Chemistry

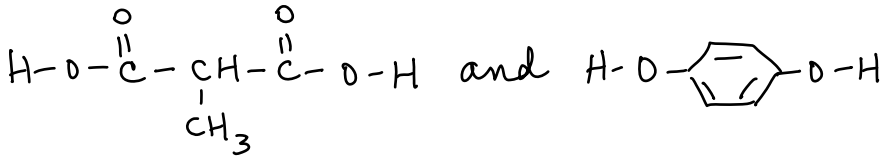
SPRING EXAMINATION STUDY QUESTIONS

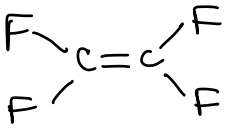
1. (Chapter 12/Bonding) Draw Lewis structures for the following molecules:
   a) N_2 b) CH_3Cl c) P_2H_2 d) H_2SO_4

2. (Chapter 12/Bonding) For the compounds in ***Question 1 a and b***, indicate their geometry and whether they are polar or nonpolar.

3. (Chapters 20/Organic Chemistry) Draw structures for each of the following compounds:
   a) butane b) 1-pentanol c) an aromatic carboxylic acid
   d) propyl amine e) 2,2,4-trimethyl,3-ethylhexane f) an isomer of (e)

4. (Chapters 20/Organic Chemistry) For each of the following, identify the type of polymer and draw the polymer from the monomer(s):

   a) 

   b) (polymer = Teflon) 

5. (Chapter 13/Gases) What is the volume of a sample of gas containing 1.10 moles with a pressure of 1.80 atmospheres at 46°C?

6. (Chapter 13/Gases) A sample of gas occupies a volume of 5.60 liters at STP.
   a) What is the pressure of this sample when it is allowed to expand to 18.0 liters at 78°C?
   b) How many moles of gas are in the sample?
   c) If the sample contains 7.50 grams of gas, what is the molar mass of this gas?

7. (Chapter 13/Gases) What is the density of ethane gas at 65°C and 1.50 atmospheres pressure?

8. (Combination)
   a) Write a balanced chemical equation for the reaction between solid magnesium metal and hydrochloric acid (HCl) to form aqueous magnesium chloride and hydrogen gas.
   b) What mass of magnesium is needed to react completely with 23.0 mL of 0.500 M HCl?
   c) What mass of magnesium is needed to produce 4.61 liters of hydrogen gas at STP?

9. (Chapter 15/Solutions) You may use the equation below to solve the following problems:
   $\Delta T_f = 1.86°C \times$ moles solute particles/kg water
   a) What is the freezing point of a solution containing 117 g NaCl in 500. g of water?
   b) How many moles of a nonelectrolyte in 50.0 g of water are required for a solution to have a freezing point of -2.79°C?

10. (Chapter 15/Solutions) Review how to prepare a solution from either solid solute or by diluting a concentrated solution.

11. (Chapter 15/Solutions)
    a) How many g of $NaNO_3$ are needed to make 157 ml of a 3.00 M $NaNO_3$ solution?
    b) What is the concentration of $NaNO_3$ in a solution prepared by diluting 240 ml of 0.500 M $NaNO_3$ to 2.00 liters?
    c) What is the mass percentage of a solution prepared by adding 2.00 moles of $NaNO_3$ to 1.00 kg of water?

12. (Chapter 17/Equilibrium)
    a) For the system at equilibrium,
    $$2\ NO_2(g) \rightleftarrows N_2O_4(g) \qquad \Delta H = -58\ kJ,$$
    what affect will each of the following have?
    i) decreasing the volume
    ii) increasing the temperature
    iii) adding a catalyst
    iv) adding more N_2O_4
    b) Write an expression for *K* for this equilibrium. Calculate $[N_2O_4]$ if the $[NO_2] = 0.010$ M when the value for *K* is 10.0.

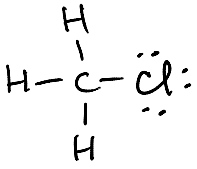
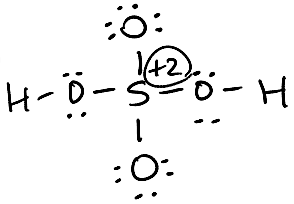
13. (Chapter 16/Acids & bases) Calculate the pH of each of the following solutions:
    a) 0.010 M $HClO_4$
    b) 1.00 g NaOH dissolved in 250. ml water

14. (Chapter 16/ Acids & bases) What is the molarity of an NH_3 solution if 12.0 liters of the NH_3 solution are neutralized by 360 ml of 4.00 M HCl?

