# Chem 1A - Review Problems for the Final Exam – Part 1

1. For each of the following, predict which would have the higher melting point:
   a. $C_{20}H_{42}$ or $C_{12}H_{26}$
   b. LiF or LiBr
   c. $Mg_3N_2$ or NaF
   d. MgO, NaF, or $C_{12}H_{26}$
2. In each of the following pairs, predict which would have the higher boiling point, which would have the higher vapor pressure, and which would have the higher heat of vaporization.
   a. HF or $C_8H_{18}$
   b. $CH_3OH$ or $H_2S$
   c. $N(CH_3)_3$ or $CH_3NHCH_2CH_3$
3. Draw the structure of $SOCl_2$ and describe its bonding using valence-bond theory.
4. Draw the best Lewis structure for each of the following: $HClO_4$, $HClO_3$, $HClO_2$, HClO.
5. Given the following reactions and their ΔH values:
   a. $Br_{2\,(l)} \rightarrow Br_{2\,(g)}$ $\Delta H = 30.7$ kJ
   b. $Br_{2\,(g)} \rightarrow 2\ Br_{(g)}$ $\Delta H = 192.5$ kJ
   Explain why process b requires more energy than process a.
6. Given the following reaction:
   $$2\ H_2S_{(g)} + 3\ O_{2\,(g)} \rightarrow 2\ H_2O_{(l)} + 2\ SO_{2\,(g)}$$
   a. $\Delta H_f^o$ of $H_2S_{(g)}$ = - 20.15 kJ/mol, $\Delta H_f^o$ of $O_{2\,(g)}$ = 0 kJ/mol, $\Delta H_f^o$ of $H_2O_{(l)}$ = - 285.8 kJ/mol, and $\Delta H_f^o$ of $SO_{2\,(g)}$ = - 296.1 kJ/mol.
   Calculate $\Delta H_{rxn}$ for the above reaction.
   b. Calculate ΔE for the above reaction at 25°C.
   c. If 3.00 g $H_2S$ is completely combusted in excess oxygen in a bomb calorimeter with a heat capacity of 742 J/°C and containing 2.00 L water which is initially at 20.00°C, what is the final temperature of the calorimeter and its contents?
7. If 150. mL of 1.45 M $Na_2CO_3$ is mixed with 230. mL of 1.53 M HCl, what volume of $CO_2$ will be produced at STP? (Hint: first write the balanced equation.)
8. Write molecular, total ionic, and net ionic equations for each of the following reactions:
   a. $BaCl_{2\,(aq)} + K_3PO_{4\,(aq)} \rightarrow$
   b. $HCl_{(aq)} + Co_2(CO_3)_{3\,(s)} \rightarrow$
   c. excess $NaOH_{(aq)} + H_3PO_{4\,(aq)} \rightarrow$
   d. $HNO_{3\,(aq)} + BaS_{(s)} \rightarrow$
   e. $NH_{3\,(aq)} + HBr_{(aq)} \rightarrow$
9. If you mix 50.0 g of ice at –20.0°C with a certain quantity of liquid water at 25.0 °C and the resulting mixture has a temperature of 10.0°C, what mass of liquid water was used?
   SHC water = 4.184 J/g•°C $\Delta H_{fus} = 333$ J/g
   SHC ice = 2.06 J/g•°C $\Delta H_{vap} = 2260$ J/g
   SHC steam = 2.03 J/g•°C

10. 30.0 mL of 0.100 M lead (II) nitrate solution is mixed with 50.0 mL of 0.100 M sodium chloride solution.
    a. What mass of the precipitate product is formed?
    b. What are all of the ion concentrations in the final solution?
11. Vinegar is a solution containing water, acetic acid, and other components. A sample of vinegar weighing 7.94 g is titrated with NaOH. The NaOH reacts with the acetic acid in the vinegar. If 56.10 mL of 0.115 M NaOH is required for a complete reaction, what is the mass percent acetic acid ($HC_2H_3O_2$) in the vinegar?
12. A 0.300 g pellet of KOH is dissolved in 45.0 g of water in a styrofoam cup. The water temperature rises from 24.1 to 25.7 °C. What is ΔH for the following process? $KOH_{(s)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$ $\Delta H = ?$
    (Assume the specific heat capacity of the solution is 4.1 J/g•°C.)
13. What is the Van der Waals equation? When is it used, and why? What does it take into account?
14. A sample of sodium peroxide, $Na_2O_2$, was reacted with an excess of water.
    $2\ Na_2O_2 + 2\ H_2O \rightarrow 4\ NaOH + O_2$
    In the above reaction, the entire sample of sodium peroxide reacted. The oxygen gas was collected over water at 20°C when the atmospheric pressure was 771 mmHg. The water level in the gas collecting tube was 25.0 cm above the water level outside the tube. If the volume of oxygen collected was 31.0 mL, how many grams of sodium peroxide were in the sample?
    vp of water at 20°C = 17.54 torr
    Density of Hg = 13.6 g/mL
15. A 20.0 mL sample of $H_2C_2O_{4\,(aq)}$ was added to 125.0 mL of water. The solution was mixed well. Then 25.00 mL of this solution was used in a titration with 15.48 mL of 0.3017 M KOH. What was the original concentration of oxalic acid in the first 20 mL sample?
16. Naphthalene, $C_{10}H_8$ (MM = 128.16) dissolves in benzene, $C_6H_6$ (MM = 78.11) and is considered to be nonvolatile relative to benzene. If a solution of naphthalene in benzene has a mole fraction of 0.159 in naphthalene, what is the boiling point of the solution?
    $K_{bp}$ benzene = 2.61 °C/m
    Normal boiling point of benzene = 80.1 °C
17. Round to the correct number of significant figures:
    a. $\dfrac{(10.098 - 9.42)}{1.100} =$
    b. $5360 + 12.98 + 500 =$
18. The lattice energy of NaCl is ΔH for :
    $NaCl_{(s)} \rightarrow Na^+_{(g)} + Cl^-_{(g)}$ $\Delta H = +786$ kJ
    The ionization energy of Na is 496 kJ/mol.
    The electron affinity of Cl is - 349 kJ/mol.
    Calculate ΔH for : $Na_{(g)} + Cl_{(g)} \rightarrow NaCl_{(s)}$
19. Write the reaction corresponding to:
    a. The second ionization energy of sodium.
    b. The heat of formation of sodium bicarbonate.

