

系所組：化學系應用化學碩士班

日期節次：100 年 3 月 20 日第 2 節 11:00-12:30

科目：物理化學

1. A first order reaction is 20% complete in 50 min. What would be the concentration at the end of another 40 min if the initial concentration of the reactant is  $4.0 \times 10^3 \text{ mol dm}^{-3}$ ? What is the half-life of this reaction? (20%)
2. The wavefunction of hydrogen 3s orbital is  $\frac{1}{\sqrt{243}} \left(\frac{1}{a_0}\right)^{3/2} (6 - 6\rho + \rho^2)e^{-\rho/2}$  with  $\rho = \frac{2r}{3a_0}$ , where are the nodes? (10%)
3. Is  $\text{O}_2$  paramagnetic or diamagnetic? Give your explanation with molecular orbitals. (20%)
4. Derive the Clapeyron equation for liquid-solid phase equilibrium in terms of  $\Delta_{\text{fus}}H$  and  $\Delta_{\text{fus}}V$ , where  $V$  means volume. (20%)
5. Given the  $\Delta_f G^\circ$  at  $25^\circ\text{C}$  of  $\text{AgCl}_{(s)} = -109.8 \text{ kJ/mol}$ , of  $\text{Ag}^+_{(aq)} = 77.1 \text{ kJ/mol}$ , and of  $\text{Cl}^-_{(aq)} = -131.3 \text{ kJ/mol}$ , calculate the  $K_{\text{sp}}$  of  $\text{AgCl}_{(s)} \leftrightarrow \text{Ag}^+_{(aq)} + \text{Cl}^-_{(aq)}$  at the same temperature. (20%)
6. Assume  $\text{CO}$  is a quantum simple harmonic oscillator having a force constant of 1902 Newton/m, what is its zero point energy? (10%)