

1. LD₅₀ is used for measuring toxicity of a compound.

(part I) (5%)

If compound A has LD₅₀ = 5 mg/L and compound B has LD₅₀ = 20 ng/L, which compound (A or B) is more toxic?

(part II) (5%)

What are the problems of this method? (write down the letters of the 2 correct answers)

- a.) It neglects the long term (chronic) effect
- b.) It neglects the synergistic effect with other toxins
- c.) It is not as accurate as LC₅₀
- d.) It can only be tested on the fish.
- e.) It can only be tested on mice.

2. In a clean river environment (not heavily polluted), will compound X (pKa = 4.5) exist in its deprotonated or protonated form? Please explain. (5%)

3. What is BOD (biological oxygen demand)? (5%)

4. Plasticizer such as bis(2-ethylhexyl)phthalate, commonly abbreviated DEHP is an example of environmental hormone (or environmental estrogen). Please explain the term 'environmental hormone.' What is it and what are the possible effects on human health and ecosystem. (5%)

5. In designing a program to monitor water systems for organics pollution, it is important to examine target compounds' physical chemical properties. What can you predict about the natural fate of these two compounds. How is compound A compared to B? Which one is more likely to be in the air phase, water or sediment phase? Please explain.

Do you not have enough information to answer this question? If not, what other information do you need? (10%)

Compound A	MW= 150	pKa = 9.8	Log Kow = 0.40
Compound B	MW = 430	pKa = 3.5	Log Kow = 4.2

6. A conventional drinking water treatment plant (WTP) practices both pre-chlorination and post chlorination with sodium hypochlorite. Due to increasing concern of disinfection byproducts in finished water, the WTP is planning to lower the pre-chlorination dosage from 5 mg/L to 0.5 mg/L. In addition, switch from 2 mg/L of post-chlorination to 3 mg/L of post-chloramination. What will happen to water treatment units and the distribution system after the switch? (hint: please consider both chemically and biologically effects) (15 %)

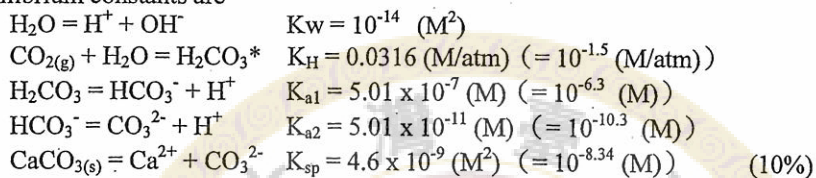
7. There was a power failure last for 10 hours in a wastewater treatment facility of a meat packing plant. During the power failure, all the wastewater generated from the meat packing plant went down to domestic sewage drainage without any prior treatment. The treatment train for the municipal wastewater treatment plant receiving the regular domestic sewage is: primary clarifier -> 2-stage trickling filter system with recirculation->secondary clarifier->disinfection. The discharge flow from the meat packing facility during the 10-hour power failure was equal to the total receiving flow over 24 hours in that municipal wastewater treatment facility. What will happen to the treatment facility and effluent quality? And, if you are a sewer engineer for that municipal plant, what will you do? (10 %)

8. A biological reactive barrier amended with zero valence iron was designed to treat a groundwater contaminated with trichloroethylene, butane, xylene, and acetic acid. What will be the order of degradation (from fast to slow) for those contaminants? And why? (10 %)

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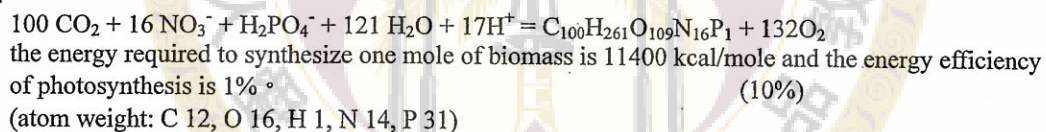
9. It has been suggested that application of waste calcium carbonate rocks in natural water to adjust the pH may be able to facilitate the sequestration of carbon dioxide from the atmosphere. A reservoir with water volume of $1 \times 10^8 \text{ m}^3$ is equilibrated with atmosphere and has pH of 5.5 and negligible concentration of calcium. If we add excess calcium carbonate rocks ($\text{CaCO}_{3(s)}$) into the reservoir and let the solid, water and air get equilibration. What will be the pH of the water finally? , and how much CO_2 has been absorbed into the reservoir?

The concentration of CO_2 in the atmosphere is $10^{-3.5}$ atm (316 ppm (v/v)), the equilibrium constant between H_2CO_3^* ($\text{CO}_{2(aq)}$) and $\text{H}_2\text{CO}_{3(aq)}$ in water and CO_2 in air is 0.0316 (M/atm) ($= 10^{-1.5}$ (M/atm)). Other equilibrium constants are



10. If the combustion heat of methanol (CH_3OH), ethanol ($\text{C}_2\text{H}_5\text{OH}$) and n-octane (C_8H_{18}) are -726, -1367 and -5450 kJ/mole, please estimate the energy produced from these three materials for 1 mole of carbon dioxide (CO_2) emitted, respectively. (10%)

11. An industrial effluent of $5 \text{ m}^3/\text{day}$ contains total nitrogen 20 mg/L, total dissolved phosphorus 5 mg/L. It is intended to remove phosphorus by using a wetland with depth of 1 m and volume of 50 m^3 full of floating plants. Assuming the solar irradiation energy on the water surface is $800 \text{ cal cm}^{-2}\text{day}^{-1}$, the photosynthesis reaction and the chemical composition of the plant biomass are as below. Please discuss whether the proposed concentration of phosphorus in the wetland treated water as 1 mg/L is possible or not.



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