20. What is the difference in energy between the two energy levels responsible for the violet emission line of the calcium atom at 422.7 nm?

21. a. Draw a diagram indicating the spacing of energy levels for the electron in a hydrogen atom.
b. Calculate the energy and wavelength of the photon emitted/absorbed (circle one) when an electron goes from the n=5 to the n=2 level in the hydrogen atom.
c. The transition described above is in the visible region of the electromagnetic spectrum. If an electron went from the n=5 to the n=1 energy level, would you expect the resulting photon to be in the ultraviolet or the infrared region of the electromagnetic spectrum?

22. State whether each of the following sets of quantum numbers is allowed or not allowed. If it is allowed, name the type of orbital. If it is not allowed, briefly state why.
a. $n = 6, l = 1, m_l = 0, m_s = +1/2$
b. $n = 5, l = 3, m_l = -2, m_s = -1/2$
c. $n = 3, l = 3, m_l = 3, m_s = -1/2$
d. $n = 4, l = 2, m_l = 3, m_s = 1$

23. A compound is 42.9% C, 2.4%H, 16.7% N, and 38.1%O by mass. 6.45 g of this compound is dissolved in 50.0 mL benzene ($C_6H_6$, density = 0.879 g/mL). The addition of this solute lowers the freezing point from 5.53 °C to 1.37°C. What is the molecular formula of the compound?
$K_f$ of benzene = 5.12 °C/m.

24. An unknown compound contains C, H, and O. When 2.00 g of this compound is burned in excess oxygen, 4.40 g of $CO_2$ and 0.800 g of $H_2O$ are produced. What is the empirical formula of the compound?

25. Calculate the mass percent oxygen in $Pb(NO_2)_4$.

26. $CO_2$ diffuses 11.2 cm in a certain amount of time. How far will Xe diffuse in the same amount of time?

27. A sample of $NH_3$ effuses from a small hole in 9.34 minutes. An unknown gas effuses from the same hole in 18.1 minutes under the same conditions. What is the molar mass of the unknown gas?

28. Aluminum has a density of 2.70 g/cm$^3$. What is the density of Al in units of lb/in$^3$? (454 g = 1 lb, 2.54 cm = 1 in)
What is the density of aluminum in units of lb/ft$^3$?

29. $\Delta H_f$ of $N_2O_5$ = 11.3 kJ/mol. What is $\Delta H$ for:
$2\ N_2O_5 \rightarrow 2\ N_2 + 5\ O_2$ ?

**Some answers:**

6. a. – 1123.5 kJ b. + 7.43 kJ, $\Delta E$ = - 1116.1 kJ c. 25.39°C
7. 3.94 L
9. 331 g
10. a. 0.695 g b. $[Pb^{2+}]$ = 0.00625 M, $[Cl^-]$ = 0 M, $[NO_3^-]$ = 0.075 M, $[Na^+]$ = 0.0625 M
11. 4.88 % acetic acid

12. - 56 kJ/mol
14. 0.194 g sodium peroxide
15. 0.677 M oxalic acid in original sample
16. bp = 86.4 °C
17. a. 0.62 b. 5900
18. -639 kJ
20. $4.70 \times 10^{-19}$ J
21. b. $-4.58 \times 10^{-19}$ J c. UV
23. $C_6H_4N_2O_4$
24. $C_9H_8O_4$
25. 32.72 % O
26. 6.48 cm
27. 64.0 g/mol
28. 0.0975 lb/in$^3$, 168 lb/ft$^3$
29. - 22.6 kJ