CYL110 2009-10
Thermodynamics Review

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1. What is the molar volume of ethane at 350 K and 70 bar according to the ideal gas and the van der Waals equation of state? The van der Waals constants for ethane are 5.562 L^2 bar mol^{-2} and 0.064 L mol^{-1}.

2. The cubic expansion coefficient α is defined by $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ and the isothermal compressibility β is defined by $\beta_T = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$. Calculate these quantities for an ideal and van der Waals' gas.

3. For each of the following processes deduce whether each of the quantities q, w, ΔU, ΔH is positive, zero, or negative. (a) Reversible melting of solid benzene at 1 atm and the normal melting point. (b) Reversible melting of ice at 1 atm and 0 °C. (c) Reversible adiabatic expansion of a perfect gas. (d) Reversible isothermal expansion of a perfect gas. (e) Adiabatic expansion of a perfect gas into a vacuum. (f) Reversible heating of a perfect gas at constant P. (g) Reversible cooling of a perfect gas at constant V.

4. One mole of liquid water is vaporized at 100 °C and 1.013 bar. The heat of vaporization is 40.69 kJ mol^{-1}. What are the values of (a) w_{rev}, (b) q, (c) ΔU and (d) ΔH?

5. How much work is done when a mole of sodium metal is added to an open beaker containing water at 25 °C.

6. How high can a person climb on an ounce of chocolate if its combustion releases 628 kJ?

7. 100 g of ice at 0 °C is dropped into an insulated beaker containing 150 g of water at 100 °C. Calculate ΔS for this process.

8. A mixture of CO(g), H_2(g), and CH_3OH(g) at 500 K with $P_{CO} = 10$ bar, $P_{H_2} = 1$ bar, and $P_{CH_3OH} = 0.1$ bar is passed over a catalyst. Can more methanol be formed? Given: $\Delta G^\circ = 21.21$ kJ mol^{-1}.

9. For each of the following sets of quantities, all the quantities except one have something in common. State what they have in common and state which quantitiy does not belong with the others. (a) H, U, q, S, T; (b) $T, \Delta S, q, w, \Delta H$; (c) $q, w, U, \Delta U, V, H$; (d) ρ, S_m, M, V; (e) $\Delta H, \Delta S, dV, \Delta P$; (f) $U, V, \Delta H, S, T$.