

Edexcel organic reaction mechanisms

Click a box below to go to the mechanism

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Homolytic

Free Radical Substitution

Free Radical Addition

Heterolytic

Electrophilic Addition

Nucleophilic Substitution

S_N2

S_N1

Electrophilic Substitution

Nitration

Br_2

Alkylation

Acylation

Nucleophilic Addition

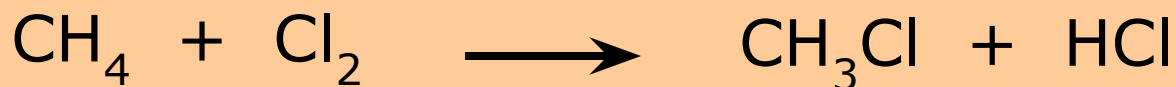


Free radical substitution

chlorination of methane

i.e. **homolytic** breaking of covalent bonds

Overall reaction equation



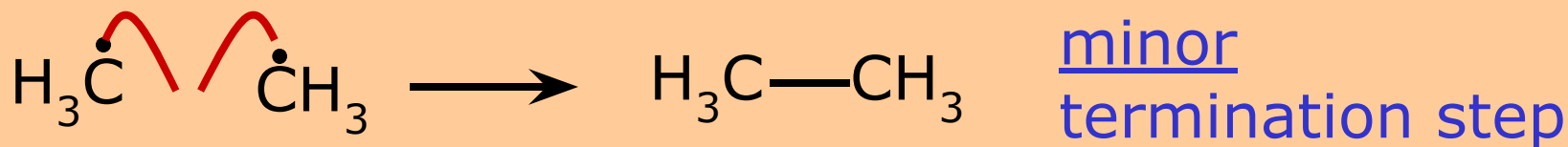
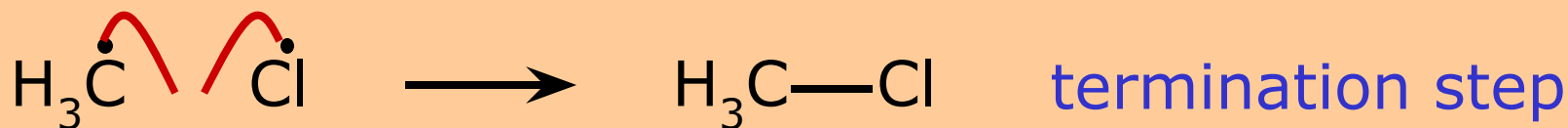
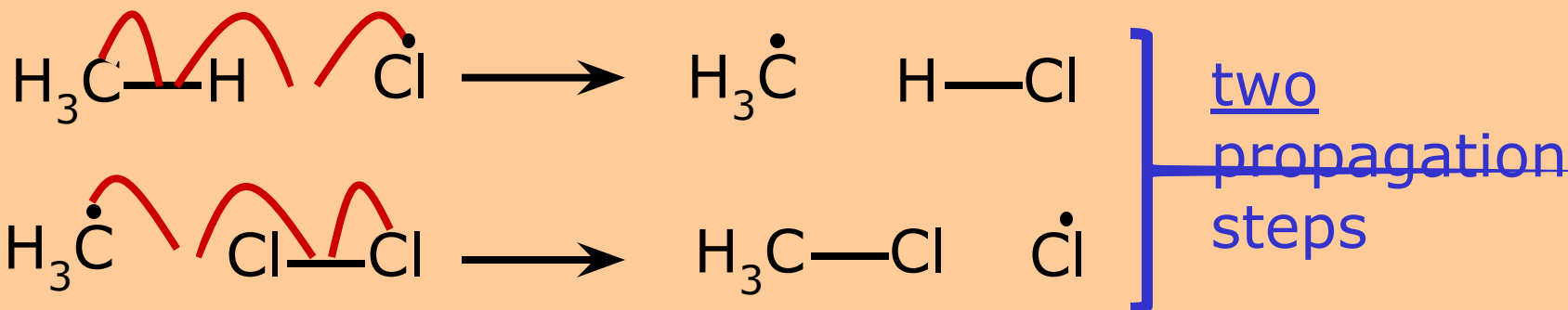
Conditions

