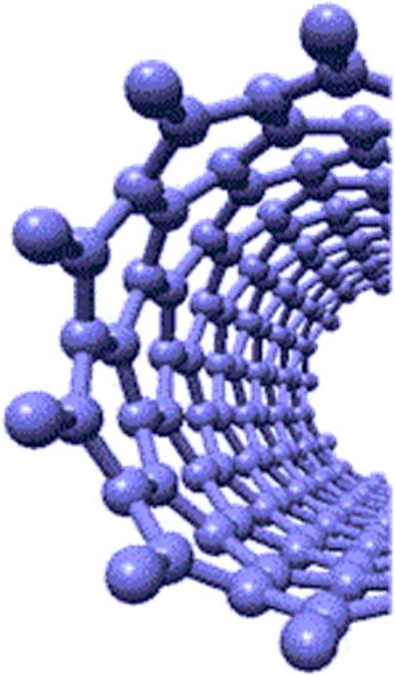
esf european social fund in the czech republic
EUROPEAN UNION
MINISTRY OF EDUCATION, YOUTH AND SPORTS
OP Education for Competitiveness
INVESTMENTS IN EDUCATION DEVELOPMENT

Innovation and Development of Study Field Nanomaterials at the Technical University of Liberec

nano.tul.cz



These materials have been developed within the ESF project: Innovation and development of study field Nanomaterials at the Technical University of Liberec

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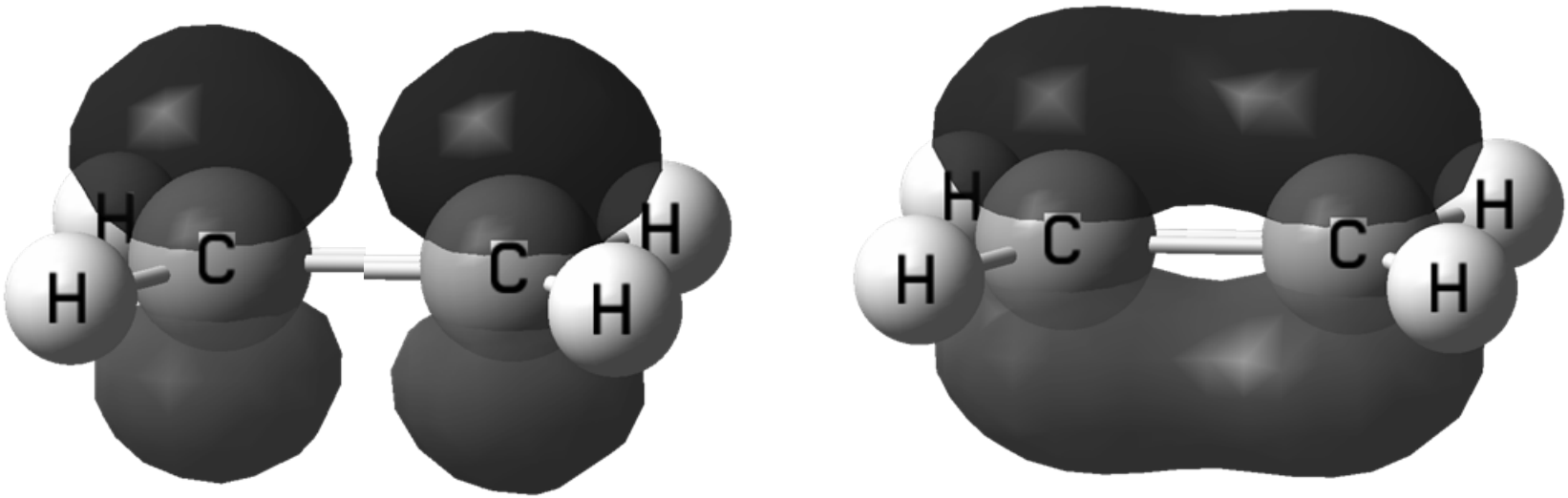
Alkenes – addition reactions

- alkenes (double bonds) A_E
- reactivity,
- additions (electrophilic) scope and synthetic applications,
- substitutions.

Alkenes

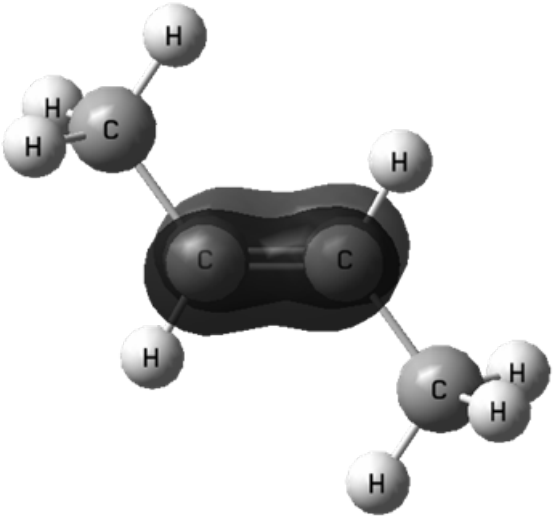
π-electrons are responsible for reactivity of alkenes

