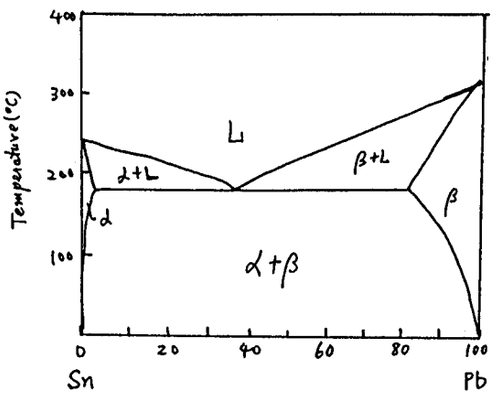
1. An engineer claims to have observed five separate phases in a ternary (three-component) alloy at the same time. Is the observation accurate? Explain. (14%)

2. Draw the free energy curves for each of the phases in the Pb-Sn alloy system at 250°C, 200°C, and 150°C. (14%)



3. Suppose a piece of iron are held at a temperature of 700°C in an annealing furnace. Composition of the furnace atmosphere is CO: 32%, CO_2: 20% and N_2: 48% by volume. The reaction to be considered is

$$CO_2 + Fe = FeO + CO$$

Equilibrium Constants of this equation at various temperature are as following

Temperature	500°C	700°C	1000°C
K	0.83	1.43	2.50

How would the surface be oxidized or be reduced, Explain (14%)

4. The equation, $dU = TdS - pdV$, is
   (1) applicable for closed systems only;
   (2) applicable for both open and closed systems;
   (3) a combination of the first and second law of Thermodynamics;
   (4) not applicable for isolated systems;
   (5) applicable for any closed system disregard to the form of work performed;
   (6) not applicable for an irreversible process; (14%)

5. Calculate the entropy change when 100 grams of Al at 100°C is placed in 100 grams of adiabatically contained water, which is initially at 25°C, for long while. H_2O: 18 g/mole, Al: 27 g/mole, $C_{p,Al(s)} = 20.7 + 12.4 \times 10^{-3} T$ J/deg-mole, $C_{p,H_2O(l)} = 75.44$ J/deg-mole. (15%)

6. The vapor pressure of solid and liquid Cu are, respectively,
   $\ln P(atm) = -\frac{40930}{T} - 0.86 \ln T + 21.67$, 298K - T_m (1356K), for Cu(s)
   $\ln P(atm) = -\frac{40350}{T} - 1.21 \ln T + 23.79$, $T_m - T_b$ (2868K), for Cu(l)
   please estimate the difference between the heat capacities of solid and liquid copper. (14%)

7. Please pick up the correct statement(s),
   (1) the entropy variation of the melting of most metals are of similar values;
   (2) the melting point of ice (i.e., $H_2O(s)$) is greater at sea level than at the top of Ah-Li-Shan (阿里山);
   (3) the Third Law of Thirmodynamics allows one to predict the spontaneity of reactions;
   (4) the excitation of nitrogen from $1s^2 2s^2 2p^3$ to $1s^2 2s^2 2p^2 3s^1$ involves only configurational entropy variation, no thermal entropy is involved;
   (5) state 1, (P_1, T_1) ⟶ state 2, (P_2, T_2) variation;
   for the above variation we would estimate $\Delta H = H_2 - H_1$, $\Delta S = S_2 - S_1$ and $\Delta W = W_2 - W_1$. (15%)