



Kinetic Chemistry (222 C)

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Chain Reactions

Chain Reactions

In these reactions, an **intermediate** is **produced** in one step.

Then, the first intermediate will **generate** another **intermediate** in a subsequent step.

After that, that intermediate **generates** another intermediate, **and so on**.

Chain Reactions proceed through **series** of **self repeating steps** involving formation of active species “**intermediates**”.

These species “**intermediates**” either **regenerate** themselves or **produce** other active species that can carry on the reaction and are responsible for the **formation** of products.

The main steps of chain reactions

*Initiation step

*Propagation step

*Termination step

Other steps in chain reactions

These steps can be occurred in **some** chain reactions but they are **not main** steps

*Branching step

*Inhibition step

*Initiation step

In this step: the **intermediates** or **free radicals** which are responsible to carry on the reaction, are formed (formation of **chain carriers**)



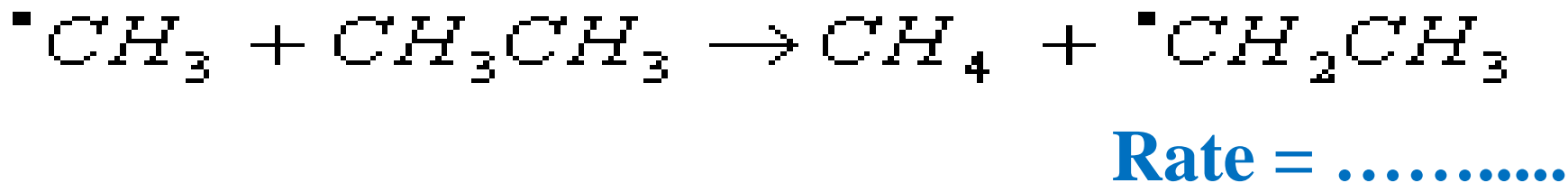
$$\text{Rate} = k[\text{Br}_2]$$

Br[•] is known as “**chain carriers**”

*Propagation step

Formation of the product **with** fast generation of **one or more reactive species (chain carrier)**.

The **chain carriers** produced in the initiation step **attack** other reactant molecules to **produce** a **new chain carriers**. Such as:

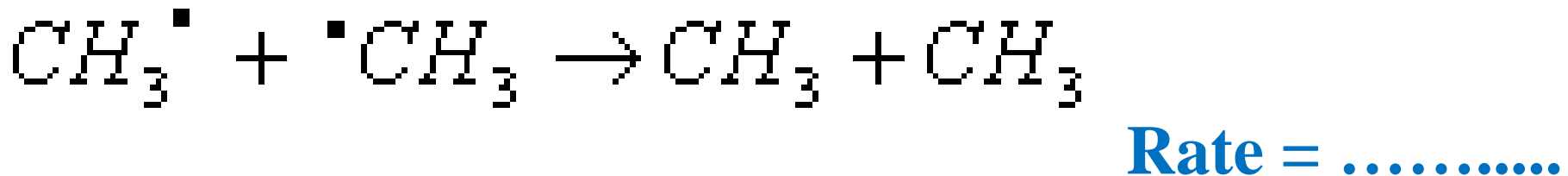
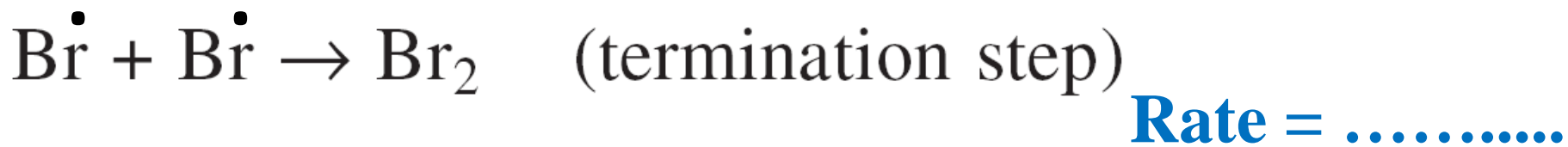


*Termination step

Removal of the **active species** “**chain carriers**” from the reaction results in **breaking** of the chain and **stopping** of the reaction.

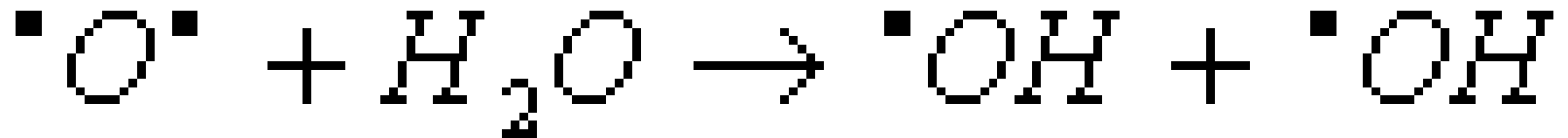
For example, when two **Br atoms** come together to unite into a **Br₂** molecule, the chain is **broken** and **stopped**.