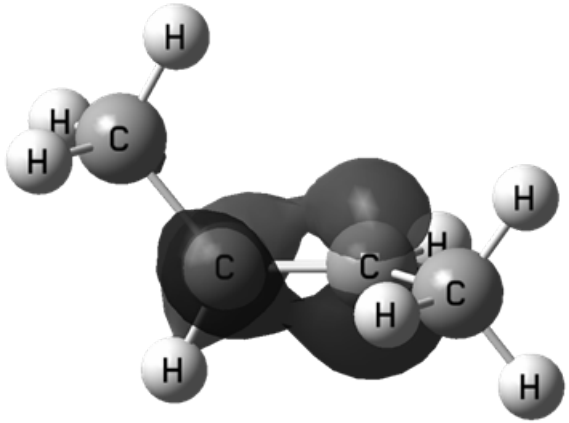


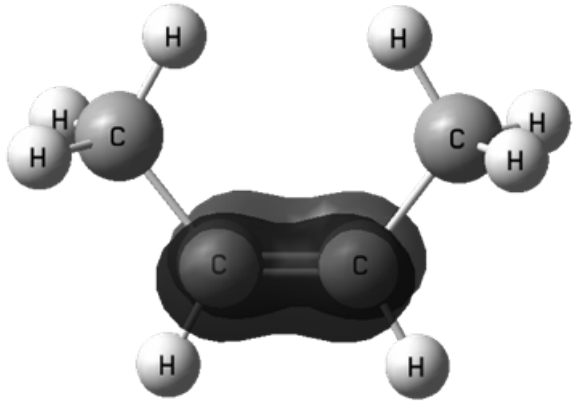
Organic Chemistry – functional groups

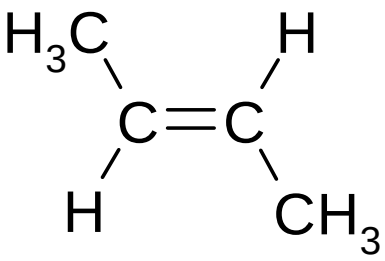
Alkenes

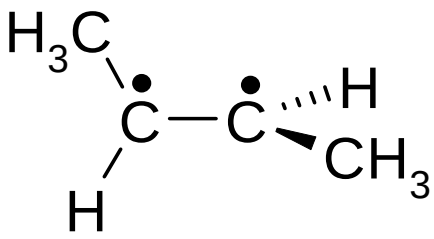
π-electrons in *cis*- to *trans*- transformation

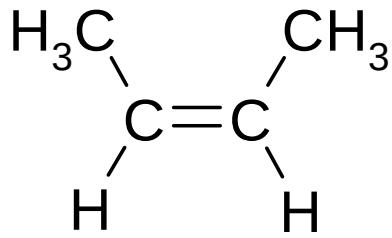








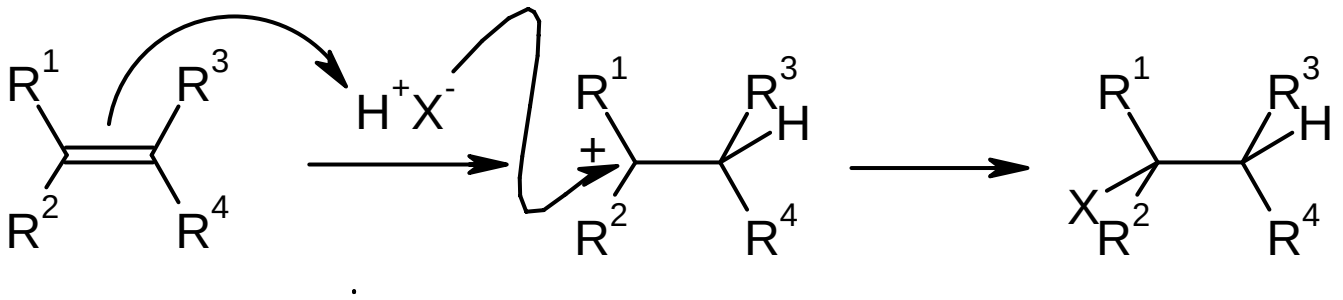




Alkenes

Addition electrophilic

- the most important alkene´s type od reaction
- protic reagents – easily understandable



X = F, Cl, Br, I, OSO_3H

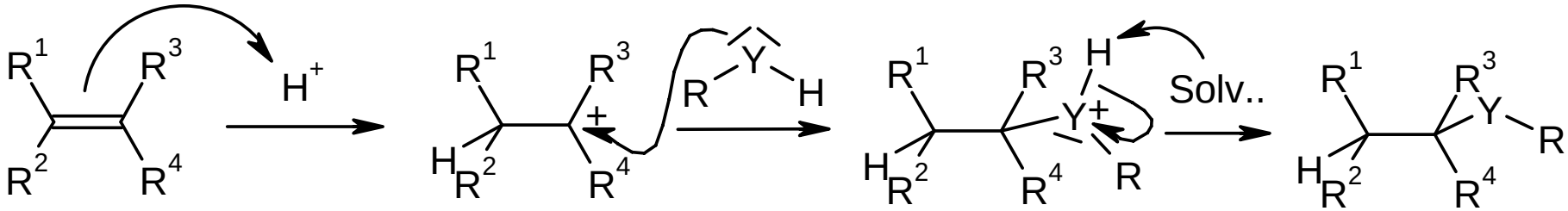
Reaction of alkenes with protic reagents

