16.1 Rate Expression & Reaction Mechanism

Mark Schemes

Course	DP IB Chemistry
Section	16. Chemical Kinetics (HL only)
Topic	16.1 Rate Expression & Reaction Mechanism
Difficulty	Medium

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

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The correct answer is **A** because:

- Statement I is correct
  - The size of *k* can indicate the speed of a reaction, e.g. high values of *k* are associated with fast reactions and low values of *k* are associated with slow reactions
- Statement II is correct
  - The rate constant is affected by temperature
- Statement III is incorrect
  - The units of *k* depend on the rate expression and therefore the orders / reactions of differing orders
  - The units of *k* are:
    mol dm^{-3} s^{-1} for a zero order reaction
    s^{-1} for a first order reaction
    mol^{-1} dm^3 s^{-1} for a second order reaction
    mol^{-2} dm^6 s^{-1} for a third order reaction

B, **C** & **D** are incorrect as	statement III is incorrect

2

The correct answer is **C** because:

- **Careful:** The graph is for the concentration of propanone only
  - You do not need to consider $[H^+]$
- As propanone features in the rate expression but is not raised to a power, we can deduce that the reaction with respect to propanone is first order
- In a first-order reaction, the rate is directly proportional to the concentration of a reactant
- On a rate-concentration graph, a first order reaction is a straight line starting at the origin

A is incorrect as	this is the shape of a first order concentration-time graph
B is incorrect as	this is the shape of a zero order concentration-time graph
D is incorrect as	this is the shape of a second order rate-concentration graph

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The correct answer is **A** because:

- When $[C_2H_5Br]$ doubles but $[OH^-]$ remains constant, then the rate doubles
  - Therefore, the reaction is first order with respect to $[C_2H_5Br]$
- When $[OH^-]$ doubles but $[C_2H_5Br]$ remains constant, then the rate doubles
  - Therefore, the reaction is first order with respect to $[OH^-]$

B, **C** & **D** are incorrect as	neither chemical is second order

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The correct answer is **C** because:

- From the overall equation
  - The only reactant listed in the table is CH_3COCH_3
  - None of the chemicals listed in the table are products
- Since CH_3COHCH_2 and H^+ are not reactants or products, they can only be intermediates or catalysts
  - Since CH_3COHCH_2 is not reformed at the end, it must be an intermediate
  - Since H^+ is reformed at the end, it must be a catalyst

A is incorrect as	none of the classifications are correct
B is incorrect as	the classifications for H^+ and CH_3COHCH_2 are incorrect
D is incorrect as	H^+ is not a product

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The correct answer is **A** because:

- The correct rate expression is rate = $\boldsymbol{k}[CH_3CHO][OH^-]$
- It is very easy to miss the rate constant, k, out of rate expressions and this can cost you a mark in exams

B is incorrect as	this is a correct statement Step 1 is identified as the slow step which means that it is the rate-determining step
C is incorrect as	this is a correct statement OH^- features in the rate expression but not in the overall reaction equation, therefore, it is a catalyst
D is incorrect as	this is a correct statement The slowest step in a reaction mechanism has the highest activation energy, therefore, steps 2 and 3 must be lower in activation energy than step 1