1. For a solution containing 0.01 M $CaCl_2$ and K_2SO_4, please calculate (a) the ionic strength of the solution (**5 points**), and (b) the activity coefficients and activities of each ion in the solution (**10 points**).

2. A mass of 0.001 mole of acetic acid is added to water to make a one-liter solution at 25°C. Please answer the following questions: (a) what are the equilibrium concentrations of all species involved (**5 points**)? (b) What are the equilibrium concentrations of all species involved if 0.01 milli-mole of Sodium Acetate (CH_3COONa) is added in place of 0.001 mole of acetic acid (**10 points**). Ignore activity corrections.

$$CH_3COOH \rightarrow CH_3COO^- + H^+ \qquad K_a = 1.8\times10^{-5} \qquad \text{at } 25^oC$$

3. In wastewater analysis, it is often to measure BOD, COD, and TOC。
   (1) Please describe the purpose for those three measurements. (**5 points**)
   (2) Please describe the similarity and difference among the results obtained from those three measurements. (**10 points**)
   (3) What are the limitations or disadvantages from those three measurements. (**5 points**)

4. In wastewater analysis, what instrumental methods of analysis are useful to analyze each of the following:
   (1) Metals; (2) Volatile organic compounds; (3) Nonvolatile organic compounds. (**12 points**)

5. Greenhouse effect is a globally environmental concern, using CO_2 as an example, explain the characteristic of wavelength of sun and molecule vibration in troposphere. (**10 points**)

6. (1) What are POPs? (**5 points**)
   (2) List two chemicals on the list of Stockholm Treaty (**6 points**)
   (3) Based on chemical structure and physical properties of POPs, explain the environmental behavior of POPs. (**5 points**)

7. For air quality,
   (1) Describe the definition and unit of $PM_{2.5}$? (**6 points**)
   (2) In addition to $PM_{2.5}$, list at least two chemical compounds in Air Quality Index (AQI) (**6 points**)

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