Your Name: Key Section: _____

Chemistry 31 – Quantitative Analysis Exam #1, February 29, 2012

Multiple Choice and Short Answer

Either circle the one correct answer from the choices listed, or enter the correct term on the blank line.

1 **(4 points)**. The common ion effect will cause the solubility of a slightly soluble salt to:

(a.) decrease
b. increase
c. stay the same
c. none of the above

2 **(4 points)**. As the pK_a of weak acids increase, the relative strength of their *conjugate bases* become:

a. has no effect
(b.) stronger
c. weaker
d. none of these

3 **(4 points)**. What is the correct answer (with correct number of significant figures) to the following calculation?

$$23.43 + 0.035 - 1.2 \times 10^{-3}$$

(a.) 23.46
b. 23.464
b. 23.5
c. 23

4 **(4 points)**. What is the correct answer (with correct number of significant figures) to the following calculation?

$$(3.53 \times 10^{-3})/(4.589 \times 10^{-5})$$

a. 7.692×10^{1}
b. 7.69×10^{-1}
b. 7.6923×10^{1}
(c.) 7.69×10^{1}

5 **(4 points)**. Student 'A' repeated an experiment 3 times. Student 'B' repeated the same experiment 12 times. Which students' results are more accurate?

a. Student A
b. Student B
b. Equal accuracy
(c.) Cannot determine from the information given

6 **(4 points)**. Random or indeterminate errors generally lead to a reduction in the Precision of a result.

7 **(4 points)**. A pH change of 2 units indicates a factor of 100 (enter a number) change in $[H^+]$.

or 0.01

8 **(4 points)**. Complex ion formation becomes an important effect on solubility for some salts as a solution becomes (a) more or (b) less concentrated in one of the salt's ions (circle a or b)?

9 **(4 points)**. A wider Gaussian distribution indicates an (a) increased or (b) decreased standard deviation (circle a or b)?

Worked out Problems

It is your responsibility to work out your answers clearly. Unclear, or unreadable work will not be graded. If there is not enough space provided to show your work, continue on the back of the page and clearly mark the problem number. Be sure to show all of your work and report your final answer with the correct number of significant figures and units. Unless otherwise noted, an unreasonable number of significant figures in a final answer will be marked off 2 points. A correct answer without work shown will not receive credit. Circle or draw a box around your final answer.

10 **(12 points)**. Given the following information:

$$C_6H_4(OH)CO_2H_{(aq)} \xleftrightarrow{K_{a1}} C_6H_4(OH)CO^-_{2(aq)} + H^+_{(aq)}; \quad pK_{a1} = 2.972$$

$$C_6H_4(OH)CO^-_{2(aq)} \xleftrightarrow{K_{a2}} C_6H_4(O)CO^{2-}_{2(aq)} + H^+_{(aq)}; \quad pK_{a2} = 13.7$$

Give the balanced chemical reaction for when the base $C_6H_4(O)CO_2^{2-}$ is added to pure water and calculate K_{b1}.

$$C_6H_4(O)CO_2^{2-} + H_2O \rightleftharpoons C_6H_4(OH)CO_2^- + OH^-$$

$$pK_{b1} = 14 - pK_{a2} = 0.3$$

$$K_{b1} = 10^{-0.3} = \boxed{0.5}$$

11 **(12 points).** What minimum mass (in grams) of $Ca(IO_3)_{2(s)}$ must be added to 3.0 liters of pure water to give a saturated solution of $Ca(IO_3)_2$? $K_{sp} = 7.1 \times 10^{-7}$, MW = 395.883 g/mole

$Ca(IO_3)_{2(s)} \rightleftharpoons Ca^{2+} + 2IO_3^-$

$[Ca^{2+}][IO_3^-]^2 = 7.1 \times 10^{-7}$

	Ca^{2+}	IO_3^-
I	–	–
C	$+x$	$+2x$
E	x	$2x$

$(x)(2x)^2 = 7.1 \times 10^{-7}$

$4x^3 = 7.1 \times 10^{-7}$

$x = 5.62 \times 10^{-3} \frac{mol}{L} \left| \frac{395.883 g}{1 mol} \right| (3L) = \boxed{6.67 g}$

12 **(12 points).** Calculate the following and report the answer with the absolute *and* % relative uncertainty (use the correct number of significant figures in the absolute uncertainty for full credit). Uncertainties given below are absolute.

$$\frac{5.76(\pm 0.01)}{87.32(\pm 0.07) + 1.67(\pm 0.03)}$$

$\sqrt{(0.07)^2 + (0.03)^2} = 0.076$ abs

$\frac{5.76(\pm 0.01)}{88.99(\pm 0.076)}$ (abs) $\rightarrow$ $\frac{5.76(\pm 1.7 \times 10^{-3})}{88.99(\pm 8.5 \times 10^{-4})}$ (rel)

$\sqrt{(1.7 \times 10^{-3})^2 + (8.5 \times 10^{-4})^2} = 1.9 \times 10^{-3}$ relative

$0.06473 (1.9 \times 10^{-3}) = 0.0001$ absolute

$\boxed{0.0647(\pm 0.0001) \text{ absolute}}$

$\boxed{1.9\% \text{ relative}}$

13 **(12 points).** What is the solubility (in moles/liter) of $Hg(SCN)_{2(s)}$ in a solution of 3.56×10^{-3}M Hg^{2+}? $K_{sp} = 2.8 \times 10^{-20}$.

$Hg(SCN)_{2(s)} \rightleftharpoons Hg^{2+} + 2SCN^-$

$[Hg^{2+}][SCN^-]^2 = 2.8 \times 10^{-20}$

	Hg^{2+}	SCN^-
I	3.56×10^{-3}	–
C	$+x$	$+2x$
E	$3.56 \times 10^{-3} + x$	$2x$

$(3.56 \times 10^{-3} + x)(2x)^2 = 2.8 \times 10^{-20}$ (assume x is small)

$x = \boxed{1.4 \times 10^{-9} M}$

14 **(16 points).** Consider the titration of 15.00 mL of a solution that contains 0.0450 M SO_4^{2-} by a 0.150 M solution of Ag^+ to form the precipitate Ag_2SO_4. How many milliliters of titrant (Ag^+ solution) are required to reach the equivalence point? What are the concentrations of Ag^+ and SO_4^{2-} at the equivalence point?
The K_{sp} for $Ag_2SO_4 = 1.5 \times 10^{-5}$.

titration: $2Ag^+ + SO_4^{2-} \rightarrow Ag_2SO_{4(s)}$

$$15.00 \text{ mL} \left| \frac{0.0450 \text{ mmol } SO_4^{2-}}{1 \text{ mL}} \right| \frac{2 \text{ mmol } Ag^+}{1 \text{ mmol } SO_4^{2-}} \left| \frac{1 \text{ mL titrant}}{0.150 \text{ mmol } Ag^+} \right| = \boxed{9.00 \text{ mL}}$$

equilibrium: $Ag_2SO_{4(s)} \rightleftharpoons 2Ag^+ + SO_4^{2-}$

$[Ag^+]^2[SO_4^{2-}] = 1.5 \times 10^{-5}$

$(2x)^2(x) = 1.5 \times 10^{-5}$

	Ag^+	SO_4^{2-}
I	–	–
C	$+2x$	$+x$
E	$2x$	x

$x = \boxed{1.6 \times 10^{-2} M = [SO_4^{2-}]}$

$2x = \boxed{3.2 \times 10^{-2} M = [Ag^+]}$