

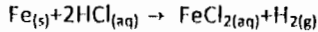
系別：化學工程與材料工程學系三年級 科目：物理化學

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| V | 計算機 |

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Problem One (25 points)

Calculate the expansion work done when 50 g of iron reacts with hydrochloric acid in (a) a closed vessel of fixed volume, and (b) an open beaker at 25 °C.



The molar mass of iron is 55.85 gmol⁻¹. Gas constant R = 8.314 JK⁻¹mol⁻¹.

Atkin Bed. P.36-37

Problem Two (25 points)

The Clapeyron equation is given in Eq.(1)

$$\frac{dP}{dT} = \frac{\Delta_{trs}S}{\Delta_{trs}V} \quad (1)$$

(a) Show that the Clapeyron equation for the liquid-vapor boundary is

$$\frac{dP}{dT} = \frac{\Delta_{vap}H}{T\Delta_{vap}V} \quad (2)$$

(b) If the gas behaves perfectly, show that Eq.(2) can be rearranged into the Clausius-Clapeyron equation:

$$\frac{d \ln P}{dT} = \frac{\Delta_{vap}H}{RT^2} \quad (3)$$

(c) Assuming that the enthalpy of vaporization is independent of temperature, show that Eq.(3) becomes:

$$P = P^* e^{-x} \quad x = \frac{\Delta_{vap}H}{R} \left(\frac{1}{T} - \frac{1}{T^*} \right) \quad (4)$$

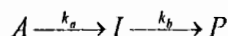
where P* is the vapor pressure when the temperature is T*.

(d) The normal boiling point of benzene is 80 °C and Δ_{vap}H = 30.8 kJmol⁻¹, calculate the vapor pressure at 20 °C. 1 atm = 101 kPa.

Atkin Bed. P.126-128

Problem Three (15 points)

Some reactions proceed through the formation of an intermediate, as in the consecutive uni-molecular reactions



Each step of the reaction is first order. It can be shown that the concentration of intermediate obeys:

$$[I] = \frac{k_a}{k_b - k_a} (e^{-k_a t} - e^{-k_b t}) [A]_0$$

At what time will [I] be at maximum?

Atkin Bed. P.812

◀ 注意背面尚有試題 ▶

本試題雙面印製

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Problem Four (35 points)

The ground-state wavefunction of a hydrogen atom is

$$\psi = \left(\frac{1}{\pi a_0^3} \right)^{1/2} e^{-r/a_0}$$

where $a_0 = 53 \text{ pm}$. Evaluate the root mean square distance, $\langle r^2 \rangle^{1/2}$ of the electron from the nucleus in the hydrogen atom in its state of lowest energy.

Atkin, 8ed., Self-test 8.9, p.269

Hint: $\int_0^{\infty} x^n e^{-ax} dx = \frac{n!}{a^{n+1}}$