ultra violet light

excess methane to reduce further substitution



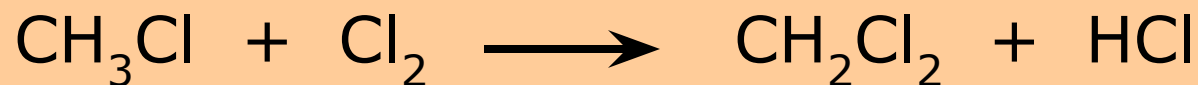
Free radical substitution mechanism





Further free radical substitutions

Overall reaction equations



Conditions ultra-violet light
 excess **chlorine**

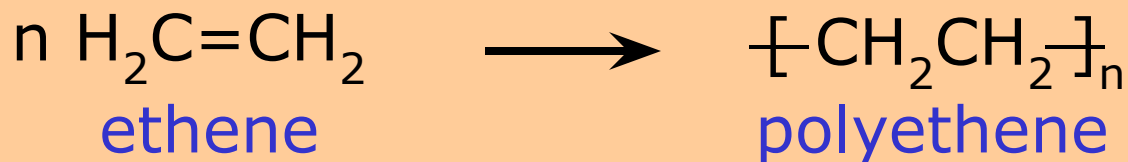


Free radical addition

addition polymerisation of ethene

i.e. **homolytic** breaking of covalent bonds

Overall reaction equation



Conditions

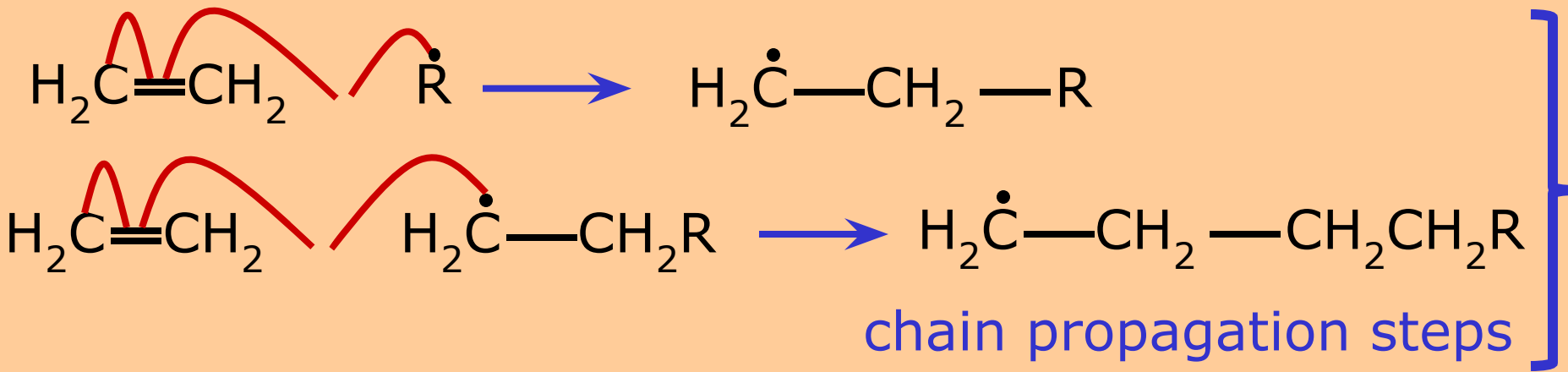
free radical source

(a species that generates free radicals

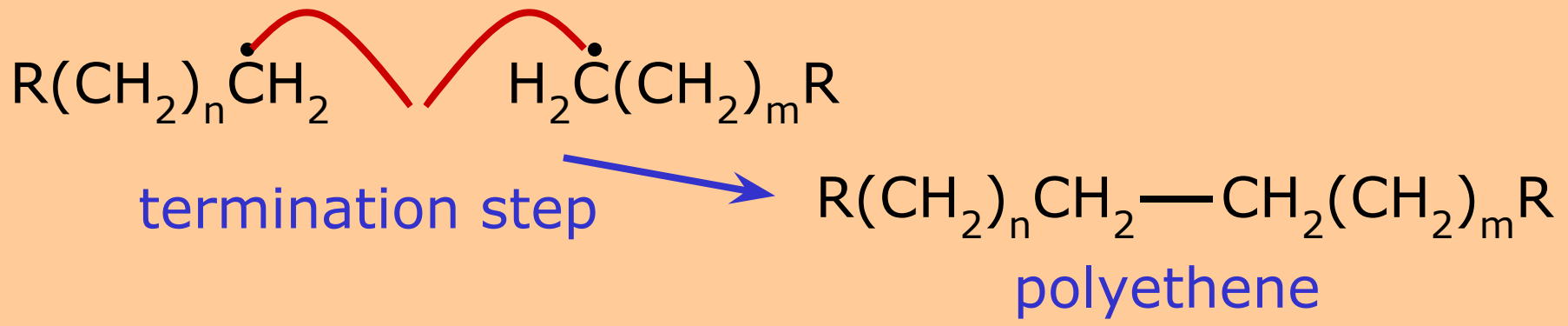
that allow the polymerisation of ethene molecules)



Free radical addition mechanism



Addition of $\text{H}_2\text{C}=\text{CH}_2$ repeats the same way until:

