

1. Consider an equation of state in the form

$$P = \left(\frac{RT}{V-b} \right) e^{-A/RT^{3/2}V}$$

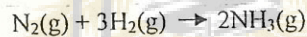
for an arbitrary gas. Show that the critical constants are given by

$$T_c = \left(\frac{A}{4bR} \right)^{2/3}, \quad V_c = 2b, \quad \text{and} \quad P_c = \frac{R}{b} \left(\frac{A}{4bR} \right)^{2/3} e^{-2} \quad (15\%)$$

2. A strip of rubber may be regarded as thermodynamically analogous to a confined gas. Stretching the rubber corresponds to compressing the gas. The work done on the rubber is $-dW = fdl$, where f is the contractile force exerted by the rubber and l its length. If there is no work other than fdl , please show that

$$\left(\frac{\partial U}{\partial l} \right)_T = -T \left(\frac{\partial f}{\partial T} \right)_l + f \quad (20\%)$$

3. In the ammonia synthesis reaction,



all the gases involved are ideal. Prove that the maximum concentration of ammonia at equilibrium is attained when the ratio of H_2 to N_2 is 3:1. (15%)

4. A certain liquid solution contains two components 1 and 2. Component 1 follows Henry's law for the mole fraction range $0 \leq x_1 \leq a$ at constant temperature (and low pressure). Show that component 2 must follow Raoult's law for the mole fraction range $(1-a) \leq x_2 \leq 1$. (20%)
5. Please define the electromotive force or emf for the electrochemical cells. (5%)
6. Please give a definition for "thermodynamics". (5%)
7. Please describe the van't Hoff's equation. (5%)
8. Please describe the second law of thermodynamics. (5%)
9. Please describe the Trouton's rule. (5%)
10. Please describe the Boltzmann distribution law. (5%)

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