The radicals combine and the chain ended



Branching step

In this step, **more than one** chain carrier can be produced:



Rate =

Inhibition step

In **some** chain reactions, inhibition step may also be involved.

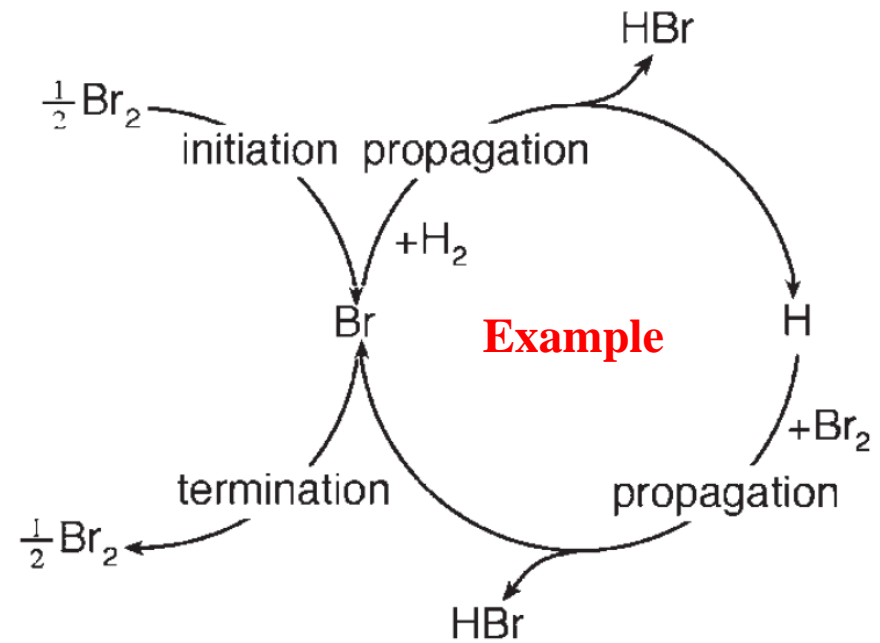
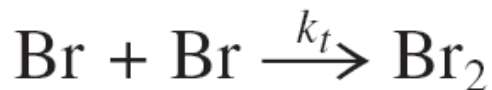
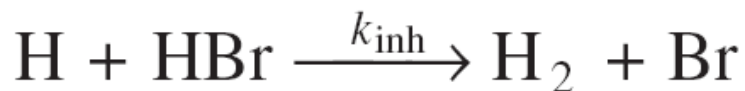
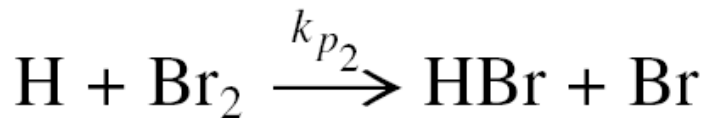
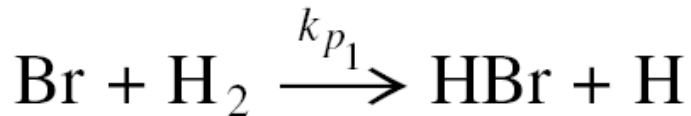
For example, in Br_2 and H_2 reaction, a **collision** between $\text{H}\cdot$ atom and HBr **inhibit** the process of the product formation.

This attack will reduce the rate of formation of product



Rate =

Example: Reaction between H₂ and Br₂



$$\frac{d[\text{HBr}]}{dt} = k_{p1} [\text{Br}][\text{H}_2] + k_{p2} [\text{H}][\text{Br}_2] - k_{inh} [\text{H}][\text{HBr}]$$

Kinetic Chemistry

- ✓ Rate of Reaction
- ✓ Reaction Rates and Stoichiometry
- ✓ Measuring Reaction Rates
- ✓ The Rate Law
- ✓ Factors Affecting Reaction Rate:
- ✓ Reaction Order and Reaction Molecularity
- ✓ First Order Reactions
- ✓ Second Order Reaction
- ✓ Third Order Reactions
- ✓ Zero Order Reactions
- ✓ Activation Energy and Temperature Dependence of Rate Constants.
- ✓ Determination of Reaction Order
- ✓ Parallel Reactions
- ✓ Series - First-Order Reactions
- ✓ Chain Reactions

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