

Chemistry 30

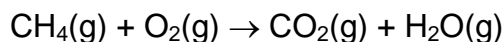
Unit 2: Chemical Kinetics

Assignment 1: 1-1 to 1-3

MAX: 10

Each question is worth 2 marks

1. During the combustion of methane, CH₄, shown by the reaction



the concentration of methane was measured at various time intervals and the following results were obtained:

Time (s)	[CH ₄] (mol · l ⁻¹)
10	2.40
20	1.20
30	0.80
40	0.60

Calculate the average rate of loss of methane during the 10 to 40 second time period.

$$\text{Rate} = \frac{\Delta[\text{CH}_4]}{\Delta \text{time}} = \frac{0.60 - 2.40}{40 - 10} = \frac{-1.8}{30} = -0.06 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1} \text{ or } \frac{0.06 \text{ M}}{\text{s}}$$

We are usually not concerned with the sign for rate (positive or negative)

2. Consider the following reaction: $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$

If the rate of decomposition of N₂(g) is 0.03 mol · L⁻¹ · s⁻¹, what is the rate of formation of NH₃(g)?

Because the ratio of moles of NH₃ to N₂ is 2:1 (from the balanced equation shown above), the rate of NH₃ production will be twice the rate of loss of N₂:

$$\text{Rate NH}_3 = 2 \times 0.03 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1} = \mathbf{0.06 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}}$$

3. Measurements taken during the reaction $\text{CO(g)} + \text{NO}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + \text{NO(g)}$

showed a concentration of carbon monoxide of 0.019 mol at 27 min and of 0.013 mol at 45 min. Calculate the average rate, in $\text{mol} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$, over this 18 min period, of each of the following:

- a) the loss of carbon monoxide, CO

$$\text{Rate} = \frac{\Delta[\text{CO}]}{\Delta \text{time}} = \frac{0.019 - 0.013}{27 - 45} = \frac{0.006}{18} = 3.3 \times 10^{-4} \text{ mol} \cdot \text{L}^{-1} \cdot \text{min}^{-1}$$

- b) the gain of carbon dioxide, CO₂

The balanced equation indicates a 1:1 ratio between CO and CO₂

Therefore the rate of gain of CO₂ will equal the rate of loss of CO

$$\text{Rate gain CO}_2 = 3.3 \times 10^{-4} \text{ mol} \cdot \text{L}^{-1} \cdot \text{min}^{-1} \text{ or } \frac{3.3 \times 10^{-4} \text{ mol}}{\text{L} \cdot \text{min}}$$

4. In the following reaction the average rate of loss of carbon monoxide, over a set period, is $0.15 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}$.



What is the average rate of production of carbon dioxide during the same period.

The ratio between CO₂ and CO is 1: 2 (1 CO₂ for 2 CO)

Thus the rate of CO₂ production is ½ the rate of loss of CO:

$$\text{Rate} = \frac{1}{2} (0.15 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}) = 7.5 \times 10^{-2} \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1}$$

$$(0.075 \text{ mol} \cdot \text{L}^{-1} \cdot \text{s}^{-1} \text{ or } \frac{0.075 \text{ M}}{\text{s}})$$