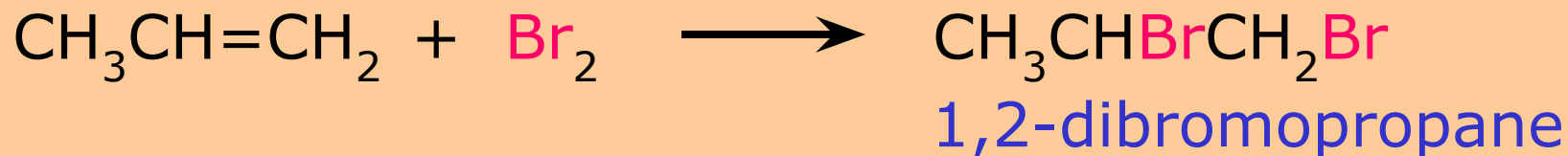




Electrophilic addition

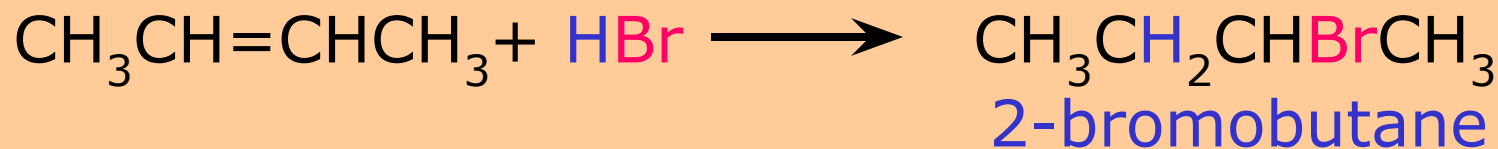
bromine with propene

mechanism



hydrogen bromide with but-2-ene

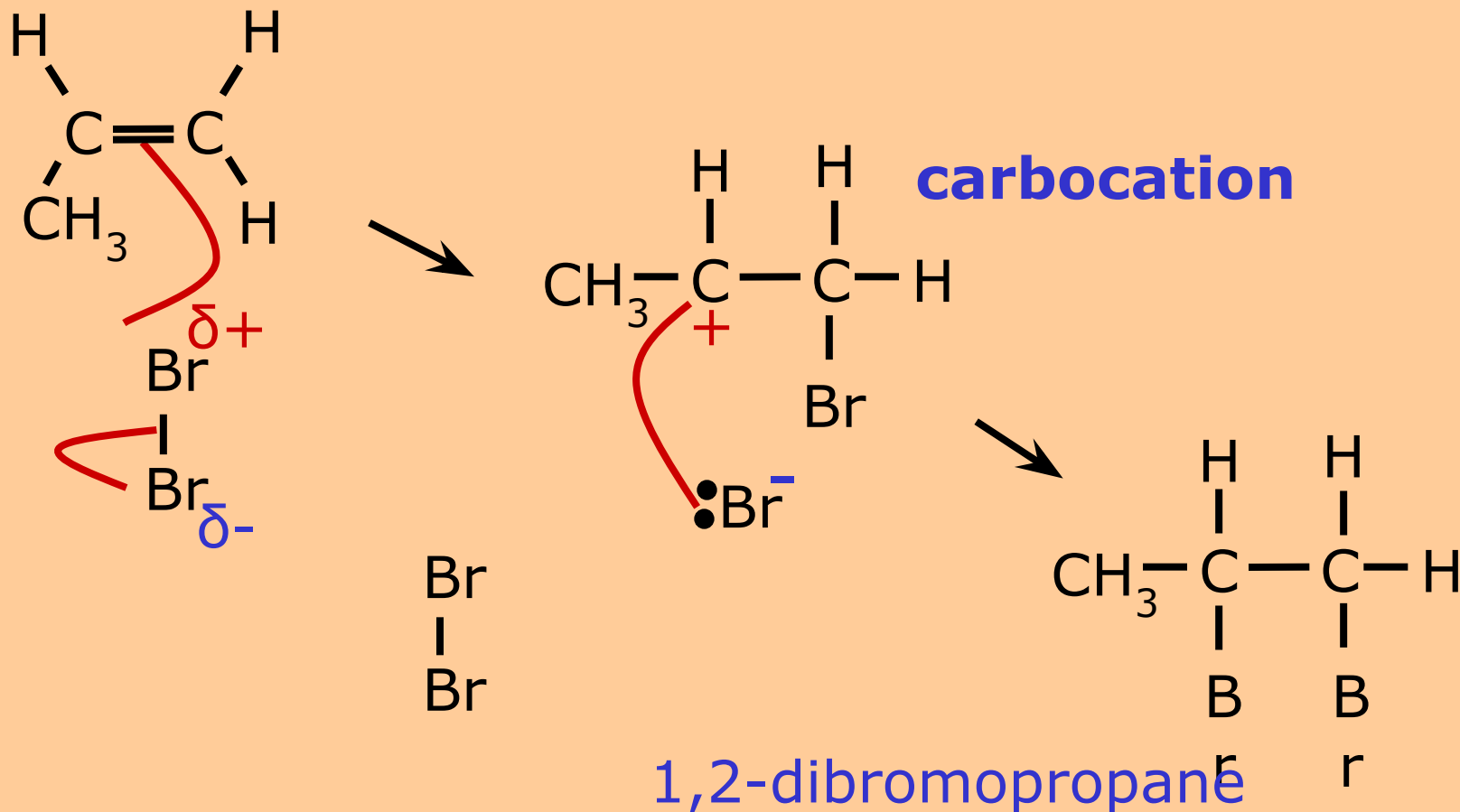
mechanism



Electrophilic addition mechanism

bromine with propene

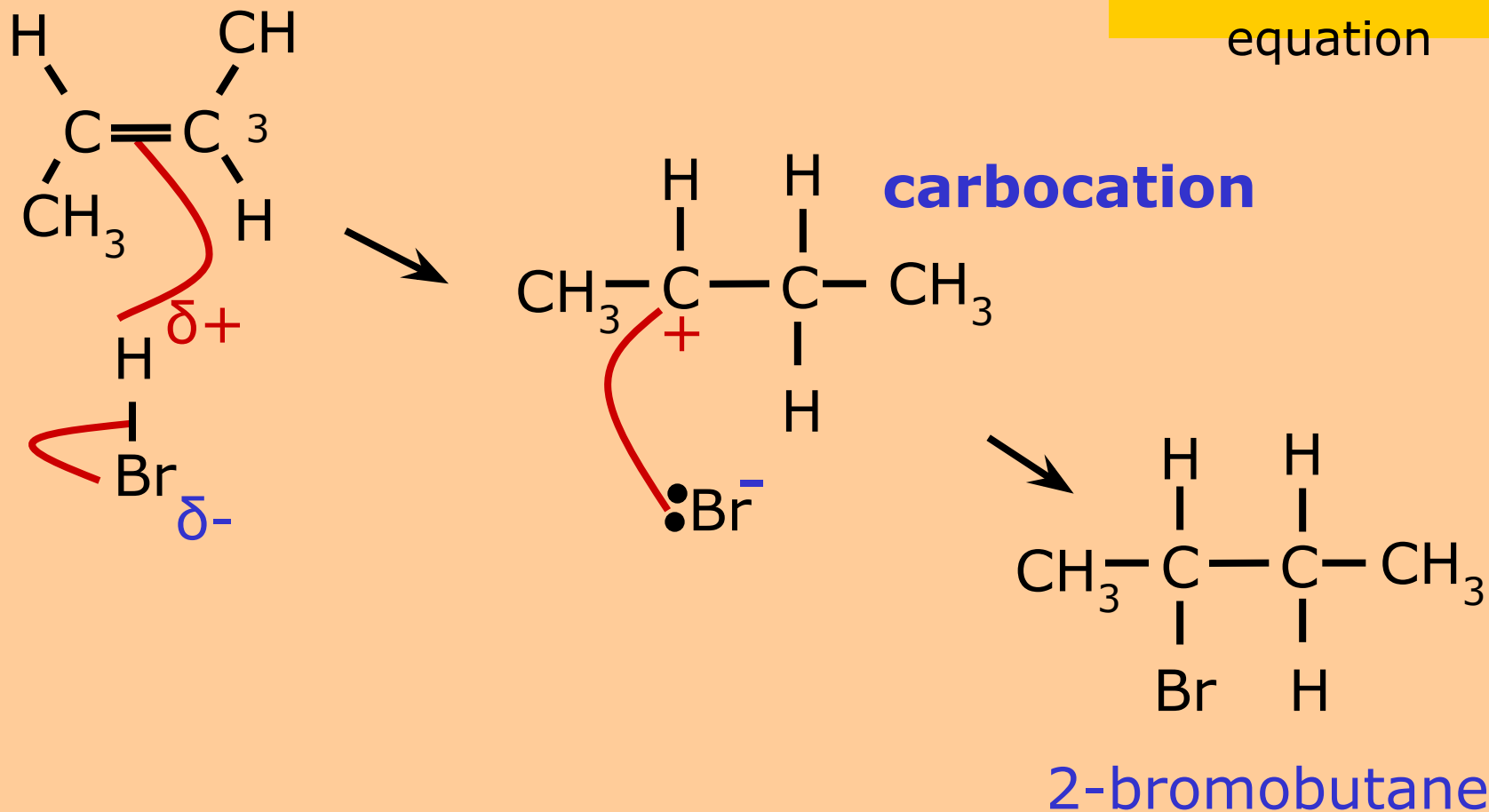
reaction
equation





Electrophilic addition mechanism

hydrogen bromide with trans but-2-ene

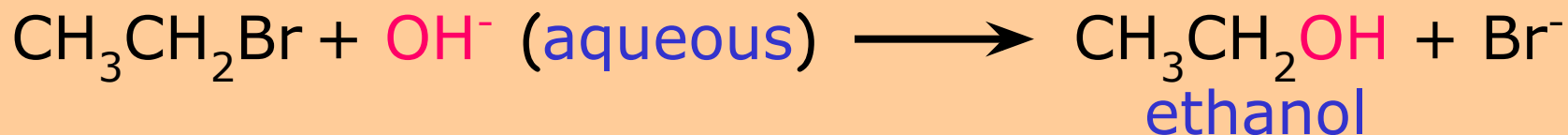




Nucleophilic substitution

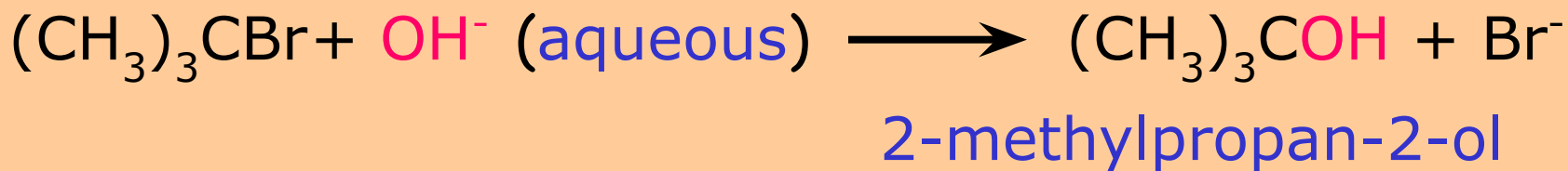
hydroxide ion with bromoethane

