

國立高雄應用科技大學  
九十七學年度碩士班招生考試  
化學工程與材料工程系

准考證號碼  (考生必須填寫)

化工熱力學和動力學

試題 共 4 頁，第 1 頁

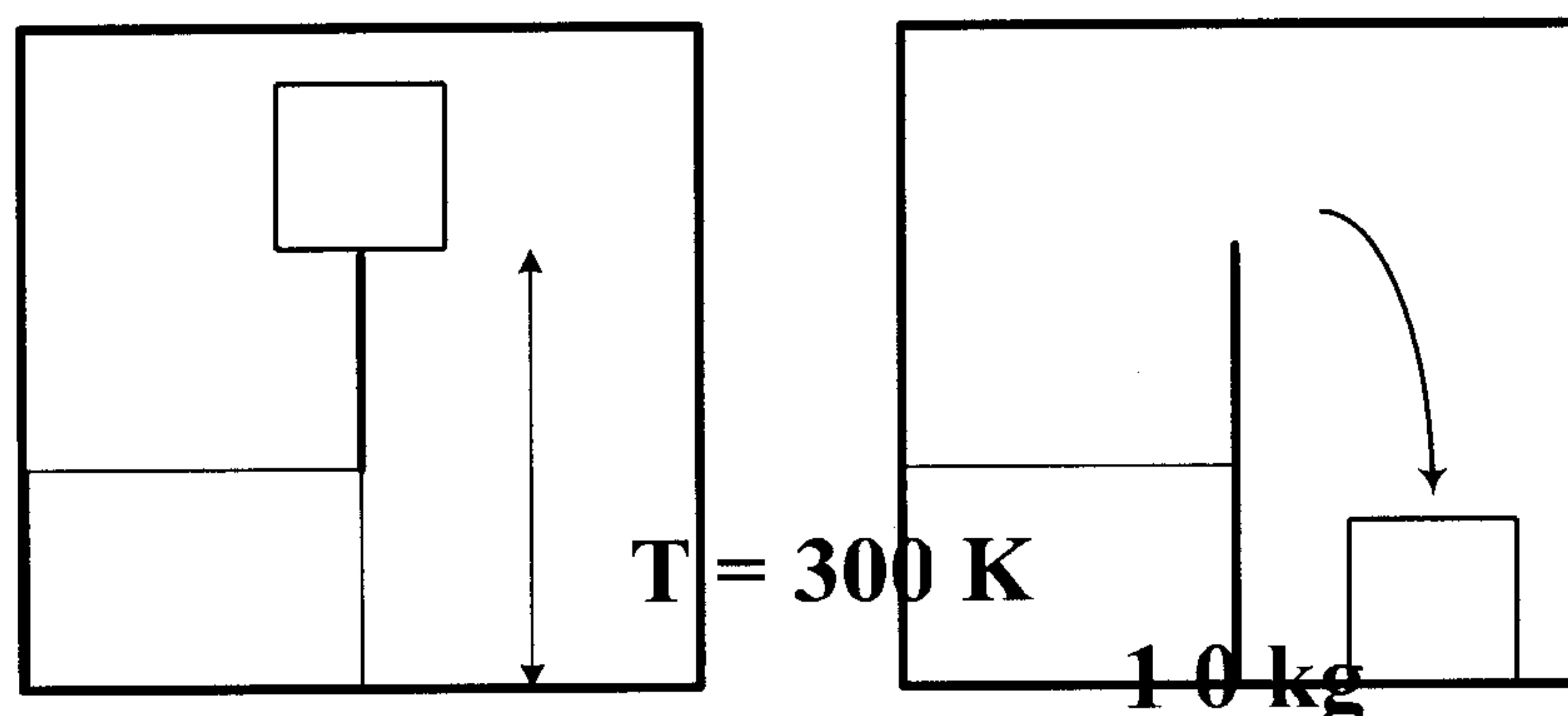
注意：a.本試題共 6 題 共 100 分。

b.作答時不必抄題。

c.考生作答前請詳閱答案卷之考生注意事項。

化工熱力學

1. A gas is confined in a 0.47 m-diameter cylinder by a piston, on which rests a weight. The mass of the piston and weight together is 150 kg. The local acceleration of gravity is  $9.8 \text{ ms}^{-2}$  and atmospheric pressure is 101.57 kPa. (20%)
- (a) What is the force in newtons exerted on the gas by the atmosphere, the piston, and the weight, assuming no friction between the piston and cylinder? (5%)
- (b) What is the pressure of the gas in kPa? (5%)
- (c) If the gas in the cylinder is heated, it expands, pushing the piston and weight upward. If the piston and weight are raised 0.83 m, what is the work done by the gas in kJ? What is the change in potential energy of the piston and weight in kJ? (10%)
2. Consider an isolated system consisting a 10 kilogram of metal block ( density =  $10 \text{ g/cm}^3$  ) in 10 m height and one kilogram of water placed in a box with basal area of 10cm x 10cm illustrated below. The temperature of the system was kept at 300 K. The local acceleration of gravity is  $9.8 \text{ ms}^{-2}$



