Solutions

Each answer shows the steps, then the **result**.

2.1

- the sum of the orders with respect to each reactant $(m+n)$

2.2

- it stays constant (independent of concentration)

2.3

- Rearranging, $k = \dfrac{\text{rate}}{[\text{A}]}$, so the units are $\dfrac{\text{mol dm}^{-3}\,\text{s}^{-1}}{\text{mol dm}^{-3}} = \text{s}^{-1}$

2.4

- Zero order; the rate is independent of concentration, so the concentration falls at a constant rate and the graph has a constant gradient

2.5

- The orders depend on the mechanism, specifically on the species in the rate-determining step; the stoichiometric equation only gives the overall ratio of reactants to products, and says nothing about the steps

3.1 C

- Overall order = 1 + 2 = 3

3.2 B

- $k = 0.693/50 = 0.0139\ \text{s}^{-1}$

3.3

(a)

- A: doubling [A] (rows 1
- 1. doubles the rate
- first order; B: doubling [B] (rows 2
- 1. makes the rate ×4
- second order

(b)

- $\text{rate} = k[\text{A}][\text{B}]^2$; $k = \dfrac{2.0 \times 10^{-3}}{(0.10)(0.10)^2} = 2.0\ \text{mol}^{-2}\text{dm}^6\text{s}^{-1}$

3.4

- the first step (or whichever contains only X) must be rate-determining; because only X appears in the rate equation, so the slow step involves X

3.5

(a)

- Experiments 1 and 2: [Q] is constant, [P] doubles and the rate doubles; so the reaction is first order in P

(b)

- Experiments 2 and 3: [P] is constant, [Q] trebles and the rate rises by a factor of 9; since $3^2 = 9$, the reaction is second order in Q

(c)

- rate $= k[\mathrm{P}][\mathrm{Q}]^2$; overall order 3

(d)

- Using experiment 1: $k = \dfrac{2.0 \times 10^{-4}}{(0.10)(0.10)^2} = 2.0$; units $\mathrm{mol^{-2}\,dm^{6}\,s^{-1}}$

(e)

- The rate equation is first order in P and second order in Q, and the orders give the number of each species in the rate-determining step, so one P and two Q is exactly what the equation predicts

(f)

- First order in S; the half-life is constant within experimental error, and a constant half-life is the characteristic of a first-order decay