mechanism



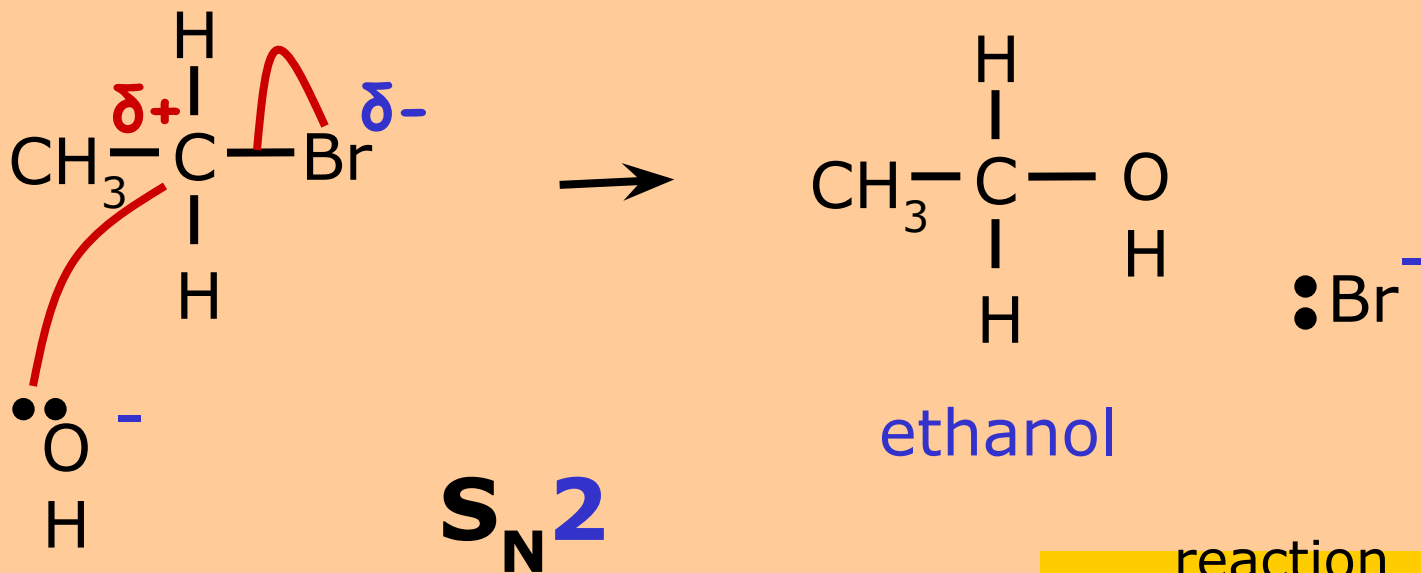
hydroxide ion with 2-bromo,2-methylpropane

mechanism



Nucleophilic substitution mechanism

hydroxide ion with bromoethane (S_N2)

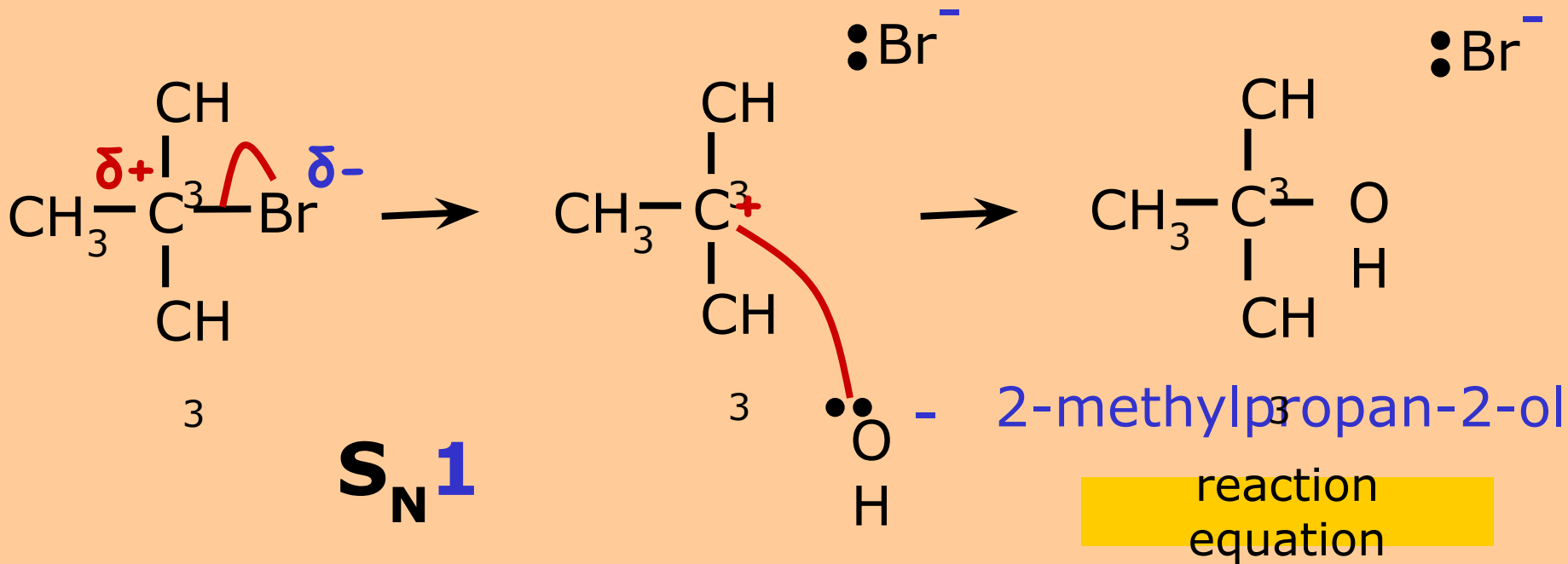


reaction
equation

S (substitution) **N** (nucleophilic) **2** (species reacting in the **slowest** step)

Nucleophilic substitution mechanism

OH⁻ ion with 2-bromo,2-methylpropane (S_N1)



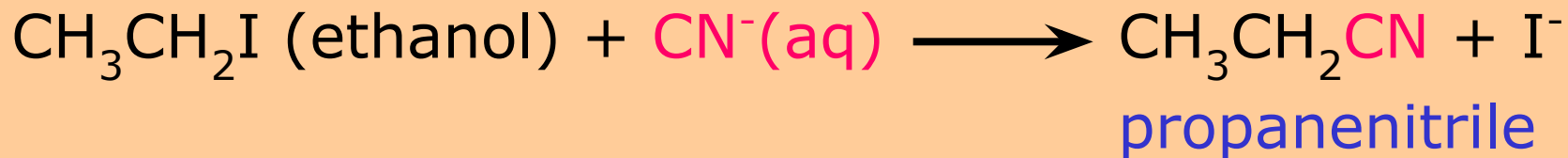
S (substitution) **N** (nucleophilic) **1** (species reacting in the **slowest** step)



