Chemistry 11 Review

Part A: Introduction to Chemistry

1) Express the following in scientific notation:
   a) 103,250
   b) -0.000059
   c) 0.00360×10^{2}
   d) 0.038×10^{-4}
2) Convert the following 22.1 mm/ms to km/s.
3) A student determines the melting point of carbon to be 315˚C. If the accepted value is 321 ˚C, what is the percent error?
4) Perform the calculations and round off each to the correct number of significant figures:
   a) 132.1 g – 189.12 g + 25.132 g
   b) 6.5 cm x 8.91 cm
   c) 62 g ÷ 4.38 g
   d) (42.8 ÷ 0.15 mm) x (38.99 mm ÷ 6.1 mm)

Part B: Matter, Change, and Energy

1) What are the three states of matter?
2) What kind of changes are the following:
   a) dissolving Alka Seltzer in water
   b) blending food
3) Define the following:
   a) atom
   b) molecule
   c) ion
   d) pure substance
   e) element
   f) compound

Part C: Chemical Nomenclature

1) Name the following:
   a) ZnO
   b) $CuSO_4$
   c) Cl_2O
   d) P_2O_4
   e) Co_2O_3
   f) $(NH_4)_2Cr_2O_7$
2) Write formulas for the following:
   a) sodium carbonate
   b) magnesium chlorite
   c) platinum (IV) chloride
   d) diiodine pentoxide
   e) disilicon hexaiodide
   f) copper (II) sulfate pentahydrate

Part D: The Mole

1) How many particles does Avogadro's number represent?
2) What is the formula mass of silver nitrate?
3) On a new atomic mass scale, the mass of a cabon-12 atom is determined to be 5.00 rmu. What would be the relative mass of zinc in rmu?
4) Determine the molar mass of the following:
   a) CO_2
   b) CaI_2
   c) $Ca(OH)_2$
   d) $Pb(C_2H_3O_2)_2 \cdot 3H_2O$
5) Determine the number of particles in the following:
   a) 4.25 g of sulfur.
   b) 5.13 g of glucose, $C_6H_{12}O_6$
6) Determine the number of atoms in the following:
   a) 1.00 mol Cl_2
   b) 32.0 g $(NH_4)_3PO_4$
7) Calculate the mass of the following:
   a) 1.20 mol FeC_2O_4
   b) 1.96×10^{26} molecules CH_4
8) Find the percentage composition of $Ti_2(SO_4)_3$.
9) Determine the empirical formula for a compound containing 24.4 % C, 3.39 % H, and 72.2 % Cl.
10) Determine the molecular formula for a compound containing 40.0 % C, 6.67 % H, and 53.3 % O if it has a molar mass of 120 g/mol.
11) Calculate the molar concentration of the following:
   a) 0.26 mol of HCl in 1.0 L of solution
   b) 0.0700 mol of NH_4Cl in 50.0 mL of solution
   c) 25.0 g of NaCl in 250.0 mL of solution
   d) 10.0 g of $Cr(NO_3)_3 \cdot 9H_2O$ in 325 mL of solution
12) Convert the following:
   a) 2.26 L of 2.00 M $CaCO_3$ to moles
   b) 20 mL of 1.30 M Na_2SO_4 to mass
13) Describe the experimental procedure you would use to prepare 2.50 L of 0.300 M $CuCl_2$ solution.

Part E: Gases

1) What is standard temperature and pressure (STP)?
2) What is Boyle's Law?
3) What is Charles' Law?
4) What is Avogadro's Law?
5) What is Dalton's Law?
6) What is the ideal gas equation? What does R represent?
7) A gas has a volume of 100 mL and a pressure of 150 kPa. If temperature remains constant, determine the new volume when the pressure is increased to 200 kPa.
8) A gas occupies a volume of 473 cm^3 at 36.0 ˚C. If pressure remains constant, determine the volume of the gas when the temperature is raised to 94.0 ˚C.
9) A sample of oxygen gas (O_2) has a volume of 7.84 cm^3 at a pressure of 71.8 kPa and a temperature of 25.0 ˚C. What will be the volume of the gas if the pressure is changed to 101 kPa and the temperature is changed to 0 ˚C?
10) Calculate the pressure of 1.65 g of helium gas at 16.0 ˚C and occupying 3.25 L.
11) What will be the volume of 0.70 g of nitrogen gas (N_2) at standard temperature and 150 kPa pressure?
12) What is the standard molar volume? What are the conditions?
13) A sample of oxygen gas (O_2) occupies 5.6 L at STP. What is the mass of the gas?

