1. Please describe and explain (a) Uncertainty principle, (b) Semiconducting element, (c) Root-mean-square (rms) molecular speed, (d) Ideal solution, (e) First ionization energy. **(20%)**

2. Calculate the pH of a solution obtained by mixing 800 $mL$ of 0.1 $M$ $NH_3$ with 200 $mL$ of 0.15$M$ HCl at $25^\circ C$. The base-ionization constant, $K_b$, of $NH_3$ is $1.8 \times 10^{-5}$ at $25^\circ C$. **(10%)**

3. Draw a potential-energy diagram for an uncatalyzed exothermic reaction. On the same diagram, indicate the change that results on the addition of a catalyst. Discuss the role of a catalyst in changing the rate of reaction. **(10%)**

4. A container with 0.25 $L$ of water is heated by microwave radiation, and the temperature of the water rose from 10.0 $^\circ C$ to 90.0 $^\circ C$. If the radiation wavelength is 12.5 $cm$, how many photons of this microwave radiation were required? Assume that all the energy from the radiation was used to raise the temperature of the water. The value of Planck's constant is $6.63 \times 10^{-34}$ J·s **(10%)**

5. Ethylene oxide, $C_2H_4O$, is made by the oxidation of ethylene, $C_2H_4$.

    $C_2H_4(g) + O_2(g) \rightarrow C_2H_4O\ (g)$ (unbalanced)

    If 10.6 $g$ of ethylene gave 9.91 $g$ of ethylene oxide, what is the percentage yield of ethylene oxide? **(10%)**

6. **(10%)** A study of the gas-phase oxidation of nitrogen monoxide at 25 $^\circ C$ and 1.0 $atm$ gave the following results:

    $2NO(g) + O_2(g) \rightarrow NO_2(g)$
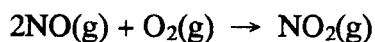
    |  | Conc. NO, $Mol/L$ | Conc. $O_2$, $Mol/L$ | Initial Rate $mol/(L\ s)$ |
    |---|---|---|---|
    | Exp. 1 | $2.2 \times 10^{-2}$ | $1.1 \times 10^{-2}$ | $0.4 \times 10^{-2}$ |
    | Exp. 2 | $2.2 \times 10^{-2}$ | $2.2 \times 10^{-2}$ | $0.8 \times 10^{-2}$ |
    | Exp. 3 | $4.5 \times 10^{-2}$ | $4.5 \times 10^{-2}$ | $6.4 \times 10^{-2}$ |
    | Exp. 4 | $1.9 \times 10^{-1}$ | $2.3 \times 10^{-3}$ | ? |

    (a) What is the experimental rate law for the reaction above?

    (b) What is the initial rate of the reaction in Experiment 4?

本試題是否可以使用計算機： ☑可使用 ， □不可使用 （請命題老師勾選）

7. Calculate the molar solubility of $Ni(OH)_2$ (a) in pure water and (b) in a solution of pH=13? (The $K_{sp}$ of $Ni(OH)_2$ is $2 \times 10^{-15}$)　　　　　　　　　　**(10%)**

8. (a) Give the electron configuration of the ground state of chlorine, using the building-up principles, (b) Write the electron-dot formula of $NO_2^+$, (c) Write Lewis formula of $IF_5$, (d) Give resonance description of $N_2O_4$.　　**(10%)**

9. A sample of natural gas is 80% methane, $CH_4$, and 20% ethane, $C_2H_6$, by mass. What is the density of this mixture at $20^oC$ and 775 *mmHg*?　　**(10%)**