The heat capacity of the metal block is given as  $420 \text{ J/kg/K}$  ; the heat capacity of the water is given as  $4200 \text{ J/kg/K}$  ; all other heat capacity in the isolated system can be neglected. (30%)

- (a) What will be the final temperature of the process if the metal block falls into right hand side on the ground (10%) (10%)
- (b) What will be the final temperature of the process if the metal block falls to the left hand side into the water (15%)? The temperature will be higher or lower than that of (a)? Why? (5%)
- Water liquid  
(1 kg)

## 化工動力學

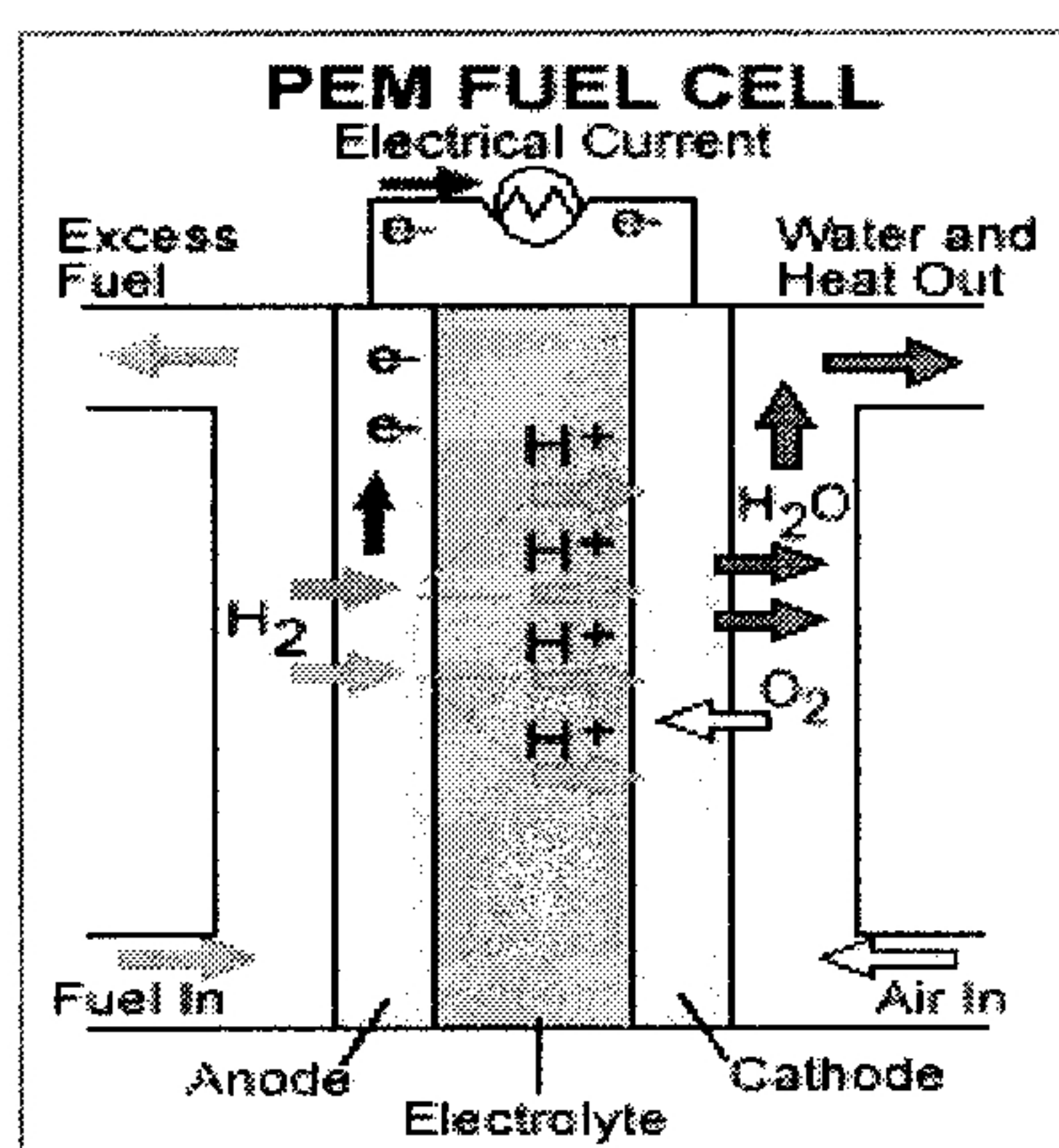
注意：a.本試題共四題、第3題 14 分，第4題 12 分，第5題 12 分，第6題 12 分,其中第3, 5 題為多選題, 選錯一則倒扣二分,扣至本題 0 分為止), 共 50 分。b.作答時不必抄題。c.各試題答案必須依題號順序寫在試卷指定的答案欄；寫錯位置不予計分。