Part F: Stoichiometry

1) Balance the following chemical equations:
   a) $\_\_Mg_3N_2 + \_\_H_2O \rightarrow \_\_Mg(OH)_2 + \_\_NH_3$
   b) $\_\_V_2O_5 + \_\_Ca \rightarrow \_\_CaO + \_\_V$
   c) $\_\_Na_2O_2 + \_\_H_2O \rightarrow \_\_NaOH + \_\_O_2$
   d) $\_\_FeCl_2 + \_\_KNO_3 + \_\_HCl \rightarrow FeCl_3 + \_\_NO + \_\_H_2O + \_\_KCl$
2) What is stoichiometry?
3) In the reaction $3\ Fe + 4\ H_2O \rightarrow Fe_3O_4 + 4\ H_2$…
   a) how many molecules of Fe_3O_4 are produced when 12 atoms of Fe react?
   b) how many moles of Fe are required to produce 16 mol of H_2?
   c) how many H_2 molecules are made when 40 molecules of Fe_3O_4 are produced?
   d) how many moles of H_2O are required to react with 14.5 mol of Fe?
4) Consider the reaction $4\ NH_3(g) + 5\ O_2(g) \rightarrow 6\ H_2O(g) + 4\ NO(g)$.
   a) What mass of NO(g) is produced when 2.00 mol of NH_3(g) is reacted?
   b) What mass of H_2O(g) is produced when 4.00 mol of O_2(g) are reacted?
5) A sample of high purity silicon is prepared by strongly heating a mixture of hydrogen and silicon tetrachloride in a sealed tube: $SiCl_4(g) + 2\ H_2(g) \rightarrow Si(s) + 4\ HCl(g)$. If exactly 1.00 g of silicon is required, what mass of each of $SiCl_4$ and H_2 must react?
6) A student titrates a 2.00 mL sample of 1.24 M hydrogen peroxide solution, H_2O_2(aq), according to the reaction:

$$2\ MnO_4^-(aq) + 5\ H_2O_2(aq) + 6\ H^+(aq) \rightarrow 2\ Mn^{2+}(aq) + 5\ O_2(g) + 8\ H_2O(l).$$

   a) What volume of 0.0496 M MnO_4^- is required for the titration?
   b) What volume of O_2(g) at STP is produced during the reaction?
7) Consider the reaction $3\ I_2(g) + 6\ F_2(g) \rightarrow 2\ IF_5(l) + I_4F_2(g)$. What volume of F_2(g) is needed to produce 2.55 L of I_4F_2(g)?
8) What is a limiting reactant?
9) What is an excess reactant?
10) What mass of CS_2 is produced when 17.5 g of C are reacted with 39.5 g of SO_2 according to the equation $5\ C + 2\ SO_2 \rightarrow CS_2 + 4\ CO$. What mass of the excess reactant will be left over?
11) The roasting of siderite ore, $FeCO_3$, produces iron (III) oxide: $4\ FeCO_3 + O_2 \rightarrow 2\ Fe_2O_3 + 4\ CO_2$. If a 35.0 g sample of pure $FeCO_3$ produces 22.5 g of Fe_2O_3, what is the percentage yield of the reaction?

Part G: Solutions

1) What is a solute? What is a solvent?

2) Define the following:

a) gaseous solution

b) solid solution
   i) alloy

c) liquid solution
   i) miscible liquid
   ii) immiscible liquid

d) aqueous solutions
   i) electrolytes
   ii) non-electrolytes

3) Define the following :

a) insoluble

b) soluble
   i) unsaturated
   ii) saturated
   iii) supersaturated

4) What is the difference between a polar and a non-polar molecule?