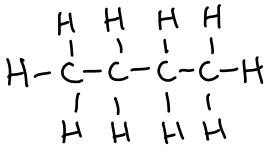
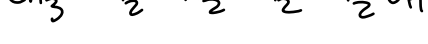
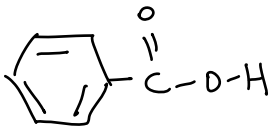
15. (Chapter 18/Oxidation-Reduction) For the following oxidation-reduction equation:
    $$NO_3^-(aq) + Cu(s) \rightarrow NO(g) + Cu^{2+}(aq)$$
    a) identify the oxidation and reduction half-equations and label them.
    b) balance the total equation for the reaction (adding H^+ and H_2O as needed).
    c) Which substance is acting as an oxidizing agent? as a reducing agent?

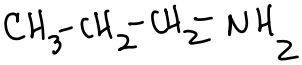
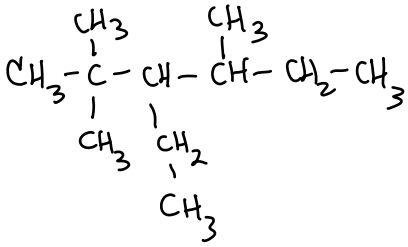
16. (Chapter 18/Electrochemistry) For the following reaction (unbalanced):
    $$Al(s) + Pb^{2+}(aq) \rightarrow Al^{3+}(aq) + Pb(s)$$
    a) identify the oxidation and reduction half-equations and label them.
    b) balance the total equation for the reaction.
    c) draw a voltaic cell for this reaction, labelling anode, cathode, and the direction of flow of electrons, positive ions and negative ions.

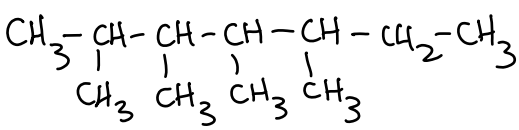
ANSWERS TO SPRING EXAMINATION STUDY QUESTIONS

1. a) b)  c) d) 

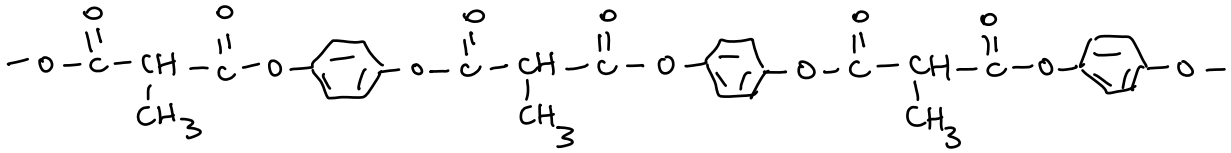
2. a) linear, nonpolar b) tetrahedral, polar

3. a)  b)  c) 

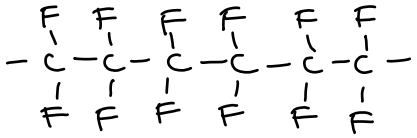
d)  e)  f) any $C_{11}H_{24}$ isomer that is different. For example:



4. a) condensation polymer, polyester



b) addition polymer



5. V = ?, n = 1.10 moles, P = 1.80 atm, T = 46 °C = 319 K.

$$V = \frac{nRT}{P} = \frac{1.10(0.08206)(319)}{1.80} = \text{ 16.0 L}$$

6. a) V_1 = 5.60 L; P_1 = 1 atm, T_1 = 273 K; P_2 = ?; V_2 = 18.0 L; T_2 = 78 + 273 = 351 K.

$$P_2 = P_1 \times \frac{V_1}{V_2} \times \frac{T_2}{T_1} = 1.00\ atm \times \frac{5.60\ L}{18.0\ L} \times \frac{351\ K}{273\ K} = \text{ 0.400 atm}$$

b) $5.60\text{ L} \times \frac{1\ mol}{22.4\ L} = 0.250\text{ mol}$; or use $n = \frac{PV}{RT}$ at either T and P.

c) molar mass = $\frac{mass}{moles} = \frac{7.50\ g}{0.250\ mol} =$ 30.0 g/mol

7. ethane = C_2H_6; molar mass = 2(12.0) + 6 (1.0) = 30.0 g/mole; 65°C = 338 K

density = $\frac{molar\ mass}{molar\ volume}$; molar volume = volume when $n = 1$

$V = \frac{nRT}{P} = \frac{1(0.08206)338}{1.50} = 18.5\ L$; $d = \frac{mm}{mV} = \frac{30.0\ g}{18.5\ L} =$ 1.62 g/L

