Show your work on all numerical problems to receive full credit. Point totals are indicated in parentheses to the right of each problem number.

1. (6 points) 15.0-g of Ar and 25.0-g of Ne are confined to a 35.0-L container. The pressure in the container is 3.0-atm.

   a. What is the temperature of the container?

   \[ N_{\text{Ar}} = \frac{15.0 \text{g}}{40.0 \text{g/mol}} = 0.375 \text{ mol Ar} \]
   \[ N_{\text{Ne}} = \frac{25.0 \text{g}}{20.2 \text{g/mol}} = 1.25 \text{ mol Ne} \]

   \[ T = \frac{PV}{RT} = \frac{3.0 \text{ atm} \times \frac{101325 \text{ Pa}}{1 \text{ atm}} \times 0.036 \text{ m}^3}{1.625 \text{ mol} \times 8.314 \text{ J/mol K}} = 787 \text{ K} \]

   b. Find the partial pressure of each of the gases in the container.

   \[ X_{\text{Ar}} = \frac{0.375 \text{ mol Ar}}{0.375 \text{ mol Ar} + 1.25 \text{ mol Ne}} = 0.231 \]

   \[ X_{\text{Ne}} = \frac{1.25 \text{ mol Ne}}{0.375 \text{ mol Ar} + 1.25 \text{ mol Ne}} = 0.769 \]

   \[ P_{\text{Ar}} = 0.231 \times 3.0 \text{ atm} = 0.69 \text{ atm} \times \frac{101325 \text{ Pa}}{1 \text{ atm}} = 70100 \text{ Pa} \]

   \[ P_{\text{Ne}} = 0.769 \times 3.0 \text{ atm} = 2.31 \text{ atm} \times \frac{101325 \text{ Pa}}{1 \text{ atm}} = 234000 \text{ Pa} \]

\[ R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \]

\[ 1 \text{ atm} = 101325 \text{ Pa} \]
2. (5 points) The temperature dependence of heat capacity at constant pressure is sometimes given as:

\[ C_{p,m} (JK^{-1}mol^{-1}) = a + bT + cT^{-2} \]

For a particular substance the values of a, b, and c are 14.36, 3.77 \times 10^{-3}, and -10.54 \times 10^{5} with units appropriate for the \( C_{p,m} \) to come out in JK\(^{-1}\)mol\(^{-1}\) if the temperatures are in Kelvin units. Find the change in enthalpy, \( \Delta H \), when 1 mol of this substance is heated at constant pressure from 30 °C to 65 °C.

\[ C_p = \frac{\partial H}{\partial T} \]
\[ dH = C_p \, dt \]
\[ \int_{T_1}^{T_2} dH = \int_{T_1}^{T_2} C_p \, dt \]
\[ \Delta H = \int_{T_1}^{T_2} \left[ a + bT + cT^{-2} \right] \, dt = aT \bigg|_{T_1}^{T_2} + \frac{b}{2} T^2 \bigg|_{T_1}^{T_2} - cT^{-1} \bigg|_{T_1}^{T_2} \]
\[ = 14.36 \left( T_2 - T_1 \right) + \frac{3.77 \times 10^{-3}}{2} \left( T_2^2 - T_1^2 \right) - \frac{10.54 \times 10^5}{303} \left( \frac{1}{338} - \frac{1}{303} \right) = 184 \text{ J mol}^{-1} \]

\[ R = 8.314 \text{ J mol}^{-1} K^{-1} \]
\[ 1 \text{ atm} = 101325 \text{ Pa} \]
3. (12 points) A perfect gas is confined in a piston arrangement. For each of the following situations state whether the total \( \Delta U \), \( q \), and \( w \) would be positive, negative, or zero.

a. The gas is heated at constant volume to a new temperature.
   i. \( \Delta U: + \) (\( \Delta U = q + w \))
   ii. \( q: + \) (\( \Delta U = q + w \))
   iii. \( w: 0 \) (Constant Volume)

b. The gas is allowed to expand and then the temperature is brought back to its original temperature.
   i. \( \Delta U: 0 \) (Constant Temp)
   ii. \( q: + \) (\( \Delta U = q + w \))
   iii. \( w: - \) (Expansion - < 0)

c. The gas is compressed adiabatically.
   i. \( \Delta U: + \) (\( \Delta U = q + w \))
   ii. \( q: 0 \) (Adiabatic)
   iii. \( w: + \) (Compress)

d. The gas is allowed to expand, heated to return to its original temperature, compressed to its original volume, and then allowed to return to its original temperature.
   i. \( \Delta U: 0 \) (No Temp Change) Cyclic Process
   ii. \( q: \)
   iii. \( w: \)

\( R = 8.314 \, \text{Jmol}^{-1}\text{K}^{-1} \) \hspace{1cm} 1 atm = 101325 Pa