5) What does the phrase "like dissolves like" mean?

6) If 20.0 mL of 0.75 M HBr is diluted to a total volume of 90.0 mL, what is the molar concentration of HBr in the resulting solution?

7) Determine the molar concentration of the chloride ions in 0.25 M $AlCl_3$(aq).

8) What is the concentration for each type of ion in a solution made by mixing 50.0 mL of 0.240 M $AlBr_3$ and 25.0 mL of 0.300 M $CaBr_2$.

9) Classify each of the following compounds as soluble or insoluble:

a) Fe_2S_3
b) $Mg(NO_3)_2$
c) $SnBr_4$
d) $PbCl_4$
e) $K_4P_2O_7$
f) CuCl

10) For the reaction $K_2SO_4 + BaCl_2 \rightarrow 2\ KCl + BaSO_4$

a) Write the complete ionic equation.
b) Write the net ionic equation.
c) What are the spectator ions?

Part H: Acid-Base Chemistry

1) What are the operational definitions of acids and bases? List as many properties as you can.

2) What are the conceptual definitions of acids and bases?

3) What are the Arrhenius definition of acids and bases?

4) Name the following acids and bases:

a) HCl
b) H_3PO_4
c) H_2SO_4
d) H_2SO_3

5) Write chemical formulas for the following acids:

a) hydroiodic acid
b) perchloric acid
c) hydrocyanic acid
d) nitrous acid

6) What is the ion-product of water? What is the formula?

7) The concentration of H_3O^+ (or H^+) in a pond exposed to pollution is 3.58×10^{-6} M. Determine the concentration of OH^- if the pond is at 25 ˚C. Is the pond acidic, basic, or neutral?

8) Determine the unknown value:

a) $[H_3O^+] = 2.5 \times 10^{-9}$ M, pOH = ?
b) pH = 3.3, $[OH^-]$ = ?

9) The ion-product, K_w of water varies with the temperature of the water. At 15 ˚C it has a $K_w = 7.721 \times 10^{-15}$. What is the pH of the water? Would a solution with a pH=7 be acidic, basic, or neutral?

10) When titrating an acid with a base, how would you determine that you have reached the equivalence point?

11) If 32.0 mL of 0.400 M H_3PO_4 just neutralizes an unknown volume of 1.30 M $Ba(OH)_2$, how much $Ba(OH)_2$ is there?

12) Maalox is an antacid which has $Mg(OH)_2$ as its medicinal ingredient. The recommended dosage contains exactly 0.285 g of $Mg(OH)_2$. If one dose was titrated with standardized 0.30 M HCl until the equivalence point was reached, determine what volume of HCl would be needed to reach the equivalence point.

Unit I: Reaction Rates

1) A piece of aluminum foil with a mass of 1.32 g reacts with excess copper (II) chloride to produce copper metal. If it takes 5 minutes 32 seconds for all of the aluminum to react, calculate the reaction rate in mol/s.

2) What is necessary for a chemical reaction to occur?

3) Define the following:

a) activation energy

b) activated complex

c) enthalpy (ΔH)

4) Differentiate between endothermic and exothermic.

5) What are the 5 factors that affect the rates of chemical reactions?

6) What is a reaction mechanism?

7) The following reaction mechanism illustrates how chlorine-containing fluorocarbons destroy ozone, O_3, in the atmosphere:

$CFCl_3 \rightarrow CFCl_2 + Cl^-$ (fast)

$Cl^- + O_3 \rightarrow ClO^- + O_2$ (slow)

$ClO^- + O^{2-} \rightarrow Cl^- + O_2$ (fast)

a) Identify the intermediate product(s).

b) Write the overall reaction equation.

c) Is there a catalyst?

d) Predict the effect on the rate by increasing:

i) the amount of $CFCl_3$

ii) the amount of O^{2-} ions

e) What is the rate determining step?