Nucleophilic substitution

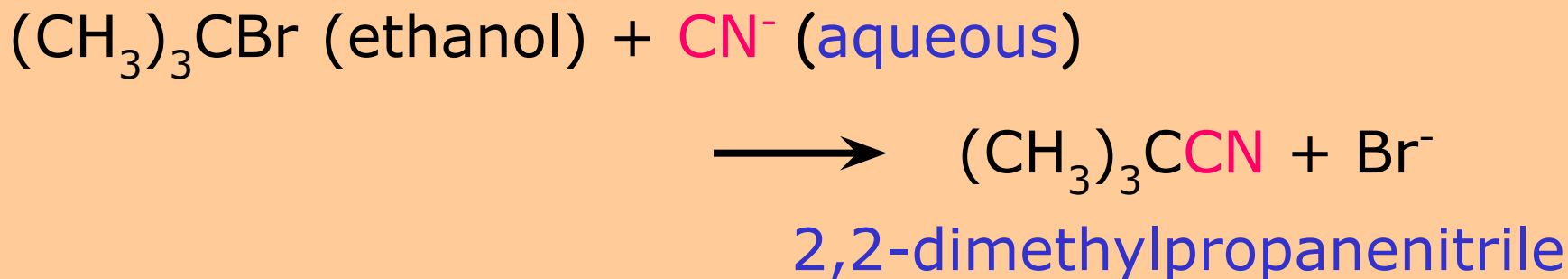
cyanide ion with iodoethane

mechanism



cyanide ion with 2-bromo,2-methylpropane

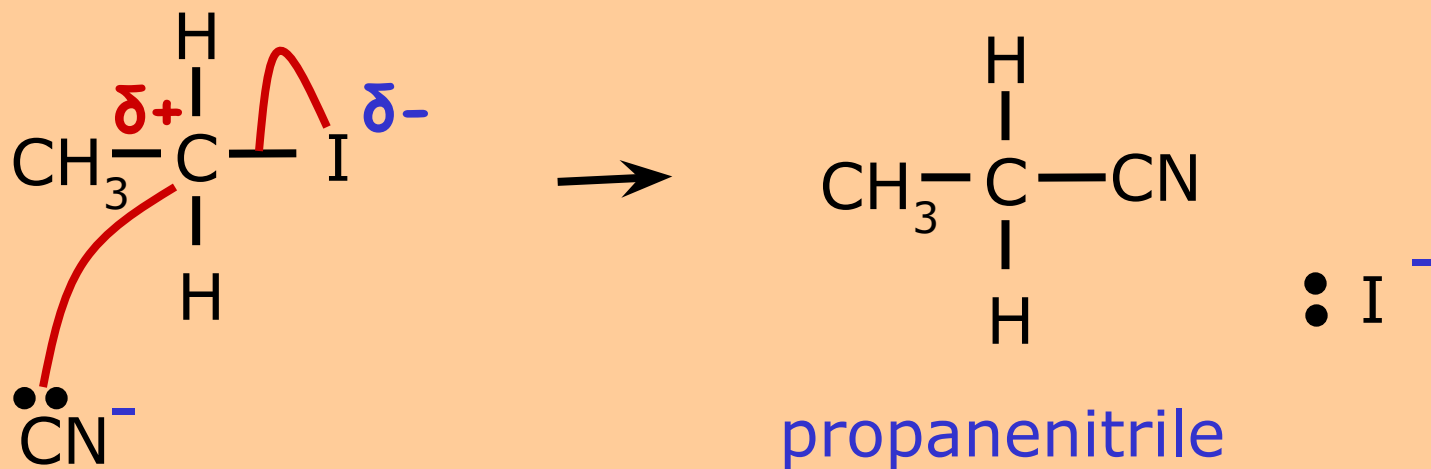
mechanism





Nucleophilic substitution mechanism

cyanide ion with iodoethane (S_N2)



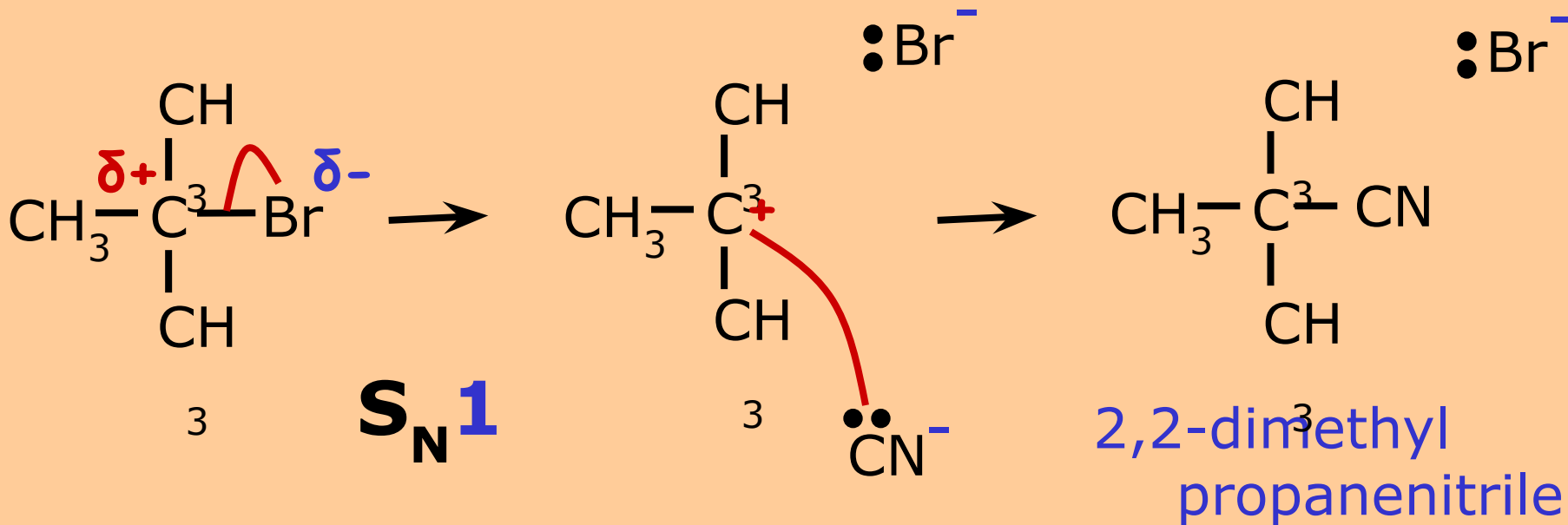
S_N2

S (substitution) **N** (nucleophilic) **2** (species reacting in the **slowest** step)

reaction equation

Nucleophilic substitution mechanism

CN⁻ ion with 2-bromo,2-methylpropane (S_N1)



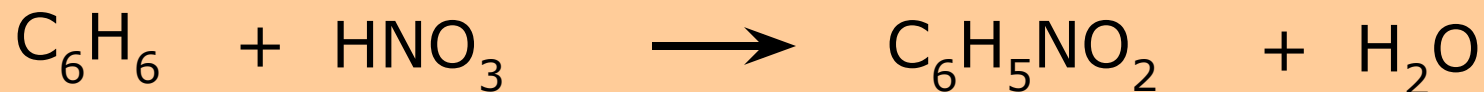
S (substitution) **N** (nucleophilic) **1** (species reacting in the slowest step)

reaction
equation

Electrophilic Substitution

Nitration of benzene

Where an H atom attached to an aromatic ring is replaced by an NO₂ group of atoms



