

## 物理化學部分 (選考兩部分)

Total 50 pts.

1. (Thermodynamics)

- (a) A certain battery runs a toy truck and becomes partially discharged. In the process, it performs a total of 117.0 joules of work ( $w$ ) on its immediate surroundings. It also gives off 3.0 joules of heat ( $q$ ), which the surroundings absorb. No other work or heat is exchanged with the surroundings. Compute  $q$ ,  $w$ , and  $\Delta U$  (internal energy) for the battery, making sure each quantity has the proper sign. (6 pts.)
- (b) The same battery is now recharged exactly to its original state. This requires 210.0 joules of electrical work from a generator. Determine  $q$  for the battery in this process. (5 pts.)
- (c) Explain why  $q$  has the sign that it does. (5 pts.)

2. (Chemical Kinetics)

- (d) Liquid A decomposes by first-order kinetics and 5% of A is converted in 5 minutes. How much longer would it take to reach 75% conversion? (8 pts.)
- (e) Repeat the previous problem for second-order kinetics. (8 pts.)

3. (Quantum Chemistry)

An extremely crude picture of an electron in an atom is to treat the electron as a particle in a one-dimensional box which has a length on the order of the size of the atom.

- (f) For an electron in a box of length  $1.0 \text{ \AA}$ , calculate the separation between the two lowest energy levels. (6 pts.)
- (g) Calculate the wavelength of a photon corresponding to a transition between these two levels. (6 pts.)
- (h) What portion of the electromagnetic spectrum does this wavelength correspond to? (6 pts.)
- ( $m_e = 9.1 \times 10^{-31} \text{ kg}$ ,  $h = 6.6262 \times 10^{-34} \text{ joule} \cdot \text{s}$ ,  $c = 3 \times 10^8 \text{ m/s}$ )

## 分析化學部分 (選考兩部分)

1. The fact that atoms and molecules absorb light is the basis for many different spectroscopic techniques in chemical analysis. List ten different ways through which absorption can be detected. In each case indicate what signal is measured and how the signal is related to atomic or molecular concentration. (25%)

2. For each of the followings, indicate an appropriate method of quantitative analysis. Provide sufficient information so that the plan of the analytical approach and the most vital experimental conditions are apparent. Include in your description a consideration of suspected interferences and give a reasonable method for eliminating or circumventing the interferences.

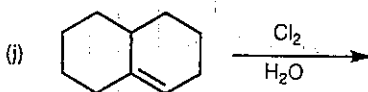
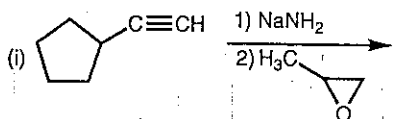
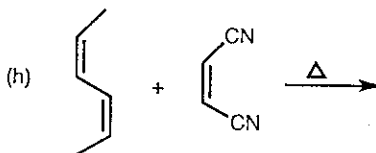
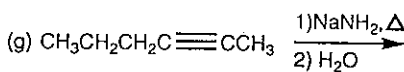
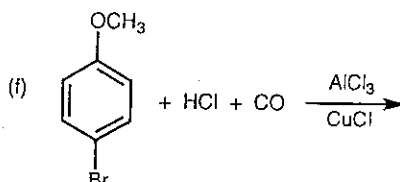
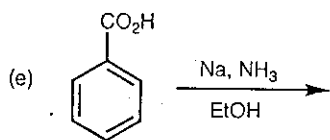
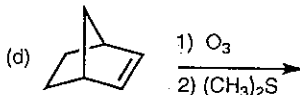
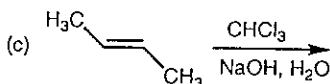
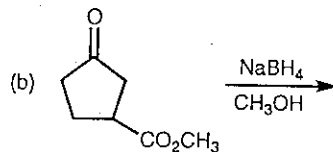
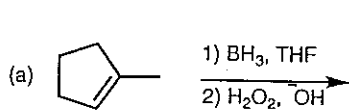
Answer any three

- (a) ppb concentrations of chloride and sulfate in steam condensate
- (b) Selenium in human hair
- (c) cadmium traces in milk powder
- (d) Glucose, fructose and sucrose in a syrup
- (e) Determination of dissolved oxygen as a function of depth in a lake
- (f) Determination of percent nitrogen in an  $\text{NH}_4\text{NO}_3$  fertilizer (5-10% N)
- (g) Determination of Cr(VI) at the ppm level in the presence of Cr(III) in industrial waste water. (25%)

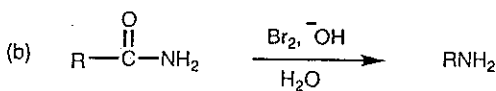
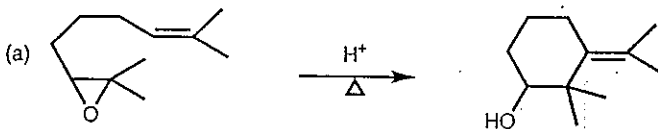


## 有機化學部分 (選考兩部分)

1. Write the structure of the major product of the following reactions (be sure to specify stereochemistry) (30 pts.).



2. Write step-by-step mechanism for the following reactions (10 pts.).



3. Explain the results of the following reactions (10 pts.).

