說明：　1. 依本校試場規則規定，考生可使用電子計算機但不可附有儲存程式功能。
　　　　2. 請依序作答並標明題號。
　　　　3. R=8.314 J K^{-1}mol^{-1}, h=6.626x10^{-34} J s, k=1.38x10^{-23} J K^{-1}, F=96485 C mol^{-1}
　　　　　atomic weight: H=1.008 g mol^{-1}, ^{35}Cl=34.97 g mol^{-1}

1. Oxygen is heated from 300 to 600 K at a constant pressure of 1 bar. What are the changes in molar enthalpy and entropy?
For oxygen, $\overline{C}_p$=25.50+13.61x10^{-3}T-42.55x10^{-7}T^2 J K^{-1} mol^{-1}.　(10%)

2. Given ΔG^o_f(N$_2$O$_4$, g)=98.286 kJ mol^{-1} and ΔG^o_f(NO$_2$, g)=51.84 kJ mol^{-1} for the equili reaction N$_2$O$_4$(g)=2NO$_2$(g) at 25°C. If initially 2 mol of N$_2$O$_4$ was present,
(a) calculate the equilibrium constant at 25°C.　(6%)
(b) calculate the partial pressure of NO$_2$(g) at 1 bar total pressure and 25°C.　(8%)

3. Calculate the ratio of the fraction of the gas molecules that have the average speed <v$_{100}$> at 100°C to the fraction that have the average speed <v$_{25}$> at 25°C.　(6%)

4. At 298°C, azomethane (CH$_3$NNCH$_3$) decomposes mainly by the first-order reaction with k=2.50x10^{-4} s^{-1}. What will be the partial pressure of azomethane when it initially at 200 torr decomposes for 30 min?　(8%)

5. The gas-phase reaction 2NO$_2$ + F$_2$ $\rightarrow$ 2NO$_2$F has a rate law
$$-d[F_2]/dt=k[NO_2][F_2].$$
Propose a mechanism which is consistent with this rate law.　(6%)

6. If the mechanism of an enzyme catalyzed reaction is E + S $\underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}}$ ES $\underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}}$ E + P with [E]$_o$<<[S]$_o$ derive the rate equation for d[P]/dt.　(10%)

7. Explain the following terms:　(8%)
(a) Bohr radius　(b) photoelectric effect

8. Calculate (a) the reduced mass and (b) the moment of inertia of H^{35}Cl and also calculate the values of (c) L(angular momentum) and (d) E(energy) for the state with J=1? The equilibrium internuclear distance R$_e$ is 127.5 pm.　(8%)

9. (a) What is a standard Daniell cell?　(3%)
(b) Calculate the equilibrium constant at 25°C for the reaction occurring in the standard Daniell cell if the standard emf is 1.100 V.　(3%)

10. Illustrate the relation between the Heisenberg uncertainty principle and the natural linewidth in detail.　(6%)

11. Give an energy expression for a diatomic molecule with vibrational and rotational energies.　(6%)

12. (a) Derive the atomic term symbols for atoms of helium and sodium in their ground states.　(6%)
(b) What are the sodium D lines and also write down the selection rules for them.　(6%)