Name: ___________________________  June 10, 2014
Chemical Principles I
Exam 2

Some useful information: \[ K = \left( \frac{\text{C} + 273.15 \text{C}}{1 \text{C}} \right) \] \[ N_A = 6.022 \times 10^{23} \] \[ PV = nRT \]
\[ R = 0.08206 \frac{\text{L atm}}{\text{mol K}} \]
1 mm of Hg = 1 torr \[ 1 \text{ atm} = 760 \text{ torr} \]
\[ q = ms\Delta t \quad 1 J = 1 \text{ kg m}^2 \text{s}^{-2} \]

\[ \chi_a = \frac{n_a}{n_a + n_b + ...} \quad P_a = \chi_a P_{total} \]
\[ M = \frac{dRT}{p} \quad w = -P\Delta V \]
\[ 1 \text{ L atm} = 101.325 J \text{ (exactly)} \]

1. The **distinguishing** characteristic of all electrolyte solutions is that they (2 pt)
   
   A) contain molecules.  
   B) always contain acids.  
   C) conduct heat.  
   D) react with other solutions.  
   E) conduct electricity.

2. A strong electrolyte is one that completely in solution. (2 pt)
   
   A) decomposes  
   B) ionizes  
   C) disappears  
   D) reacts

3. A weak electrolyte exists predominantly as in solution. (2 pt)
   
   A) ions  
   B) electrons  
   C) atoms  
   D) molecules  
   E) an isotope

4. Identify the following as strong electrolytes (strong), weak electrolytes (weak), or nonelectrolytes (non). (10 pt)

   methanol, CH₃OH     strong  weak  non
   NaBr                 strong  weak  non
   HF                   strong  weak  non
   HNO₃                 strong  weak  non
   KOH                  strong  weak  non

5. A neutralization reaction between an acid and a metal hydroxide produces (2 pt)
   
   A) sodium hydroxide  
   B) hydrogen gas  
   C) oxygen gas  
   D) water and a salt  
   E) ammonia
6. Identify the following as strong acids, weak acids, strong bases, or weak bases. (8 pt)

\[
\begin{align*}
\text{NH}_3 & \quad \text{strong acid} \quad \text{weak acid} \quad \text{strong base} \quad \boxed{\text{weak base}} \\
\text{HCl} & \quad \boxed{\text{strong acid}} \quad \text{weak acid} \quad \text{strong base} \quad \text{weak base} \\
\text{HNO}_2 & \quad \text{strong acid} \quad \boxed{\text{weak acid}} \quad \text{strong base} \quad \text{weak base} \\
\text{LiOH} & \quad \text{strong acid} \quad \text{weak acid} \quad \boxed{\text{strong base}} \quad \text{weak base}
\end{align*}
\]

7. List the formula of any polyprotic acid. (2 pt)

\[
\text{H}_2\text{SO}_4 \quad \text{H}_2\text{SO}_3 \quad \text{H}_2\text{CO}_3 \quad \text{H}_3\text{PO}_4
\]

8. What is the molarity of a solution prepared by dissolving 457 grams of sodium nitrate, \(\text{NaNO}_3\), in water to make a total of 2.00 liters of aqueous solution? (5 pt)

\[
\begin{align*}
\text{a}) & \quad 2.69 \text{ M} \\
\text{b}) & \quad 9.30 \times 10^{-2} \text{ M} \\
\text{c}) & \quad 1.08 \times 10^2 \text{ M} \\
\text{d}) & \quad 2.69 \times 10^{-3} \text{ M} \\
\text{e}) & \quad 5.38 \text{ M}
\end{align*}
\]

\[
\text{M} = \frac{\text{mass}}{\text{mol}} = \frac{457 \text{ g} \times 1 \text{ mol} \text{ NaNO}_3}{85.1 \text{ g}} / 2.00 \text{ L} = 2.69 \text{ M}
\]

9. How many milliliters of a 0.100 molar sulfuric acid, \(\text{H}_2\text{SO}_4\), solution is needed to make 25.0 milliliters of a \(5.00 \times 10^{-3}\) molar solution? (5 pt)

\[
\begin{align*}
\text{V}_a = \frac{M_f V_f}{M_i} = \frac{(25.00 \text{ mL})(5.00 \times 10^{-3} \text{ M})}{0.100 \text{ M}} = 1.25 \text{ mL}
\end{align*}
\]

10. 34.62 mL of 0.1510 M \(\text{NaOH}\) was needed to neutralize 50.0 mL of an \(\text{H}_2\text{SO}_4\) solution. What is the concentration of the original sulfuric acid solution? (5 pt)

\[
\begin{align*}
\text{A}) & \quad 0.0229 \text{ M} \\
\text{B}) & \quad 0.218 \text{ M} \\
\text{C}) & \quad 0.0523 \text{ M} \quad \boxed{\text{D})} \quad 0.209 \text{ M} \\
\text{E}) & \quad 0.105 \text{ M}
\end{align*}
\]

\[
\begin{align*}
2 \text{NaOH} + \text{H}_2\text{SO}_4 & \rightarrow 2 \text{H}_2\text{O} + \text{Na}_2\text{SO}_4 \\
34.62 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.1510 \text{ mol} \text{NaOH}}{1 \text{ mol} \text{H}_2\text{SO}_4} & = 0.0522 \text{ M}
\end{align*}
\]
11. For problem 10,
   a. write the net ionic equation. (2 pt)
   \[ \text{H}^+_{(aq)} + \text{OH}^-_{(aq)} \rightarrow \text{H}_2\text{O}(l) \]
   b. identify the spectator ions. (2 pt)
   \[ \text{Na}^+, \text{SO}_4^{2-} \]

