Your Name: Key Section:_________

Chemistry 31 – Quantitative Analysis Exam #1, March 2, 2011

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**). What is the pH of a 5.0×10^{-6} M solution of CsOH?

strong base

a. 5.3
b. 8.7
c. 2×10^{-9}
d. need to know the equilibrium constant for CsOH

2 (**4 points**). At high concentrations of common ion, the formation of complex ion can have what effect on some slightly soluble ionic salts?

a. decreases solubility
b. no effect on the solubility
c. increases solubility
d. none of these

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

$$(1.35 \times 10^{-4} \times 1000.1) + 8.2 \times 10^{-4}$$

a. 1.35×10^{-1}
c. 1.358×10^{-1}
b. 1.4×10^{-1}
d. 1.36×10^{-1}

4 (**4 points**). Student A and B each measured the concentration of lead in the same water sample. Student A's reported result was 12.6 (±0.7) ppm. Student B's reported result was 13.8 (±0.7) ppm. Reported precision represents 95% confidence intervals with n = 3. Which student's result has the lowest **relative** uncertainty?

a. student A
d. student B
b. they are the same
c. impossible to know with the given information

5 (**4 points**). Which solution has the **highest** concentration of protons $[H^+]$?

a. 0.10M solution of weak acid with $pK_a = 6$
b. 0.10M solution of weak acid with $K_a = 1.0\times10^{-3}$
c. 0.10M solution of weak acid whose conjugate base has $pK_b = 9$
d. Cannot determine from the information given

6 (**4 points**). Spilling analyte on the floor during lab is an example of a systematic or determinate error.

7 (**4 points**). Adding 1.0 g of $NaI_{(s)}$ (fully soluble) to 1 L of a solution saturated with $AgI_{(s)}$ (very slightly soluble) will have what effect on the solubility of the $AgI_{(s)}$? Ignore complex ion formation.

a. decreases the solubility
d. no effect on the solubility
b. increases the solubility
c. none of these

8 **(4 points).** A confidence interval tells you:

a. the probability that the true value being measured falls within a defined range of values.
d. the probability that the true population mean value falls within a defined range of values.
b. the probability that an additional measurement will fall within a defined range of values.
c. none of these.

9 **(4 points).** In 1 complete sentence or less, describe how the standard deviation for a measured set of values is related to the precision of the measurement used to generate those values (do **not** make a picture or diagram).

As precision increases, the standard deviation decreases, and vice versa.

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 for the weak base B:

$$B_{(aq)} + H_2O_{(l)} \xleftrightarrow{K_{b1}} BH^+_{(aq)} + OH^-_{(aq)};\ pK_{b1} = 6.00$$

$$BH^+_{(aq)} + H_2O_{(l)} \xleftrightarrow{K_{b2}} \cancel{BH^{2+}_{(aq)}} + OH^-_{(aq)};\ pK_{b2} = 9.00$$

BH_2^{2+}

Give the correct balanced **chemical reaction** and **equilibrium expression** (include the correct value for K_a) for when the acid $\cancel{BH^{2+}}$ is added to pure water. Only consider the acid dissociation.

BH_2^{2+}

$$BH_2^{2+} + H_2O \rightleftharpoons BH^+ + H_3O^+ \qquad \frac{[BH^+][H^+]}{[BH_2^{2+}]} = 10^{-5}$$

or

$$BH_2^{2+} \rightleftharpoons BH^+ + H^+$$

11 **(12 points).** What are the equilibrium concentrations of Pb^{2+} and I^- (reported in mol/L) after $PbI_{2(s)}$ has been added to pure water? The K_{sp} for $PbI_{2(s)}$ is 7.9×10^{-9}.

$$PbI_{2(s)} \rightleftharpoons Pb^{2+} + 2I^-$$

	Pb^{2+}	I^-
I	–	–
C	+x	+2x
E	x	2x

$[Pb^{2+}][I^-]^2 = 7.9 \times 10^{-9}$

$(x)(2x)^2 = 7.9 \times 10^{-9}$

$x = 1.25 \times 10^{-3}$

$$\boxed{\begin{array}{l}[Pb^{2+}] = 1.3 \times 10^{-3}\,M \\ [I^-] = 2.5 \times 10^{-3}\,M\end{array}}$$

