of crucible + oxide (after heating) = 32.06 g

7. (Chapter 6) Find the molecular formula of a substance with an empirical formula of CH_2O and a molar mass of 90.0 g/mole.

8. (Chapter 8) For each of the reactions below, write a *balanced* chemical equation, and classify the reaction as one of the following types: single replacement, synthesis, decomposition, double displacement, or complete combustion. (Be sure to include physical states.)
   a) $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
   b) the reaction between aluminum and chlorine to form a compound.
   c) the reaction between solutions of ammonium hydroxide and copper(II) nitrate.
   d) the addition of solid iron to a nitric acid solution to form iron(III) nitrate and hydrogen gas.
   e) the splitting of water into its elements.

9. (Chapter 8) Decide whether a precipitate will form when the following solutions are mixed. If a precipitate forms, give the name and formula of the precipitate.
   a) sodium sulfate and barium chloride
   b) ammonium sulfide and strontium nitrate
   c) lithium carbonate and cobalt(III) chloride
   d) potassium phosphate and sodium hydroxide

10. (Chapter 8) For each case where there was a net reaction in **Question *6***, write both a balanced molecular equation and a net ionic equation for the reaction.

11. (Chapter 9 & 10) For the reaction,

$$3\ CO(g) + 7\ H_2(g) \rightarrow C_3H_8(g) + 3\ H_2O(l) \qquad \Delta H = -630.\ kJ$$

   a) How many moles of C_3H_8 are produced from 9.30 moles of CO?
   b) How many grams of C_3H_8 are produced when 3.66 moles of H_2 are used up?
   c) How many grams of water are produced from 14.4 g of H_2?
   d) How many *molecules* of C_3H_8 are produced from 8.0 moles of carbon monoxide?
   e) How many kJ of heat are produced when 753 *milligrams* of carbon monoxide react?
   f) Is this reaction endothermic or exothermic?

12. (Chapter 9) Barium hydroxide precipitates when it is formed in a double replacement reaction.
   a) Write a balanced molecular equation for the formation of barium hydroxide precipitate from barium nitrate and sodium hydroxide.
   b) Calculate the mass of barium nitrate needed to form 3.00 g of barium hydroxide.
   c) Calculate the percent yield if only 2.70 g of barium hydroxide are formed in *(b)*.
   d) Determine the mass percentage of each element in barium hydroxide.
   e) Determine the number of moles of oxygen in 49.7 grams of barium hydroxide.

13. (Chapter 10) A calorimeter containing water is used to measure the heat produced by a chemical reaction. If the water absorbs 58.5 kJ when the temperature is raised from 21.2°C to 77.2°C, how much water was in the calorimeter? (The specific heat of water is 4.18 J/g °C.)

14. (Chapter 10) For the reaction between iron and water to form iron(III) oxide and hydrogen gas,
   a) write a balanced chemical equation.
   b) using the equations below and Hess' Law, calculate ΔH for this reaction.

$$2\ Fe(s) + 1\tfrac{1}{2}\ O_2(g) \rightarrow Fe_2O_3(s) \quad \Delta H = -822.2\ kJ$$

$$H_2(g) + \tfrac{1}{2}\ O_2(g) \rightarrow H_2O(l) \quad \Delta H = -285.8\ kJ$$

   c) determine whether this reaction is endothermic or exothermic.

15. (Chapter 11) Give the abbreviated ground state electron configuration for the following atoms:
   a) Ar
   b) Y

16. (Chapter 11) Which element . . . . . ?
   a) has an outer electron configuration of $3s^2$?
   b) has the lowest ionization energy in Period 3?
   c) has the smallest atomic radius in Group 14?
   d) is found in most polyatomic ions?
   e) is a main group element that forms an ion with a +3 charge?

Chemistry

Answers to Fall Exam Study Questions

1. a) physical b) chemical c) physical d) physical e) physical f) chemical g) chemical

2. a) covalent, P_2O_5 b) ionic, $Mg(NO_3)_2$ c) ionic, Ag_2O d) ionic, KOH

3. a) lead(II) chloride b) copper(I) sulfate c) carbon disulfide d) hydrofluoric acid e) sodium chlorate

4. a) 3 b) 2 c) 2 d) 2 (answer is 7.6) e) 2

5. a) In 100 g of the compound:

   52.3 g Fe x $\frac{1\,mol\,Fe}{55.8\,g\,Fe}$ = 0.937 mol Fe 0.937/0.937 = 1 FeO_3H_3 =

   44.9 g O x $\frac{1\,mol\,O}{16.0\,g\,O}$ = 2.81 mol O 2.81/0.937 = 3 $Fe(OH)_3$

   2.8 g H x $\frac{1\,mol\,H}{1.0\,g\,H}$ = 2.8 moles H 2.8/0.937 = 3

   b) Fe^{3+} and OH^- c) $Fe_2O_3(s) + 3\,H_2O(l) \rightarrow 2\,Fe(OH)_3(s)$

6. Mass of Al = 30.62 g - 29.00 g = 1.62 g Al
   Mass of O = 32.06 g - 30.62 g = 1.44 g O

   1.62 g Al x $\frac{1\,mol\,Al}{27.0\,g\,Al}$ = 0.0600 mol Al 0.0600/0.0600 = 1 x 2 = 2

   1.44 g O x $\frac{1\,mol\,O}{16.0\,g\,O}$ = 0.0900 mole O 0.0900/0.0600 = 1.5 x 2 = 3 Al_2O_3

7. molar mass of CH_2O = 12.0 + 2(1.0) + 16.0 = 30.0; 90.0/30.0 = 3; therefore molecular formula = $C_3H_6O_3$

