

國立清華大學 101 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 乙組（環境分子科學組）

考試科目（代碼）：環境科學與工程 (2302)

共 2 頁，第 1 頁 *請在【答案卷、卡】作答

1. Define and explain the following terms and, if necessary, write out the structural formula for each of the following compounds: (30%: 6% of each)
 - (a) Pollutants and contaminants
 - (b) Risk and hazard
 - (c) Secondary air pollutants and secondary maximum contaminant levels for drinking-water standards
 - (d) Peroxyacetyl nitrate (PAN) and trihalomethanes (THMs)
 - (e) PAHs and PCBs
2. Schematic of a typical municipal wastewater treatment plant for surface water showing pretreatment, primary treatment, secondary treatment, and tertiary treatment. Please label all of the parts and explain their functions. (10%)
3. Describe the biogeochemical cycle of nitrogen in the aqueous environment with a figure. List and explain the major pathways in the nitrogen cycle, the chemical species that are transformed in each, and the species that accomplish each of the transformations. Explain why photochemical reactions have important implications for nitrogen availability in many aquatic ecosystems. (10%)
4. The Lotka-Volterra model has been successfully applied to the periodic nature of predator-prey relationships in ecology. Write down two differential equations to describe the numbers of predator (lynx), K , and prey (hares), P , with four constants (a: growth rate of the prey, b: mortality parameter of the prey, c: growth rate of the predator, and d: mortality parameter of the predator). Derive that the interactions between two species result in periodic behavior, rather than decaying exponentially. (10%)

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5. A nuclear power station is situated in Coal Valley, which is a roughly rectangular valley that is 5 km long, 2 km wide, and 200m deep. You have been asked to evaluate the effects of a worse-case scenario where the reactor housing fails, and radiation is released to the atmosphere. In your evaluation, you determine that 120 kg of Iodine-131 (a radioisotope that causes thyroid gland and liver damage) could be released into the atmosphere (1 atm and 20°C). (a) Assuming the release of Iodine-131 was very rapid and all of it was uniformly distributed through the valley's atmosphere with none escaping the valley, what would the concentration of Iodine-131 be in the valley's air? (express in units of ppmv) (b) Assuming the Iodine-131 concentration you calculated in (a) is the initial concentration in the valley, determine the time it will take for the concentration to decrease to the safe limit of 1.0×10^{-5} ppmv. The average windspeed through the valley (entering at one end and exiting at the other) is only 1.5 m/min. Iodine-131 also is removed by two other processes: (1) radioactive decay with a half life of 8.1 days, and (2) sedimentation to the ground with a rate constant of 0.02 d^{-1} . (20%)
6. The air pollution control equipment on a municipal waste incinerator includes a fabric filter particle collector (known as a baghouse). The baghouse contains 424-cloth bags arranged in parallel, that is 1/424 of the flow goes through each bag. The gas flow rate into and out of the baghouse is $47 \text{ m}^3/\text{s}$. and the concentration of particles entering the baghouse is $15 \text{ g}/\text{m}^3$. In normal operation the baghouse particulate discharge meets the regulatory limit of $24 \text{ mg}/\text{m}^3$. During preventive maintenance replacement of the bags, one bag is inadvertently not replaced, so only 423 bags are in place. Calculate the fraction of particulate matter removed and the efficiency of particulate removal when all 424 bags are in place and the emissions comply with the regulatory requirements. Estimate the mass emission rate when one of the bags is missing and recalculate the efficiency of the baghouse. Assume the efficiency for each individual bag is the same as the overall efficiency for the baghouse. (20%)