

KEY

Worksheet # 4 (Total number of points you can get is 3 pts)

1. At what temperature T and pressure P will H_2 be in a corresponding state with CH_4 at 600 K and 2.5 bar pressure? The critical temperatures are $T_c = 33.2$ K for H_2 and $T_c = 190.6$ K for CH_4 ; the critical pressures $P_c = 13.0$ bar for H_2 and $P_c = 46.0$ bar for CH_4 .

$$P_R = \frac{P}{P_c} = \frac{2.5}{46.0} = 0.054 \Rightarrow P_{H_2} = P_R \cdot P_c = 0.702 \text{ bar}$$

$$T_R = \frac{T}{T_c} = \frac{600}{190.6} = 3.149 \Rightarrow T_{H_2} = T_R \cdot T_c = 109.52 \text{ K}$$

1. In an open beaker at 400 K and 1 bar pressure, 1 mol of zinc are caused to react with dilute sulfuric acid: $Zn + H_2SO_4 \Rightarrow ZnSO_4 + H_2$. Calculate the work done by the produced hydrogen gas, assuming it behaves as an ideal gas and $T = \text{const}$, $P = \text{const}$.

$$\begin{aligned} W &= -P \Delta V = -\Delta n_{H_2} \cdot RT \quad (PV = nRT) \\ &= -1 \text{ mol} \cdot 8.3145 \frac{J}{K \cdot mol} \cdot 400 K \\ &= -3325.8 J \end{aligned}$$

2. n mole of gas N_2 occupy a volume of $V_1 = 1.00$ l at temperature $T_1 = 200$ K and pressure $P_1 = 1000$ KPa. Determine the volume V_2 of the same amount n of N_2 at $T_2 = 400$ K and $P_2 = 250$ KPa. The compressibility factor for N_2 is $z_1 = 2.0$ at $T_1 = 200$ K and $P_1 = 1000$ KPa; and $z_2 = 1.0$ at $T_2 = 400$ K and $P_2 = 250$ KPa

$$\left. \begin{aligned} z_1 &= \frac{P_1 V_1}{n R T_1} \Rightarrow n = \frac{P_1 V_1}{z_1 R T_1} \\ z_2 &= \frac{P_2 V_2}{n R T_2} \Rightarrow V_2 = \frac{z_2 n R T_2}{P_2} \end{aligned} \right\} V_2 = \frac{z_2}{z_1} \frac{T_2}{T_1} \frac{P_1}{P_2} V_1$$

$$= \frac{1.0 \cdot 400 \cdot 1000 \cdot 10^{-3}}{2.0 \cdot 200 \cdot 250 \cdot 10^{-3}} \cdot 1.0 \text{ l}$$

$$= 4.0 \text{ l}$$