20分　1. Calculate the quantities of heat required to carry out the isothermal expansion of one mole of an ideal gas, initially occupying 30 L at a pressure of 1 atm, to a volume of 50 L. (10分) (a) reversibly, and (10分) (b) irreversibly against a pressure equal to the final pressure of the gas.

You should use the SI units in the calculation.

20分　2. At 700 K, Kp is 0.022 for the gaseous reaction 2AB === AA + BB.

10分　(a) Calculate the standard free energy change of the reaction.

10分　(b) Interpret your result.

30分　3. The irreversible reaction, A → B + C + D, is second order. The following data were obtained for the reaction

Time (hour)	0	1	2
Concentration of A (M)	0.60	0.45	0.36

10分　(a) Calculate the rate constant.

10分　(b) Calculate the concentration of A after three hours.

10 分 (c) Calculate the half-life.

20 分 4. The average kinetic energy of a single hydrogen molecule is 1.5 kT,

where k is the Boltzmann constant. The molar mass of hydrogen is

2.016 g.

Use the SI units in all calculation stated below.

10 分 (a) Calculate the mean-square velocity of this molecule at 298 K.

10 分 (b) Calculate the wavelength of a hydrogen molecule at 298 K.

10 分 5. What does the Gibbs phase rule tell us for a two-component system?