

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

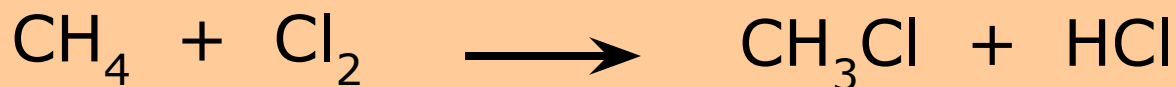
Nucleophilic Addition

Free radical substitution

chlorination of methane

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

Overall reaction equation



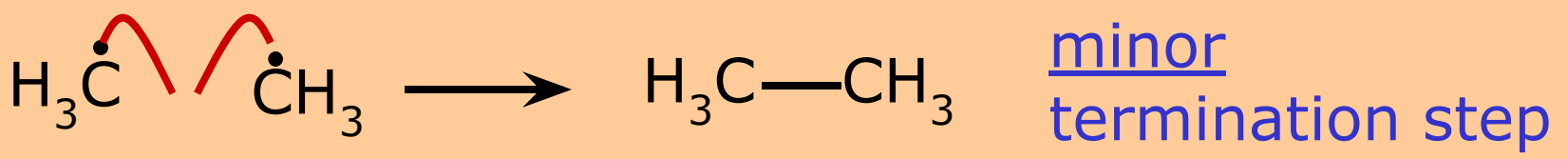
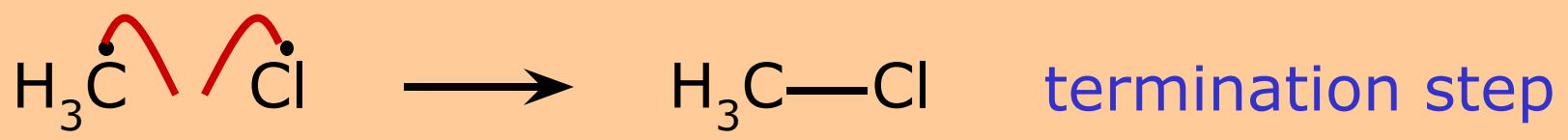
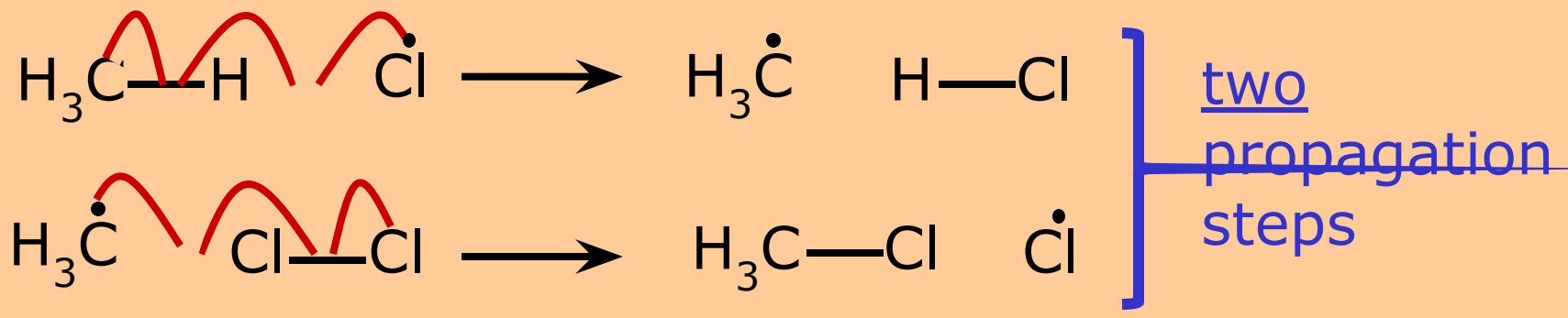
Conditions

