CHEMISTRY 311 - ASSIGNMENT 1

Hand-in your answers in a neat organized format to the appropriate number significant figures, showing chemical equations and calculations where appropriate.

Due date: Tuesday, October 3rd

1. A student prepares a combined standard solution by weighing out 252.6 mg of **KNO_3** and 148.5 mg of **$NaH_2PO_4 \cdot 3H_2O$**, dissolving in deionized water to a final mass of 102.234 g. After mixing, 1.022 g of this solution was transferred to a clean dry container and diluted with deionized water to a final mass of 250.654 g. Calculate the final concentration **NO_3^--N** and **PO_4^{3-}-P** in ppb.

2. A method to measure the soluble organic carbon in seawater includes oxidation of the organic materials to **CO_2** with **$K_2S_2O_8$**, followed by gravimetric determination of the **CO_2** trapped by a column of **NaOH**-coated asbestos. A water sample weighing 6.234 g produced 2.378 mg of **CO_2**. Calculate the concentration of organic carbon in seawater as ppm **C**.

3. The amount of iron in a meteorite was determined by redox titration using **$KMnO_4$** as the titrant. A 0.4185 g sample of the meteorite was dissolved in acid and the liberated **Fe^{3+}** was quantitatively converted to **Fe^{2+}** using a reducing column. Titrating this solution with 0.02500 M **$KMnO_4$** requires 41.27 mL to reach the end-point. Determine the wt% of **Fe_2O_3** in the sample.

4. The *Total Hardness* of a water sample can be determined volumetrically using ethylenediamine tetraacetate (EDTA), which forms a 1:1 complex with **Ca^{2+}** and other divalent metal cations. Calculate the *Total Hardness* and express as ppm **$CaCO_3$**, if a 50.00 ± 0.05 mL water sample required 3.22 ± 0.03 mL of a $(1.330 \pm 0.005) \times 10^{-3}$ M EDTA titrant to reach a *Calmagite* end-point. Estimate the uncertainty in your answer by propagation of the reported errors, given that only one analytical determination was made.

5. A *Standard Reference Material* is certified to contain 94.6 ppb of a persistent organic pollutant. The results of five replicate analysis are 98.6, 98.4, 97.2, 94.6 and 96.2 ppb. Quantify the precision and accuracy of this determination.

6. A field portable volumetric analysis method for *Total Alkalinity* using a Hach Digital Titrator™ is based on the neutralization of bases in a water sample with the protons of a standardized sulfuric acid titrant (**H_2SO_4**). The volume of titrant added is recorded with a digital counter which corresponds to the delivery of 1.25 µL and can be converted to an analyte concentration with an appropriate 'digit multiplier'. Calculate the 'digit multiplier' for the titration of a 25 mL sample with 0.1600 N **H_2SO_4** titrant cartridge to yield the total alkalinity in units of ppm as **$CaCO_3$**.

7. The following method is reported in *Standard Methods for the Examination of Water and Wastewater* for the analysis of sodium hypochlorite (**NaOCl**) in bleach.

- a 20.00 mL sample of bleach is diluted to 100.0 mL.
- a 25.00 mL aliquot of the diluted sample is then transferred into a flask and treated with an excess acidic iodide solution.
- the iodine thus formed, is titrated with a standard thiosulfate solution.

The chemistry is outlined below (unbalanced equations):
Excess iodide is reacted with the analyte in an acidic solution.

$$OCl^- + I^- + H^+ \rightarrow Cl^- + I_2 + H_2O$$

The resulting iodine (**I_2**) is then titrated with a standardized solution of sodium thiosulfate.

$$S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + I^-$$

If 12.62 mL of a 0.00400 N thiosulfate solution was required to reach the end point, what is the concentration of the original bleach solution as wt% and ppm as **Cl_2**?

8. A 64.3 mg sample of a protein (MW = 58,600) was treated with 2.00 mL of 0.0487 M sodium periodate (**$NaIO_4$**) to selectively react with all of the serine and threonine residues.
The resulting solution was then treated with excess iodide ion to convert the unreacted periodate into triiodide ion (**I_3^-**).

$$IO_4^- + 3\,I^- + H_2O \rightarrow IO_3^- + I_3^- + OH^-$$

A microtitration of the triiodide ion required 823 µL of 0.0988 M thiosulfate.

$$2\,S_2O_3^{2-} + I_3^- \rightarrow 3\,I^- + S_4O_6^{2-}$$

Calculate the total number of serine + threoine residues per molecule of protein.