

國立彰化師範大學 100 學年度碩士班招生考試試題

系所： 化學系

科目： 物理化學

☆☆請在答案紙上作答☆☆

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1. (10 %) For a second-order reaction, starting from the rate law, obtain the relation between the concentration of the reactant and time.
2. (15 %) Obtain the standard enthalpy of formation for $\text{CH}_4(\text{g})$, given that the standard enthalpies of combustions are: $\text{C}(\text{s})$: -394 kJ/mol ; $\text{H}_2(\text{g})$: -286 kJ/mol ; and $\text{CH}_4(\text{g})$: -890 kJ/mol .
3. (15 %) For H_2 and D_2 , (a) what is the ratio of their vibrational frequencies ? (b) which has the larger portion of molecules on the first vibrational excited state and why? (c) Are these vibrations IR active and why ?
4. (20 %) A balloonist is preparing to make a trip in a He-filled balloon. The trip begins in early morning at 10 degrees C, but by afternoon it increases to 30 degrees C. Assuming the pressure remains constant at 1.0 atm, for each mole of He, calculate the following:
 - (a) The initial and final volumes (in liter) of He.
 - (b) The change in internal energy, ΔE (in J) (assuming ideal-gas behavior of the He gas).
 - (c) The work done by He (in J).
 - (d) The heat transferred (in J).
 - (e) ΔH for the process (in J).
5. (40 %) Explain the following terms of quantum chemistry as clearly as possible: (a) wave function; (b) zero-point vibrational energy, (c) correspondence principle, (d) eigenvalue, (e) uncertainty principle, (f) equipartition theorem, (g) probability density, (h) expectation value, (i) uncertainty principle, (j) tunneling effect.

Constants:

$$h = 6.62608 \times 10^{-34} \text{ Js}$$

$$c = 2.998 \times 10^8 \text{ ms}^{-1}$$

$$k = 1.3807 \times 10^{-23} \text{ JK}^{-1}$$

$$R = 8.3145 \text{ JK}^{-1} \text{ mol}^{-1}$$