

## ENV 6002: Physical & Chemical Principles of Environmental Engineering

Fall 2008  
Homework #3  
Due Thurs., Sept. 18, 2008

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### INSTRUCTIONS

- Pick any five of the first ten questions below. Be aware that you might be expected to know (e.g., on an exam) the material from the other questions, as well. For 2008, please select only from the first ten questions, i.e., do not select question (11) or higher.
  - Each answer is worth 10 points, for a total of 50 points on this assignment.
  - Your answers to these questions may not exceed 1 page each (with reasonably-sized font, margins, and spacing). If you are able to answer the questions thoroughly while keeping each answer to under half-a-page, it will put you in my good graces as I am grading. If your answer to any of the questions exceeds 1 page, I will not read your answer, and *you will not receive credit for that question.* (I'm not bluffing.)
  - Your answers should be written *in your own words*, so that I can tell you understand what you are writing. It is not acceptable to just copy answers word-for-word from another source.
- (1) (a) Define *primary* and *secondary* drinking water standards as these terms are used under the Safe Drinking Water Act. Be sure to specify the most important difference(s) between the two.
- (b) Primary drinking water standards are generally specified in one of two ways. What are the two ways?
- (c) Define *maximum contaminant level* (MCL) and *maximum contaminant level goal* (MCLG), specifying the most important difference(s) between the two.
- (2) (a) Define water quality *criteria* and water quality *standards* as these terms are used under the Clean Water Act, specifying the most important difference(s) between the two.
- (b) Explain the difference between drinking water standards and water quality criteria. What is the intended use of water quality criteria?
- (c) Compare the current National Primary Drinking Water Standards (reader section 2E) with the freshwater and saltwater National Recommended Water Quality Criteria (reader section 2C) for cyanide, copper, and polychlorinated biphenyls (PCBs). Which values are more stringent: drinking water or water quality criteria? Why do you think the values are different?
- (3) Look again at the Water Quality Criteria for polychlorinated biphenyls (PCBs). Compare the criteria for freshwater, saltwater, human consumption of organism, and human consumption of organism with water. What do the values suggest with regard to the relative importance of fish tissue concentrations versus aqueous concentrations in evaluating human risks? (We will learn how the chemical properties of PCBs lead to this relative importance.)

- (4) Arsenic regulation in drinking water was a subject of debate in the U.S. in the early 2000's. A new arsenic rule was passed by EPA in 2001. You can *skim* the rule at this site: <http://www.epa.gov/fedrgstr/EPA-WATER/2001/January/Day-22/w1668.htm> in order to answer the following questions. What are some of the benefits of lowering the arsenic standard? What are some of the costs? Briefly explain why we are concerned about arsenic levels. What human health effects are associated with arsenic exposure? Where does arsenic in drinking water come from?
- (5) (a) Summarize the approach and the specific steps used by EPA in setting a drinking water standard for trichloroethene (TCE). Refer to section 3A of the reader.
- (b) In your opinion, is it reasonable to establish a MCL for this contaminant? In other words, is there need to regulate TCE specifically in public water supplies?
- (c) Read the short article on perchlorate, Section 3B. Keeping in mind the process that you described in part (a) above, what action (if any) do you recommend EPA should take at this point in terms of setting a MCL for perchlorate?
- (6) Read the article "The Pollution Within" in your course reader (Section 3C).
- (a) What xenobiotic chemicals were found to have accumulated in the author's body? (Be specific when possible, though some of the chemicals were discussed only in general terms.) How might the author have become exposed to these chemicals? What are the possible or likely health effects that could ensue from exposure to these chemicals?
- (b) If you were to undergo the same battery of tests as the author of this article, what xenobiotic chemicals do you suspect would be found in your own body?
- (7) Read the article "The Great Impostors" in your course reader (Section 3D). Also read "The Chemicals Within" and "Chemical linked to brain problems" which I will post on Blackboard. (I was not quite organized enough to get these into the 2008 edition of the course reader – consider it a preview of the 2009 edition.)
- (a) Based on these three articles, which chemicals or classes of chemicals are implicated as causing health problems in people or other animals? (Be as specific as possible.) What are likely exposure routes to these chemicals? What are the possible or likely health effects that could ensue?
- (b) Besides the effects that you listed in part (a), what other observations are mentioned in "The Great Impostors" that could possibly be attributed to exposure to endocrine-disrupting compounds?
- (c) Given what you now know about drinking water treatment and about endocrine-disrupting chemicals, which would you recommend for drinking: tap water or bottled water? Explain your answer. (There is no "right" answer to this.)

