1) Find the compressibility factor at the critical point for a real gas which follows van der Waals equation. (16%)

2) A 5-ml container with a hole 10 μm in diameter is filled with hydrogen. This container is placed in an evacuated chamber at 0°C. How long will it take for 90% of the hydrogen to effuse out? (17%)

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

(a) Calculate the voltage of the cell at 25°C.

$$Pt|Ti^{3+}(a=0.3), Ti^{4+}(a=0.5) \| Ce^{4+}(a=0.7), Ce^{3+}(a=0.002)|Pt$$

(b) Write the cell reaction

(c) Calculate ΔG for the cell reaction as written

(d) Calculate K. (16%)

4) The mechanism of the pyrolysis of the acetaldehyde at 520°C and 0.2 bar is

$$CH_3CHO \xrightarrow{k_1} CH_3 + CHO$$
$$CH_3 + CH_3CHO \xrightarrow{k_2} CH_4 + CH_3CO$$
$$CH_3CO \xrightarrow{k_3} CO + CH_3$$
$$CH_3 + CH_3 \xrightarrow{k_4} C_2H_6$$

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

5) What is the deBroglie wavelength λ of an electron that has been accelerated through a potential difference of 100 V? (17%)

6) In the photoelectric effect an electron is emitted from a metal as the result of the absorption of a photon of light. Part of the energy of the photon is required to release the electron from the metal; this energy is called the work function. For the 100 face of silver the work function is 4.64 eV. What is the velocity of the ejected electron if the wavelength of the light is 200 nm? (17%)

Note: mass of electron $m = 9.110 \times 10^{-31}$ kg

Planck constant $h = 6.626 \times 10^{-34}$ J·s

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