ln2=0.693, R= 8.314 J/K mol = 1.98 cal /K mol (不得使用計算機)

1. (15%)

Calculate ΔH, q and w for the change of state of 1.00 mol of helium from a volume of 4.00 L and a temperature of 298°K to a volume of 10.00 L and a temperature 373°K. Assume the $Cp=5R/2$ and that the gas is ideal. (Calculate ΔH, q and w for step 1, step 2 and the overall process)

2. (15%)

Glucose-6-phosphate $\rightleftharpoons$ Fructose-6-phosphate

(a) The equilibrium constant for this reaction is 0.5, at 25 C, 1 atm and pH 7.0. Please calculate the standard free energy change from Keq. (b) The actual concentration of theses substances in human red blood cell are [Glucose-6-phosphate]= 8μM and [Fructose-6-phosphate]= 1μM. Please calculated the actual $\Delta G'$ for the interconversion of these sugars in the red blood cells (c) Is this conversion of Glucose-6-phosphate into Fructose-6-phosphatethe thermodynamically possible under these concentrations?

3. (20%)

Select the one choice that best completes the statement or answer that question

(1). A negative free energy change indicates that
A) The reaction is not possible
B) Energy must be added to the reaction before it can proceed.
C) The reaction is endothermic
D) The reaction is exothermic
E) The reaction is at equilibrium

(2). Which of the following is defined as the "heat content"?
A) Energy
B) Heat
C) Electrical work
D) Solar radiation
E) Enthalpy

(3). The statement "The energy is the universe is constant" is a tenet of
A) The first law of thermodynamics
B) The second law of thermodynamics
C) Thermodynamics spontaneity
D) Entropy
E) Enthalpy

(4). Fireflies have the ability to convert the energy in ATP to light. Which of the following types of work is used by the firefly?
A) Bioluminescence
B) Heat
C) Concentration
D) Electrical
E) Mechanical and synthetic

(5). In biochemical reaction, reactants may be converted into products. The extent to which this occurs spontaneously is expressed as which of the following?
A) ΔG
B) Keq
C) ΔS
D) Temperature
E) None of the above

(6). The statement "Energy is neither created or destroyed" describes
A) The first law of thermodynamics
B) The second law of thermodynamics
C) Thermodynamics spontaneity
D) Enthalpy
E) Both A and C

(7) Which of the following is NOT true of the ΔH?
A) ΔH is change in heat content
B) ΔH is change in enthalpy
C) In biology, is basically the same as ΔE
D) A reaction with a positive value is exothermic
E) $\Delta H = \Delta E + \Delta(PV)$

(8). In a chemical reaction, the standard free energy change (ΔG^o) is calculated to be 5. What can be said of the chemical reaction?
A) The reaction is at equilibrium under standard conditions
B) The reaction goes spontaneously to the right under standard conditions
C) The reaction goes spontaneously to the left under standard conditions.
D) Products predominate over reactants at equilibrium under standard conditions
E) Both C and D

(9) An ideal gas expands adiabatically against external pressure of 1 atm. What kinds of the following thermodynamic quantities q, w, ΔE or ΔH is equal to zero?
A) q
B) ΔE
C) ΔH
D) Both w & ΔE
E) Both q & ΔH

(10). An ideal gas expands isothermally against external pressure of 1 atm. What kinds of the following thermodynamic quantities q, w, ΔE or ΔH is equal to zero?
A) ΔH
B) ΔE
C) w
D) Both ΔH & ΔE
E) Both q & w

4. (32%) Answer the following questions. 8 points each

(1). (A) How many electrons can enter the following sets of atomic orbitals : (a) 3p, (b) 3d, and (c) 4s?

   (B) What are the degeneracies of the following orbitals for hydrogenlike atoms: (a) n = 1 and (b) n = 3 ?

(2). (A) Calculate the energy in joules per quantum, and joules per mole of photons of wavelength 600 nm.

   $H = 6 \times 10^{-34}$ Js $C = 3 \times 10^{10}$ cm/s

   (B) Most chemical reactions require activation energies ranging between 40 and 400kJ mol^{-1}. What are the equivalents of 40 and 400 kJ mol^{-1} in terms of (a) nm and (b) wavenumbers?

(3). (A) What is the "ideal" gas?

   (B) In which condition real gases behave ideally?

(4). For an enzyme-substrate system, addition of 0.1 mmol/L competitive inhibitor increase K_m by a factor of 3 (meaning $K'_m = 3 K_m$). What is the dissociation constant K_I of the inhibitor?

5. (18%) Multiple choice: Choose the best answer. 3 points each, no penalty for incorrect answer.

   (A) Consider a 2-phase system with a μ(liquid) > μ(vapor). The substance will (1) move from liquid to vapor (2) move from vapor to liquid (3) not change (4) cannot calculate

   (B) If ΔG for the reaction in a galvanic cell is positive, the cell voltage will be (1) > 0 (2) < 0 (3) 0 (4) the same as a size AA battery

   (C) The correct units for a first-order rate constant are (1) no units (2) 1/sec (3) L/(mol sec) (4) L/(mol sec)^2

   (D) In the steady state approximation, we approximate a value of zero for the time derivative of the concentration of (1) reactant concentration (2) intermediate concentration (3) reaction rate (4) rate constant

   (E) Rate constants are always (1) > 0 (2) < 0 (3) = 0 at equilibrium (d) dependent on reaction

   (F) For a class I second order reaction, which of the following is linear in time (1) concentration (2) ln(concentration) (3) 1/concentration (4) (concentration)^2