國立清華大學命題紙

99學年度 核子工程與科學研究所甲組(工程組) 碩士班入學考試

科目 材料熱力學 科目代碼 2805 共 1 頁，第 1 頁 *請在【答案卷卡】作答

1. A nuclear power plant generates 5×10^5 kW, the reactor temperature is 600 K, and a local river with water temperature about 300 K acts as sink. (1) Find the maximum possible thermal efficiency of the plant and the minimum quantity of heat which is discharged into the river. (10%)(2) If the actual thermal efficiency of the plant is 70% of the maximum value how much heat is discarded into the river?(10%)

2. In a liquid Pb-Bi alloy, the activity coefficient of Pb depends on its molar fraction in the following way:

$$\log_{10}(\gamma_{Pb}) = -0.32(1 - X_{Pb})^2 .$$

What is the activity coefficient of Bi at $X_{Bi} = 0.4$. (20%)

3. The equilibrium constant $K_P = 1.78$ at $T = 525$ K for the reaction

$$PCl_5 \rightarrow PCl_3 + Cl_2$$

The reaction proceeds at constant volume. Find the total pressure p_o of an initial equi-molar mixture PCl_5 and Cl_2 (a mixture where the numbers of molecules of PCl_5 and Cl_2 are the same), if the partial pressure of PCl_5 in equilibrium is $p_{PCl_5} = 0.89$ atm. (20%)

4. Two identical bodies of constant heat capacity C_p have the same initial temperature T_i. If a refrigerator working between the two bodies cools down one of them to temperature T_2, show that the minimum work required to do this is

$$W_{min} = C_P\left(\frac{T_i^2}{T_2} + T_2 - 2T_i\right). \quad (20\%)$$

5. For a first-order phase transition, $\Delta G = 0$, $\Delta T = 0$, show that during a first-order phase transition

$\Delta U = \Delta H\left(1 - \frac{d\ln T}{d\ln P}\right)$. (20%)