INKCHEMISTRY FLASHCARDS

Rate equations

Unit C09 · 30 cards · fronts and backs

Print double-sided, flipping on the long edge, and each answer lands behind its question. Cut along the card borders.

Definitions to learn and misconceptions to correct. These cards, and a check-yourself question for every lesson, run on the website with spaced-repetition scheduling, at inklearning.co.uk/chemistry/flashcards.

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DEFINITION

Define: Rate of reaction.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Rate equation.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Order with respect to a reactant.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Overall order.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Zero order.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Rate constant, k.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: First order.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Second order.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

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DEFINITION

An expression, found by experiment, of the form rate = $k[A]^m[B]^n$, showing how the rate depends on the concentration of each substance.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

The change in the concentration of a reactant or a product per unit time, measured in mol dm^{-3} s^{-1}.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

The sum of the powers of all the concentration terms in the rate equation.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

The power to which the concentration of that reactant is raised in the rate equation.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

The constant of proportionality in the rate equation; it is fixed at a given temperature and increases as the temperature rises.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

A reactant is zero order when changing its concentration has no effect on the rate; it does not appear in the rate equation.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

A reactant is second order when the rate is proportional to the square of its concentration: doubling the concentration multiplies the rate by four.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

A reactant is first order when the rate is directly proportional to its concentration: doubling the concentration doubles the rate.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

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DEFINITION

Define: Half-life, t½.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

SPOT THE ERROR

Say what is wrong with this claim:

The orders in the rate equation are the numbers in front of each substance in the balanced equation.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

Define: Initial rate.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Clock reaction.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Continuous monitoring.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Half-life, t½.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Absorbance.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Calibration graph.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

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SPOT THE ERROR

Orders are found by experiment and cannot be read from the equation. Hydrogen reacts 1 : 1 with iodine and with bromine, yet the first rate is first order in each and the second is half order in bromine. The orders describe the slow step of the mechanism, which the balanced equation does not show.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

The time taken for the concentration of a reactant to fall to half of its starting value.

RATE EQUATIONS, ORDERS OF REACTION AND THE RATE CONSTANT

DEFINITION

A reaction in which the time taken to form a fixed amount of product is measured, usually by a sudden colour change; 1/t is proportional to the initial rate.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

The rate of reaction at the moment the reactants are mixed, found from the gradient of the tangent to a concentration–time graph at t = 0.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

The time taken for the concentration of a reactant to fall to half of its starting value.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Following one reaction mixture by measuring a property that depends on concentration at regular intervals as the reaction proceeds.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

A graph of absorbance against known concentrations of the coloured species, used to convert each absorbance reading into a concentration.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

A measure of how much light of a chosen colour a solution absorbs; for a dilute solution it is proportional to the concentration of the coloured species.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

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DEFINITION

Define: Quenching.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Isolation method.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

SPOT THE ERROR

Say what is wrong with this claim:

Any rate measured during the reaction will do for comparing runs, as long as it is measured the same way each time.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Define: Activation energy, Ea.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Arrhenius equation.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Pre-exponential factor, A.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Reaction mechanism.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Rate-determining step.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

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DEFINITION

Finding the order with respect to one reactant by putting every other reactant in large excess, so that only the isolated reactant's concentration changes during the run.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

Stopping the reaction in a withdrawn sample, by cooling, dilution or removing a reactant or catalyst, so its composition at that moment can be measured.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

The minimum energy that colliding particles must have for a reaction to take place.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

SPOT THE ERROR

Rates must be compared at known concentrations, and only at t = 0 are they the ones that were mixed. Later, every reactant has fallen by an amount that differs from run to run, so a rate measured then belongs to an unknown mixture. The initial rate is the gradient of a tangent at t = 0, or 1/t from a clock reaction.

FINDING ORDERS FROM INITIAL RATES, HALF-LIVES AND GRAPHS

DEFINITION

The constant in the Arrhenius equation, with the same units as k, related to the frequency of collisions with the correct orientation.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

k = Ae^(-Ea/RT), relating the rate constant to the activation energy and the absolute temperature.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

The slowest step in a reaction mechanism, which limits the overall rate of the reaction.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

The sequence of steps by which a reaction takes place, which add up to the overall equation.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

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DEFINITION

Define: Intermediate.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Transition state.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: Catalyst.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: SN2.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Define: SN1.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

SPOT THE ERROR

Say what is wrong with this claim:

The slowest step must be the last step, because the reaction cannot finish until it has happened.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

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DEFINITION

The arrangement of highest energy along a single step, in which bonds are partly broken and partly formed; it cannot be isolated.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

A species formed in one step of a mechanism and used up in a later step, so it does not appear in the overall equation.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Nucleophilic substitution in one step, in which the nucleophile and the halogenoalkane are both in the rate-determining step, so the reaction is second order.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

A substance that increases the rate of a reaction by providing an alternative route of lower activation energy; it is used in one step of a mechanism and regenerated in a later one, so it is chemically unchanged at the end.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

SPOT THE ERROR

The slow step can be any step in the mechanism. The rate equation shows which: the species in it, with their orders, are the ones in the slow step and any step before it. A reactant that appears only after the slow step has no effect on the rate and is absent from the rate equation, however many moles of it react.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

DEFINITION

Nucleophilic substitution in two steps, in which the carbon–halogen bond breaks heterolytically in the slow first step to give a carbocation, so only the halogenoalkane is in the rate equation.

THE ARRHENIUS EQUATION AND THE RATE-DETERMINING STEP

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