Answers

Part A: Introduction to Chemistry

1a) 1.03250×10^5 b) -5.9×10^{-5} c) 3.60×10^{-1} d) 3.8×10^{-6}

2) 2.21×10^{-2} km/s

3) -1.87 %

4a) -31.9 g b) 58 cm^2 c) 14 g d) 1.8×10^3 mm

Part B: Matter, Change, and Energy

1) gas, solid, liquid

2a) chemical b) physical

Part C: Chemical Nomenclature

1a) zinc oxide c) dichlorine monoxide e) cobalt (III) oxide

b) copper (II) sulphate d) diphosphorous tetroxide f) ammonium dichromate

2a) Na_2CO_3 c) $PtCl_4$ e) Si_2I_6

b) $Mg(ClO_2)_2$ d) I_2O_5 f) $CuSO_4 \cdot 5H_2O$

Part D: The Mole

1) 6.02×10^{23} particles

2) 169.9 a.m.u.

3) 27.3 rmu

4a) 44.0 g/mol b) 293.9 g/mol c) 74.1 g/mol d) 379.2 g/mol

5a) 7.97×10^{22} b) 1.72×10^{22}

6a) 1.20×10^{24} b) 2.59×10^{24}

7a) 173 g b) 5.20×10^3 g

8) 24.9 % Ti, 25.1 % S, 50.0 % O

9) $C_3H_5Cl_3$

10) $C_4H_8O_4$

11a) 0.26 M b) 1.40 M c) 1.71 M d) 0.0769 M

12a) 4.52 moles b) 3.7 g

13) add water to 101 g $CuCl_2$ until there is 2.50 L of solution)

Part E: Gases

1) 0 °C or 273 K, 1 atm or 101.3 kPa
2) $P_1V_1 = P_2V_2$
3) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
5) $P_T = P_a + P_b + P_c + \ldots$
6) PV = nRT, R = 0.0821 atm-L/mol-K or 8.31 kPa-L/mol-K or 8.31 Pa-m^3/mol-K
7) 75.0 mL
8) 562 cm^3
9) 5.11 cm^3
10) 305 kPa
11) 0.38 L
12) 22.4 L/mol, STP
13) 8.0 g

Part F: Stoichiometry

1a) 1,6,3,2 b) 1,5,5,2 c) 2,2,4,1 d) 3,1,4,3,1,2,1
3a) 4 molecules b) 12 mol c) 160 molecules d) 19.3 mol
4a) 60.0 g b) 86.4 g
5) 6.05 g $SiCl_4$, 0.14 g H_2
6a) 0.0200 L b) 0.0556 L
7) 15.3 L
10) 22.2 g, 2.1 g
11) 93.3 %

Part G: Solutions

6) 0.17 M
7) 0.75 M
8) $[Al^{3+}] = 0.160$ M, $[Ca^{+2}] = 0.100$ M, $[Br^-] = 0.680$ M
9a) insoluble c) soluble e) soluble
b) soluble d) soluble f) insoluble
10a) $2\ K^+(aq) + SO_4^{2-}(aq) + Ba^{2+}(aq) + 2\ Cl^-(aq) \rightarrow 2\ K^+(aq) + 2\ Cl^-(aq) + BaSO_4(s)$
b) $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
c) K^+, Cl^-

Part H: Acid-Base Chemistry

4a) hydrochloric acid b) phosphoric acid c) sulfuric acid d) sulfurous acid
5a) HI b) $HClO_4$ c) HCN d) HNO_2
6) $K_w = [H_3O^+][OH^-]$
7) 2.79 x 10^{-9} M, acidic
8a) 5.40 b) 2.00 x 10^{-11} M
9) 7.06, acidic
11) 14.8 mL
12) 33 mL

Unit I: Reaction Rates

1) 1.47 x 10^{-4} mol/s
7a) Cl, ClO^-
b) $CFCl_3 + O_3 + O^{2-} \rightarrow CFCl_2 + 2\ O_2 + Cl^-$
c) no
di) increase
ii) no effect
e) second step