Organic Chemistry – functional groups

Alkenes

Addition electrophilic

- the most important alkene´s type od reaction
- catalysis by mineral acid

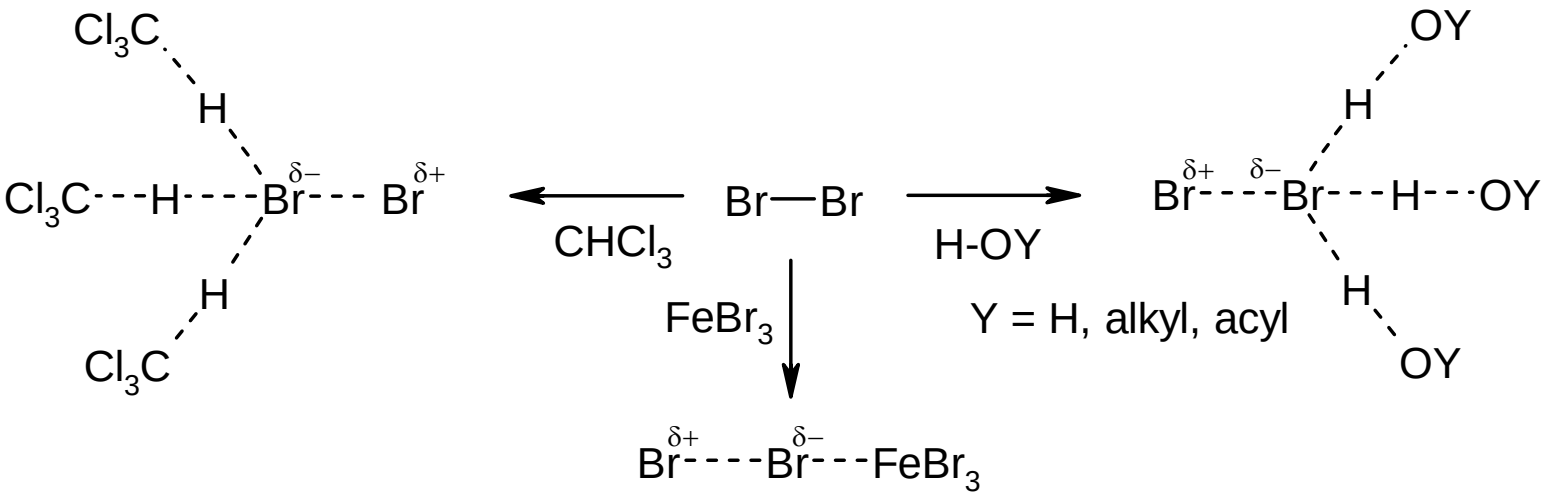


Reaction of alkenes with protic reagents - catalysis by mineral acid

Alkenes

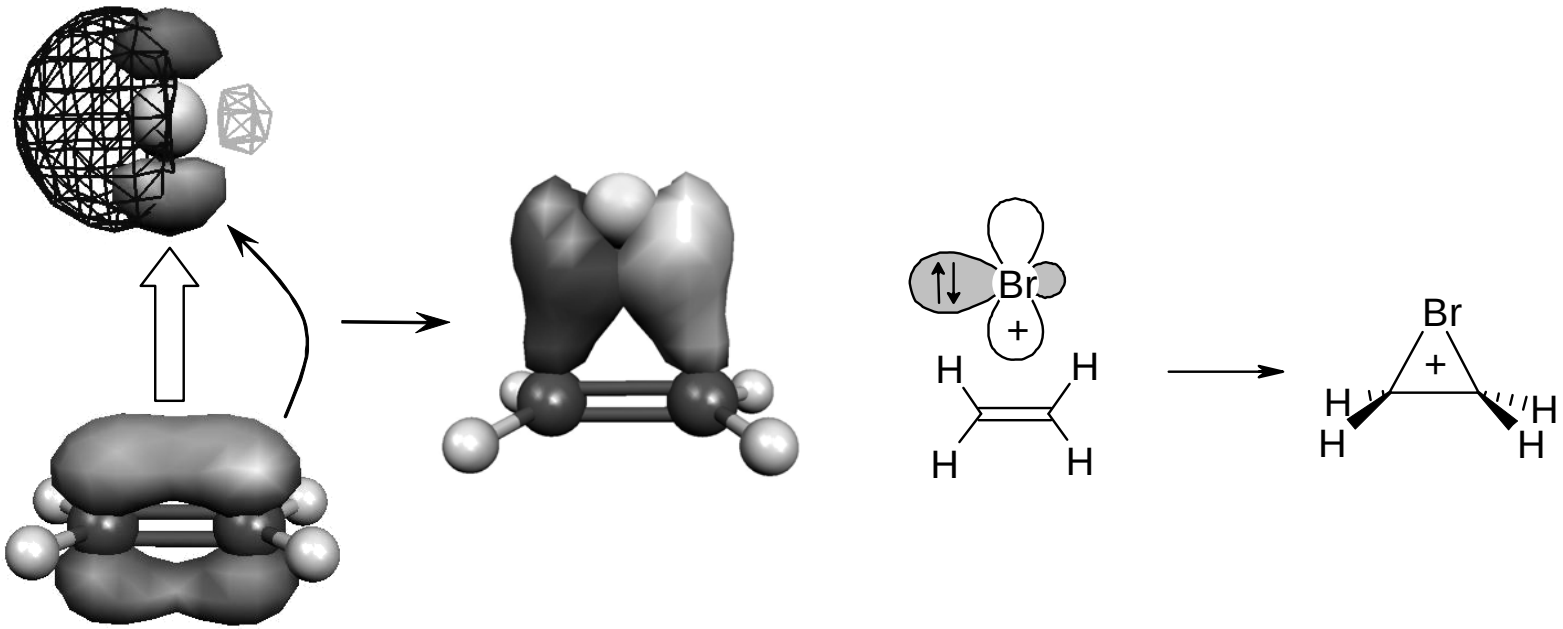
Addition electrophilic

- *in situ* formation of electrophile (nucleophile)
- possible role of Lewis acid



