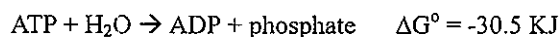
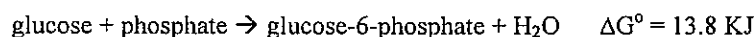


Please mark your answers clearly and provide derivation and calculations.

1. True or false? (5% each)
  - A. For a one phase fluid system with 3 components (substances), there are 4 independent variables.
  - B. The following are state variables: internal energy, pressure, and heat under constant pressure.
  - C. For a reversible adiabatic process in a simple system, the final temperature is a single-valued function of the final volume for a given initial state.
  - D. All spontaneous process must be exothermic.
  - E. The minimum of the Helmholtz energy of a system corresponds to the maximum of the entropy of the system plus surroundings if a system is at constant temperature and pressure.
  - F. The energy of an isolated system remains constant when a reversible process occurs in the system.
2. Calculate enthalpy, heat, work, and internal energy for the process in which 1.0 mol of an ideal gas is first heated at a constant volume from 298.15K to 373.15K and then expanded isothermally from a volume of 5 L to a volume of 10 L.  $C_v = 3R/2$ ,  $C_p = 5R/2$ ,  $R = 8.3145 \text{ J/K/mol}$  (hint: make your own process if necessary) (20%).
3. The van der Waals equation of state:  $(P + \frac{a}{V^2})(\bar{V} - b) = RT$ 
  - A. Find expressions for the temperature, molar volume ( $\bar{V}$ ), pressure, and compression factor for a van der Waals gas at the critical point (20%).
  - B. For reversible isothermal expansion, find expressions for work, heat, internal energy, and enthalpy (20%).
4. In cells, ATP (adenosine triphosphate) acts as the free-energy donor in most energy-requiring processes such as motion, active transport, or biosynthesis. A large amount of free energy is liberated when ATP is hydrolyzed to adenosine diphosphate (ADP) and phosphate:



In order to metabolize glucose, a phosphate group is added to the glucose molecule (a process known as phosphorylation) by hexokinase as a first step:



ATP hydrolysis is coupled with this reaction for it to be thermodynamically favorable. Calculate the phosphorylation equilibrium constants with and without the coupling of ATP hydrolysis (all reactions take place at the physiologic temperature 37°C) (10%).

試題隨卷繳回