

國立臺北科技大學

九十三年學年度有機高分子研究所入學考試

物理化學試題

填准考證號碼

第一頁 共一頁

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注意事項：

1. 本試題共 8 題，配分共 100 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. (a) Calculate the heat absorbed, ΔH , at constant pressure when one mole of $N_{2(g)}$ is heated from 25 °C to 150 °C. The heat capacity at constant pressure is: $C_p = 6.76 + 0.606 \times 10^{-3} T + 1.3 \times 10^{-7} T^2$ (cal $K^{-1} mol^{-1}$)
 (b) One mole of an ideal diatomic gas is heated from 25 °C to 150 °C. Calculate ΔH , excluding vibrational contributions. (15%)
2. Two moles of an ideal monoatomic gas initially at 1 atm and 300 K are put through the following cycle, all stages of which are reversible:
 - (1) isothermal compression to 2 atm,
 - (2) isobaric temperature increase to 400 K
 - (3) return to the initial state by the path $P = a + bT$, where a and b are constants.
 Please sketch the cycle on a P-T plot and evaluate numerically ΔU (U: internal energy) and ΔS (S: entropy) for the working substance for each stage of the cycle. (20%)
3. Consider the formation of ethylcyclohexane (C_8H_{16}):

$$C_8H_{10(l)} + 3 H_{2(g)} = C_8H_{16} \quad \Delta H_{298 K} = -48.3 \text{ kcal}$$
 and

$$C_8H_8(l) + 4 H_{2(g)} = C_8H_{16} \quad \Delta H_{298 K} = -74.65 \text{ kcal}$$
 Given that at 298 K, the heat of combustion of C_8H_{16} to water vapor and CO_2

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- is -1238.23 kcal/mole, and the heats of formation of water vapor and CO_2 are, -58.32 and -94.05 kcal/mol respectively, calculate (a) heat of hydrogenation of styrene to ethylbenzene. (b) the heat of formation of ethylbenzene. (10%)
4. Use kinetic model to link the root mean square molecular speed (c) with temperature (T). (10%)
 5. A reaction: $2A \rightarrow P$ has a third-order rate law with $k = 3.50 \times 10^{-4} \text{ L}^2\text{mol}^{-2}\text{s}^{-1}$. Please calculate the time required for the concentration of A to change from 0.077 mol L^{-1} to 0.021 mol L^{-1} . (10%)
 6. A beam of 30 KeV electrons impinges on a metal surface. What is the shortest wavelength of X-ray emitted. ($1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$) (5%)
 7. Calculate the probability that a particle in a one dimension box (length=a) is found to be between 0 and $a/2$. (10%)
 8. Explain the following terms: (20%)
 - (1) Born-Oppenheimer approximation
 - (2) Zeeman effect
 - (3) point group
 - (4) zero-point energy

Physical Constants:

Gas constant (R) $8.314 \text{ JK}^{-1}\text{mol}^{-1} = 1.987 \text{ cal K}^{-1}\text{mol}^{-1} = 0.08206 \text{ dm}^3\text{atm K}^{-1}\text{mol}^{-1}$

Planck constant (h) $6.626 \times 10^{-34} \text{ J s}$

Speed of light in vacuum (C) $2.998 \times 10^8 \text{ m s}^{-1}$