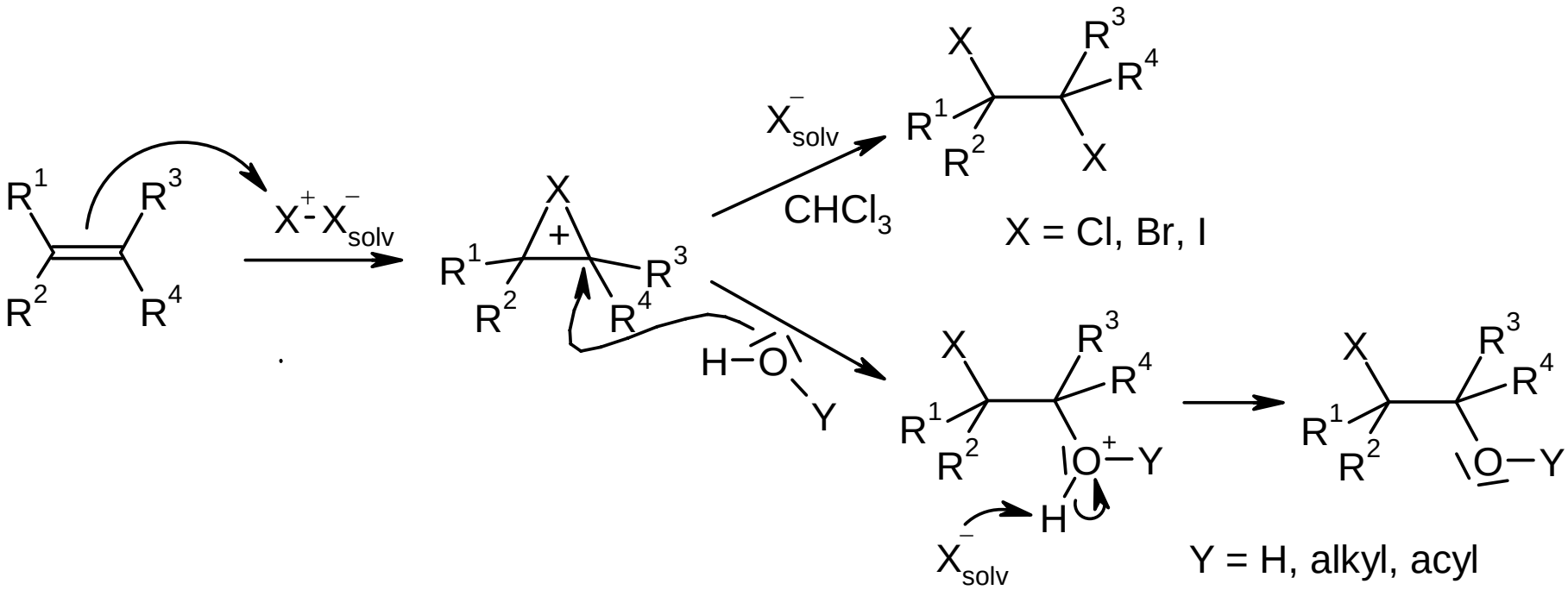
Alkenes

Addition electrophilic – orbital description



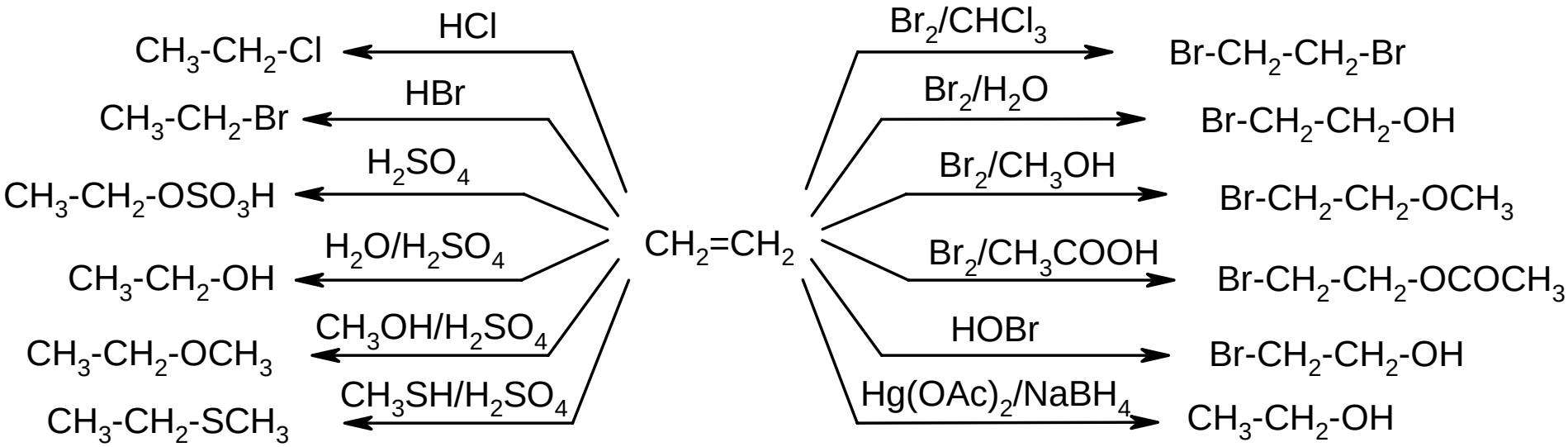
Alkenes

Addition electrophilic – three-centered intermediate



Alkenes

Addition electrophilic – versatile synthetic reaction

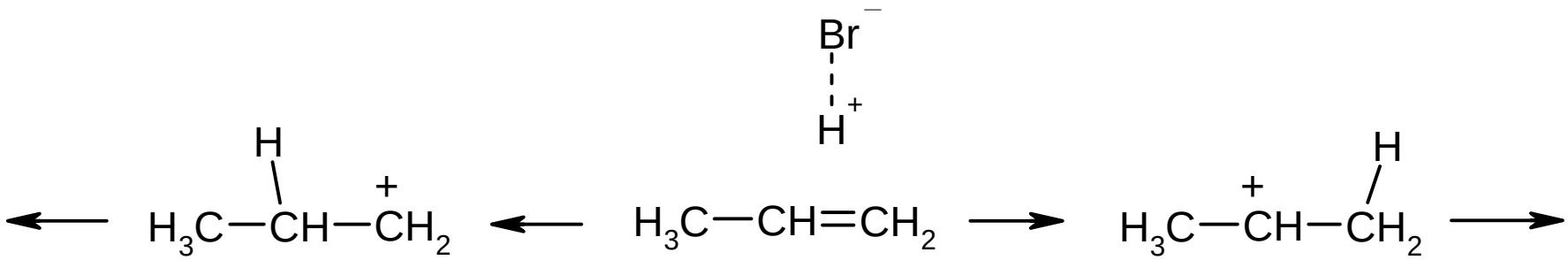


Organic Chemistry – functional groups

Alkenes

Addition electrophilic

- regioselectivity
- Markovnikov rule
- stability of carbocations



methyl < ethyl (primary) < isopropyl (secondary) < tert butyl (tertiary)

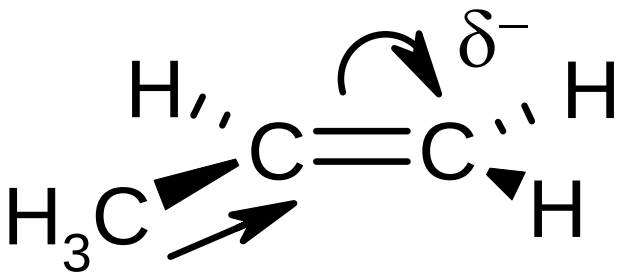
!!! very important !!!