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

$$\frac{21.1(\pm 0.4)}{4.97(\pm 0.05) - 1.86(\pm 0.04)}$$

$3.11 \pm \sqrt{0.05^2 + 0.04^2}$

$$\frac{21.1(\pm 0.4)}{3.11(\pm 0.064)}$$

$6.78 \pm \sqrt{\left(\frac{0.4}{21.1}\right)^2 + \left(\frac{0.064}{3.11}\right)^2}$

6.78 ± 0.0280 relative

$\boxed{6.8(\pm 0.2)}$ absolute

13 **(12 points)**. What mass of $BaSO_{4(2)}$ will dissolve in 5.00 L of aqueous solution that initially contains 0.087 M SO_4^{2-}? The K_{sp} for $BaSO_4$ is 1.1 x 10^{-10}. The molecular weight of $BaSO_4$ is 233.4 g/mole.

$BaSO_{4(s)} \rightleftharpoons Ba^{2+} + SO_4^{2-}$

$[Ba^{2+}][SO_4^{2-}] = 1.1 \times 10^{-10}$

	Ba^{2+}	SO_4^{2-}
I	-	0.087
C	+x	+x
E	x	0.087+x

ignore x

$(x)(0.087 + x) = 1.1 \times 10^{-10}$

$x = 1.26 \times 10^{-9} M = [Ba^{2+}]$

$\frac{1.26 \times 10^{-9} \text{ mol}}{L} \cdot \frac{1 \text{ mol } BaSO_4}{1 \text{ mol } Ba^{2+}} \cdot \frac{233.4 \text{ g } BaSO_4}{1 \text{ mol } BaSO_4} = 2.95 \times 10^{-7} \text{ g/L}$

$\times$ 5L

$= \boxed{1.5 \times 10^{-6} \text{ g } BaSO_4}$

or 1.5 μg $BaSO_4$

1

14 **(16 points)**. 10.00 mL of 0.500 M $Ag^+_{(aq)}$ is added to 20.00 mL of solution already saturated with $AgBr_{(s)}$. Once equilibrium is reached, what additional mass (μg; 1μg = 10^{-6}g) of $AgBr_{(s)}$ will have formed? What is the concentration of Br^- in the final solution? The K_{sp} of AgBr is 5.0×10^{-13}; molecular weight of AgBr is 187.8 g/mol.

$$\underset{\substack{\uparrow \\ \text{limiting}}}{Ag^+ + Br^-} \rightarrow AgBr_{(s)}$$

$$AgBr_{(s)} \rightleftharpoons Ag^+ + Br^-$$

$$[Ag^+][Br^-] = 5.0\times10^{-13}$$

$$x^2 = 5.0\times10^{-13}$$

$$x = 7.07\times10^{-7}\,M = [Br^-] = [Ag^+]$$

in saturated solution

$$20.00\,mL \left| \frac{7.07\times10^{-7}\,mol\ Br^-}{1000\,mL} \right| \frac{1\,mol\ AgBr}{1\,mol\ Br^-} \left| \frac{187.8\,g\ AgBr}{1\,mol\ AgBr} \right| \frac{10^6\,\mu g}{1\,g} \Bigg| = \boxed{2.7\,\mu g\ AgBr}$$

$$10.00\,mL \left| \frac{0.500\,mmol}{1\,mL} \right| = \frac{5.00\,mmol\ Ag^+}{30.0\,mL} = 0.167\,M\ Ag^+$$

	Ag^+	Br^-
I	0.167	–
C	+ x	+ x
E	0.167 + x	x

ignore x

$$(0.167 + \cancel{x})(x) = 5.0\times10^{-13}$$

$$x = \boxed{3.0\times10^{-12}\,M = [Br^-]}$$