Conditions / Reagents

concentrated HNO₃ **and** concentrated H₂SO₄

50°C

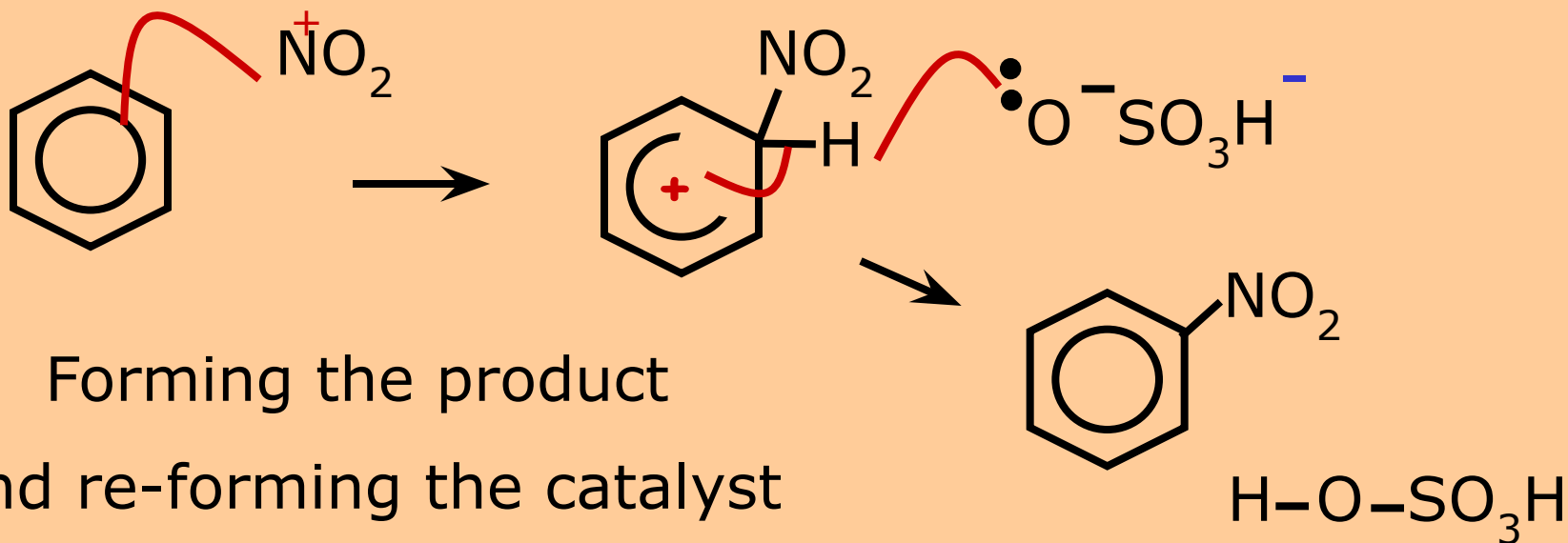
mechanism

electrophilic substitution mechanism (nitration)

