Problem Set 2
CEEG 340–Introduction to Environmental Engineering
Instructor: Deborah Sills

Due Date

Wednesday, 4 September

Learning Goals

1. Calculate chemical concentrations in water in units of mass/mass, mass/volume, mole/volume, ppm_m.

2. Calculate chemical concentrations in water in units of mass/mass, mass/volume, mole/volume, ppm_m, and in air, in units of ppm_v, mass/vol, and partial pressure.

3. Calculate chemical concentrations of nitrogenous compounds in common constituent units of nitrogen (or as N).

Questions

1. **(10 pts)** What is the molar concentration of 10 grams/liter for each of the following chemicals?

   - NaOH
   - Na_2SO_4
   - $K_2Cr_2O_7$
   - KCl

2. **(10 pts)** (modified from Mihelcic and Zimmerman) Coliform bacteria (for example, <u>E. coli</u>) are excreted in large numbers in human and animal feces. Water that meets a standard of less than one coliform per 100 mL is considered safe for human consumption. Is a 1 m³ water sample that contains 9000 coliforms safe for human consumption? **Show your work.**

3. **(10 pts)** Vinyl chloride is used to produce polyvinyl chloride (PVC), which is a plastic material used in construction. Vinyl chloride is classified as a known carcinogen by the U.S. Environmental Protection Agency (EPA), and according to their website, "EPA has set an enforceable regulation for vinyl chloride, called a maximum contaminant level (MCL), at 0.002 mg/L or 2 ppb_m." Prove that 0.002 mg/L equals 2 ppb_m.

4. **(10 pts)** Benzene is associated with petroleum products and is typically found in contaminated soil beneath gas stations. What is the maximum contaminant level (MCL) of benzene (in units of mg/L) allowed in drinking water (hint: check out Ch. 10 in the textbook or search online)? Express this drinking water standard in terms of (a) ppm_m, (b) ppb_m, and (c) $moles/m^3$.

5. **(10 pts)** A gasoline station has a patch of contaminated soil over a 45 m^2 area and 0.5 m deep. Any samples that exceed Total Petroleum Hydrocarbons (TPH) of 50 mg/kg will require a complete remediation of all soil. If the soil bulk density is 1.5 g/cm^3, what is the maximum total mass (in kg) of TPH that may remain on site without cleanup?

6. **(10 pts)** Text: 2.13, part (a) only. Note that M is mole/L.

7. **(10 pts)** Text: 2.15

8. **(10 pts)** (modified from Mihelcic and Zimmerman) The EPA regulates nitrate in drinking water with a MCL of $10 \frac{mg-N}{L}$. Babies under the age of 6 months who drink water with nitrate concentrations higher than the MCL could be come very ill and even die from a syndrome called "blue-baby syndrome." If a water sample contains 10 mg NO_3^-/L, does it violate the MCL? Also convert the MCL to units of (a)ppm_m, (b) $moles/L$, and (c) ppb_m.

9. **(10 pts)** 2.24

10. **(10 pts) Who loves hockey?** (modified from Mihelcic and Zimmerman)
Ice resurfacing machines (aka Zambonis) use internal combustion vehicles that give off exhaust containing carbon monoxide (CO) and nitrogen oxides (NO_x). The outdoor air quality 1-h standard of CO is set at 35 mg/m^3. Average CO concentrations measured at Lynah Rink (at Cornell University) have been reported to be as high as 115 ppm_v and as low as 35 ppm_v. (1) Should Prof. Sills be concerned about spending 1 h at Lynah Rink, watching Cornell Women's Ice Hockey Team play (and hopefully beat) Harvard on October 26? Assume the temperature equals 20^0C. (2) Calculate the partial pressure (in atm) of CO in the rink. Assume that the atmospheric pressure is 1 atm.