12. Oxidation is the \underline{loss} of electrons and reduction is the \underline{gain} of electrons. (2 pt)

13. The oxidation number of P in P_2O_5 is (3 pt)
   A) +8 \hspace{1cm} B) +7 \hspace{1cm} C) +5 \hspace{1cm} D) -7 \hspace{1cm} E) -8

14. The oxidation number of S in SO_4^{2-} is (3 pt)
   A) +2 \hspace{1cm} B) -2 \hspace{1cm} C) +4 \hspace{1cm} D) -4 \hspace{1cm} E) +6

15. Considering the following reaction, what is undergoing reduction? (2 pt)
   \( 2\text{K} + \text{Br}_2 \rightarrow 2\text{KBr} \)
   a) insufficient information to determine
   b) K and Br_2
e) KBr
d) Br_2

16. Consider the following reactions:
   \[ X^{2+}(aq) + Y(s) \rightarrow X(s) + Y^{2+}(aq) \rightarrow X > Y \]
   \[ X^{2+}(aq) + Z(s) \rightarrow \text{no reaction} \]
   \[ Z^{2+}(aq) + Y(s) \rightarrow Z(s) + Y^{2+}(aq) \rightarrow Y > Z \]
   Write an activity series for the elements X, Y, and Z. (4 pt)
   \[ Z < X < Y \]
17. Indicate if the following are soluble or insoluble in water at 25°C? (4 pt)

a) AgBr        soluble          insoluble
b) CaCl₂       soluble          insoluble
c) Ca(NO₃)₂     soluble          insoluble
d) CaCO₃        soluble          insoluble

18. Which of these properties is/are characteristic(s) of gases? (4 pt)

A) High compressibility  **yes**
B) Relatively large distances between molecules  **yes**
C) Formation of homogeneous mixtures regardless of the nature of gases  **yes**
D) A and B.
E) A, B, and C

19. At what temperature will a fixed amount of gas with a volume of 175 L at 15°C and 760 mmHg occupy a volume of 198 L at a pressure of 640 mm Hg? (5 pt)

A) 274°C   B) 214°C   C) 114°C   D) 1°C   E) -59°C

\[
\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad T_2 = \frac{P_2V_2T_1}{P_1V_1} = \frac{(640 \text{ mm Hg})(198 \text{ L})(288 K)}{(760 \text{ mm Hg})(175 \text{ L})} = 274.1 K
\]

19°C

20. At a temperature of _________ °C, 0.444 mol of CO gas occupies 11.8 L at 889 torr.

A) 379   B) 73   C) 14   D) 32   E) 106 (5 pt)

\[
T = \frac{PV}{NR} = \frac{(889 \text{ torr})(11.8 \text{ L})}{(0.444 \text{ mol})(0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1})} = 378.8 K
\]

\[106°C\]
21. The molecular weight of a gas is ________ g/mol if 3.5 g of the gas occupies 2.1 L at STP.  
A) 41 B) $5.5 \times 10^3$ C) 37 D) $4.6 \times 10^2$ E) $2.7 \times 10^2$ 
\[ M = \frac{dRT}{P} = \frac{\frac{3.5 \text{ g}}{2.1 \text{ L}} \times 0.08206 \text{ L atm/mol K} \times 273.15 \text{ K}}{1.00 \text{ atm}} = 37.9 \text{ g/mol} \]

22. A vessel contained N₂, Ar, He, and Ne. The total pressure in the vessel was 987 torr. The partial pressures of nitrogen, argon, and helium were 44.0, 486, and 218 torr, respectively. The partial pressure of neon in the vessel was _______ torr. 
A) 42.4 B) 521 C) 19.4 D) 239 E) 760 
\[ 987 \text{ torr} = (44 + 486 + 218) = 239 \]

23. Which gas has molecules with the greatest average molecular speed at 25°C? 
A) CH₄ B) Kr C) N₂ D) CO₂ E) Ar 

24. Deviations from the ideal gas law are greater at 
A) low temperatures and low pressures. B) low temperatures and high pressures. 
C) high temperatures and high pressures. D) high temperatures and low pressures. 

25. An exothermic reaction causes the surroundings to 
A) warm up D) decrease its temperature. 
B) become acidic E) release CO₂. 
C) expand. 

26. The value of $\Delta H^\circ$ for the reaction below is -126 kJ. _____ kJ are released when 2.00 mol of NaOH is formed in the reaction? 
\[ 2 \text{ Na}_2\text{O}_2(s) + 2 \text{ H}_2\text{O(l)} \rightarrow 4 \text{ NaOH(s) + O}_2(g) \] 
A) 252 B) 63 C) 3.9 D) 7.8 E) -126