CHEM1612 Worksheet 3 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Enthalpy ($\Delta_{rxn}H$) and Entropy ($\Delta_{rxn}S$) of Reaction

1. $\Delta_{rxn}H° = -57$ kJ mol^{-1}. $\Delta_{rxn}S° = -176$ J K^{-1} mol^{-1}
2. The reaction involves making a N-N bond, with no bonds being broken. It is exothermic.

   The reaction involves the conversion of 2 mol of gas → 1 mol of gas. The entropy decreases.
3. $\Delta_{rxn}H° = -28.5$ kJ mol^{-1}. $\Delta_{rxn}S° = -88$ J K^{-1} mol^{-1}. These values are exactly half those for reaction A.
4. $\Delta_{rxn}H° = +57$ kJ mol^{-1}. $\Delta_{rxn}S° = +176$ J K^{-1} mol^{-1}. These values are equal to -1 times the values for reaction A. Reaction C involves breaking a N-N bond, with no bonds being made. It is endothermic. The reaction involves the conversion of 1 mol of gas → 2 mol of gas. The entropy increases..
5. $\Delta_{rxn}H° = +28.5$ kJ mol^{-1}. $\Delta_{rxn}S° = +88$ J K^{-1} mol^{-1}.

Model 2: Free Energy of Reaction ($\Delta_{rxn}G$)

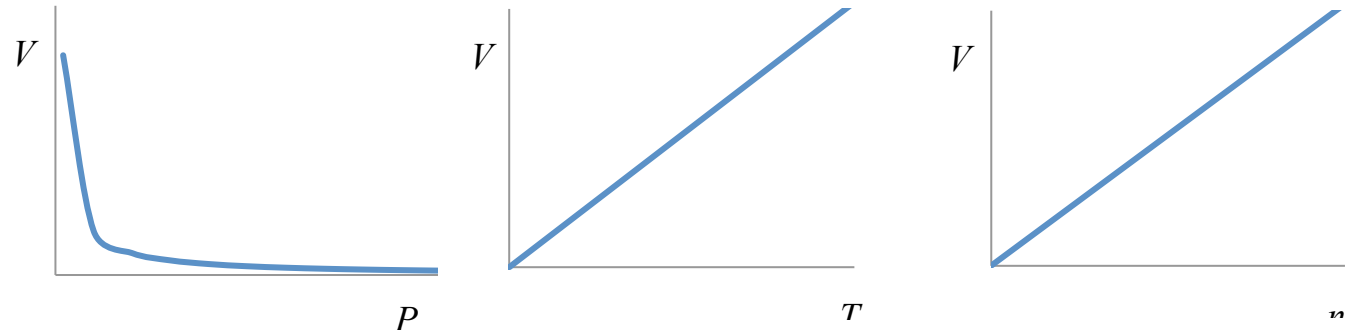
1. Favourable.
2. Unfavourable.
3. Unfavourable.
4. Favourable.
5. The temperature.
6. (a) $\Delta_{rxn}G° = -4550$ J mol^{-1} = -4.55 kJ mol^{-1} = -5 kJ mol^{-1} (1 sf). Reaction is favourable.

   (b) $\Delta_{rxn}G° = +13050$ J mol^{-1} = +13.05 kJ mol^{-1} = +13 kJ mol^{-1} (1 sf). Reaction is unfavourable.
7. (a) $\Delta_{rxn}G° = +4550$ J mol^{-1} = +4.55 kJ mol^{-1} = +5 kJ mol^{-1} (1 sf). Reaction is unfavourable.

   (b) $\Delta_{rxn}G° = -13050$ J mol^{-1} = -13.05 kJ mol^{-1} = -13 kJ mol^{-1} (1 sf). Reaction is favourable.
8. An exothermic reaction becomes less favourable as the temperature is increased.
9. An endothermic reaction becomes more favourable as the temperature is increased.
10. $\Delta_{rxn}H > 0$ and $\Delta_{rxn}S < 0$.

Model 3: The Gas Laws

1. (i) Boyle's Law: (ii) Charles' Law: (iii) Avogadro's Hypothesis:



2. As 1.000 atm = 1.01325×10^5 Pa and 22.414 L = 0.022414 m^3,

$$R = \frac{PV}{nT} = \frac{(1.01325 \times 10^5 \text{ Pa}) \times (0.022414 \text{ m}^3)}{(1.000 \text{ mol}) \times (273.15 \text{ K})} = 8.314 \text{ Pa m}^3 \text{ mol}^{-1} \text{ K}^{-1}$$

3 (a) 22.414 L corresponds to 0.022414 m^3.

(b) $R = \frac{PV}{nT} = \frac{(1.01325 \times 10^5\ \text{Pa}) \times (0.022414\ \text{m}^3)}{(1.000\ \text{mol}) \times (273.15\ \text{K})} = 8.314\ \text{Pa m}^3\ \text{mol}^{-1}\ \text{K}^{-1}$

The units arise directly from the equation: (Pa × m^3) / (mol × K).

Model 4: Partial Pressures

1. $P_{N_2} = 0.80 \times 1.0000\ \text{atm} = 0.80\ \text{atm}$

   $P_{O_2} = 0.20 \times 1.0000\ \text{atm} = 0.20\ \text{atm}$

   } $P_{\text{total}} = (0.20 + 0.80)\ \text{atm} = 1.00\ \text{atm}$

2. At 15.0 m, $P = 2.50$ atm. $V_{15.0\ \text{m}} = 2.40$ L.

3. At 30.0 m, $P = 4.00$ atm. $V_{\text{surface}} = 20.$ L. It will burst.

4. Air caught in a cavity will try to expand as the pressure is reduced during ascent. If trapped, it may cause severe pain or a perforated eardrum in the ear or very severe toothache in a tooth.

5. $P_{35\ ^\circ\text{C}} = 209$ atm.

6. The increasing pressure leads to an increase in the density, $\rho = \frac{MP}{RT}$. More air is held in the same volume so the density increases.

7. From Q1, $P_{O_2} = 0.20$ atm at the surface. At a depth of 10.0 m, $P_{\text{total}} = 2.0$ atm and so $P_{O_2} = 0.40$ atm. The increase in total pressure does not affect the percentage composition of the air.

8. If $P_{O_2} = 1.6$ atm then $P_{\text{total}} = 8.0$ atm. This corresponds to a depth of 70.0 m.

Key to success: practice further by completing this week's tutorial homework

Key to even greater success: practice even further by completing this week's suggested exam questions