5% 1. Sugest a practicable method for determining the heat of formation $\Delta_f H°$ of gaseous carbon monoxide at 25°C. (Note: Burning graphite in a limited supply of oxygen is not satisfactory, since the product will be a mixture of unburned graphite, CO and CO_2.)

5% 2. A phase transition, such as the melting of a solid, can occur reversibly and therefore $\Delta S = 0$. But it is often stated that melting involves an entropy increase. Reconcile these two statements.

5% 3. The difference between C_P and c_v is given as
$$C_P - C_v = P\left(\frac{\partial V}{\partial T}\right)_P + \left(\frac{\partial V}{\partial T}\right)_P\left(\frac{\partial U}{\partial V}\right)_T$$
Interprete meanings of the two terms on the right side.

20% 4. A mole of perfect gas is expanded isothermally and reversibly from 30 to 100 L at 300K. (a) What are the values of w, q, ΔU, ΔH, ΔG and ΔS? (b) If the expansion is carried out irreversibly by allowing the gas to expand into an evacuated container, what are the values of w, q, ΔU, ΔG, and ΔS? (c) If the gas initially at 300K and 30L is expanded adiabatically and reversibly to a volume of 100L what is the final temperataure? (C_v =3/2 R)

10% 5. The reaction of heated coal (approximated here by graphite) with superheated steam absorbs heat. This heat is usually provided by burning some of the coal. Calculate $\Delta H°$(500K) for both reactions.

(a) C (graphite) + $H_2O_{(g)}$ = $CO_{(g)}$ + $H_{2(g)}$
(b) C (graphite) + $O_{2(g)}$ = $CO_{2(g)}$

How many moles of carbon are required to produce 1 mole of hydrogen?

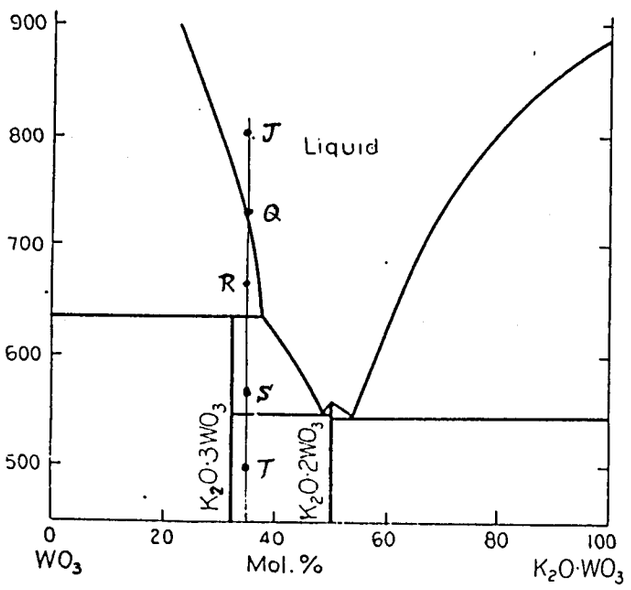
	$\Delta_f H°$ (500K), kJmol^{-1}
H_2O	-243.831
CO	-110.022
CO_2	-393.677

15% 6. Two of the oxides of iron are FeO and Fe_3O_4. Solid Fe exisits in equilibrium with one of these oxides at lower temperatures and exists in equilibrium with the other at higher temperatures. The molar free energies of formation of these oxides are, or Fe + 1/2 O_2= FeO, $\Delta G°$ = -259,600 + 62.55T J and, for 3Fe + $2O_2$= Fe_3O_4, $\Delta G°$ =-1,091,000 + 312.8T J. Determine which of the two oxides is in equilibrium with iron at room temperature and the maximum temperature at which this oxide is in equilibrium with iron.

10% 7. State the phenomena that the additions of cations in water lowers the freezing point and also raises the boiling point of water using thermodynamic terms.

10% 8. What is freezing point constant? Calculate the freezing point constant k_f for water. (The enthalpy of fusion is 79.9 cal g^{-1} at 273.1K)

20% 9. State the facts via phase diagram of WO_3 -$K_2O \cdot WO_3$ for a melt with composition J when it cools from the temperataure of 800 to 500°C. (a) Its crystallization path, (b) The phases appear, the ratioes of the different phases, and their microstructure at the points Q, R, S and T respectively.



System WO_3–$K_2O \cdot WO_3$.

M. Amadori, *Atti reale ist. Veneto sci.*, 72 [II] 893 (1913).

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