Organic Chemistry – functional groups

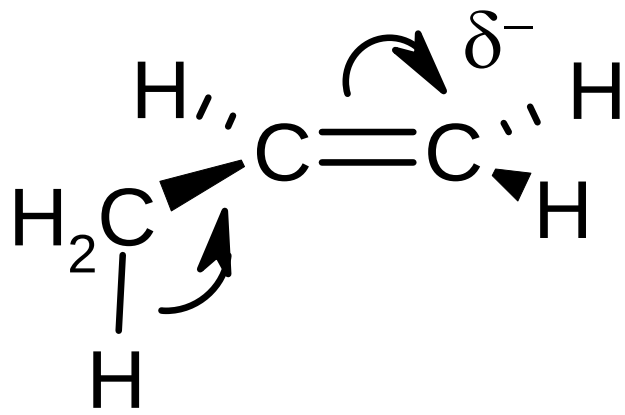
Alkenes

Addition electrophilic

- regioselectivity
- Markovnikov rule
- effect of alkyl(s)



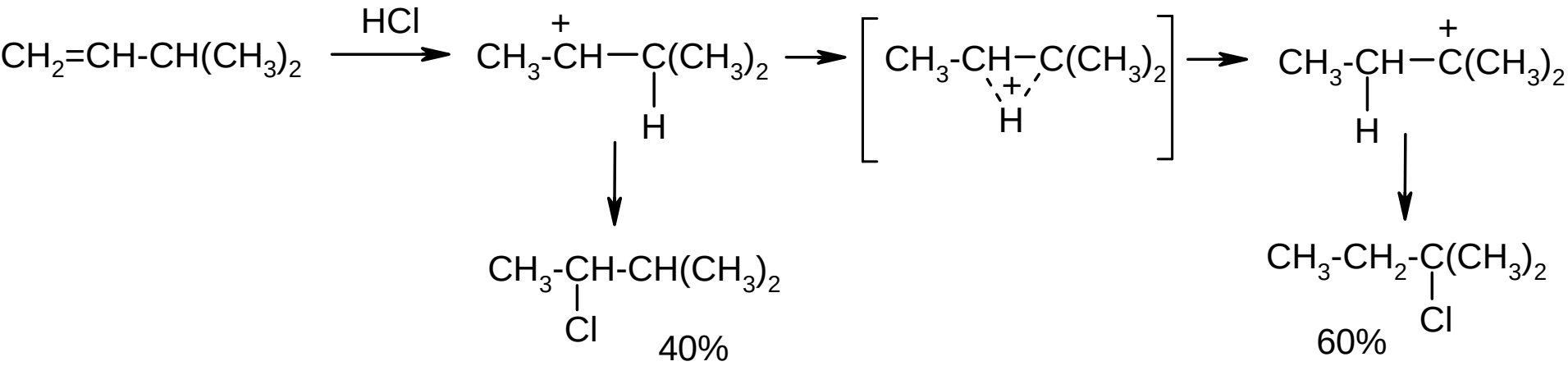
induction



hyperconjugation

Alkenes

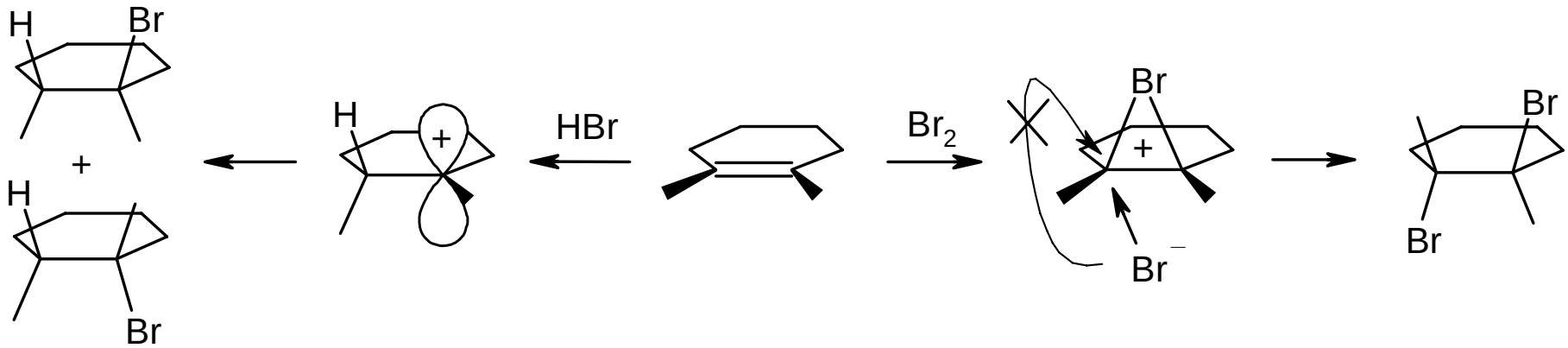
Addition electrophilic
- regioselectivity
- molecular rearrangements



Alkenes

Addition electrophilic - stereochemistry

Easily visible when addition is performed on cyclic alkenes.