ultra violet light

excess methane to reduce further substitution



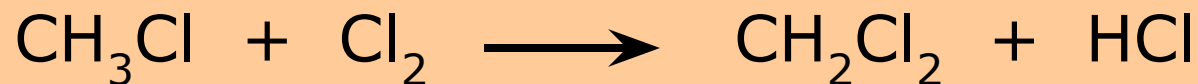
Free radical substitution mechanism





Further free radical substitutions

Overall reaction equations



Conditions ultra-violet light
 excess **chlorine**

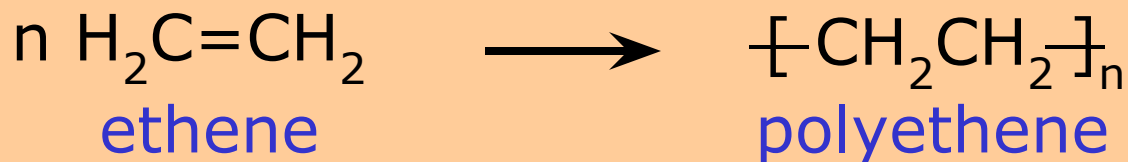


Free radical addition

addition polymerisation of ethene

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

Overall reaction equation

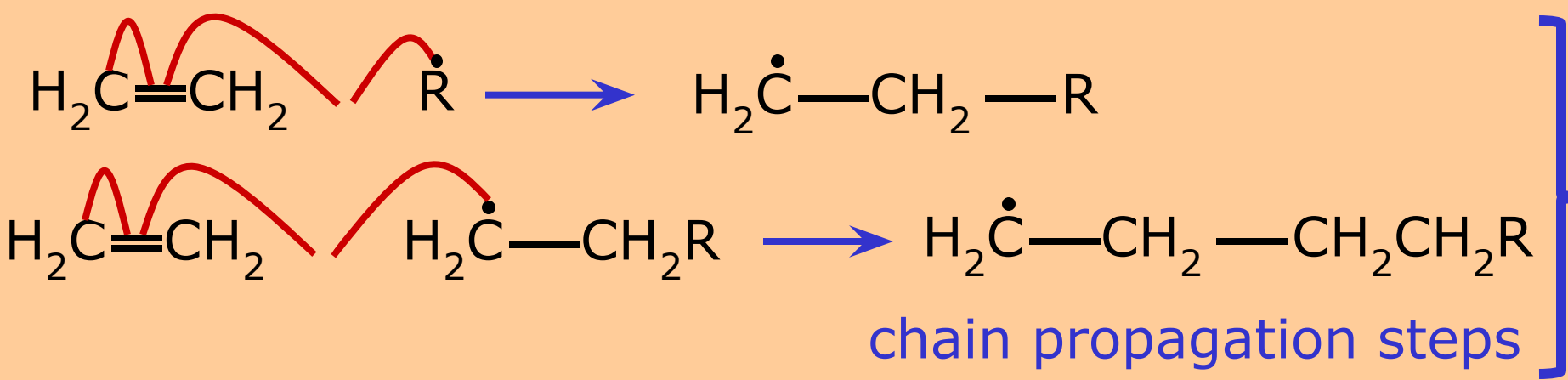


Conditions

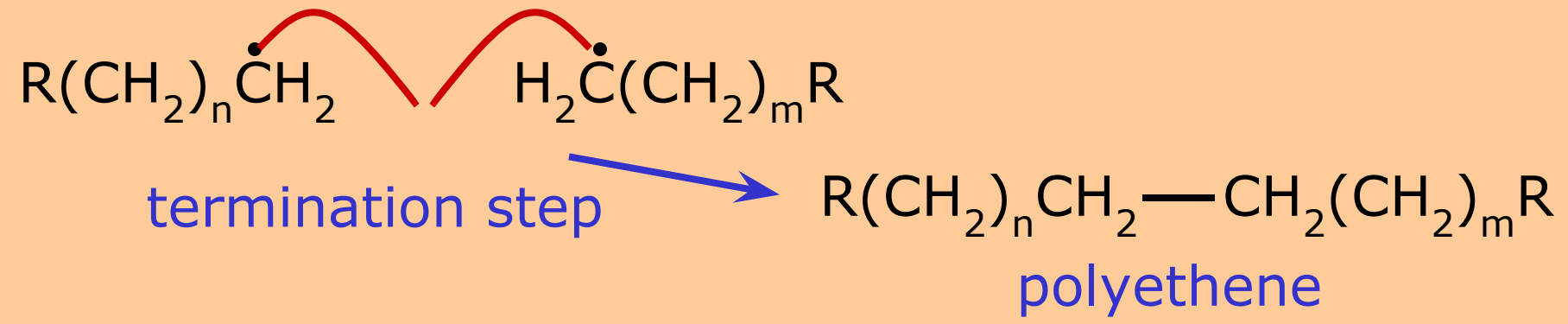
free radical source
(a species that generates free radicals
that allow the polymerisation of ethene molecules)



Free radical addition mechanism



Addition of $H_2C=CH_2$ repeats the same way until:

