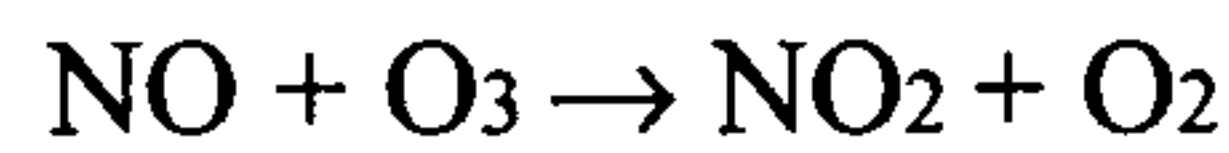


國立清華大學 102 學年度碩士班入學考試試題
系所班組別：生醫工程與環境科學系 乙組 (環境分子科學組)
考試科目 (代碼)：環境化學 (2305)

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

1. Consider the reaction (15%)



which has a rate constant give by $k = 1.8 \times 10^{-12} e^{-1370/T} \text{ cm}^3 \text{ molecules}^{-1} \text{ s}^{-1}$. Use the following standard heats of formation.

Substance	ΔH_f° (kJ mol ⁻¹)
NO	90.25
NO ₂	33.18
O ₃	142.7

- What is the activation energy of this reaction?
 - What is the standard enthalpy of this reaction? Is it exothermic or endothermic?
 - Draw the potential energy profile of this reaction.
2. J. A. Pyle at the University of Cambridge in England has proposed that ozone destruction in the late spring over northern latitudes may be initiated in the lower stratosphere by the photolysis of ClONO₂ to Cl and NO₃, followed by photolysis of the latter to NO and O₂. Deduce a catalytic ozone destruction cycle, requiring no atomic oxygen, that incorporates these reactions. What is the overall reaction? (Note that this mechanism is especially important in the polar ozone holes since initially the active chlorine is converted almost exclusively to ClONO₂ rather than predominantly to HCl because the former is much faster to re-form than is the latter.) (10%)
3. Carbon monoxide binds to hemoglobin 320 times more effectively than oxygen does. Continuous exposure of more than 50 ppm CO is accompanied by some observable impairment, 250 ppm results in loss of consciousness and 750 ppm can result in death. A room having the dimension 4 m×3 m×8 m is kept at 20°C by a natural gas (CH₄) space heater. (15%)
- Write the two balanced chemical equations for the combustion of CH₄ to produce (1) CO₂ and water and (2) CO and water.
 - The fuel-air mixture of the heater is running slightly rich (CH₄:O₂ ratio of 1.00:1.92) resulting in some incomplete combustion to CO. Calculate what percent of the total carbon oxides produced is carbon monoxide.
 - The heater combusts 10.0 g of methane per hour. Assuming all the carbon monoxide from the heater is expelled into the room and there is no ventilation, how long will it take before there is a danger of losing consciousness?

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共 3 頁，第 2 頁 *請在【答案卷、卡】作答

4. Water has three vibrational modes with fundamental bands centered at 3756, 3652 and 1595 cm^{-1} . (15%)
- Illustrate the three types of vibrations expected by drawing water molecules and arrows depicting the vibrational motion.
 - Convert the vibrational modes from wavenumbers (cm^{-1}) to wavelengths (μm) and state which one(s) occur within the thermal IR region.
 - A similar three vibrational modes can be found in molecules like SO_2 . However, CO_2 has only two fundamental bands that appear in the infrared. Why?
5. The enthalpies of combustion for liquid octane and methanol are -5471 and -726 kJ mol^{-1} , respectively. (15%)
- Write out the balanced chemical equations for the complete combustion of each compound.
 - Which fuel generates more heat per mole of carbon dioxide produced?
 - Some service stations offer gasohol (10% methane in gasoline) as an alternative fuel for automobiles. What effect might you predict for engine emissions in a car running on gasohol instead of gasoline? (Assume gasoline is essentially octane.)
6. In a DDT biomagnifications study the bioconcentration factor (BCF) for the links in a food chain were determined. (15%)

<u>Links</u>	<u>BCF</u>
Water → Zooplankton	800
Zooplankton → Fish A	30
Fish A → Fish B	2
Fish B → Seagull	5

- What is the overall biomagnification that occurs from water to seagulls?
- If the water started with 4.7×10^{-3} mg/mL DDT, what is the concentration in the tissue of Fish B?
- If a seagull had 136 ppm DDT in its tissue, what is the concentration expected in the zooplankton?

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共 3 頁，第 3 頁 *請在【答案卷、卡】作答

7. Residual chlorine in drinking water is usually less than 1 ppm. (15%)
- What is the purpose of residual chlorine?
 - A small amount of ammonia is sometimes added just after the disinfection stage to generate chloramines. What advantage do they have with respect to residual chlorine in finished water?
 - Assuming all the residual chlorine initially exists as NCl_3 , how much NCl_3 (ppm) is needed to achieve 1 ppm residual chlorine?

Note: The atomic masses of elements are as follows:

H = 1.0	C = 12.0	N = 14.0	O = 16.0	Ca = 40.0	Na = 23.0
Mg = 24.3	S = 32.1	Cl = 35.5	K = 39.1	Cu = 64.0	F = 19.0