Alkenes

Addition radical

Initiation:

$$Br_2 \xrightarrow{h\nu} 2\ Br\bullet$$

Propagation:

$$CH_2{=}CH_2 + Br\bullet \longrightarrow Br\text{-}CH_2\text{-}\dot{C}H_2$$

$$Br\text{-}CH_2\text{-}\dot{C}H_2 + Br_2 \longrightarrow Br\text{-}CH_2\text{-}CH_2\text{-}Br + Br\bullet$$

Termination:

$$2\ Br\text{-}CH_2\text{-}\dot{C}H_2 \longrightarrow Br\text{-}(CH_2CH_2)_2\text{-}Br$$

$$Br\text{-}CH_2\text{-}\dot{C}H_2 + Br\bullet \longrightarrow Br\text{-}CH_2\text{-}CH_2\text{-}Br$$

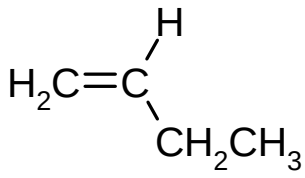
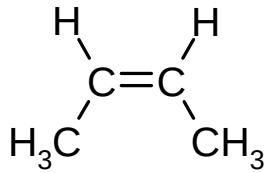
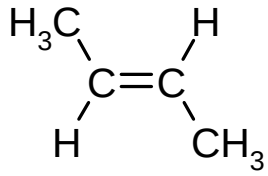
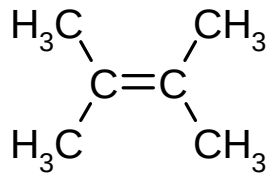
$$2\ Br\bullet \longrightarrow Br_2$$

Organic Chemistry – functional groups

Alkenes

Addition of hydrogen - hydrogenation

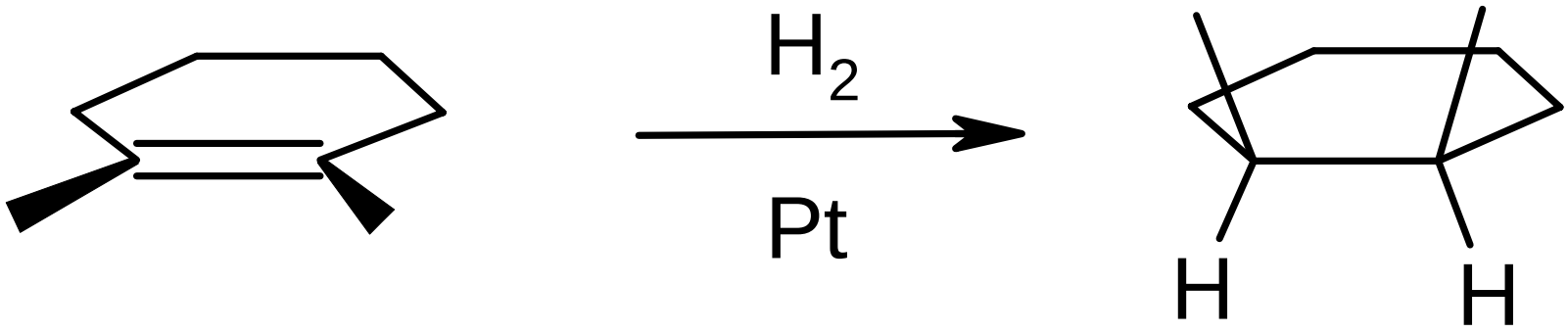
- heterogenous x homogenous catalysis
- reaction on solid surface

