

1. (30%) The gas chromatograph (GC) is a commonly used instrument of analyzing organic chemicals in the environmental samples.
 - (a) Draw a schematic diagram that shows all of the components of a GC and explain the function of each component (10 points).
 - (b) If electron capture detector (ECD) is equipped in the GC, describe how it works? Why is ECD extremely sensitive for chlorinated compounds (10 points)?
 - (c) A standard solution containing 5.0×10^{-3} M tetrachlorobenzene and 2.0×10^{-4} M chlorotoluene (an internal standard) in methylene chloride gave peak areas of 350 and 700, respectively. A 1-L sample of river water was extracted with 50 mL of methylene chloride and after separation of the water layer, methylene chloride was reduced to 1.0 mL; 2.0×10^{-7} moles of internal standard chlorotoluene were added to the final methylene chloride extract. A GC separation of the extract gave peak areas of 320 and 630 for tetrachlorobenzene and chlorotoluene, respectively. Assuming the injection volume is the same each run. What was the concentration of tetrachlorobenzene in the river water (10 points)? Please list calculation steps.
2. (15 %) (a) The environmental fate of organic compounds can be estimated using the Kow value. What is Kow (e.g., definition and equation) (5 points)?
(b) How is the Kow experimentally determined (10 points)?
3. (15 %) What is the value of hardness index for a 250 mL samples of river water that contains 0.0020 g of calcium ion (MW= 40 g/mole) and 0.0012 g of magnesium ion (MW=24 g/mole)? Please show the result in milligrams of CaCO_3 per liter.
4. (10 %) Consider a body of water in equilibrium with solid calcium sulfate, CaSO_4 for which $K_{sp} = 4.0 \times 10^{-4}$ at 30°C . Calculate the solubility, in g/L of calcium sulfate in water assuming that other reactions are negligible.
5. (10%) Please explain primary and secondary air pollutants.
6. (10%) Please explain "Chapman Cycle" in the stratosphere.
7. (10%) Please explain the mechanism (how and when) of the ozone depletion in Antarctic. In addition, please explain why the ozone depletion is more severe in the Antarctic than in the Arctic.

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