

- 1) (a) Show that  $f = P \exp\left(\int_0^P \frac{Z-1}{P} dP\right)$   
 (b) For a van der Waals gas show that to a first approximation  
 $f = P \exp\left(b - \frac{a}{RT}\right) \frac{P}{RT}$  (18%)
- 2) Find the compressibility factor at the critical point for a real gas which follows van der Waals equation. (16%)

- 3) Experimental data show that the vapor-liquid equilibrium for acetone (1)-acetonitrile (2) is well represented by Raoult's law. Vapor pressures are represented by

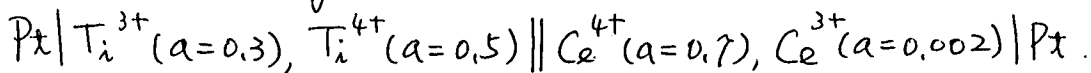
$$\ln P_1^{\text{sat}} = 14.37 - \frac{2787}{t + 229.6}$$

$$\ln P_2^{\text{sat}} = 14.88 - \frac{3413}{t + 250.5}$$

for  $P_i^{\text{sat}}$  in kPa and  $t$  in  $^{\circ}\text{C}$ . Find the equilibrium temperature and total pressure if  $x_1 = 0.40$  and  $y_1 = 0.62$ . (16%)

- 4) The standard electrode potentials of  $\text{Ti}^{4+}, \text{Ti}^{3+} | \text{Pt}$  and  $\text{Ce}^{4+}, \text{Ce}^{3+} | \text{Pt}$  at  $25^{\circ}\text{C}$  are 0.04 V and 1.61 V, respectively.

(a) Calculate the voltage of the cell at  $25^{\circ}\text{C}$



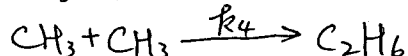
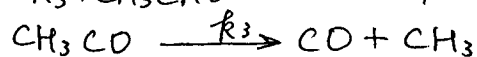
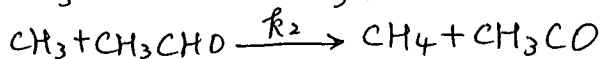
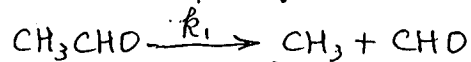
(b) Write the cell reaction.

(c) Calculate  $\Delta G$  for the cell reaction as written

(d) Calculate  $K$

- 5) A 5-ml container with a hole 10  $\mu\text{m}$  in diameter is filled with hydrogen. This container is placed in an evacuated chamber at  $0^{\circ}\text{C}$ . How long will it take for 90% of the hydrogen to effuse out? (16%)

- 6) The mechanism of the pyrolysis of the acetaldehyde at  $520^{\circ}\text{C}$  and 0.2 bar is (17%)



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What is the rate law for the reaction of acetaldehyde, using the usual assumptions. (17%)