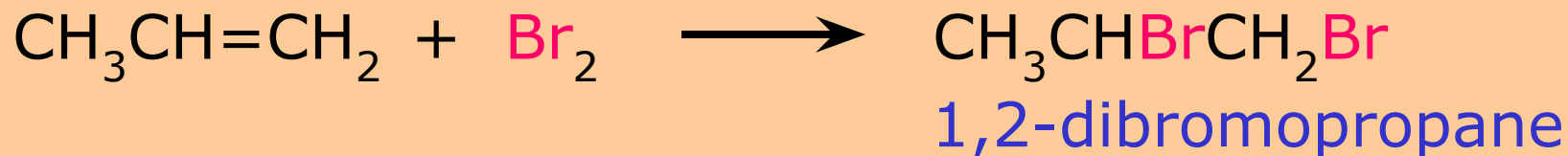




Electrophilic addition

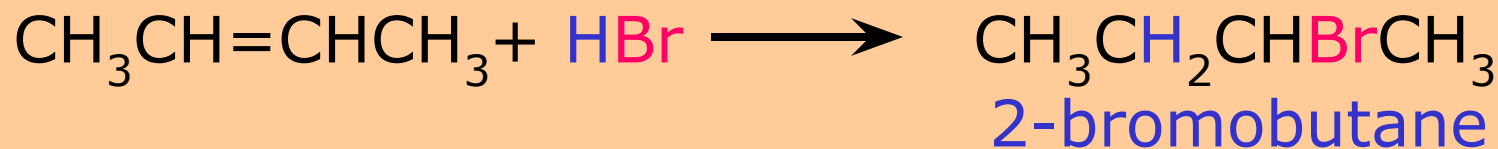
bromine with propene

mechanism



hydrogen bromide with but-2-ene

mechanism

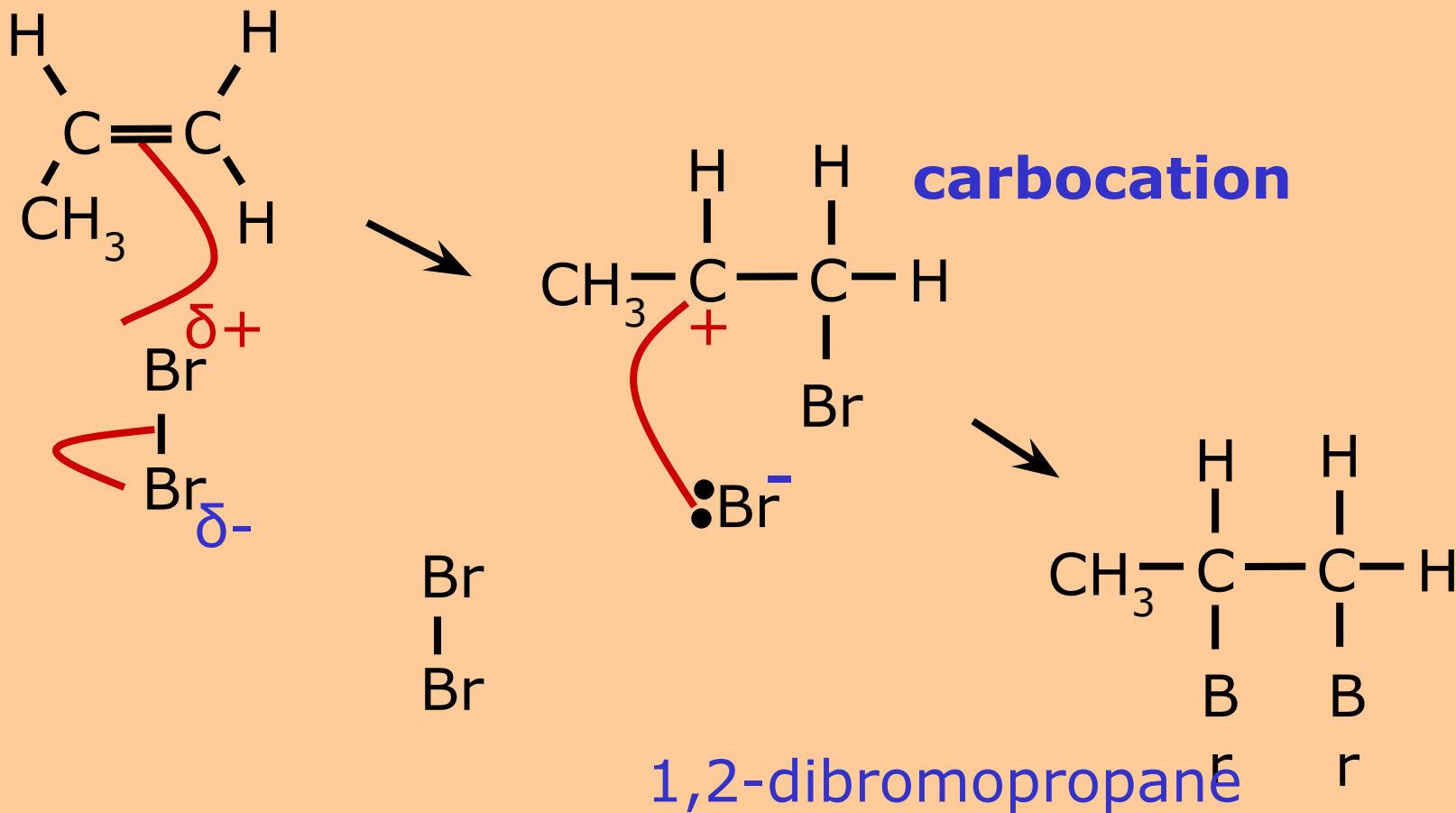




Electrophilic addition mechanism

bromine with propene

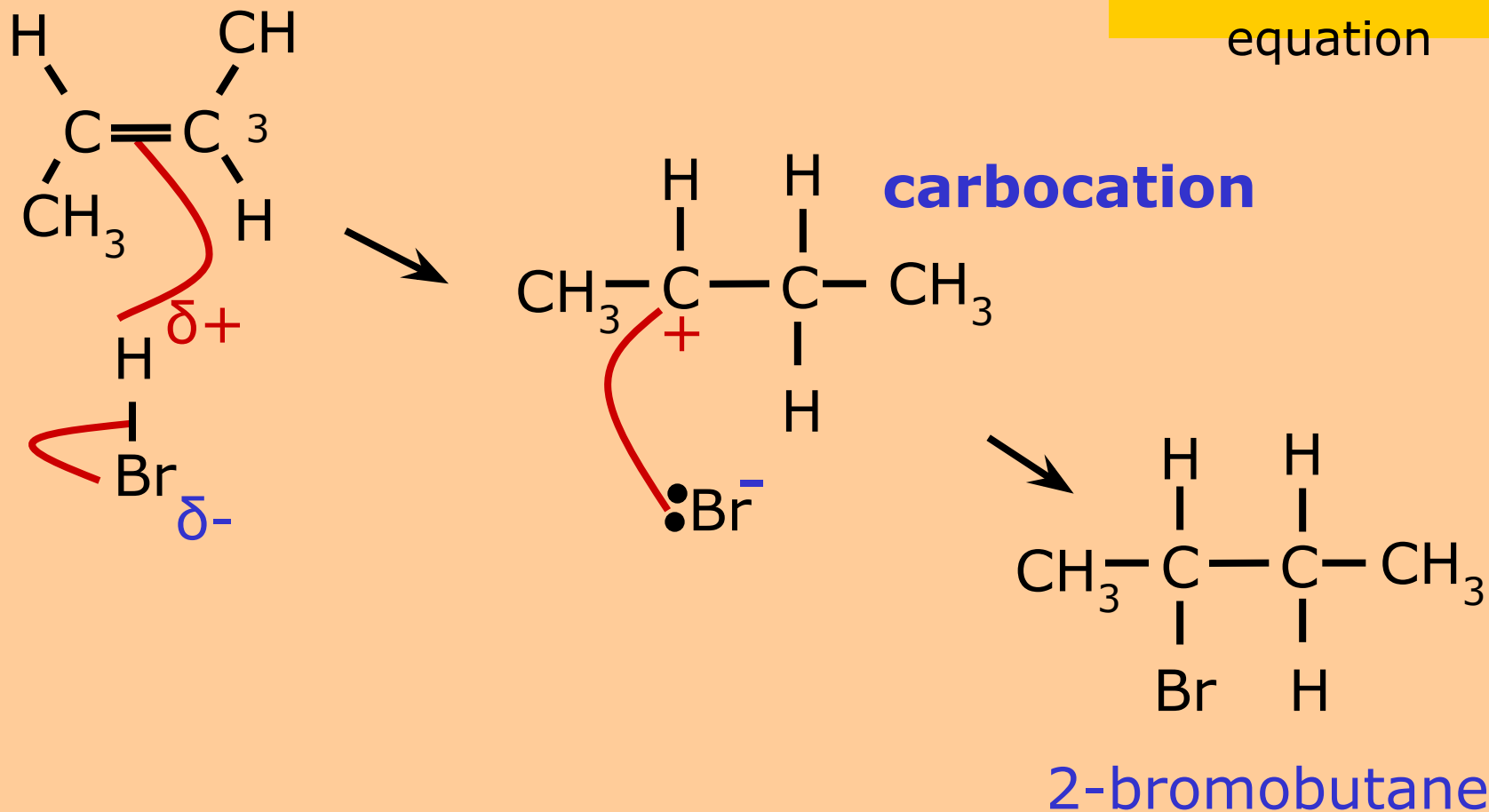
reaction
equation





Electrophilic addition mechanism

hydrogen bromide with trans but-2-ene

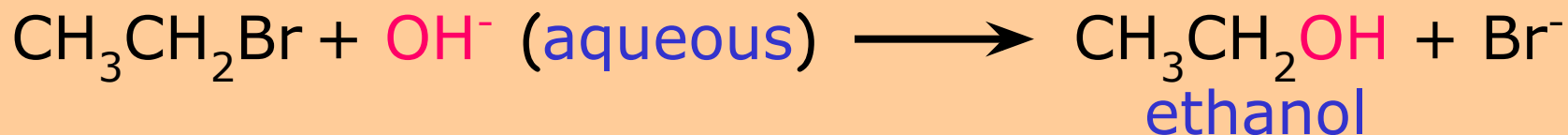




Nucleophilic substitution

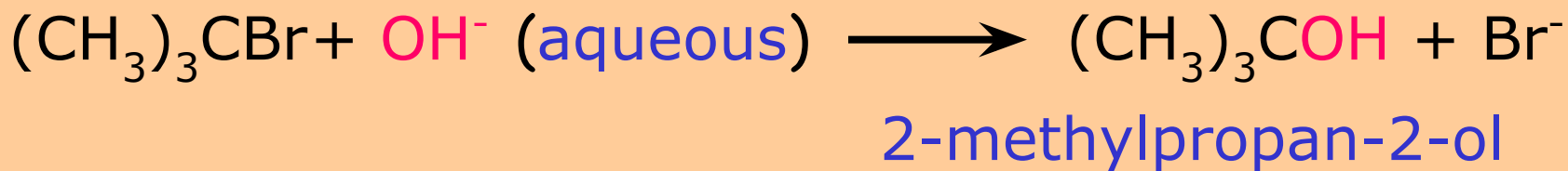
