Chem 1B Practice problems for Exam 2
Once again, this is not a "practice test". These problems are provided to see if you have mastered the concepts of the chapters covered. Do not use your book or notes on your first attempt at these problems.

17.9-17.10

1. In a gas phase reaction, dimethylamine, $(CH_3)_2NH$, reacts with HCl to form $[(CH_3)_2NH_2]Cl$. In the is reaction dimethylamine is acting as a
   a) Lewis acid
   b) Lewis base
   c) Lewis acid, Bronsted-Lowry acid
   d) Lewis base, Bronsted-Lowry base

Answer d

2. Identify from the following list of molecules and ions which two behave as Lewis bases: H_2O, F^-, BH_3, Fe^{3+}.
   a) H_2O an F^- b) F^- and BH_3 c) BH_3 and Fe^{3+} d) H_2O and Fe^{3+} e) F^- and Fe^{3+}

   Answer: a

3. All of the following compounds are acids containing chlorine. Which compound is the weakest acid?
   a) HCl b) HClO c) $HClO_2$ d) $HClO_3$ e) $HClO_4$

   Answer: b

4. The chemical equations below show the reaction of $Al(OH)_3$ as a Lewis acid and as a Lewis base, respectively.

   $Al(OH)_3(s) + OH^-(aq) \leftrightarrow Al(OH)_4^-(aq)$

   $Al(OH)_3(s) + 3\ H_3O^+(aq) \leftrightarrow Al^{3+}(aq) + 3\ H_2O(\ell)$

   Substances that can behave as either Lewis acids or bases are called :
   a) Answer: amphoteric
   b) Bronsted Lowry acid-base pairs
   c) Conjugate acid-base pairs
   d) Adducts

6. When a Lewis acid and a Lewis base combine, the product may be referred to as :
   a) anode b) Bronsted Acid c) Bronsted Base d) Adduct e) None of the above

   Answer: adduct (or complex)

59. Which is the stronger Brønsted-Lowry acid, $Fe(H_2O)_6^{2+}$ or $Fe(H_2O)_6^{3+}$? Not multiple choice but can you explain based on the readings from your text?Explain.
   Answer: $Fe(H_2O)_6^{3+}$. When a proton dissociates from the oxygen atom, the oxygen is left with an extra electron. This negative charge is stabilized by the interaction of the oxygen with the iron cation. Since the Fe^{3+} is more positively charged than the Fe^{2+}, it can more effectively stabilize the negative charge.

18.4-18.7

16. If a metal complex has a K_f that is significantly greater than 1, one can conclude that for the reaction in water

    Metal + Base →Complex

    a) The complex is kinetically stable
    b) The concentration of Lewis base is relatively small (Answer)

c) The concentration of the complex is low
d) K_w is less than one

17. In which aqueous solution should AgBr have the highest solubility?
a) 0.1M LiBr
b) Pure water (answer)
c) 0.2M $AgNO_3$
d) 0.3M KBr
18. Salts containing basic anions have a greater solubility in water than predicted from calculations using K_{sp} values (ie $CaCO_3$, PbF_2, $Ca_3(PO_4)_2$). Why?

a) *Answer:* Basic anions react with water to form their conjugate acids
b) These reactions increase the concentration of the basic anion.
c) Basic anions do not react at all
d) None of the above

19. Which of the following equations is the solubility product for lead(II) iodate, $Pb(IO_3)_2$?

a) $K_{sp} = \dfrac{[Pb(IO_3)_2]}{[Pb^{2+}][IO_3^-]^2}$

b) $K_{sp} = \dfrac{[Pb^{2+}][IO_3^-]^2}{[Pb(IO_3)_2]}$

c) $K_{sp} = [Pb^{2+}][IO_3^-]$

d) $K_{sp} = [Pb^{2+}]^2[IO_3^-]$

e) $K_{sp} = [Pb^{2+}][IO_3^-]^2$

Answer: e

20. The K_{sp} of $PbCl_2$ is 1.7×10^{-5} at 25 °C. What is the concentration of Cl^-(aq) in a saturated solution of $PbCl_2$(aq)?
a) 4.1×10^{-3} M b) 1.6×10^{-2} M c) 2.6×10^{-2} M d) 3.2×10^{-2} M e) 5.1×10^{-2} M

Answer: d

21. The K_{sp} of $CaSO_4$ is 4.9×10^{-5} at 25 °C. What mass of $CaSO_4$ (molar mass = 136.1 g/mol) will dissolve in 1.0 L of water at 25 °C?
a) 0.0067 g b) 0.0070 g c) 0.081 g d) 0.67 g e) 0.95 g

Answer: e

43. What is the molar solubility of CaF_2 in 0.010 M NaF(aq) at 25 °C? The value of K_{sp} for CaF_2 is 5.3×10^{-11} at 25 °C.
a) 5.3×10^{-9} mol/L
b) 5.3×10^{-7} mol/L
c) 7.3×10^{-6} mol/L
d) 7.2×10^{-4} mol/L
e) 0.010 mol/L

Answer: b

23. The concentration of Mg^{2+} in an aqueous solution is 1.5×10^{-3} M. What concentration of CO_3^{2-} is required to begin precipitating $MgCO_3$? The K_{sp} of $MgCO_3$ is 6.8×10^{-6}.
a) 6.8×10^{-6} M b) 1.3×10^{-3} M c) 1.5×10^{-3} M d) 2.6×10^{-3} M e) 4.5×10^{-3} M

