

1. (a) Explain the phenomenon of osmotic pressure and deduce the mathematical relationship between π and the activity of solvent a_{solvent} in a certain solution. (b) How do you approximate the previous relation into $\pi = MRT$, where M is the molarity of solute in the solution. 20%

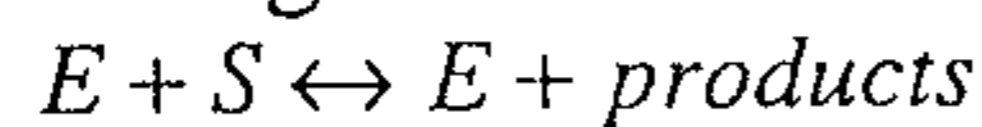
2. (a) Explain the two correction terms in van der Waals' equation with respect to the ideal gas equation. (b) Calculate, to a precision of 1 %, the molar volume of carbon dioxide CO_2 , given the constants of van der Waals' equation as $a = 3.66 \text{ bar liter}^2 \text{ mol}^{-2}$ and $b = 0.0428 \text{ liter mol}^{-1}$. 20%

3. Deduce the following relation

$$(a) \left(\frac{\partial U}{\partial V} \right)_T = T \left(\frac{\partial P}{\partial T} \right)_V - P,$$

$$(b) C_p - C_v = T \left(\frac{\partial P}{\partial T} \right)_V \left(\frac{\partial V}{\partial T} \right)_P. \quad 20\%$$

4. Suggest a mechanism and verify it for enzyme-catalyzed reactions as following



$$\text{with rate-equation as } R = \frac{k[E_{\text{total}}][S]}{K_M + [S]}$$

20%

5. Oxygen is expanded reversibly and adiabatically from a volume of 1 liter at 100 bar and 100°C , until the volume is 20 liter. The C_p of oxygen can be taken to be $29.38 \text{ J K}^{-1} \text{ mol}^{-1}$. (a) Calculate the final pressure and temperature assuming ideal gas behavior. (b) Calculate ΔU_{therm} , ΔU_{mech} for the thermal and mechanical surrounding, and ΔU , ΔH for the oxygen gas. 20%