hydroxide ion with bromoethane

mechanism



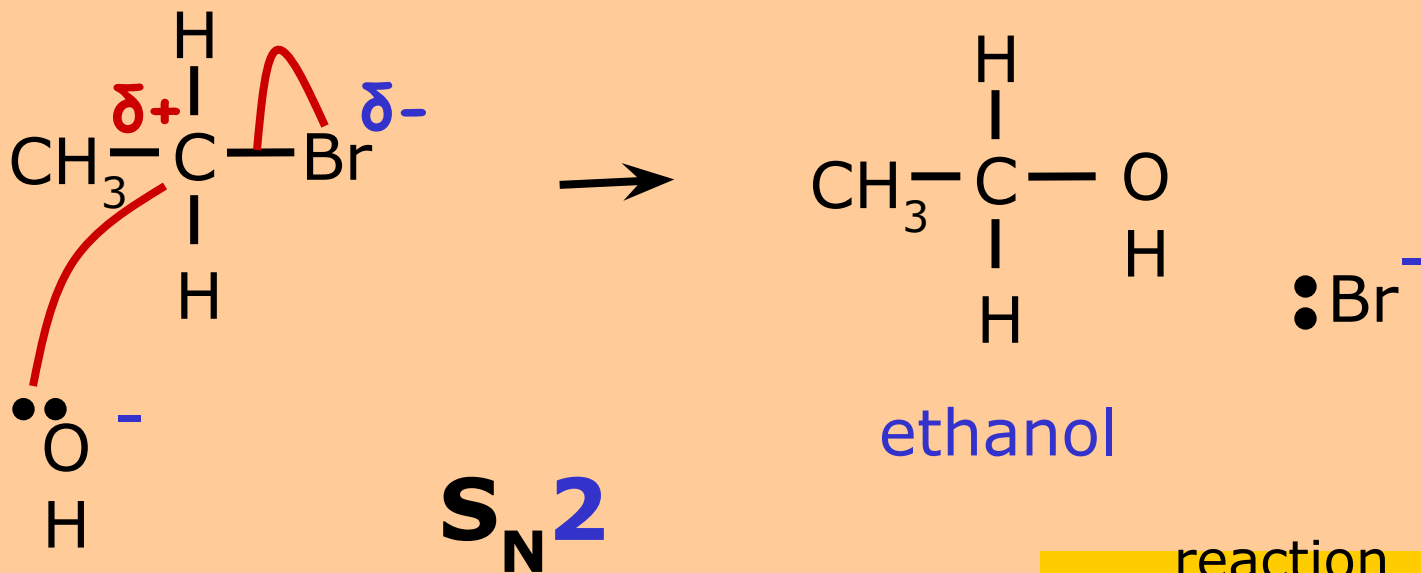
hydroxide ion with 2-bromo,2-methylpropane

mechanism



Nucleophilic substitution mechanism

hydroxide ion with bromoethane (S_N2)

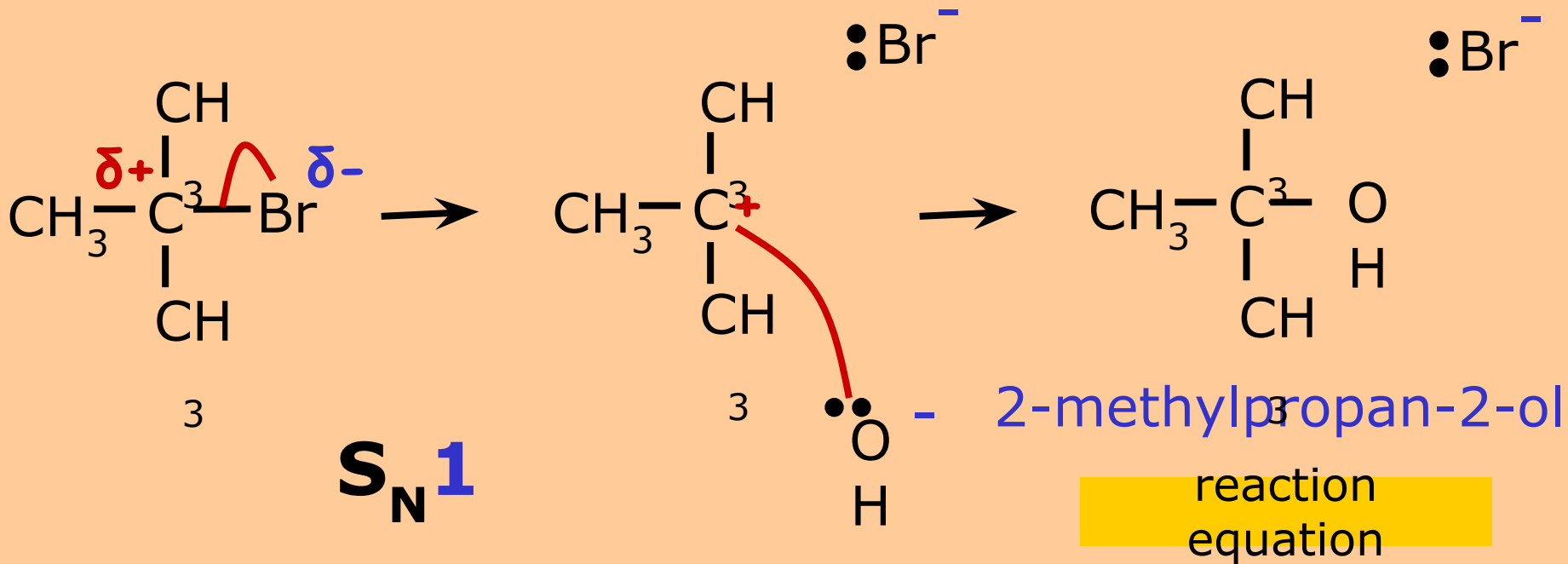


reaction
equation

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

Nucleophilic substitution mechanism

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



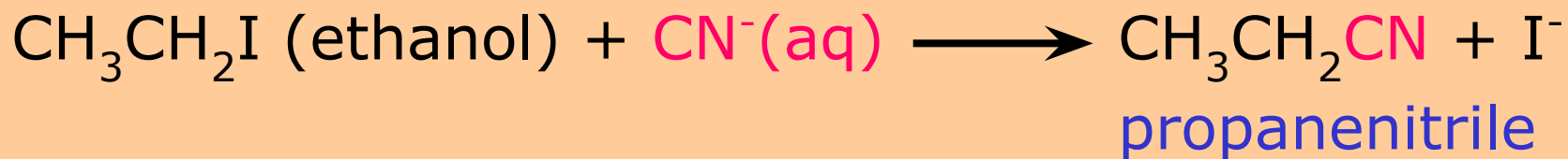
S (substitution) **N** (nucleophilic) **1** (species reacting in the slowest step)