1. Formation of NO_2^+ the **nitronium ion**



2. Electrophilic attack on benzene



3. Forming the product
and re-forming the catalyst

reaction
equation



Bromination of benzene

Where an H atom attached to an aromatic ring is replaced by a Br atom

electrophilic substitution



R = alkyl group

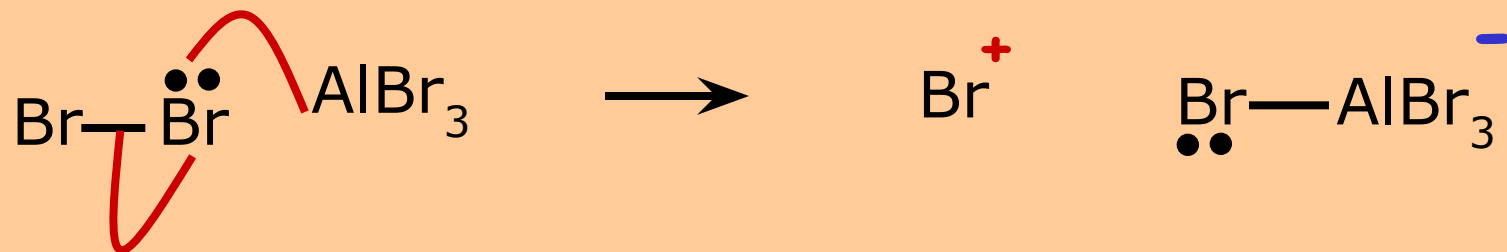
Conditions / Reagents

Br_2 **and** anhydrous AlBr_3

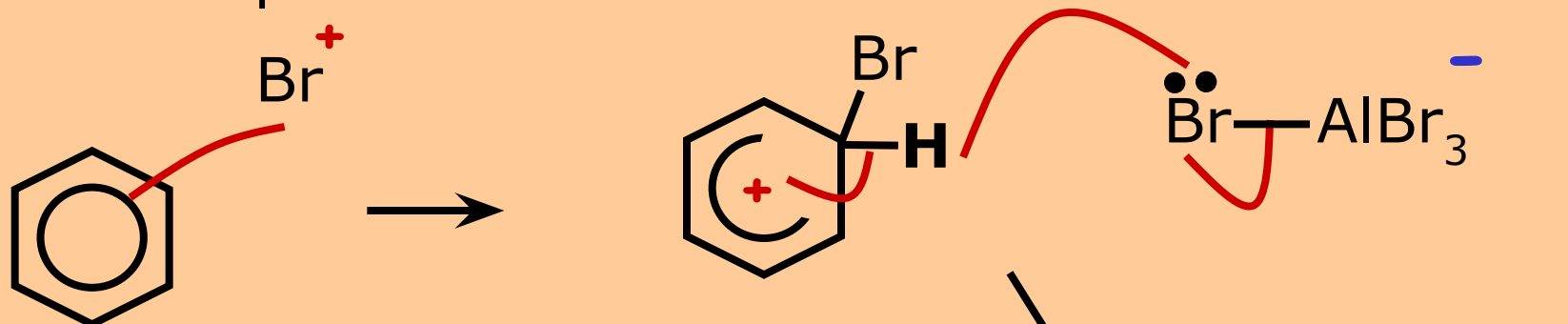
25°C

Electrophilic substitution mechanism

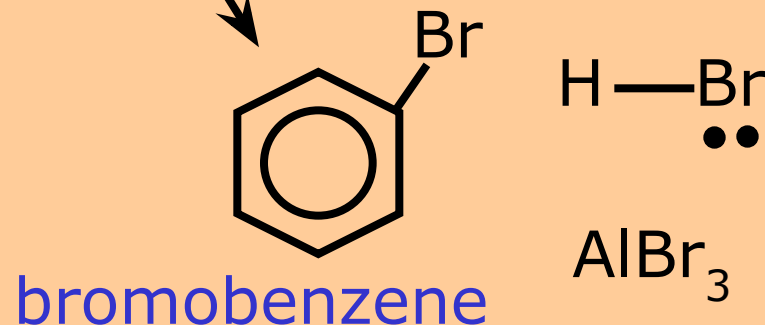
1. Formation of the electrophile



2. Electrophilic attack on benzene



3. Forming the products
and re-forming the catalyst



Alkylation of benzene

Where an H atom attached to an aromatic ring is replaced by a C atom

electrophilic substitution



R = alkyl group

Conditions / Reagents

RCl (haloalkane) **and** anhydrous AlCl_3

0 - 25°C to prevent further substitution



Alkylation example

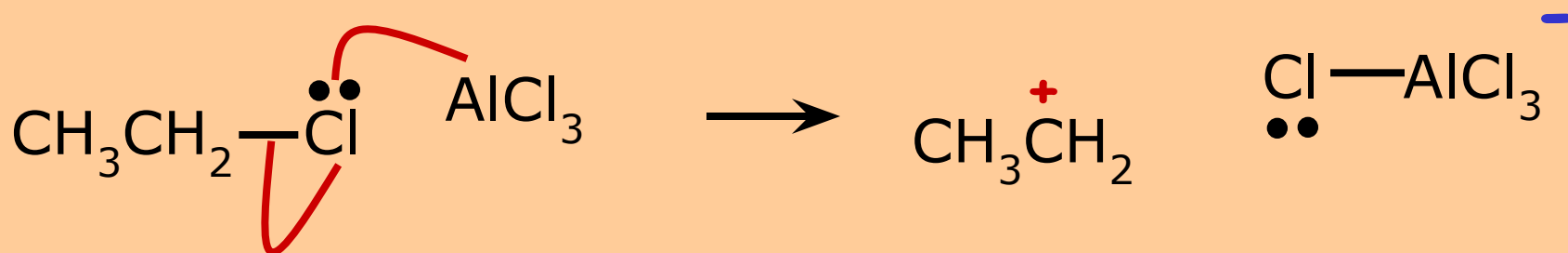
With chloroethane

overall reaction equation



Three steps in electrophilic substitution mechanism

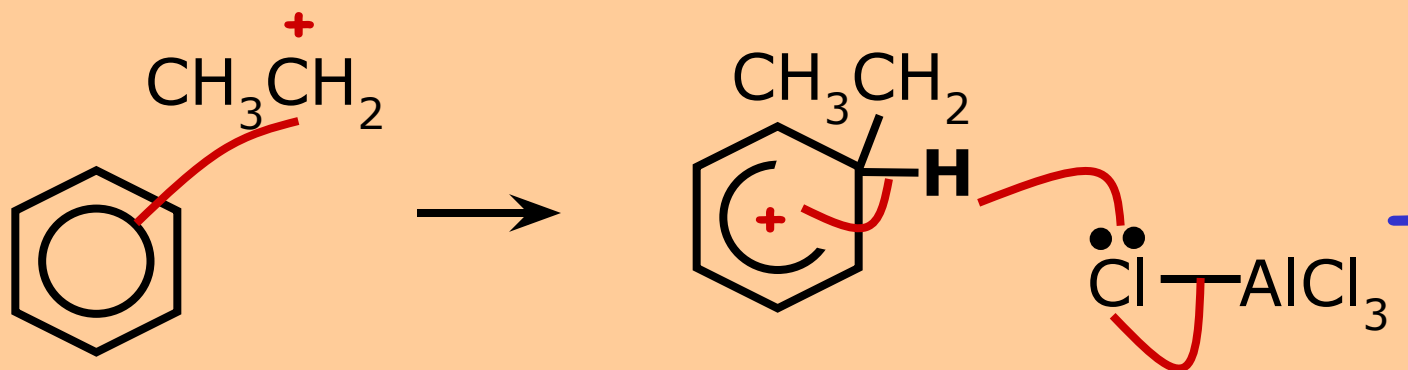
1. Formation of the electrophile (a **carbocation**)



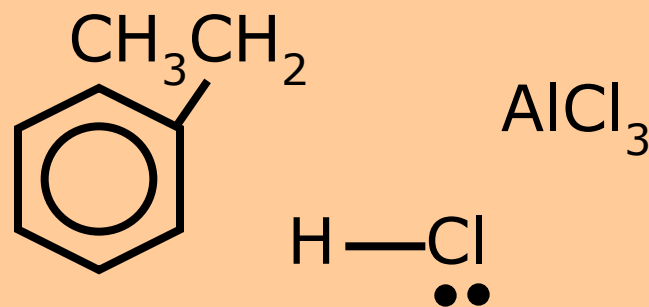


Alkylation electrophilic substitution mechanism 2

2. Electrophilic attack on benzene



3. Forming the product and re-forming the catalyst



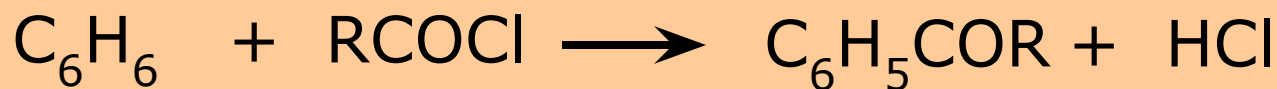
ethylbenzene



Acylation of benzene

An H atom attached to an aromatic ring is replaced by a C atom where C is part of C=O

electrophilic substitution



Conditions / Reagents

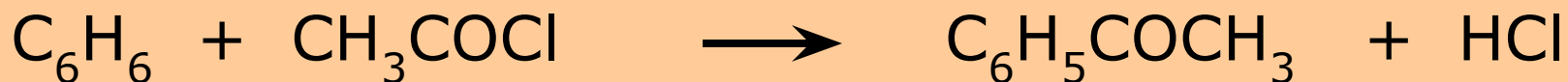
RCOCl (acyl chloride) **and** anhydrous AlCl_3

