

1. Two moles of gas at 1 bar and 298 K are compressed at constant temperature by use of a constant pressure of 5 bar. How much work is done on the gas? 10%

2. The molar heat capacity at constant volume of $O_2(g)$ is given by

$$\bar{C}_V = \alpha + \beta T + \gamma T^2$$

where $\alpha = 17.23 \text{ J K}^{-1} \text{ mol}^{-1}$, $\beta = 13.61 \times 10^{-3} \text{ J K}^{-2} \text{ mol}^{-1}$, $\gamma = 42.55 \times 10^{-7} \text{ J K}^{-3} \text{ mol}^{-1}$.

(a) What is the change in molar internal energy when oxygen is heated from 298 to 500 K?

(b) What is the increase in molar entropy when oxygen is heated from 300 to 500K at a constant pressure of 1 bar? (a)10% (b)20%

3. Given that the van der Waals constants of nitrogen are $a = 1.408 \text{ L}^2 \text{ bar mol}^{-2}$ and $b = 0.3913 \text{ L mol}^{-1}$, estimate the fugacity of nitrogen gas at 50 bar and 298 K. 20%

4. What is the change in the boiling point of water at 100°C per Pa change in atmospheric pressure? The molar enthalpy of vaporization is $40.69 \text{ kJ mol}^{-1}$, the molar volume of liquid water $0.019 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$, and the molar volume of steam is $30.199 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$, all at 100°C and 1.01325 bar. 20%

5. Derive the equation of the rate of enthalpy (H) change with pressure (P) at a constant temperature (T).

$$\left(\frac{\partial H}{\partial P}\right)_T = V(1 - \alpha T)$$

where V is the molar volume, α is the cubic expansion coefficient. 20%