Nucleophilic substitution

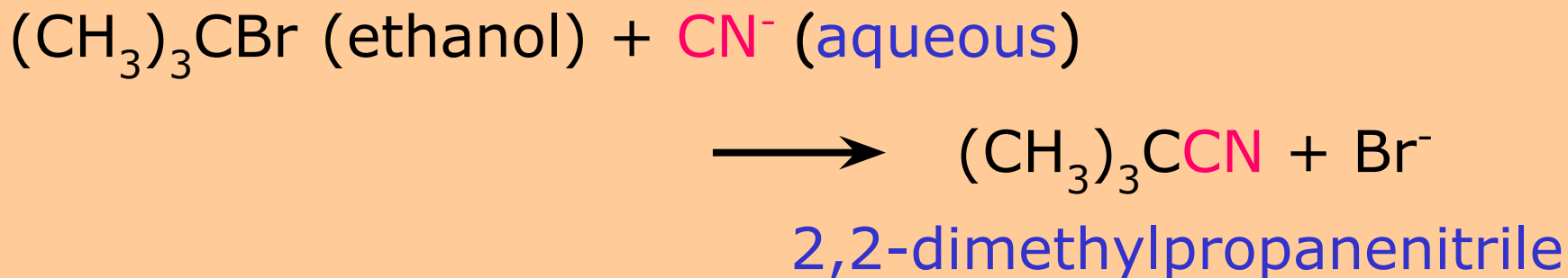
cyanide ion with iodoethane

mechanism



cyanide ion with 2-bromo,2-methylpropane

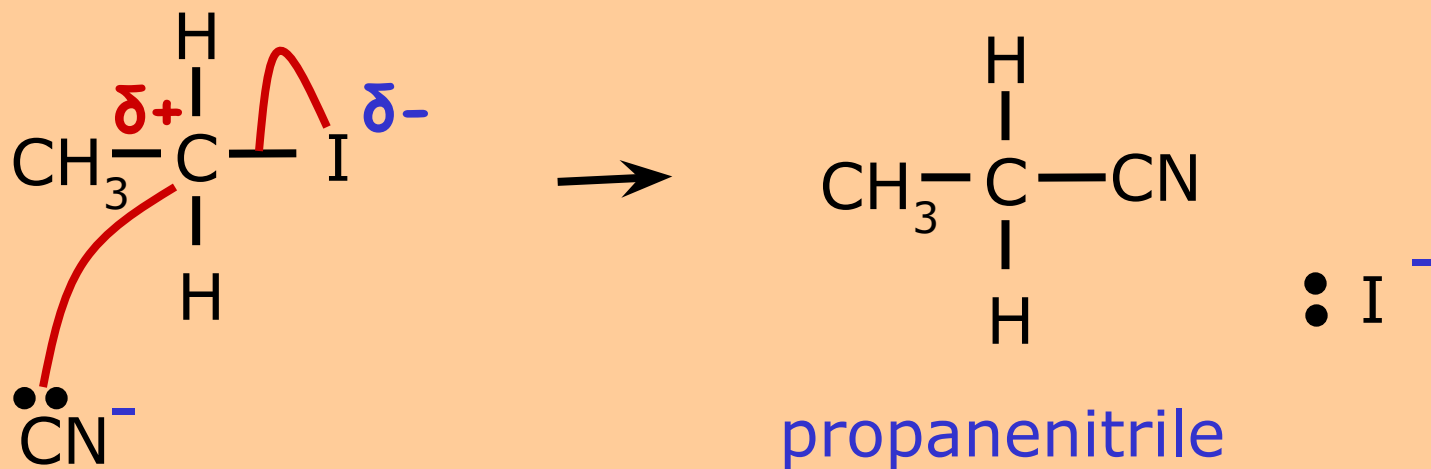
mechanism





Nucleophilic substitution mechanism

cyanide ion with iodoethane (S_N2)



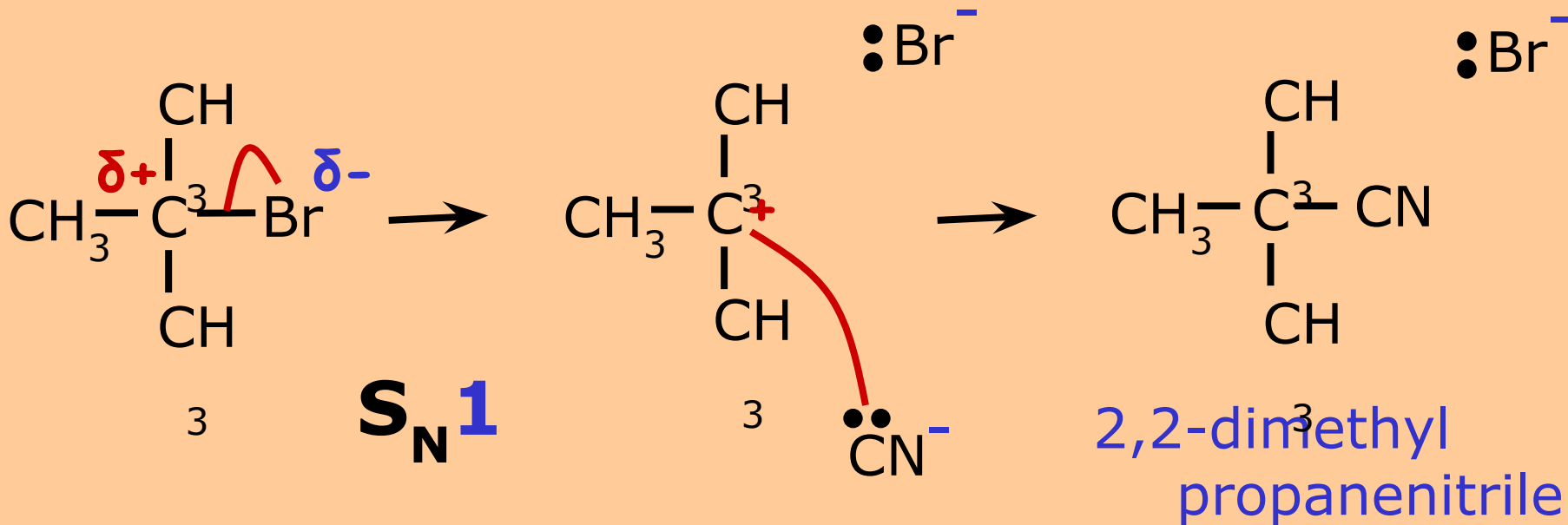
S_N2

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)



