1. Calculate the following results: 15 pts
   (a) [4.97(± 0.05) –1.86(± 0.01)] / 21.1(± 0.2)
   (b) $[3.14(\pm 0.05)]^{1/3}$
   (c) log [3.14(± 0.05)]

2. (a) A chromatography column with a length of 10.3 cm and inner diameter of 4.61 mm is packed with a stationary phase that occupies 70.0% of the volume. If the volume flow rate is 1.13 mL/min, find the linear flow rate in cm/min.
   (b) How long does it take for solvent which is the same as unretained solute to pass through the column?
   (c) Find the retention time for a solute with a capacity factor of 10.0. 15pts

3. A solution containing 3.47 mM X (analyte) and 1.72 mM S (standard) gave peak areas of 3473 and 10222, respectively, in a chromatographic analysis. Then 1.00 mL of 8.47 mM S was added to 5.00 mL of unknown X, and the mixture was diluted to 10.0 mL. This solution gave peak areas of 5428 and 4431 for X and S, respectively. 15 pts
   (a) Calculate the response factor for the analyte.
   (b) Find the concentration of S (mM) in the 10.0 mL of mixed solution.
   (c) Find the concentration of X in the original unknown.

4. Given the following equations : 20pts

$CaSO4(s) \rightleftharpoons Ca^{2+} + SO_4^{2-}$ $K_{sp} = 2.4 \times 10^{-5}$
$CaSO_4(s) \rightleftharpoons CaSO_{4(aq)}$ $K_{ion\ pair} = 5.0 \times 10^{-3}$
$Ca^{2+} + H_2O \rightleftharpoons CaOH^+ + H^+$ $K_{acid} = 2.0 \times 10^{-13}$
$SO_4^{2-} + H_2O \rightleftharpoons HSO_4^- + OH^-$ $K_{base} = 9.8 \times 10^{-13}$
$H_2O \rightleftharpoons H^+ + OH^-$ $K_w = 10^{-14}$

(a)Write mass balance for Ca species and charge balance.
(b)Estimate the concentration of $[Ca^{2+}]$, $[SO_4^{2-}]$, $[CaOH^+]$, and $[HSO^4]$ if γ_{Ca2+}= 0.570 and γ_{SO42-}= 0.542 are considered, but the remaining activity coefficients are assumed to be 1.

5. According to Beer's law, given b = 1cm, ε = 10000 $M^{-1}cm^{-1}$ for a substance measured at λ=600nm, and the acquired T = 0.20±0.02, estimate the concentration of the substance including the uncertainty. 15pts

6. The dissociation of the complex between thorium and quercetin can be expressed as $ThQ_2 \longleftrightarrow Th + 2Q$ (omitting formal charges). For a solution that was 2.30 x 10^{-5} M in thorium and contained a large excess of quercetin, sufficient to ensure that all of the thorium is present as the complex, the absorbance was 0.780. When the same amount of thorium is mixed with a stoichiometric amount of quercetin, the absorbance was 0.520.
   Calculate (a) the degree of dissociation and (b) the value of the formation constant of the complex. 20pts

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