

## Quiz 1 Solution

1. One kilogram of air is heated reversible at constant pressure from an initial state of 298.15 K and 1.0 bar until its volume triples. Calculate  $W$ ,  $Q$ ,  $\Delta U$ , and  $\Delta H$  for the process. Assume for air,  $PV/T = 83.14 \text{ bar}\cdot\text{cm}^3\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$  and  $C_p = 29 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$ .

$$T_1 = 298.15 \text{ K} \quad P = 1 \text{ bar} \quad n = \frac{1 \text{ kg}}{28.9 \frac{\text{g}}{\text{mol}}} = 34.602 \text{ mol}$$

$$V_1 = 83.14 \frac{\text{bar}\cdot\text{cm}^3}{\text{mol}\cdot\text{K}} \frac{T_1}{P} = 24788.191 \frac{\text{cm}^3}{\text{mol}}$$

$$W = -n \int_{V_1}^{V_2} P dV = nP(V_1 - V_2) = nP(V_1 - 3V_1) = -nP2V_1 =$$

$$-(34.602 \text{ mol}) \times (10^5 \text{ Pa}) \times 2 \times (24788.191 \frac{10^{-6} \text{ m}^3}{\text{mol}}) = -171.544 \text{ kJ}$$

$$\text{Given } T_2 = T_1 \frac{V_2}{V_1} = 3T_1$$

$$C_p = 29 \frac{\text{J}}{\text{mol}\cdot\text{K}} \quad \Delta H = C_p(T_2 - T_1) = 29(2T_1) = 17.293 \text{ kJ/mol}$$

$$Q = n\Delta H \quad Q = 598.372 \text{ kJ}$$

$$\Delta U = \frac{Q+W}{n} \quad \Delta U = 12.335 \text{ kJ/mol}$$