

九十一學年度 生命科學院四所 碩士班研究生招生考試

科目 物理化學 科號 0903 1003 共 2 頁第 1 頁\*請在試卷【答案卷】內作答

1. (10%)

Find the entropy change of the system ( $\Delta S_{\text{sys}}$ ), of the surrounding ( $\Delta S_{\text{sur}}$ ) and of the universe ( $\Delta S_{\text{univ}}$ ) if 3.00 mol of water freezes reversible at 1.00 atm. The freezing temperature is 0.00 °C at this pressure, and the specific enthalpy change of fusion is equal to 79.7 cal g<sup>-1</sup> at this temperature. (The specific heat capacity of liquid water = 4.184 J cal<sup>-1</sup>)

2. (25%)

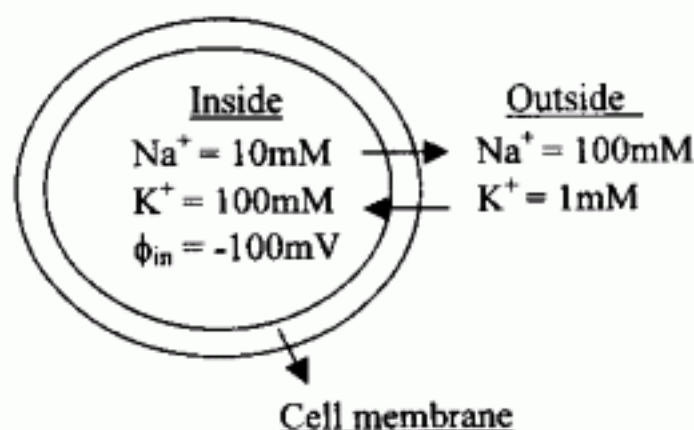
Please state the thermodynamic quantities  $q$ ,  $w$ ,  $\Delta E$  and  $\Delta H$  is greater than, equal to, or less than zero for the following process. Explain your answers briefly.

- Two copper bars, one initially at 80°C and the other initially at 20°C, are brought into contact with each other in a thermally insulated compartment and then allowed to come a equilibrium
- A sample of liquid in a thermally insulated container (a calorimeter) is stirred for 1 hr by a mechanical linkage to a motor in the surroundings.
- A sample of H<sub>2</sub> gas is mixed with an equimolar amount of O<sub>2</sub> gas at the same temperature and pressure under conditions where no chemical reaction occurs between them.

3. (15%)

The Na<sup>+</sup>-K<sup>+</sup> pump uses the free energy of hydrolysis of ATP to pump Na<sup>+</sup> ions out of the cell and K<sup>+</sup> ions into the cell at 300°K. The chemical potential  $\Delta\mu^\circ$  is -40 KJ for ATP hydrolyses at 300°K; the ratio of ATP to ADP in cells is 100. There is also a voltage difference of -100mV across the membrane. The inside membrane is negative relative to the outside membrane. The [Na<sup>+</sup>]<sub>in</sub> = 10mM, [Na<sup>+</sup>]<sub>out</sub> = 100mM, [K<sup>+</sup>]<sub>in</sub> = 100mM, [K<sup>+</sup>]<sub>out</sub> = 1mM. (ln10 = 2.3, R = 8.314 J/K mol, Faraday constant = 96.485 KJ/mol)

- What is the free energy to transport 3 mol Na<sup>+</sup> out the membrane?
- What is the free energy to transport 2 mol K<sup>+</sup> into the membrane?
- What is the total free energy cost of transporting 3 mol Na<sup>+</sup> ions out the membrane and 2 mol of K<sup>+</sup> ions into the membrane in Na<sup>+</sup>-K<sup>+</sup> pump?
- What is the free energy for the hydrolysis of ATP (ATP → ADP + P)?
- Weather this active transport reaction Na<sup>+</sup>-K<sup>+</sup> pump can occur using the free energy of hydrolysis of ATP?



4. (15%)

Natural chlorine ( $Z=17$ ) is composed of two isotopes,  $^{35}\text{Cl}$  and  $^{37}\text{Cl}$ . The atomic mass for chlorine is 35.5 in the periodic table.

- (1) What is the composition of each nucleus?
- (2) What is the natural abundance of each isotope?
- (3) Can they be detected by nmr? Why?

5. (12%)

- (1) For a 400-nm light, calculate its frequency, energy and wavenumber.
- (2) Which region of the electromagnetic spectrum would you expect it to appear?  
(Plank's constant  $h = 6.63 \times 10^{-34} \text{ J}\cdot\text{sec}$ ;  $c = 3 \times 10^8 \text{ m/sec}$ )

6. (14%)



- (1) If the above reaction is zero order in substance A.
- (2) If the above reaction is first order in substance A.

Starting with the differential rate law derive an expression for  $t_{1/2}$  in terms of the starting concentration,  $[\text{A}]_0$ , and rate constant,  $k$ .

7. (9%)

For the reaction



The rate law is found to be

$$-d[\text{A}]/dt = k[\text{A}][\text{OH}^-]$$

- (1) Propose a mechanism for this reaction.
- (2) Deduce the rate law from the proposed mechanism.