

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

### Problem 1

What is the difference between steady state and equilibrium?

Please define steady state and equilibrium respectively and then discuss their difference. (20pt.)

### Problem 2

Acetic acid ( $\text{CH}_3\text{COOH}$ ) has one acid dissociation constant  $K_{a1}=10^{-4.74}$ . Phosphoric acid ( $\text{H}_3\text{PO}_4$ ) has three acid dissociation constants  $K_{a1}=10^{-4.12}$ ,  $K_{a2}=10^{-7.2}$  and  $K_{a3}=10^{-12.4}$  at 25 °C. If you want to conduct an experiment at neutral pH, which acid will you chose to prepare your buffer solution. If you want to conduct an experiment at pH = 5, which acid will you use to prepare your buffer solution? Please state your reason clearly. (20pt.)

### Problem 3

Ammonia-based fertilizers are very important for agriculture use. Ammonia is produced from the reaction of nitrogen gas and hydrogen gas. However, nitrogen is very unreactive because the molecules are held together by strong triple bonds. At room temperature, the equilibrium is strongly in favor of ammonia, but the reaction doesn't proceed at a detectable rate.

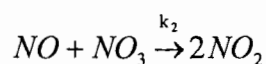
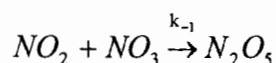
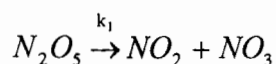
- Please provide three methods to increase the yield of ammonia. State your reason clearly. (10pt.)
- Please provide a method that can accelerate this process without changing the equilibrium of the reaction. State your reason clearly. (10pt.)

### Problem 4

Nitrogen pentoxide reacts with nitric oxide in the gas phase according to the stoichiometric equation



The following mechanism has been proposed.



Assume that the steady-state treatment can be applied to  $\text{NO}_3$ , and derive an equation for the rate of consumption of  $\text{N}_2\text{O}_5$ . (20pt.)

### Problem 5

What is fractional distillation? Please define it. (5pt.)

- Give an example of applying fractional distillation theory on industry. (7pt.)
- Give an example of applying fractional distillation theory on environmental engineering. (8pt.)