Answer: e

25. Consider the reaction

$$Zn^{2+}(aq) + 4\ OH^-(aq) \leftrightarrow Zn(OH)_4^{2-}(aq) \qquad K_f = 2.9 \times 10^{15}$$

If K_{sp} for $Zn(OH)_2$ is 3.0×10^{-17}, what is the value of the equilibrium constant, K, for the reaction below?

$$Zn(OH)_2(s) + 2\ OH^-(aq) \leftrightarrow Zn(OH)_4^{2-}(aq)$$

a) 1.0×10^{-32} b) 1.6×10^{-9} c) 8.7×10^{-2} d) 11 e) 9.7×10^{31}

Answer: c

Ch 19

1. Which substance is likely to have the largest standard molar entropy at T = 25°C.
a) CH_4 (g) b) C_2H_6 (g) c) C_3H_8 (g) d) C_4H_{10} (g)

2. As defined by Ludwig Boltzmann, the third law of thermodynamics states that
a) there is no disorder in a perfect crystal at 0 K.
b) in a spontaneous process, the entropy of the universe increases.
c) the total entropy of the universe is always increasing.
d) the total mass of the universe is constant.
e) mass and energy are conserved in all chemical reactions.

Answer: a

3. Which one of the following processes involves a decrease in entropy?
a) the decomposition of NH_3(g) to H_2(g) and N_2(g)
b) the condensation of steam to liquid water
c) the sublimation of CO_2 from a solid to a gas
d) the evaporation of ethanol
e) the dissolution of NH_4NO_3(s) in water

Answer: b

5. Calculate the standard entropy change for the combustion of propane at 25 °C.

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$$

Species	$S°$ (J/K·mol)
C_3H_8(g)	270.3
O_2(g)	205.1
CO_2(g)	213.7
H_2O(g)	188.8

a) -72.9 J/K b) +72.9 J/K c) +100.5 J/K d) +877.9 J/K e) +2692 J/K

Answer: c

6 For the following reaction at 298.2 K,

$$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g)$$

calculate $\Delta S°$(universe) given $\Delta S°$(system) = -173.1 J/K and $\Delta H°$(system) = -566.0 kJ.
a) -2071.3 J/K b) -739.0 J/K c) -175.0 J/K d) -171.3 J/K e) +1725.0 J/K

Answer: e

7. If $\Delta_r G$º < 0 for a reaction at all temperatures, then $\Delta_r H$º is _____ and $\Delta_r S$º is _____.
a) negative, positive
b) positive, negative
c) negative, negative
d) positive, positive
e) positive, either positive or negative

Answer: a

8. Diluting concentrated sulfuric acid with water can be dangerous. The temperature of the solution can increase rapidly. What are the signs of $\Delta_r H$, $\Delta_r S$, and $\Delta_r G$ for this process?
a) $\Delta_r H < 0$, $\Delta_r S > 0$, $\Delta_r G < 0$
b) $\Delta_r H < 0$, $\Delta_r S < 0$, $\Delta_r G < 0$
c) $\Delta_r H < 0$, $\Delta_r S > 0$, $\Delta_r G > 0$
d) $\Delta_r H > 0$, $\Delta_r S > 0$, $\Delta_r G < 0$
e) $\Delta_r H > 0$, $\Delta_r S < 0$, $\Delta_r G > 0$

Answer: a

9. At what temperatures will a reaction be spontaneous if $\Delta_r H° = +45$ kJ and $\Delta_r S° = +312$ J/K?
a) All temperatures below 144 K.
b) All temperatures above 144 K.
c) Temperatures between 45 K and 312 K.
d) The reaction will be spontaneous at any temperature.
e) The reaction will never be spontaneous.

Answer: b

10. Calculate $\Delta_r G°$ for the reaction below at 25.0 °C.

$$Fe_3O_4(s) \rightarrow 3\ Fe(s) + 2\ O_2(g)$$

Species	$\Delta_f H°$ (kJ/mol-rxn)	$S°$ (J/K·mol-rxn)
$Fe_3O_4(s)$	-1118.4	146.4
Fe(s)	0	27.8
$O_2(g)$	0	205.1

a) -1221.9 kJ b) -1014.9 kJ c) -771.2 kJ d) +771.2 kJ e) +1014.9 kJ

Answer: e

11. For a chemical reaction, if $\Delta_r G^\circ = 0$, then _____.
    a) $K > 1$ b) $K = 0$ c) $K = -1$ d) $K < 0$ e) $K = 1$

    Answer: e

12. What is the equilibrium constant for reaction below at 25 °C? (R = 8.314 J/K·mol)
    $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$
    given $\Delta_f G^\circ$ [$MgCO_3(s)$] = -1028.2 kJ/mol, $\Delta_f G^\circ$ [MgO(s)] = -568.8 kJ/mol, and $\Delta_f G^\circ$ [$CO_2(g)$] = -394.4 kJ/mol.
    a) 4.0×10^{-12} b) 0.97 c) 1.0 d) 1.0×10^{4} e) 2.5×10^{11}

    Answer: a

28. Calculate $\Delta_r G^\circ$ for the reaction below at 25.0 °C
    $2\ CaO(s) \rightarrow 2\ Ca(s) + O_2(g)$
    given $\Delta_r H^\circ$ = +1270.2 kJ and $\Delta_r S^\circ$ = +211.9 J/K.
    a) -1058.3 kJ b) +5.994 kJ c) +1058.3 kJ d) +1207.0 kJ e) +1482.1 kJ

    Answer: d