

Question 1. A vessel is filled completely with liquid water and sealed at 15.0°C and a pressure of 1.00 bar. What is the pressure if the temperature of the system is raised to 75.5°C ? Under these conditions, $\alpha_{\text{water}} = 2.04 \times 10^{-4} \text{ 1/K}$, $\alpha_{\text{vessel}} = 1.42 \times 10^{-4} \text{ 1/K}$, and $\kappa_T = 4.59 \times 10^{-5} \text{ 1/bar}$.

Question 2. Let $f(x, y) = xy \sin 5x + x^2 \sqrt{y} \ln y + 3e^{-2x^2} \cos y$. Determine

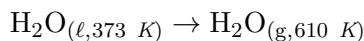
$$\begin{array}{lll} (a) \frac{\partial f}{\partial x} & (c) \frac{\partial^2 f}{\partial x^2} & (e) \frac{\partial^2 f}{\partial y \partial x} \\ (b) \frac{\partial f}{\partial y} & (d) \frac{\partial^2 f}{\partial y^2} & (f) \frac{\partial^2 f}{\partial x \partial y} \end{array}$$

Obtain an expression for the exact differential df .

Question 3. A mass of 25.0 g of $\text{H}_2\text{O}_{(s)}$ at 273 K is dropped into 130 g of $\text{H}_2\text{O}_{(\ell)}$ at 298 K in an insulated container at 1 bar of pressure. Calculate the temperature of the system once equilibrium has been reached. Assume that $C_{P,m}$ for H_2O is constant at its values for 298 K throughout the temperature range of interest.

Question 4. A 62.5-g piece of gold at 650 K is dropped into 165 g of $\text{H}_2\text{O}_{(\ell)}$ in an insulated container at 1 bar pressure. Calculate the temperature of the system once equilibrium has been reached. Assume that $C_{P,m}$ for Au and H_2O are constant at their values for 298 K throughout the temperature range of interest.

Question 5. Calculate W , q , ΔH and ΔU for the process in which 2.50 mol of water undergoes the transition



at 1 bar of pressure. The volume of the liquid water at 373 K is $1.89 \times 10^{-5} \text{ m}^3/\text{mol}$ and the volume of steam at 373 K and 610 K is 3.03 and $5.06 \times 10^{-2} \text{ m}^3/\text{mol}$, respectively. For steam, $C_{P,m}$ can be considered constant over temperature interval of interest at 33.58 J/mol K.

Question 6. The molar heat capacity $C_{P,m}$ of $\text{SO}_{2(g)}$ is described by the following equation over the range $300 \text{ K} < T < 1700 \text{ K}$:

$$\frac{C_{P,m}}{R} = 3.093 + 6.967 \times 10^{-3} \frac{T}{K} - 45.81 \times 10^{-7} \frac{T^2}{K^2} + 1.035 \times 10^{-9} \frac{T^3}{K^3}$$

In this equation, T is the absolute temperature in Kelvin. The ratios T^n/K^n ensure that $C_{P,m}$ has the correct dimension. Assuming ideal gas behavior, calculate q , W , ΔU and ΔH if 2.25 mol of $\text{SO}_{2(g)}$ are heated from 10.0°C to 1250°C at a constant pressure of 1 bar. Explain the sign of W .

Question 7. For a gas that obeys the equation of state

$$V_m = \frac{RT}{P} + B(T)$$

derive the result

$$\frac{\partial H}{\partial P} = B(T) - T \frac{dB}{dT}$$