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國立臺北科技大學九十六學年度碩士班招生考試

系所組別：3210 環境工程與管理研究所甲組

第一節 環境工程 試題

第一頁 共二頁

注意事項：

1. 本試題共 8 題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。
4. 中、英文作答皆可。

1. Are the following statements true or false? (10%)

- (a) A volatile substance is one that evaporates completely at ambient conditions.
- (b) The saturated amount of dissolved oxygen in water depends strongly on the pH.
- (c) Pristine rainwater is slightly acidic.
- (d) The death rate of cells in microbial kinetics is modeled as a 1st-order reaction.
- (e) In environmental engineering terminology, substrate means a biodegradable substance introduced in the water to purify it from undesirable bacteria.

2. You have just been hired by the Taiwan EPA. One of your first assignments has been to develop a treatment standard for the toxic chemical known as greenspartanite. You are to set the MCL (Maximum Contaminant Level) for drinking water at a level that will achieve a lifetime risk of 10^{-7} for an adult. You are to assume that the average adult drinks this water for half of their life, weighs 60 kg, drinks 2 L water/day and has a life expectancy of 78 years. The oral potency factor for greenspartanite is $1.3 \times 10^{-3} \text{ (mg/kg/day)}^{-1}$. At what level ($\mu\text{g/L}$) should the MCL be set? (10%)

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3. Clear Lake has a surface area of $432,000 \text{ m}^2$ and an average depth of 12 m. During the month of May, the lake has an average inflow of $1.8 \text{ m}^3/\text{s}$ and an average outflow of $1.70 \text{ m}^3/\text{s}$. A storage change of $+344,000.0 \text{ m}^3$ was recorded. If a precipitation gage recorded a total of 32.5 cm for this month, determine the evaporation loss (in cm) for the lake. Assume that seepage loss is negligible. May has 31 days. (10%)

4. A coal-fired electricity plant is designed to deliver electrical energy at the rate of 1000 MW (1 megawatt = 1000 kilowatts; about 1 kW of power is needed to supply an average household, so 1000 MW can supply about 1 million households). The coal has a chemical heat content of 24,000 KJ/kg. The power plant has an overall efficiency of converting chemical energy into electrical energy of 40%. (20%)

- (a) What is the mass of coal (kg) that is needed to generate 1000 MW of electricity for one day?
- (b) Of the waste heat that is generated, 15% is lost in the smokestack. The remaining heat must be removed by cooling water. What flow rate (in m^3/s) is needed if the cooling water can only increase by 10°C during its passage through the plant?
- (c) To gain perspective about how much water this is, calculate how high (meters) a column of water representing the volume used in one day would rise above a football field (110 by 49 m).
- (d) If the plant was converted to a cogeneration facility and 50% of the waste heat was recovered and used productively (e.g., for heating buildings), what would the overall efficiency of the cogeneration plant be?

5. Certain building materials emit formaldehyde (HCHO), a toxic air pollutant. The following technique is proposed to determine the emission rate. i) Place a sample of the material to be tested in a well mixed chamber of volume, V (m^3). ii) Supply uncontaminated air into the chamber at a flow rate Q ($\text{m}^3 \text{ s}^{-1}$) and allow air to flow out of the chamber at the same rate. iii) Monitor the HCHO concentration in the outlet air until a steady-state value, C_{ss} ($\mu\text{g m}^{-3}$) is reached. Given V , Q , and C_{ss} from such an experiment, determine an expression for the HCHO emission rate from the sample in $\mu\text{g s}^{-1}$. You may assume that HCHO is non-reactive. (10%)

