InkChemistry

QUESTION WORKBOOK

Rate equations, orders of reaction and the rate constant

Rate equations · Unit C09

AQA 3.1.9.1 · OCR A 5.1.1

18 questions · 62 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks

A1 REO-Q4

Calculate the new rate of a reaction with rate = $k[X][Y]^2$, whose rate is 2.0×10^{-5} mol dm^{-3} s^{-1}, when [X] is doubled and [Y] is tripled at the same temperature. [2]

SECTION B · Standard, 3 to 5 marks

B1 REO-Q1

State what is meant by the order of reaction with respect to a reactant and by the overall order of a reaction, and give the units of the rate constant for reactions that are first order and second order overall. [4]

B2 REO-Q6

Calculate the rate constant, with its units, for a reaction with rate = $k[A][B]$, given a rate of 4.5×10^{-5} mol dm^{-3} s^{-1} when [A] = 0.040 mol dm^{-3} and [B] = 0.025 mol dm^{-3}. Then calculate the rate immediately after the mixture is diluted with an equal volume of water. [4]

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B3 REO-Q8

Explain why changing the concentration of a zero-order reactant has no effect on the rate, and why increasing the concentration of a first-order reactant increases the rate but does not change k. [4]

B4 REO-Q12

Describe how the rate constant is found from a graph for a reaction with rate = k[A], and for one with rate = k[A]², and explain why the second needs a different plot. [4]

B5 REO-Q15

Compare the graphs expected for a reactant that is first order with those for a reactant that is second order, for rate against concentration and for concentration against time. [4]

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B6 REO-Q16 Evaluate a student's claim that the reaction $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$, whose rate equation is rate = $k[NO]^2[O_2]$, shows that the orders in a rate equation can be taken from the coefficients. [4]

B7 REO-Q3 Calculate the value of the rate constant, with its units, for a reaction with rate = $k[A]^2[B]$, given that the rate is 3.6×10^{-4} mol dm^{-3} s^{-1} when [A] = 0.030 mol dm^{-3} and [B] = 0.020 mol dm^{-3}. [3]

B8 REO-Q5 Calculate the new rate when the volume of a mixture of nitrogen monoxide and oxygen is halved at constant temperature. The rate equation is rate = $k[NO]^2[O_2]$ and the rate before the change is 1.5×10^{-3} mol dm^{-3} s^{-1}. [3]

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B9 REO-Q7 Explain why the orders in a rate equation cannot be deduced from the balanced equation for the reaction. [3]

B10 REO-Q9 Explain how a concentration–time graph for a single reactant can show that the reaction is first order with respect to that reactant. [3]

B11 REO-Q10 Justify the factor by which the rate of $S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$, rate = $k[S_2O_8^{2-}][I^-]$, changes when $[I^-]$ is tripled, and identify the error in a student's answer of 9. [3]

B12 REO-Q11 Identify the order with respect to A in each case: (a) doubling [A] doubles the rate; (b) tripling [A] multiplies the rate by 9; (c) halving [A] leaves the rate unchanged. [3]

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B13 REO-Q13 Suggest why ammonia decomposing on a hot tungsten wire is zero order with respect to ammonia at high pressure, but first order at very low pressure. [3]

B14 REO-Q14 Suggest why H^+ appears in the rate equation for the reaction of propanone with iodine, rate = $k[CH_3COCH_3][H^+]$, although it does not appear in the overall equation, and why iodine does not appear in the rate equation although it is a reactant. [3]

B15 REO-Q17 Explain how raising the temperature and adding a catalyst each affect the value of the rate constant, given that neither changes any concentration. [3]

B16 REO-Q19 Calculate the rate of formation of NO_2 and the rate of formation of O_2 in the reaction $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$, at a moment when the concentration of N_2O_5 is falling at 4.0×10^{-6} mol dm^{-3} s^{-1}. [3]

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SECTION C · Long, 6 marks or more

C1 REO-Q18

Describe the rate–concentration graph and the concentration–time graph for a reactant that is zero order, first order and second order, and explain the shape of each concentration–time graph. [6]

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