3. A proton exchange membrane fuel cell transforms the chemical energy liberated during the electrochemical reaction of hydrogen and oxygen to electrical energy. A stream of hydrogen is delivered to the anode side of the membrane electrode assembly (MEA). The  $\text{H}_2$  is split into protons and electrons with the aid of Pt catalysts at the anode side. The protons permeate through the polymer electrolyte membrane to the cathode side; and the electrons travel along an external load circuit to the cathode side of the MEA. Meanwhile, a stream of oxygen is delivered to the cathode side of the MEA.  $\text{O}_2$  react with the protons permeating through the polymer electrolyte membrane and the electrons arriving through the external circuit to form water at the cathode side, thus creating the



current output of the fuel cell. Which of the following alternations can be useful for increasing the operating current, as well as the output power, of the cell?

- (1) Increasing the pressure of inlet hydrogen from 770 to 1000 mmHg.
- (2) Replacing the air stream feeding into cathode chamber by pure oxygen stream at the same pressure.
- (3) Manufacturing a new MEA with a proton exchange membrane having twice film thickness for the cell.
- (4) Increasing the loading amount of Pt catalyst at the anode and cathode of the MEA.
- (5) Increasing the operating temperature of the cell from 70 to 80°C.
- (6) Increasing particle size of the Pt catalysts loaded at the anode and cathode of the MEA.
- (7) Removing all the H<sub>2</sub>O gas in the hydrogen stream before feeding into the anode chamber.



A diagram of proton exchange membrane fuel cell.

4. An aqueous reaction,  $A \rightarrow S$ , was carried out in a stirred batch reactor at 25 °C with an initial concentration of 1.20 M. The conversion of A obtained at reaction time 30, 60, 90 and 120 minutes was 23.1, 37.5, 47.4 and 54.5 %, respectively.

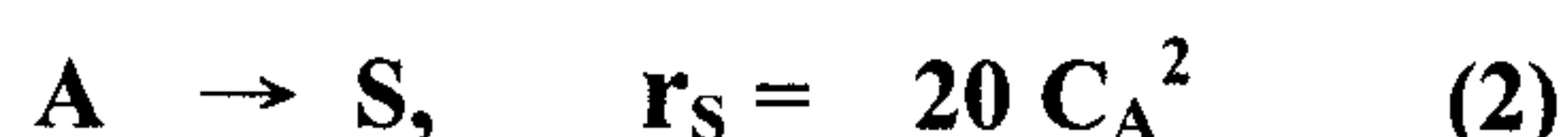
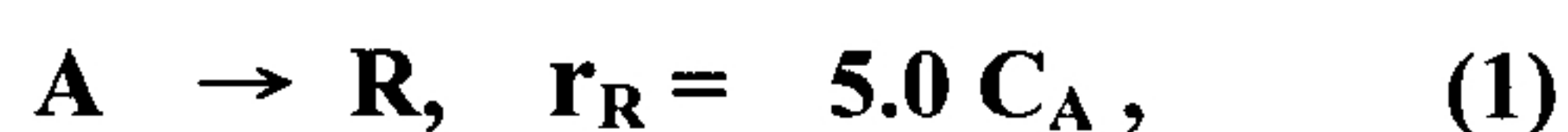
- (1) Please find out the rate equation of the reaction.
- (2) If the reaction is carried out in a stirred mixed flow reactor having a volume of 100 liter in a flow rate of 1.0 liter per minute, what is the concentration of A in the outlet stream of the reactor? The initial concentration of A is 1.20 M, and reaction temperature is 25 °C.

5. Please indicate the *incorrect* descriptions concerning chemical reactions

presented in the follows, and give a correction or explain the reasons for the items you chose in your answers.

- (1) Rate of a chemical reaction always increases with the increase in reaction temperature.
- (2) The activation energy of an irreversible chemical reaction ,  $A \rightarrow S$ , is dependent on the reaction temperature.
- (3) The reaction order of  $N_2 + 3 H_2 = 2 NH_3$  is 4.
- (4) For reaction  $A + 2B = C$ , the reaction rate  $-r_A$  and  $-r_B$  , based on reactant A and B, respectively, are equal.

6. Consider the aqueous reactions



If R is the desired product and S is undesired, the activation energy of reaction (1) and (2) is 40 and 200 K J./mole A, respectively.

The selectivity, (moles of desired product formed/moles of undesired product formed), of the reaction at 30°C performed in a mixed flow reactor with a conversion of 80% is 0.25. Please evaluate the selectivity of the reaction at 80 °C with the inlet concentration of A diluted to 50% of its initial value, while other operation conditions remained unchanged.

(gas law constant  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ )

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