國立彰化師範大學 99 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☆☆　　共 1 頁，第 1 頁

1. (12 %) A ping-pong of 0.01 kg is moving at the speed of 10 m s^{-1} in a 1-D box, the length of the box is 1 m. Calculate (a) the quantum number (n) corresponding to this system, (b) the energy needed to promote the system from *n* to *n*+1. (c) Is this energy meaningful ?

2. (12 %) Two 1.0 g masses are attached to each other by a spring with a force constant of 420 kg s^{-2}, (a) what is the vibrational frequency ? (b) How does the zero-point energy compare with kT at room temperature? (c) What does the result in (b) tell us concerning the magnitude of energy quantization in macroscopic systems?

3. (28 %) Explain the following: (a) correspondence principle, (b) zero-point energy, (c) Dalton's law of partial pressures, (d) Avogadro's principle, (e) Law of multiple proportions, (f) second law of thermodynamics, (g) colligative properties.

4. (10 %) Express the energy of a photon with wavelength 450 nm (in J, and in kcal/mol).

5. (10 %) Within the Hückel approximation, obtain the energy of the π-system of butadiene and cyclobutadiene, which is more stable?

6. (12 %) For a first-order reaction, (a) write down the rate law which relates the concentration of reactant and time, (b) obtain by integration, the relation between the concentration of reactant and time, (c) obtain the expression of half-life.

7. (6 %) For a second-order reaction, obtain the relation between the concentration of reactant and time.

8. (10 %) Obtain the standard enthalpy of formation for $CH_4(g)$, given that the standard enthalpies of combustions are: C(s): −94.1 kcal/mol; $H_2(g)$: −68.3 kcal/mol; and CH_4 (g): −212.8 kcal/mol.

Constants:
$h = 6.62608\times10^{-34}$ Js
$c = 2.998\times10^{8}$ ms^{-1}
$k = 1.3807\times10^{-23}$ JK^{-1}
$m_e = 9.1\times10^{-31}$ kg
u (amu) = 1.6605×10^{-27} kg; H atom: 1.0079 amu