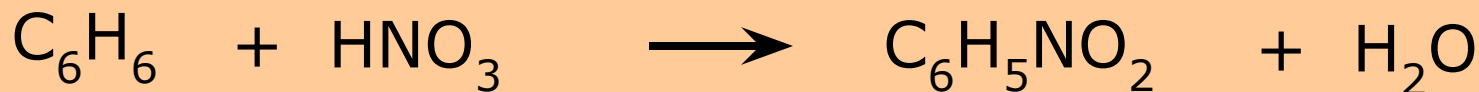
S (substitution) **N** (nucleophilic) **1** (species reacting in the slowest step)

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

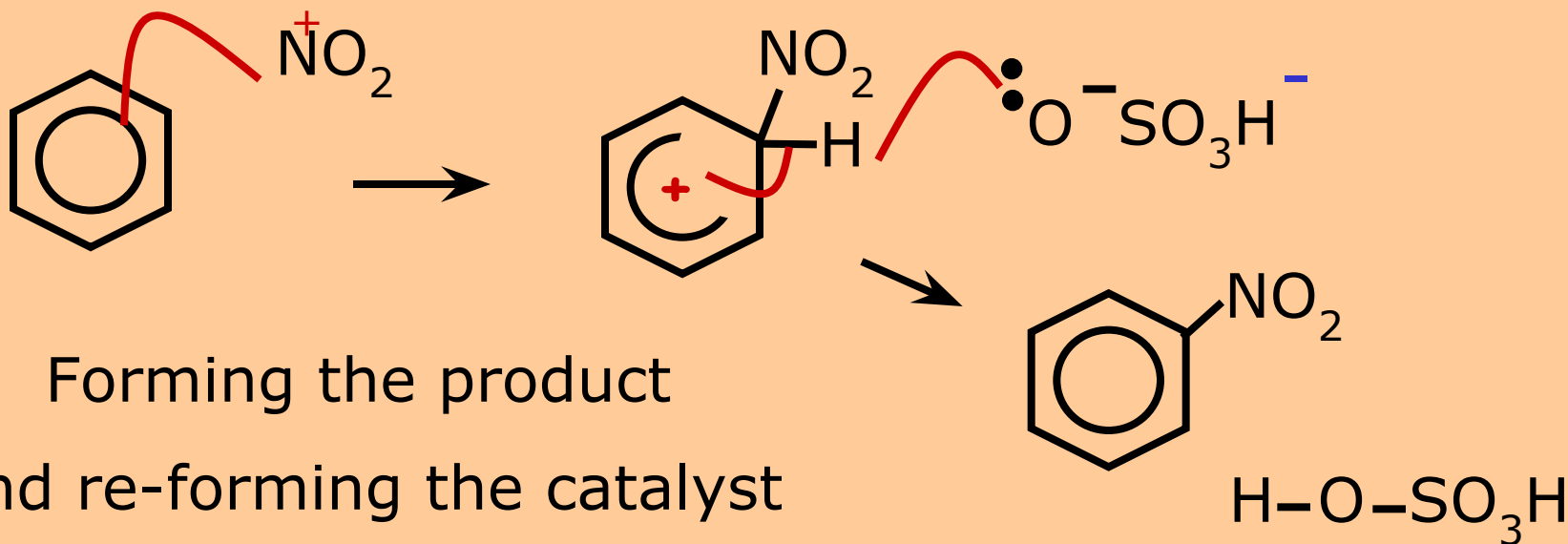
mechanism

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

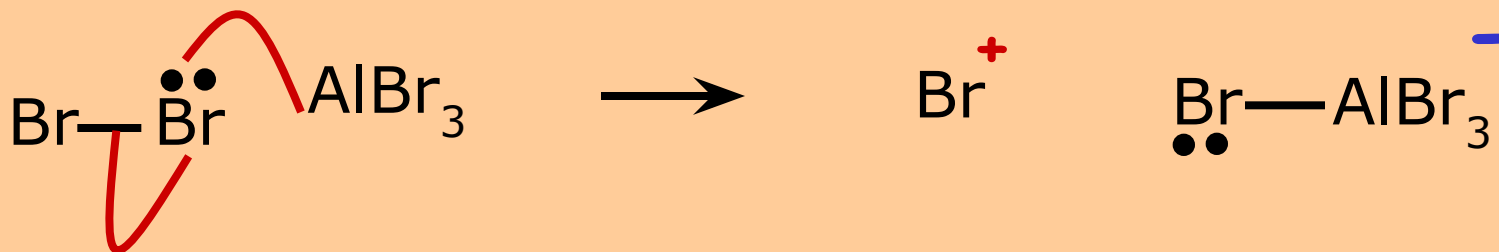
Conditions / Reagents

Br_2 **and** anhydrous AlBr_3

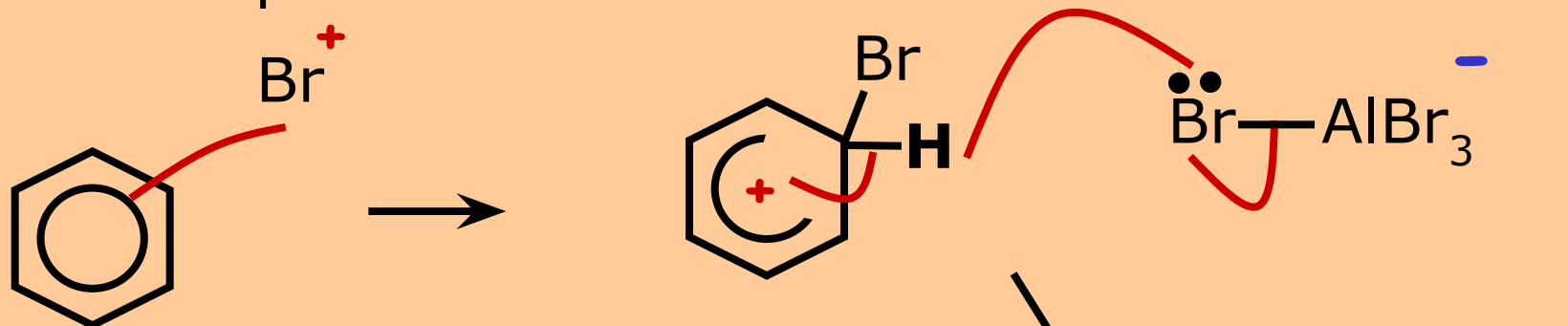
25°C

Electrophilic substitution mechanism

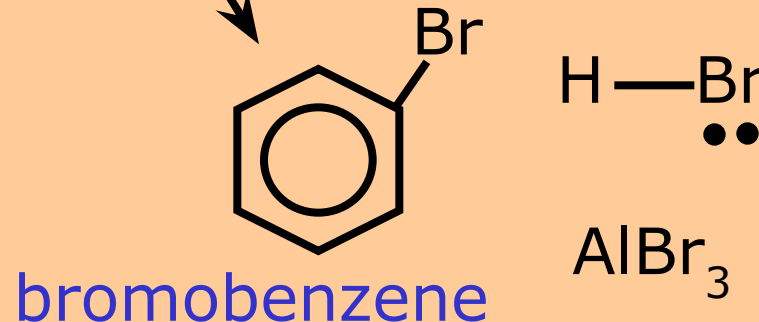
1. Formation of the electrophile



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