50 °C



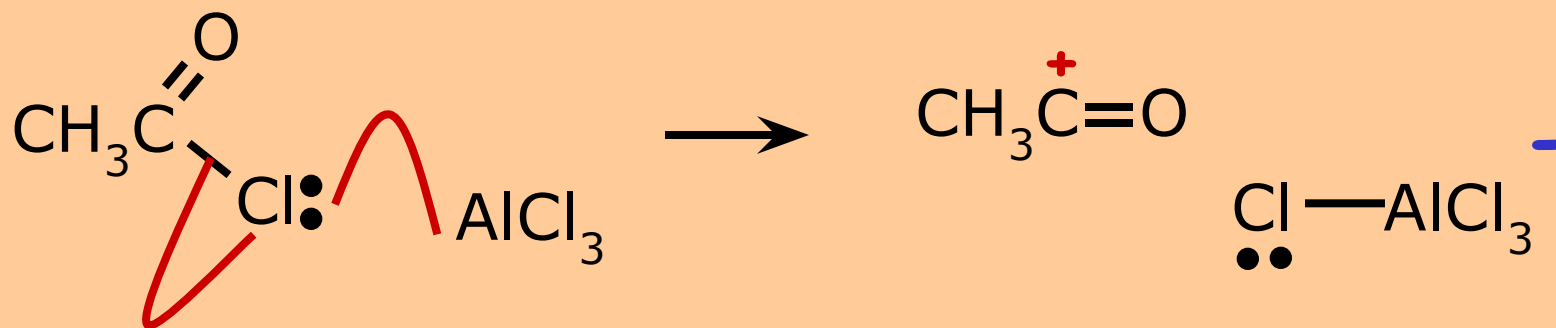
Acylation example

With ethanoyl chloride **overall reaction equation**



Three steps in electrophilic substitution mechanism

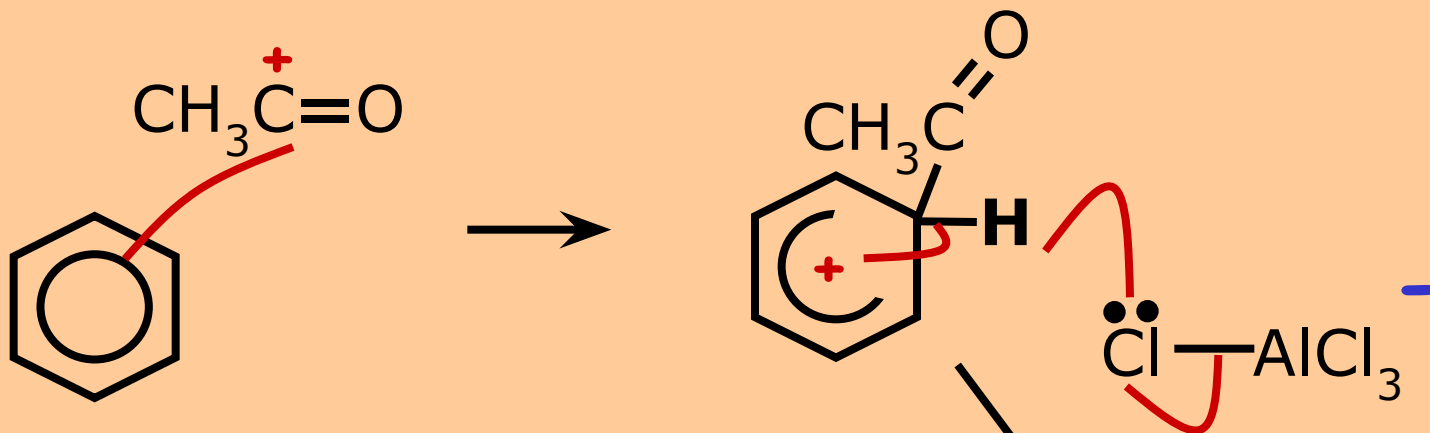
1. Formation of the electrophile (an **acylium** ion)





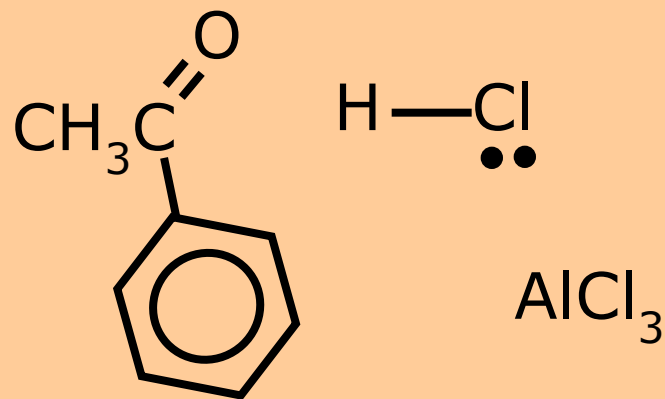
Acylation electrophilic substitution mechanism 2

2. Electrophilic attack on benzene



3. Forming the products

and re-forming the catalyst

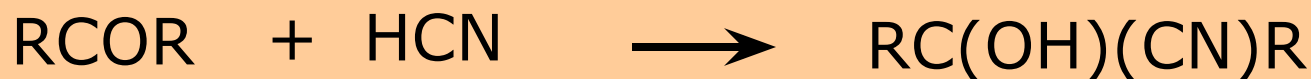


phenylethanone



Nucleophilic Addition

addition of hydrogen cyanide to carbonyls
to form **hydroxynitriles**



Conditions / Reagents

NaCN (aq) and $\text{H}_2\text{SO}_4(\text{aq})$ supplies H^+
supplies the CN^- nucleophile

Room temperature and pressure

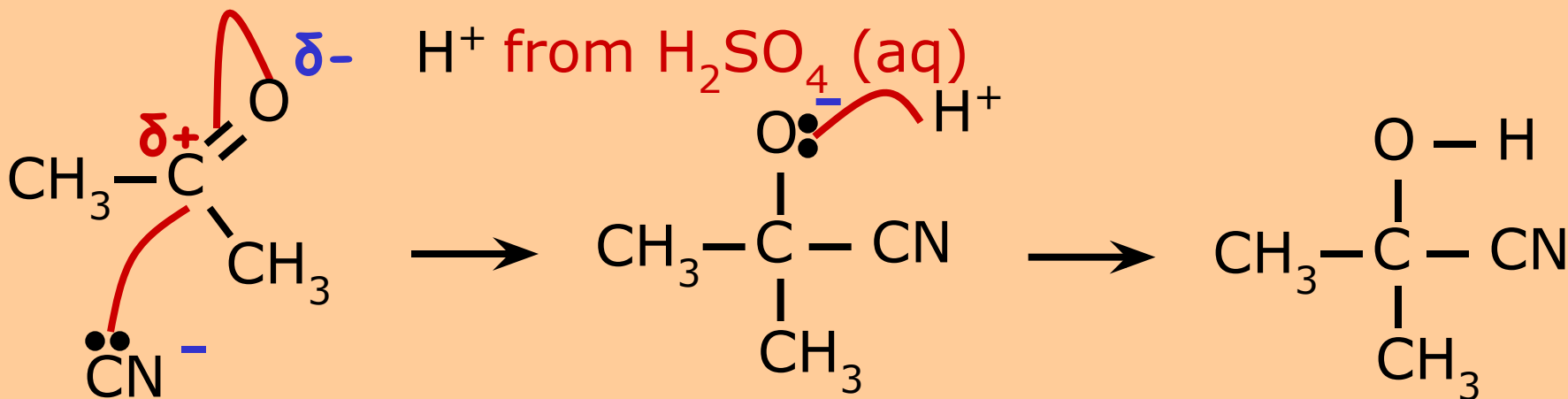


Nucleophilic Addition Mechanism

hydrogen cyanide with propanone




NaCN (aq) is a source of **cyanide ions** $\text{:C}\equiv\text{N}^-$



2-hydroxy-2-methylpropanenitrile



Advice

To get back to the mechanism links page from anywhere in the presentation, click the  button at the **top right corner** of the screen.

This version provides the organic mechanisms specified (2002/3) by the **Edexcel** exam board. Each stage of a reaction equation, its conditions and mechanism are revealed in turn on a mouse click or keyboard stroke. Note that there is another version available where each reaction and mechanism play automatically after an initiating click or key stroke.

The number of ways of **navigating** through this presentation may depend on the version of PowerPoint being used and how it is configured.

Some possible ways of advancing:

left mouse click or return key or right arrow key or up arrow key.

Some possible ways of reversing:

backspace key or left arrow key or down arrow key.



References

Steve Lewis for the Royal Society of Chemistry