招生學年度	100	招生類別	碩士班
系所班別	材料科學與工程學系碩士班		
科目	冶金熱力學		
注意事項	本考科可使用掌上型計算機		

1. (20 %) A four-step reversible cycle heat engine use one molecule of an ideal monoatomic gas (C_p=2.5R) as working medium and compressed two constant pressure steps at 1 atm and 12 atm, respectively.
(a) Find ΔS for each of the four steps.
(b) How much heat is converted into work in complete cycle?

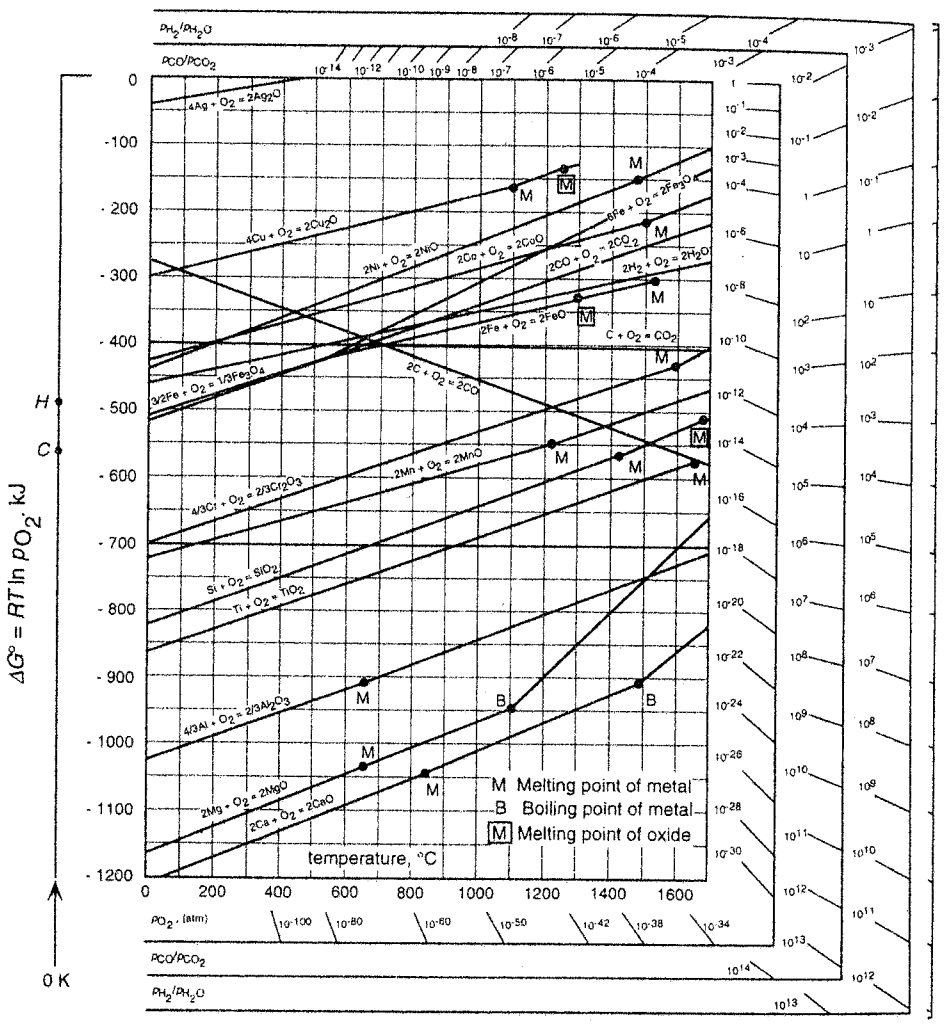
(Answer in Joule, R=8.314 J/mole · degree)

2. (15 %) Show that for ideal gas and $C_p=C_v+R$

(a) The reversible adiabatic process obeys PV^{γ} = constant

(b) The reversible isothermal process obeys PV= constant
(c) Show that the work done in the isothermal process is greater than that in the adiabatic process

3. (15 %) From the Ellingham diagram, estimate the molecular values based on $MgO_{(s)}$ for the following reactions
(a) $Al_2O_{3(s)} + 3Mg_{(s)} = 2Al_{(s)} + 3MgO_{(s)}$ ΔG^0 (500°C) =?
(b) $Al_2O_{3(s)} + 3Mg_{(l)} = 2Al_{(l)} + 3MgO_{(s)}$ ΔH^0 (500°C) =?
(c) $Al_2O_{3(s)} + 3Mg_{(g)} = 2Al_{(l)} + 3MgO_{(s)}$ ΔS^0 (500°C) =?



The Ellingham diagram for selected oxides

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4. (20 %)The EMF of the reversible cell

$Pb_{(s)} \mid PbCl_{2(s)} \mid KCl_{(aqueous)} \mid AgCl_{(s)} \mid Ag_{(s)}$ and

$Pb_{(s)} \mid PbI_{2(s)} \mid KI_{(aqueous)} \mid AgI_{(s)} \mid Ag_{(s)}$

at 25°C (298K) are 0.4902 and 0.2111 V, respectively. The temperature coefficients of the EMF of the above cells are -1.86×10^{-4} and -1.27×10^{-4} volt/degree, respectively.
(a) Calculate the value of ΔG^0 and ΔH^0 for the reaction :
$PbI_{2(s)} + 2AgCl_{(s)} = PbCl_{2(s)} + 2AgI_{(s)}$ at 25°C.
(b) If the standard enthalpies of $PbI_{2(s)}$, $AgCl_{(s)}$, and $PbCl_{2(s)}$ at 25°C are -41.9, -30.3, and -85.8 Kcal/mole, respectively. Calculate the standard enthalpy of $AgI_{(s)}$ at 25°C.

5. (15 %) Assuming that nitrogen behaves as a van der Waals gas with a = 1.39 $l^2 \cdot atm/mole^2$ and b = 39.1 cm^3/mole, calculate the change in the Gibbs free energy and the change in entropy when the volume of 1 mole of nitrogen is increased from 1 to 2 liters at 400 K.

(van der Waals gas $P=\frac{RT}{V-b}-\frac{a}{V^2}$)

6. (15 %) (a) Explain the first, second and third law of thermodynamics, (b) Using the second law, construct a thermodynamic quantity that can be used to determine whether a reaction is spontaneous thermodynamically.