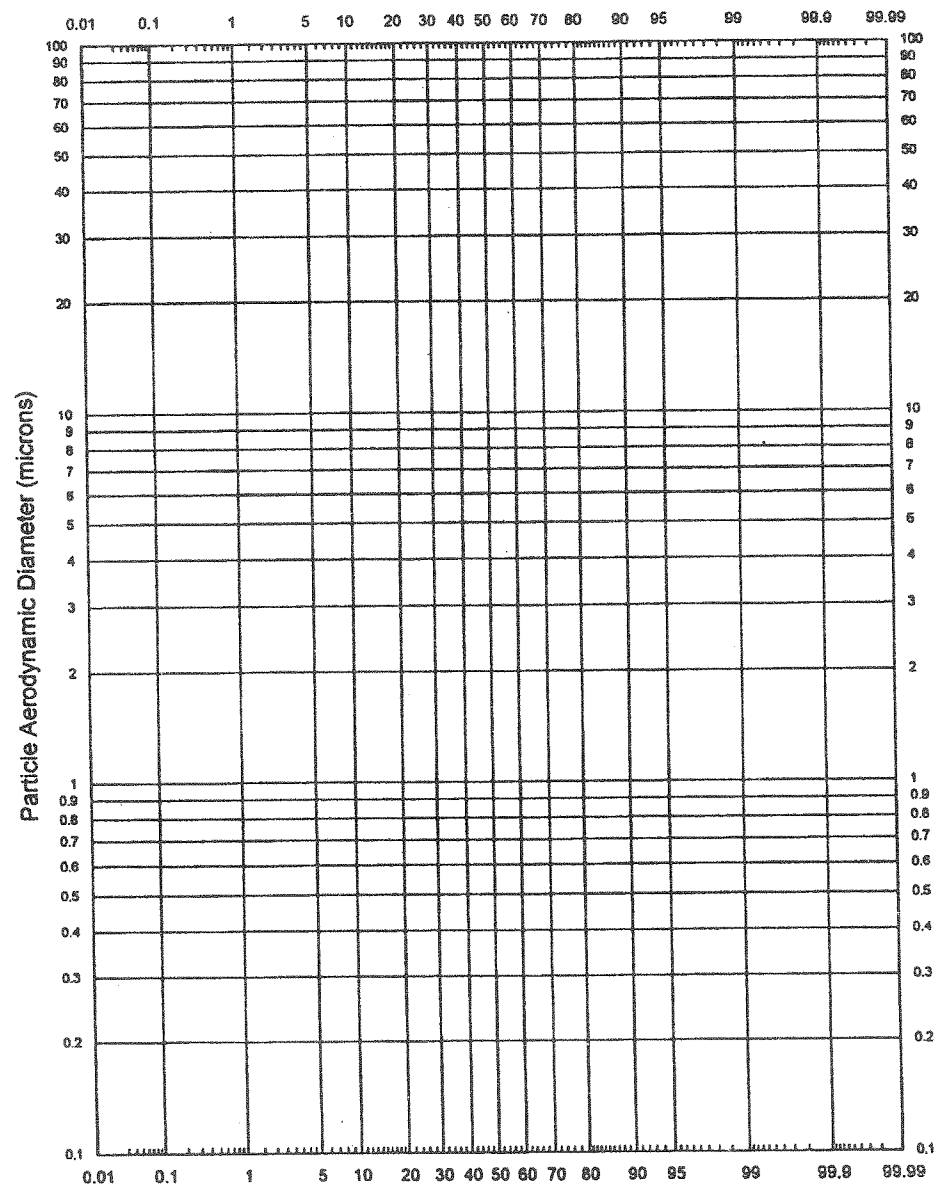
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6. The data shown in the table below were obtained from a cascade impactor run on a sample from an aerosol population. Estimate the values of MMD and σ_g . (10%)

Size range (μm)	Mass (mg)
0-2	4.5
2-5	179.5
5-9	368
9-15	276
15-25	73.5
>25	18.5



7. Natural gas, which is mostly methane (CH_4) is one energy source for generating electricity. (20%)

- (a) Calculate the gross heat of combustion for natural gas (CH_4), given the enthalpies of formation (in kJ/mol) for the following compounds: $\text{CH}_4(\text{g}) = -74.9$, $\text{O}_2 = 0$, $\text{CO}_2 = -393.5$, $\text{H}_2\text{O}(\text{l}) = -285.8$.
- (b) The mass of carbon released per unit of energy delivered by a fuel is called the carbon intensity. What is the carbon intensity (gC/MJ) of natural gas and how does this compare with the carbon intensity of coal (24 gC/MJ) and oil (20 gC/MJ)?
- (c) A natural gas electricity plant has an efficiency of 40%. If a household that obtains all of its electricity from this plant uses 400 kW-hr per month, how many kg of CO_2 are produced by this household's electricity use each month?
- (d) CO_2 is a greenhouse gas that contributes to global warming. Based solely on CO_2 emission potential, which of the three fuels considered in part b) has the largest potential to contribute to global warming? Explain your answer.

8. Your neighbors just dumped a gallon bottle of unused pesticide down an uncapped well behind their house. The pesticide has a retardation coefficient of 2.3. This well is 120 m upgradient from your drinking water well that is located in an unconfined aquifer having a permeability of 1.9×10^{-4} m/s. The hydraulic gradient and the porosity of the aquifer are 0.005 m/m and 38%, respectively. Assuming that the pesticide is not reactive in the aquifer, how long (in days) will it take before the pesticide is detected in your drinking water well? (10%)