

科目	材料熱力學	適用 系別	材料系三年級	時間	80分鐘
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※ 請務必在答案卷作答區內作答 ※

共 1 頁第 1 頁

1. 選擇題：一題 3 分；答錯一題倒扣 1 分；未答者不得分，亦不倒扣。 (24%)

Two mole of a monatomic ideal gas is subjected to the following sequence of steps:

Step 1: Starting at 500 K and 20 atm, the gas expands freely into a vacuum to double its volume.

(1) () which answer is *incorrect*: (a) $q = 20786$ J, (b) $q = \Delta H$, (c) $\Delta U = 0$, (d) $q = w$.

(2) () $\Delta S =$ (a) 0, (b) 28.82, (c) 11.53, (d) 0.284 J/K.

Step 2: The gas is next heated reversibly to 600 K at constant volume.

(3) () which answer is *incorrect*: (a) $w = 0$, (b) $q = \Delta H$, (c) $q = \Delta U$, (d) $\Delta U = 2494$ J.

(4) () $\Delta H =$ (a) 12471, (b) 42.14, (c) 2494, (d) 4157.2 J.

(5) () $\Delta S =$ (a) 4.58, (b) 25.28, (c) 7.58, (d) 8.43 J/K.

Step 3: The gas is reversibly expanded at constant temperature until its volume is again doubled.

(6) () which answer is *incorrect*: (a) $\Delta U = 0$, (b) $q = w$, (c) $\Delta U = \Delta H$, (d) $w = 0$.

(7) () $q =$ (a) 0, (b) 11526, (c) 6915.7, (d) 17289 J.

(8) () $\Delta S =$ (a) 0, (b) 11.53, (c) 28.82, (d) 19.21 J.

2. The virial equation of state for *n*-butane at 460 K is $Z = 1 + A/V + B/V^2$ in which $A = -265$ cm³/g-mole and $B = 30,250$ cm⁶/g-mole². Calculate the change in the Helmholtz free energy when the volume of one mole of *n*-butane is decreased from 400 to 300 cm³ at 460 K. (16%)

3. Show that $\left(\frac{\partial T}{\partial P}\right)_H = \frac{TV\alpha - V}{C_p}$ (10%)

where $\alpha = \frac{1}{V} \left(\frac{\partial V}{\partial T}\right)_P$ the isobaric thermal expansivity.

4. Given $\text{Ca}_{(\alpha)} + 1/2 \text{O}_{2(g)} = \text{CaO}_{(s)}$ $\Delta H_{298} = -634,900$ J, and
 $\Delta C_p = 9.42 + 9.68 \times 10^{-3} T - 6.115 \times 10^5 T^{-2}$ in the range 298 – 716 K
 At 716 K, $\text{Ca}_{(\alpha)} \rightarrow \text{Ca}_{(\beta)}$ $\Delta H_{\text{trans}} = 900$ J
 $\text{Ca}_{(\beta)} + 1/2 \text{O}_{2(g)} = \text{CaO}_{(s)}$ $\Delta C_p = 35.15 - 38.83 \times 10^{-3} T - 6.115 \times 10^5 T^{-2}$ (716 – 1000 K)
 Calculate ΔH for the formation of $\text{CaO}_{(s)}$ from Ca and 1/2 O_2 at 1000 K. (20%)

5. For reaction $\text{C}_{(gr)} + \text{CO}_{2(g)} = 2 \text{CO}_{(g)}$, $\Delta G^0 = 170,000 - 174.5 T$ (J). Calculate the ratio $P_{\text{CO}_2}/P_{\text{CO}}$ for carbon starts to precipitate at 1000 K and a total pressure of 1 atm. (20%)

6. What kind of slope, positive or negative, will you expect for the Ellingham diagram of $4\text{Ag}_{(s)} + \text{O}_{2(g)} = 2\text{Ag}_2\text{O}_{(s)}$? (10%)