1. (25%) Give a brief description or a definition of the following terminologies:
   (a) Chemical Oxygen Demand
   (b) Radiative Forcing
   (c) Eutrophication
   (d) In-situ Bioremediation
   (e) Life Cycle Assessment
   (f) Montreal Protocol

2. (10%) In general, what two treatment methods are required for removal/inactivation of microorganism?

3. (15%) How does PM2.5 particulate matter differ from that called PM10? Which poses the greatest risk to human health and why?

4. (15%) A large industrial smokestack located within an urban area emits vast quantities of sulfur dioxide and nitrogen oxide. Following criticism from local residents that emissions from the stack are contributing to poor air quality in the area, the management raises the height of the stack from 10 m to 100 m. Will this increase in stack height change any of the existing air quality problems? Will it create any new problems? Explain.

5. (10%) List a principal disadvantage of use of any three accepted alternative methods for disinfection of public drinking water in comparison to chlorination.

6. (25%) The component below is a monocarboxy diamino acid, asparagine:
   $$H_2NC(O)CH_2CH(NH_2)COOH$$
   This organic compound can be oxidized biologically to form CO_2, H_2O, and NH_3 as products.
   (a) Please write a balanced reaction equation(calculate the stiochiometric coefficients) for the oxidation reactions.
   (b) If the initial concentration of asparagine in solution is 5 mg/L and

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the asparagines is oxidized quantitatively to CO_2, H_2O, and NH_3, how much dissolved oxygen (as mg O_2/L) will be consumed in the reaction?

(c) Under the circumstances of (a)&(b) ammonia will be released, in units of mMol/L? In units of mg/L, expressed as NH_3? In units of mg/L, expressed as N?

(d) Under the circumstances (a)&(b) what is the concentration of dissolved organic carbon[DOC] before and after reaction takes place?

(e) Based on the thermodynamic reasoning and calculations, show that the oxidation of asparagine can be expected to proceed to completion spontaneously, or not.(Hint: calculate the change in Gibbs free energy for the reaction).

	$H_2NC(O)CH_2CH(NH_2)COOH$	O_2	CO_2	H_2O	NH_3
ΔG_f^0 (kJ/mol)	-764	0	-394.5	-228.5	-16.5

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