8. a) $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(l)$; complete combustion

   b) $2\,Al(s) + 3\,Cl_2(g) \rightarrow 2\,AlCl_3(s)$; synthesis (note that Al forms a +3 ion in compounds)

   c) $2\,NH_4OH(aq) + Cu(NO_3)_2(aq) \rightarrow 2\,NH_4NO_3(aq) + Cu(OH)_2(s)$; double displacement

   d) $2\,Fe(s) + 6\,HNO_3(aq) \rightarrow 2\,Fe(NO_3)_3(aq) + 3\,H_2(g)$; single replacement

   e) $2\,H_2O(l) \rightarrow 2\,H_2(g) + O_2(g)$; decomposition

9. a) barium sulfate, $BaSO_4$ b) no reaction, NH_4NO_3 and SrS are both soluble
   c) cobalt(III) carbonate, $Co_2(CO_3)_3$ d) no reaction, Na_3PO_4 and KOH are both soluble

10. a) $Na_2SO_4(aq) + BaCl_2(aq) \rightarrow 2\,NaCl(aq) + BaSO_4(s)$; $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
    c) $3\,Li_2CO_3(aq) + 2\,CoCl_3(aq) \rightarrow 6\,LiCl(aq) + Co_2(CO_3)_3(s)$;
    $2\,Co^{3+}(aq) + 3\,CO_3^{2-}(aq) \rightarrow Co_2(CO_3)_3(s)$

11. a) 9.30 mol CO x $\frac{1\,mol\,C_3H_8}{3\,mol\,CO}$ = 3.10 mol C_3H_8

b) 3.66 mol H_2 x $\frac{1\,mol\,C_3H_8}{7\,mol\,H_2}$ x $\frac{44.0\,g\,C_3H_8}{1\,mol\,C_3H_8}$ = 23.0 g C_3H_8

c) 14.4 g H_2 x $\frac{1\,mol\,H_2}{2.016\,g\,H_2}$ x $\frac{3\,mol\,H_2O}{7\,mol\,H_2}$ x $\frac{18.0\,g\,H_2O}{1\,mol\,H_2O}$ = 55.1 g H_2O

d) 8.0 moles CO x $\frac{1\,mol\,C_3H_8}{3\,mol\,CO}$ x $\frac{6.02\,x\,10^{23}\,molecules}{1\,mol\,C_3H_8}$ = 16.0 x 10^{23} = **1.6 x 10^{24} molecules**

e) 753 mg CO x $\frac{1\,g\,CO}{1000\,mg\,CO}\times\frac{1\,mol\,CO}{28.0\,g\,CO}\times\frac{630\,kJ}{3\,mol\,CO}$ = 5.65 kJ

f) exothermic (– ΔH)

12. a) $Ba(NO_3)_2(aq)$ + 2 NaOH(aq) → $Ba(OH)_2(s)$ + 2 $NaNO_3(aq)$

b) 3.00 g $Ba(OH)_2$ x $\frac{1\,mol\,Ba(OH)_2}{171.3\,g\,Ba(OH)_2}$ x $\frac{1\,mol\,Ba(NO_3)_2}{1\,mol\,Ba(OH)_2}$ x $\frac{261.3\,g\,Ba(NO_3)_2}{1\,mol\,Ba(NO_3)_2}$ = 4.58 g $Ba(NO_3)_2$

c) % yield = $\frac{2.70}{3.00}$ x 100% = 90.0%

d) $Ba(OH)_2$ = 1 mole Ba = 137.34 g Ba 137.34/171.36 = **80.1% Ba**
2 mole O = 32.00 g O 32.0/171.36 = **18.7% O**
2 mole H = 2.016 g H 2.016/171.36 = **1.18% H**

e) 49.7 g $Ba(OH)_2$ x $\frac{1\,mol\,Ba(OH)_2}{171.3\,g\,Ba(OH)_2}$ x $\frac{2\,mol\,O}{1\,mol\,Ba(OH)_2}$ = 0.580 moles O

13. Q = s x m x ΔT; Q = 58.5 kJ = 58,500 J; m = ?; ΔT = 77.2-21.2 = 56.0°C; s = 4.18 J/g °C

m = $\frac{Q}{s\,x\Delta T}=\frac{58{,}500\,J}{4.18\,J/g\,^oC\,x56.0\,^oC}$ = 250 g = 2.50 x 10^2 g (3 sig fig)

14. a) 2 Fe(s) + 3 $H_2O(l)$ → $Fe_2O_3(s)$ + 3 $H_2(g)$

b) (i) 2 Fe(s) + 1½ $O_2(g)$ → $Fe_2O_3(s)$ ΔH = –822.2 kJ
(ii) $H_2(g)$ + ½ $O_2(g)$ → $H_2O(l)$ ΔH = –285.8 kJ

(i) 2 Fe(s) + 1½ $O_2(g)$ → $Fe_2O_3(s)$ ΔH = –822.2 kJ
-3 x (ii) 3 $H_2O(l)$ → 3 $H_2(g)$ + 1½ $O_2(g)$ ΔH = +3(285.8) kJ = +857.4
2 Fe(s) + 3 $H_2O(l)$ → $Fe_2O_3(s)$ + 3 $H_2(g)$ ΔH = –196.5 + 204.9 = +35.2 kJ

c) endothermic

15. a) $[_{10}Ne]3s^23p^6$ or $[_{18}Ar]$ b) $[_{36}Kr]5s^24d^1$

16. a) Mg (period 3, Group 2) b) Na c) C d) O e) Al (also Bi)