

97 學年度 核子工程與科學研究所 甲(工程) 組碩士班入學考試

科目 材料熱力學 科目代碼 3105 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. (a)(10%) Show that $c_p - c_v = \frac{TV\alpha^2}{\beta}$,

where c_p is constant pressure molar heat capacity

c_v is constant volume molar heat capacity

V is molar volume

T is absolute temperature

α is thermal expansion coefficient

β is isothermal compressibility coefficient

(b)(5%) From the physical meaning of c_p and c_v , explain that c_p is always larger than c_v .

2. (15%) Pressure cooker is a time-saving tool for cooking beans and meat. The principle of the pressure cooker is to increase the pressure in the cooker and thereby increasing the boiling point of water. However, the cooker may explode if it is over-pressurized. Therefore, a steam exhaust opening should be designed in the pressure cooker. If the weight on the steam exhaust opening of a pressure cooker prevents the pressure rising above 220 kPa inside it, find the temperature at which water boils in the cooker. Given the latent heat of vaporization of water is 2257 kJ/kg at 100°C, and 1 atm = 101.325 kPa. No other information is available.

3. (20%) The molar excess Gibbs free energy of formation of solid solution in the system Au-Ni can be represented by

$$G^{XS} = X_{Ni}X_{Au}(24,140X_{Au} + 38,280X_{Ni} - 14,230X_{Au}X_{Ni})(1 - \frac{T}{2660})J$$

Calculate the activities of Au and Ni in the alloy of $X_{Au} = 0.5$ at 1100 K.

4. A Van der Waal's gas has the equation of state

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

(a) (10%) Discuss the physical origin of the parameters a and b . Why is the correction to P inversely proportional to V^2 ?

(b) (10%) The gas undergoes an isothermal expansion from volume V_1 to volume V_2 . Calculate the change in the Helmholtz free energy.

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5. Let $f(T, l)$ be the tension in a rubber band of length l and temperature T . Let $S(T, l)$ be its entropy.

(a) (10%) Show that $\left(\frac{\partial f}{\partial T}\right)_l = -\left(\frac{\partial S}{\partial l}\right)_T$ (Hint: $dw = fdl$)

(b) (10%) It is known that if a rubber band is stretched at constant temperature, its molecules assume a more regular arrangement. With the help of the relation in (a) explain why the tension in a rubber band increases when the band is heated at constant length.

6. (a) (5%) State the First Law and Second Law of Thermodynamics.

(b) (5%) Try to explain entropy from both classical thermodynamics and statistical mechanics.