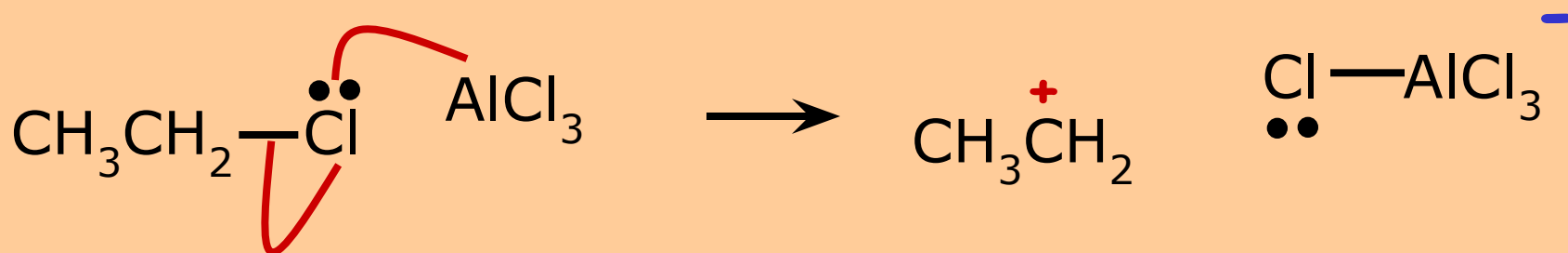
With chloroethane

overall reaction equation



Three steps in electrophilic substitution mechanism

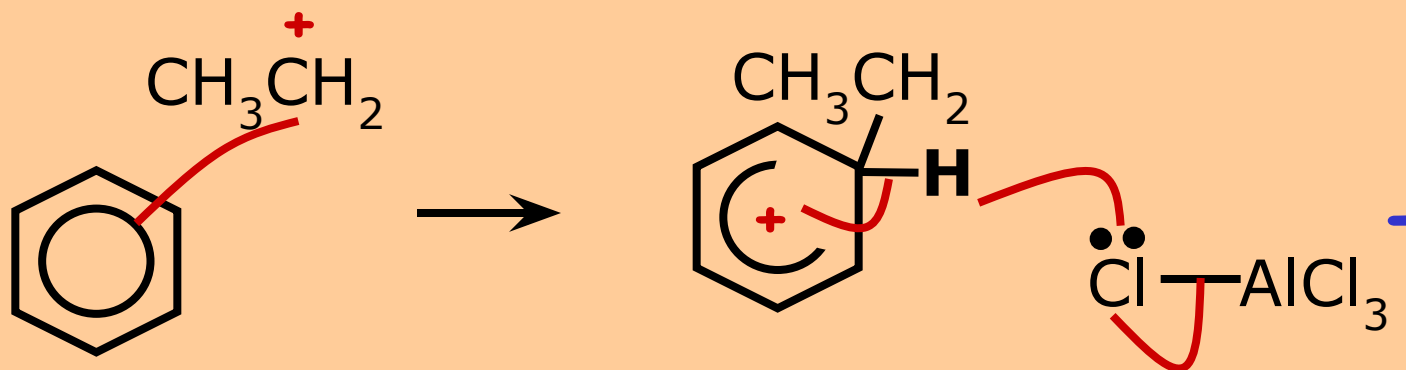
1. Formation of the electrophile (a **carbocation**)



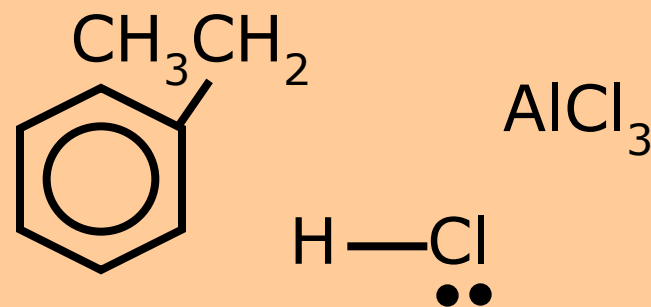


Alkylation electrophilic substitution mechanism 2

2. Electrophilic attack on benzene



3. Forming the product and re-forming the catalyst



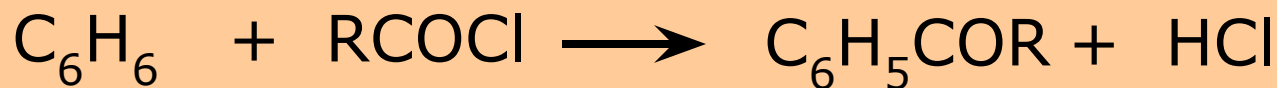
ethylbenzene



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

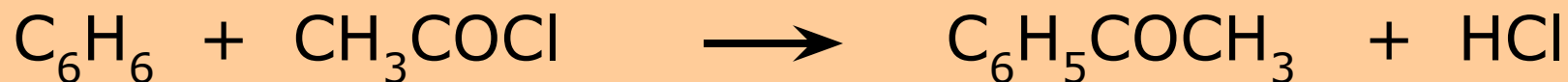
RCOCl (acyl chloride) **and** anhydrous AlCl_3