8. a) $Mg(s) + 2\ HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

b) $23.0\text{ mL} \times \frac{0.500\ mol}{1\ L} \times \frac{1\ L}{1000\ mL} \times \frac{1\ mol\ Mg}{2\ mol\ HCl} \times \frac{24.3\ g\ Mg}{1\ mol\ Mg} =$ 0.140 g Mg

c) $4.61\text{ L } H_2 \times \frac{1\ mol\ H_2}{22.4\ L\ H_2} \times \frac{1\ mol\ Mg}{1\ mol\ H_2} \times \frac{24.3\ g\ Mg}{1\ mol\ Mg} =$ 5.00 g Mg

9. a) moles particles = $117\text{ g NaCl} \times \frac{1\ mol\ NaCl}{58.5\ g\ NaCl} \times \frac{2\ mol\ particles}{1\ mol\ NaCl} =$ 4.00 mol particles

$\Delta T_f = 1.86 \times \frac{4.00\ mol\ particles}{0.500\ kg\ H_2O} =$ 14.9°C; $T_f = 0 - 14.9°C =$ −14.9°C

b) ΔT_f = 2.79°C, moles = ?, 50.0 g = 0.0500 kg H_2O

$\Delta T_f = 1.86 \times \frac{mol\ particles}{kg\ H_2O}$; moles = $\frac{\Delta T_f \times kg\ H_2O}{1.86} = \frac{2.79 \times 0.0500}{1.86} = 0.0750$ mol

10. Check out Procedure from the "Solution Preparation" experiment.

11. a) $157\text{ mL} \times \frac{3.00\ mol\ NaNO_3}{1\ L} \times \frac{1\ L}{1000\ mL} \times \frac{85.0\ g\ NaNO_3}{1\ mol\ NaNO_3} =$ 40.0 g $NaNO_3$

b) $V_1 \times M_1 = V_2 \times M_2$; V_1 = 240 mL; M_1 = 0.500 M; V_2 = 2.00 L = 2000 mL; M_2 = ?

$M_2 = \frac{V_1 \times M_1}{V_2} = \frac{240\ mL \times 0.500\ M}{2000\ mL} =$ 0.0600 M

c) mass solute = $2.00\text{ mol } NaNO_3 \times \frac{85.0\ g\ NaNO_3}{1\ mol\ NaNO_3} =$ 170. g $NaNO_3$

mass solution = 1000 g H_2O + 170. g $NaNO_3$ = 1170 g

mass % = $\frac{mass\ solute}{mass\ solution} \times 100\% = \frac{170\ g\ NaNO_3}{1170\ g\ solution} \times 100\% =$ 14.5 %

12. a) i) shift to right (shift to side with fewer moles); ii) shift to the left (shift in endothermic direction to use up heat); iii) no shift; iv) shift to left (use up some of the N_2O_4 added).

b) $K = \frac{[N_2O_4]}{[NO_2]^2}$; $[N_2O_4] = K \times [NO_2]^2 = 10.0\ (0.010)^2 =$ **0.0010 M**

13. a) $HClO_4$ = strong acid, so $[HClO_4] = [H^+] = 0.010\ M = 1 \times 10^{-2}\ M$; **pH = 2.0**

b) NaOH = strong base, so $[NaOH] = [OH^-] = \frac{1\ g\ NaOH}{0.250\ L} \times \frac{1\ mol\ NaOH}{40.0\ g\ NaOH} = 0.100$ M NaOH

$[OH^-] = 0.100\ M = 1 \times 10^{-1}\ M$; $[H^+] = 1 \times 10^{-13}\ M$; **pH = 13.0**

14. $V_A \times M_A = V_B \times M_B$; $V_A = 360$ mL $= 0.360$ L; $M_A = 4.00$ M; $V_B = 12.0$ L; $M_B = ?$

$$M_B = \frac{V_A \times M_A}{V_B} = \frac{0.360\ L \times 4.00\ M}{12.0\ L} = \textbf{0.120 M}$$

15. a) oxidation: $Cu(s) \rightarrow Cu^{2+}(aq) + 2\ e^-$; reduction: $3\ e^- + 4\ H^+ + NO_3^-(aq) \rightarrow NO(g) + 2\ H_2O$

b) overall: $2\ NO_3^-(aq) + 3\ Cu(s) + 8\ H^+(aq) \rightarrow 2\ NO(g) + 3\ Cu^{2+}(aq) + 4\ H_2O$

c) NO_3^- is the oxidizing agent (it's reduced); Cu is the reducing agent (it's oxidized).

16. a) oxidation: $Al(s) \rightarrow Al^{3+}(aq) + 3\ e^-$; reduction: $Pb^{2+}(aq) + 2\ e^- \rightarrow Pb(s)$

b) $2\ Al(s) + 3\ Pb^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Pb(s)$

c)