CHEM 370 Week 2 Activity

Name: Key

Introduction

This assignment covers Chapter 2 of *Analytical Chemistry 2.1* by Harvey. It is a review of basic chemical principles you have studied in the past.

Consult Scientific Tools by Roland Stull for a concise overview of these topics.

You should work in groups to complete this activity. Remember to maintain physical distance even when working in groups!

Significant Figures

When chemists write a number, they don't arbitrarily decide how to round. Rather, they consider how many digits carry *significance*. Any digits that contains meaningful information *must* be included; any digit which does not contain meaningful information *must not* be included. Using the correct number of significant figures is important because it tells other scientists about the uncertainty of your measurements.

> The number of significant figures in a measurement is the number of digits known exactly plus one digit whose value is uncertain. Significant digits in the lab are usually determined by your choice of glassware, instrumentation, etc.

1. How many significant figures are in each of the following values? Convert each measurement to its equivalent scientific notation or decimal form (you may use SI prefixes if desired).
   1. 903 3 9.03×10^{2}
   2. 0.903 3 9.03×10^{-1}
   3. 1.0903 5 1.0903×10^{0}
   4. 0.0903 3 9.03×10^{-2}
   5. 0.09030 4 9.03×10^{-2}
   6. 9.03×10^2 3 903

2. Report results for the following calculations to the correct number of significant figures.
   1. 4.591 + 0.2309 + 67.1 71.9
   2. 313 - 273.15 (40.) → 39.8

3. 1.712×8.6 15

4. $(8.314 \times 298) / 96485$ 25.7×10^{-3}

5. $\log(6.53 \times 10^{-5})$ -4.185

6. $10^{-7.14}$ 7.2×10^{-8}

7. $(6.51 \times 10^{-5}) \times (8.14 \times 10^{-9})$ 5.30×10^{-13}

3. You have a 10-mL graduated cylinder containing water, with the meniscus at the 5.2 mL mark. What value, including significant digits, do you record in your notebook? The cylinder is marked every 0.2 mL.

5.20 mL

Units and Dimensions

Scientists often talk in numbers and charts. When presenting these items, it is important that we all use the same language and clearly specify our units so that we avoid confusion.

> There are seven basic dimensions from which we base all other measurements; these define the SI (international system) *base units*. All other units are *derived units*.
>
> Any data value may be broken into four parts:
>
> **value = number × magnitude × prefix × units**
>
> For example:
>
> concentration value = $1.3 \times 10^3 \mu M$
>
> A value **must** have a number and units; magnitude and prefix are optional. A chemical species may be included as part of the unit.

Thus, units can be treated like numbers algebraically. This gives rise to *dimensional analysis* in which a value is successively multiplied by *values* of 1 using unit conversions to remove undesired units and add the desired units.

1. If you have 5.24 mM aqueous solution of copper, what is the concentration of copper in mg L^{-1}?

$$\frac{5.24 \text{ } \cancel{\text{mmol Cu}}}{\text{L}} \times \frac{63.546 \text{ g Cu}}{\cancel{\text{mol Cu}}} = \boxed{333 \text{ mg Cu}}$$

2. Express this value in parts per million (ppm).

333 ppm

$\frac{1 \text{ mg}}{\text{L}} = 1 \text{ ppm}$

$\frac{1 \text{ ug}}{\text{L}} = 1 \text{ ppb}$

3. List the number, units, prefix, and magnitude for 5.24 mM; if it doesn't have an item state such.

number — unit

prefix

no magnitude

Preparing Solutions

Although we try to be explicit when writing chemical methods, we often use significant figures to imply important details. Learning to understand this implied advice makes life in the chemistry lab easier.

> When preparing a solution, consider how accurate and precise you need to be. Look to the method and you chemical knowledge for clues.

1. You've been asked to prepare 1 L of a "50/50 solution of methanol in water" as a general-purpose extraction solvent. You have the following available: (1) a 500-mL graduated cylinder, (2) a 1000-mL volumetric flask, (3) a 1-L bottle with 100-ml gradations printed on it, (4) a high-capacity balance, (5) an analytical balance. Which glassware/equipment would you choose and why?

   (1) + (2) OK
   (1) + (3) OK
   } Do not need precision

2. You've been asked to prepare 1 L of a 500.0 mg/L nicotine (a liquid at room temperature) stock solution in 50/50 methanol water solution. You have the following available: (1) a 10-mL graduated cylinder, (2) a 1000-mL volumetric flask, (3) a 1-L bottle with 100-ml gradations printed on it, (4) a high-capacity balance, (5) an analytical balance. Assuming you're given 100% pure nicotine and pre-made 50/50 methanol/water, Which glassware/equipment would you choose and why?

   (2) + (5) only - need precision!

3. Building on the previous question, suppose:

   1. That you made the stock with a graduated cylinder (marked in 0.2-mL increments) and 1000 ± 0.3 mL volumtric flask. How many significant digits should you report the concentration to? What limits your uncertainty?

      500.. w/ grad cyl limiting

      Eg: $\frac{5.20}{1000.0}$ ← grad. cyl. - 3 sf; ← vol. flask - 5 sf

2. That you made the stock with an analytical balance (displays to 0.0001 mg) and a 1000 ± 0.3 mL volumtric flask. How many significant digits should you report the concentration to? What limits your uncertainty?

500.00 w/ vol flask limiting or balance limiting

Eg: $\frac{5.0000}{1000.0}$ ← balance - 5 sf; flask - 5 sf

/

4. An analyst wishes to add 256 mg of Cl^- to a reaction mixture. How many mL of 0.217 M $BaCl_2$ should they add?

$$\frac{0.217\ \cancel{\text{mol } BaCl_2}}{\text{L soln}} \times \frac{35.453\ \text{g } Cl^-}{\cancel{\text{mol } Cl^-}} \times \frac{2\ \cancel{\text{mol } Cl^-}}{\cancel{1\ \text{mol } BaCl_2}} = \frac{15.3866\ \text{g } Cl^-}{\text{L soln}}$$

$$256\ \text{m}\cancel{\text{g } Cl^-} \times \frac{1\ \text{L soln}}{15.3866\ \cancel{\text{g } Cl^-}} = \boxed{16.6\ \text{mL soln}}$$

5. †A 12.1374 g sample of an ore containing Ni and Co was carried through Fresenius' analytical scheme shown in Figure 1.1 (Analytical Chemistry 2.1). At point A the combined mass of Ni and Co was found to be 0.3013 g, while at point B the mass of Co was found to be 0.0419 g. Report the weight percent Ni in the ore to the correct number of significant figures.

$$\frac{(0.3013\text{g} - 0.0419\text{g})}{12.1374\text{g}} \times 100\% = \boxed{2.137\ \%\ Ni}$$

6. †A 12.1374 g sample of an ore containing Ni was carried through the analytical scheme shown in Figure 1.2 (Analytical Chemistry 2.1). The mass of the precipitate was found to be 1.2770g. Report the weight percent Ni in the ore to the correct number of significant figures. Does this method or Fresenius' have better precision? Why? Note that ratio of formula weights between Ni and $Ni(dmg)_2$ is 0.2.03149.

↑ Typo 0.203149

$$\frac{(1.2770\text{g} \times 0.203149)}{12.1374\text{g}} \times 100\% = 2.1374\ \%\ Ni$$
