Name: _____   Chem 209
                                                 Exam 2
                                                 7/22/16

PRINT your **NAME**, your **STUDENT ID NUMBER**, and the **COLOR OF YOUR TEST** on your Scantron answer sheet. Also, please **SIGN** the sheet as well. Record your answers to the following questions on the FRONT of the answer sheet in the first 12 positions. Note that **the correct response to some of the questions may require you to black out more than one answer on a single line**.

1. Which of the following would you find in a <u>gas chromatograph</u>?

        A) monochromator
        B) stationary phase
        C) light source
        D) pH electrode
        E) oven

2. In Experiment 2, which of the following changes would make the ABSORBANCE of an $Fe(SCN)^{2+}$ solution DECREASE?

        A) increasing the $Fe(SCN)^{2+}$ concentration
        B) decreasing the $Fe(SCN)^{2+}$ concentration
        C) increasing the injection volume from 1 microliter to 2 microliters
        D) changing the wavelength from 450-460 nm (λ_{max}) to 600 nm
   E) decreasing the He flow rate

3. Suppose that you take 0.5000 gram of Na_2CO_3 and titrate it with 0.115 M HCl solution. What is the equivalence point volume expected for the <u>complete</u> (i.e., methyl orange end point) titration. (Formula weights: Na_2CO_3 = 105.99 gram/mole; HCl = 36.46 gram/mole)

        A) 9.44 mL
        B) 20.5 mL
        C) 41.0 mL
        D) 82.0 mL
        E) none of the above

4. Suppose that a student is determining the total base content of an antacid tablet by performing a back titration. He/she weighs out a 0.3012 g portion of a tablet whose total weight is 1.5312 g, dissolves this in exactly 40.00 mL of deionized water, and then adds exactly 30.00 mL of 0.1000M HCl in order to bring the pH down to 1.9. This solution is then carefully back-titrated with 0.2000M NaOH, with 12.50 mL required to reach the equivalence point. Calculate the total base content (i.e., the number of mmoles of base contained) of the antacid tablet. (Formula weight of HCL = 36.46 g/m; formula weight of NaOH = 40.00 g/m)

        A) 0.500 mmoles   D) 8.90 mmoles
        B) 1.75 mmoles   E) none of the above
        C) 2.54 mmoles

5. Consider the following balanced net ionic reaction:

$$B_4O_7^{2-} + 2\ H_3O^+ + 3\ H_2O \rightleftharpoons 4\ H_3BO_4$$
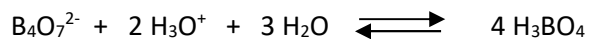
Which of the following is the correct equilibrium constant expression?

A) $\dfrac{[H_3BO_4]}{[H_3O^+][B_4O_7^{2-}]}$

D) $\dfrac{[B_4O_7^{2-}][H_3O^+]^2[H_2O]^3}{[H_3BO_4]^4}$

B) $\dfrac{[H_3BO_4]^4}{[B_4O_7^{2-}][H_3O^+]^2[H_2O]^3}$

E) $\dfrac{2\ [B_4O_7^{2-}]\ [H_3O^+]}{4\ [H_3BO_4]}$

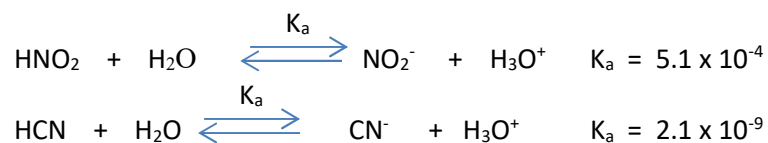C) $\dfrac{[H_3BO_4]^4}{[B_4O_7^{2-}][H_3O^+]^2}$

6. Which of the following terms appear in Beer's Law?

A) molar absorptivity   D) energy
B) wavelength   E) %T
C) absorbance

7. Following the titration of a KHP unknown with 0.10 M NaOH, what parameters should you plot to obtain the titration curve?

	x-axis	y-axis
A)	NaOH concentration	pH
B)	KHP weight	pH
C)	pH	NaOH volume
D)	pH	KHP volume
E)	NaOH volume	pH

8. Consider two acids HCN and HNO_2:

$$HNO_2 + H_2O \xrightleftharpoons{K_a} NO_2^- + H_3O^+ \qquad K_a = 5.1 \times 10^{-4}$$

$$HCN + H_2O \xrightleftharpoons{K_a} CN^- + H_3O^+ \qquad K_a = 2.1 \times 10^{-9}$$

Which of the following statements is/are true?

A) HNO_2 is a strong acid.
B) HNO_2 is a stronger acid than HCN.
C) HCN is a stronger acid than HNO_2.
D) HNO_2 and HCN are both weak acids.
E) The conjugate base of HNO_2 is H_3O^+.

9. What is the pH of a 1.0 x 10^{-6} M NaOH solution?

A) 14
B) 13
C) 8.0

D) 7.0
E) 6.0

10. The pH of a test solution is found to be 13.3. What it's the [H$^+$] in molarity?

A) 5.0 x 10^{-14} M
B) 0.00050 M
C) 0.70 M

D) 13.3 M
E) none of the above

11. Consider the titration of KHP with NaOH. Which of the following statements is/are true?

A) the pH is higher at the end of the titration than at the start
B) KHP is a weak acid
C) one of the products is H$_2$CO$_3$
D) the equivalence point volume can be used to determine the # of moles of KHP
E) all of the above

12. Calculate the volume of 6.0M NaOH solution that you would need to prepare 500 mL of a 0.15M NaOH solution. (Formula weight of NaOH = 40.00 g/m)

A) 8.33 mL
B) 12.5 mL
C) 20.0 mL

D) 75 mL
E) none of the above

13. A Chem major obtains a high-paying summer job and is given the task of determining the ethanol content (in vol %) of a commercial mouthwash sample. He/she decides to do this by gas chromatography because the experiment was so much fun in Chem 209. Accordingly, the student takes exactly 5.0 mL of the mouthwash sample and dilutes this to 30.0 mL with deionized water. He/she then injects 2.0 µL of the diluted sample into the GC and obtains a chromatogram containing two peaks. The first peak, which corresponds to ethanol, has a retention time of 58 seconds and an area of 282. The student then makes up several standard ethanol solutions ranging from 0 to 30% ethanol (vol %), injects 2.0 µL of each into the GC, and uses the areas of the ethanol peak to create a calibration curve whose linear regression equation is:

$$y = 174.2\,x\ +\ 3.2$$

What is the ethanol content of the mouthwash sample?

A) 1.6%
B) 1.9%
C) 9.6%

D) 48%
E) none of the above

14. Which of the following changes would cause the ethanol peak in your gas chromatography experiment to have a <u>larger area</u>?

    A) an increase in the column length
    B) an increase in the sample volume
    C) an increase In the ethanol concentration
    D) an increase in the He flow rate
    E) an increase in the oven temperature

BONUS QUESTIONS (1 POINT EACH!):   Why don't cats play poker in the jungle?

    _____

    How do you get down from an elephant?

    _____