1. In your kitchen (T = 25 C) you drop a small bottle with 20 mL of finger nail polish remover. The bottle spills on your kitchen floor. The doors and windows are closed. On your stove there is an open pan containing 2 L of cold olive oil. Furthermore, on the floor there is a large bucket that is filled with 50 L of water. The air volume of the kitchen is 30 cubic meters. Assuming the nail polish remover is pure acetone, calculate the concentration of acetone in the air, in the water, and in the olive oil at equilibrium by assuming that the adsorption of the compound to any other phases/surfaces present in the kitchen can be neglected.

2. Polycyclic aromatic hydrocarbons have been accumulating in the sediments of the Willamette River. A study was performed to determine if the pore water in the river bed was in equilibrium with the sediment concentration. To separate the sediments from pore water, centrifugation was used. The table below contains some data for phenanthrene and the sediment:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqueous solubility (mol/m³)</td>
<td>6.62e-3</td>
</tr>
<tr>
<td>molecular weight</td>
<td>178.2</td>
</tr>
<tr>
<td>log K_{oc}</td>
<td>4.12</td>
</tr>
<tr>
<td>f_{oc}</td>
<td>0.035</td>
</tr>
</tbody>
</table>

a. Given that the concentration of phenanthrene found in the sediment was 10^{-3} ng/g, calculate the equilibrium aqueous phase concentration. Be sure to state any assumptions.
b. The measured porewater concentration was 48 ng/L. Does this agree with your answer? If not, suggest the mechanism(s) to explain the difference. What measurement, calculations or experiments could be conducted to test your suggestions?

3. You are responsible for analyzing the concentration of chlorobenzene in a contaminated groundwater sample. Knowing the detection limits of your laboratory analytical equipment you decide a liquid-liquid extraction might serve you best. Specifically you’d like to consider hexane and hexadecane as an extracting solvent. Find the volume of hexane and the volume of hexadecane required to get 95% extraction efficiency. What additional/alternative steps would you recommend to improve/increase the extraction efficiency?

4. When flushing a gasoline-contaminated soil in a laboratory soil column with clean water, after 5 pore volumes (i.e., after 5 times replacing the water in the column), benzene
concentrations in the column effluent decreased from initial 370 to about 75 \( \mu \text{g} / \text{L} \), while 1,2-dimethylbenzene concentrations increased from 1200 to 1400 \( \mu \text{g} / \text{L} \). Explain these findings.

5. You are the boss of a commercial analytical laboratory, and your job is to check all results before they are sent to the customers. One day, you look at the results from the analysis of benzene in aqueous samples of very different origins, namely

a. groundwater;
b. seawater (ionic strength \( \sim 0.5 \text{ M} \));
c. water from the Dead Sea (ionic strength \( \sim 5 \text{ M} \)); and

For all samples, your laboratory reports a benzene concentration of 1 \( \mu \text{g} / \text{L} \). Knowing the problems associated with the analysis of volatile organic compounds (VOC’s), you inquire immediately about the handling of the samples. You learn the samples (100 mL each) were put into 1 L flasks which were then sealed and stored at 5 \( \text{C} \) for several days. Then, an aliquot of the water was withdrawn and analyzed for benzene. What were the original concentrations of benzene in the 4 samples?

Begin your analysis by considering the following pertinent information:

- Mass of benzene in the aqueous phase initially = mass of benzene in the water at equilibrium (assume 5 days is sufficient to reach equilibrium) + mass of benzene in the air (i.e., the headspace of the 1L flask) at equilibrium.
- Assume the change in volume of aqueous solution in the flask upon reaching equilibrium is negligible.
- \( K_{aw} \) (i.e., Henry’s law constant for benzene) equals 0.224 [dimensionless] at 25 \( \text{C} \).
- \( K_i^b \) equals 0.20 L/mol.