

Prep for Quiz 1—Environmental Measurements

CENG 340—Introduction to Environmental Engineering

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September 3, 2013

Rationale

A lecture on the units used to express concentrations of chemicals and biological entities (e.g., coliforms) would bore you and me to death. Therefore, I'm asking you to engage with the textbook and answer the following questions in preparation for an in-class quiz on Wednesday 9/4.

In class on Monday, I will be prepared to answer questions on the assignment, and I will give you some time to work on it. Note that I will not collect this preparatory assignment, but if you work through these problems, you should be able to do well on Wednesday's quiz.

Learning Goals

1. Calculate chemical concentration in units of mass/mass, mass/volume, mole/volume, etc.
2. Calculate chemical concentration in common constituent units such as hardness, nitrogen, and CO₂ equivalents.
3. Become comfortable using standard environmental measurements.

Questions

A subset of similar questions will appear on an in-class quiz to held on Wednesday 9/4.

1. 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." Prove that 0.002 mg/L equals 2 ppb.
2. (modified from Mihelcic and Zimmerman) The [EPA regulates nitrate in drinking water with a MCL of 10 mg/L-N](#). Babies under the age of 6 months who drink water with nitrate concentrations higher than the MCL could become very ill and even die from a syndrome called "blue-baby syndrome." If a water sample contains 10 mg NO₃⁻/L, does it violate the MCL? Also convert the MCL to units of (a) ppm_m, (b) moles/L, and (c) ppb_m.

3. **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/m³. 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) Northeastern on October 19th? Assume the temperature equals 20°C. (2) Calculate the partial pressure (in atm) of CO in the rink. Assume that the atmospheric pressure is 1 atm.

4. What is the molar concentration of 10 grams/liter for each of the following chemicals?

- NaOH
- Na₂SO₄
- K₂Cr₂O₇
- KCl

5. Express 50 mg/L of HCO₃⁻ as:

- equivalents/liter
- moles/liter
- milligram/liter as CaCO₃

6. A lake water sample has the following cation composition:

- Ca²⁺ = 42 mg/L
- Na⁺ = 35 mg/L
- Mg²⁺ = 12 mg/L
- Mn²⁺ = 10 mg/L

Determine the hardness of the water (express the hardness as mg/L of CaCO₃).

7. (modified from Mihelcic and Zimmerman) Coliform bacteria (for example *E. coli*) 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.**

8. (from Mihelcic and Zimmerman) In 2004, U.S. landfills emitted approximately 6,709 Gg of methane, and wastewater treatment plants emitted 1,758 Gg of methane. How many Tg of CO₂ equivalents did landfills and wastewater plants emit in 2004. What percent of the total methane emissions (and greenhouse gas emissions [GHGs]) do these two sources contribute? Total methane emissions in 2004 were 556.7 Tg CO₂ equivalents and total GHG emissions were 7074 CO₂ equivalents.

9. Two hundred milliliters of a lake water sample is completely evaporated at 104°C in an evaporating dish. The tare weight of the dish was 12.819 grams. After evaporation of the sample the weight of the dish plus residue was 13.020 grams. The dish plus residue was then heated

(ignited) at 550°C . The dish plus residue weighed 12.982 grams after cooling. Determine (1) total solids content, (2) total inorganic (fixed) solids, and (3) total organic (volatile) solids content of the sample.