50 °C



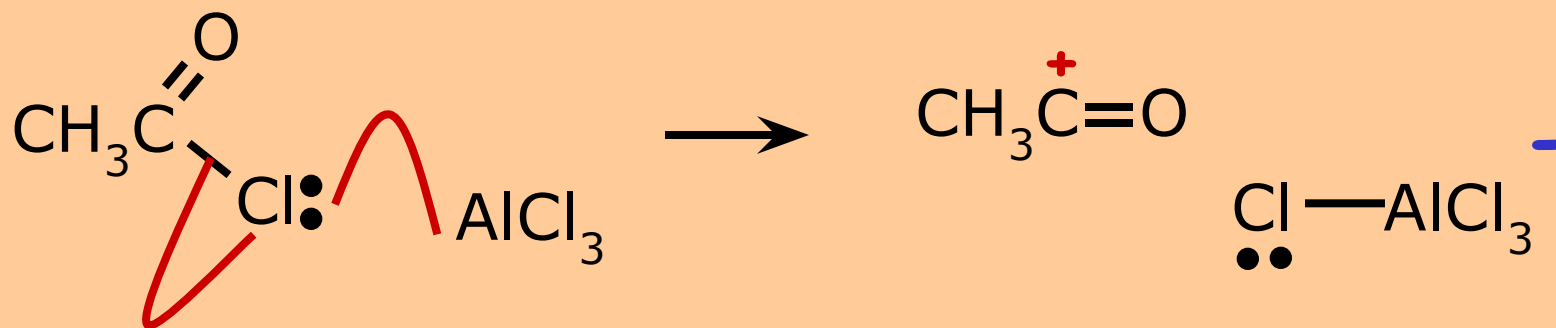
Acylation example

With ethanoyl chloride **overall reaction equation**



Three steps in electrophilic substitution mechanism

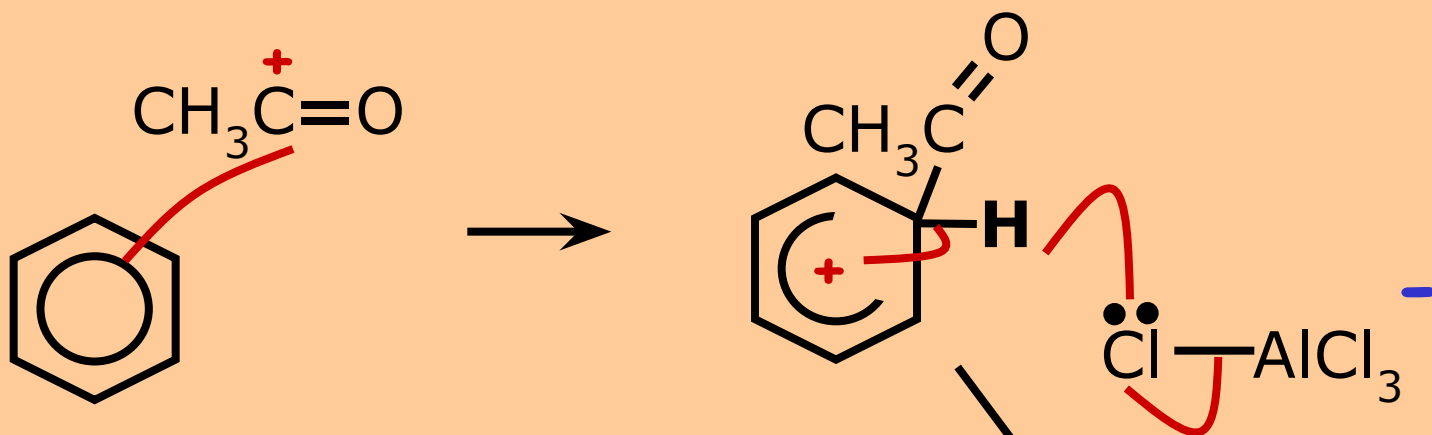
1. Formation of the electrophile (an **acylium** ion)





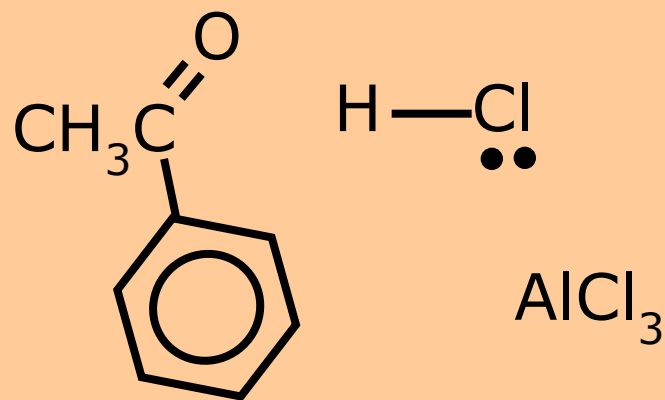
Acylation electrophilic substitution mechanism 2

2. Electrophilic attack on benzene



3. Forming the products

and re-forming the catalyst

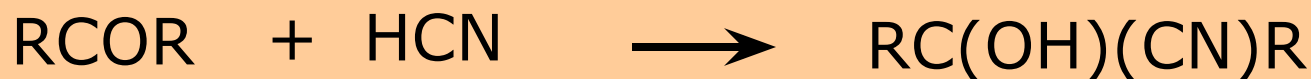


phenylethanone



Nucleophilic Addition

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



Conditions / Reagents

NaCN (aq) and H₂SO₄(aq) **supplies H⁺**
supplies the CN⁻ nucleophile

Room temperature and pressure

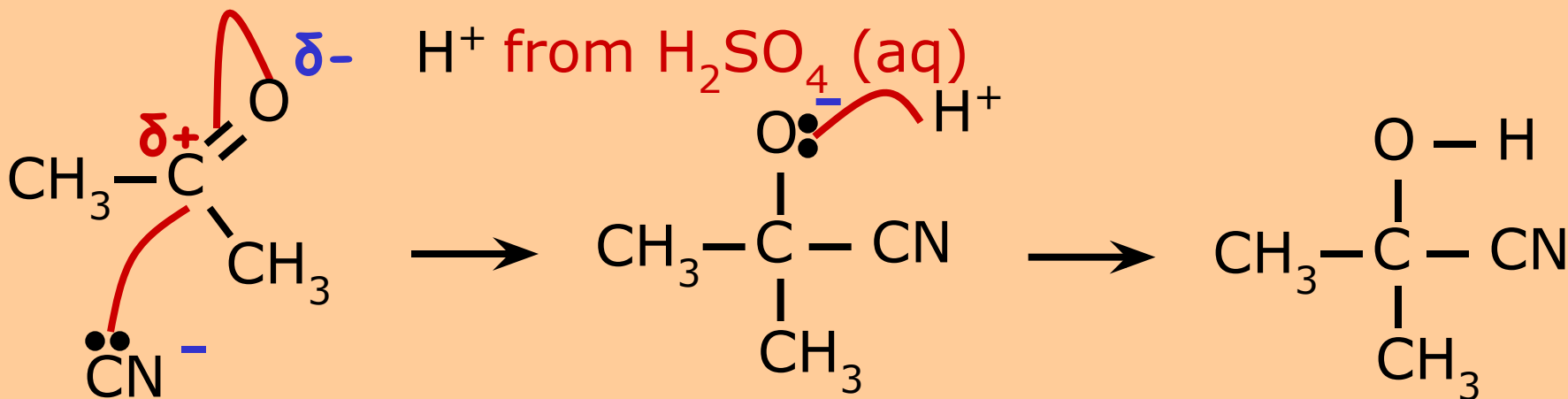


Nucleophilic Addition Mechanism

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.

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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