- (8) Read the article “Kids at Risk” in your course reader (Section 3E).
- Which chemicals or classes of chemicals are implicated as causing health problems in children? (Be as specific as possible.) What are likely exposure routes to these chemicals? What are the possible or likely health effects that could ensue?
  - Briefly explain why children are particularly sensitive to harm from chemicals.
  - Looking through the list of U.S. drinking water standards in the reader, are there specific chemicals particularly harmful to children that may be found in drinking water?
- (9) Read the article “Dow’s Dioxins” [Chemical & Engineering News, August 11, 2008, pp. 15–20], which is posted on Blackboard.
- What are the principal chemicals of concern discussed in this article? How did they get released into the environment?
  - In what compartment(s) or phase(s) of the environment are these chemicals found predominantly? Why?
  - Approximately how long have these chemicals been in the environment? Why have the chemicals not been flushed out of the river system by now?
  - What is the most likely exposure route for humans to be exposed to these chemicals? According to the article, what other exposure routes are possible or likely?
  - What are the likely health effects if humans are exposed to these chemicals?
  - Find the National Recommended Water Quality Criterion for dioxin (2,3,7,8-TCDD) under the Clean Water Act. According to this recommended criterion, what concentration may safely be in the river if people are going to eat fish caught in the river? What is the MCL for dioxin under the Safe Drinking Water Act? Compare these concentrations to those of some other hazardous organic chemical (DDT, or PCBs, or some other nasty chemical of your choice). What do you conclude about the relative toxicity of dioxin?
  - Given your answers to parts (a)–(f) above, do you believe you have enough information to recommend a course of action for the contaminated rivers in Michigan? If so, what do you recommend?
- (10) Read the article “Malaria Control” in Section 3G. What are the arguments for and against the use of DDT for malaria control? Do you agree with the USAID’s recent decision to fund interior DDT spraying in malarial regions? Do you think this is an easy decision, or a tough one? Justify your answers appropriately. (Additional information relevant to the debate over DDT can be found in the articles “The Great Impostors,” “Kids at Risk,” and “Malaria: Bedlam in the Blood,” all of which are in your course reader; you can cite arguments from these articles if you wish.)

- (11) (a) Compare U.S. EPA drinking water standards (reader section 2E) with World Health Organization (WHO) drinking water guidelines (the WHO guidelines are sometimes hard to find...try [http://www.who.int/water\\_sanitation\\_health/dwq/gdwq3/en/index.html](http://www.who.int/water_sanitation_health/dwq/gdwq3/en/index.html)). Which list is stricter with respect to disinfection byproducts?
- (b) How do the U.S. EPA drinking water standards and the WHO drinking water guidelines consider silver and zinc? Can you make a clear judgement about which organization is stricter with respect to silver and zinc? Explain.
- (12) Summarize the federal legislation currently in effect that aims to control water pollution and protect drinking water supplies. Refer to Section 2 of the reader, particularly section 2A. Which of the laws are intended mainly to prevent contamination of water resources, and which focus primarily on treatment of already-contaminated water resources?
- (13) Read the article “The Challenge of Micropollutants in Aquatic Systems” in your course reader (Section 3F).
- (a) What are some of the processes that micropollutants can undergo once they are in an aqueous system? Why is it difficult to quantify the extent to which these processes occur?
- (b) According to the authors, what are the major challenges associated with removing micropollutants from the aqueous systems?
- (c) What technical or management solutions do the authors recommend to address the challenges you described in part (a) and (b)?