alkene					
heat of hydrogenation (kJ/mol)	136	126	119	115	110

Alkenes

Addition of hydrogen - hydrogenation

- heterogenous x homogenous catalysis
- reaction on solid surface

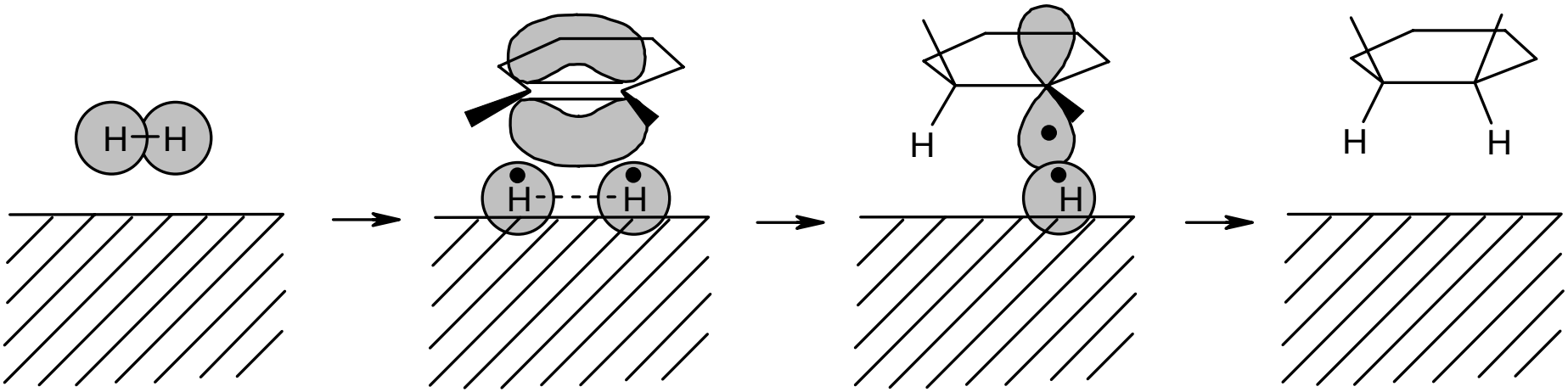


Organic Chemistry – functional groups

Alkenes

Addition of hydrogen - hydrogenation

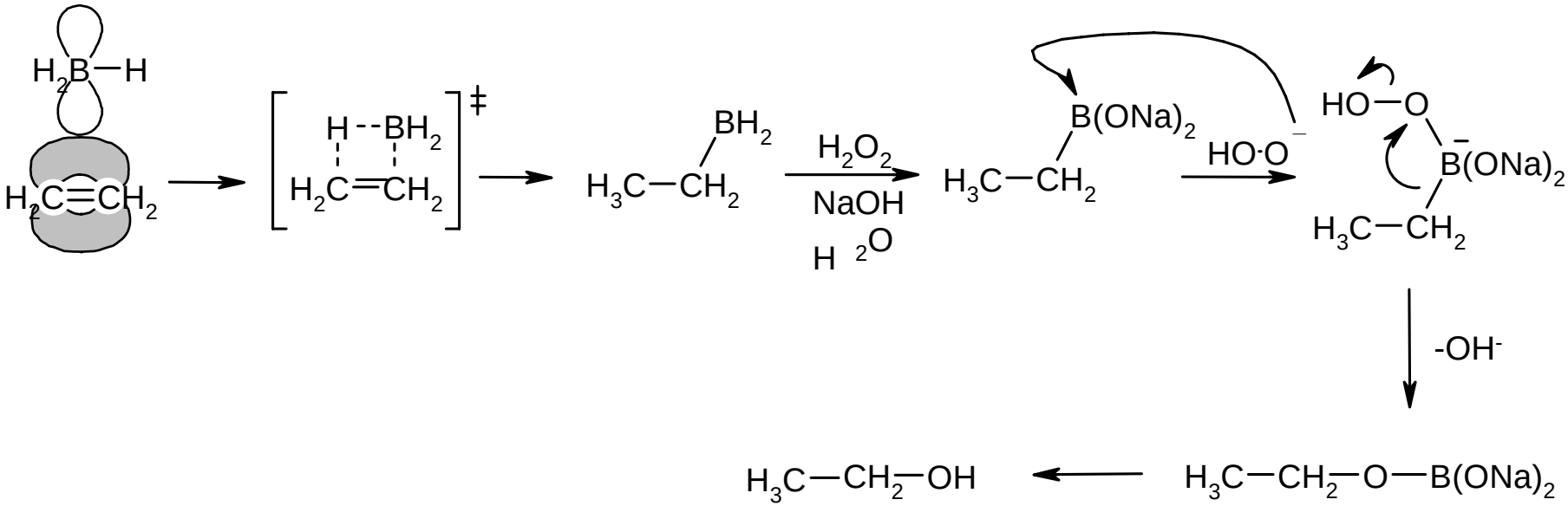
- heterogenous x homogenous catalysis
- reaction on solid surface



Alkenes

Addition of borane - hydroboration

Regioselectivity of hydration

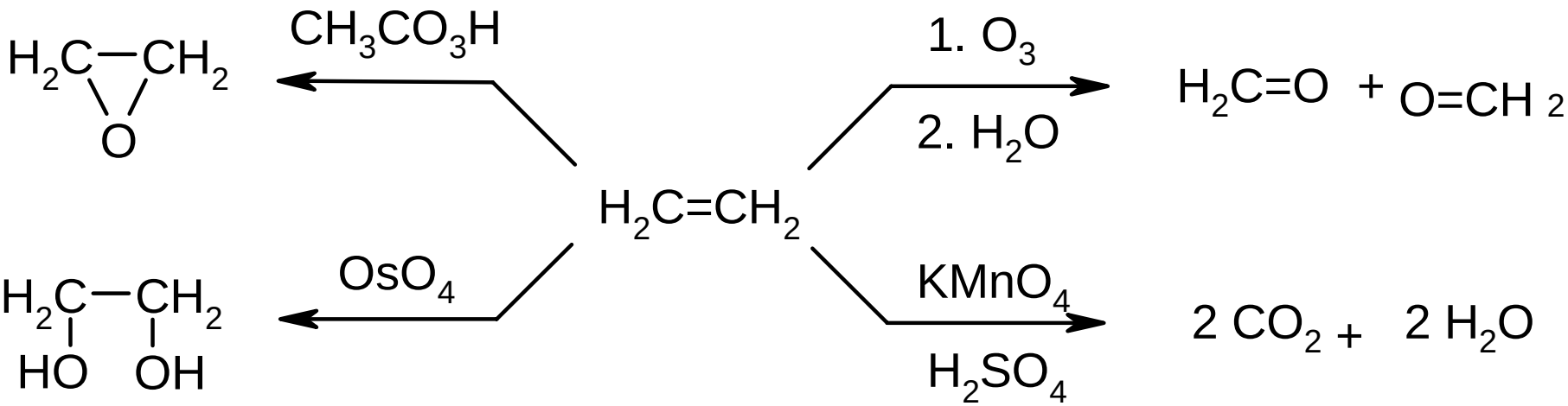


Organic Chemistry – functional groups

Alkenes

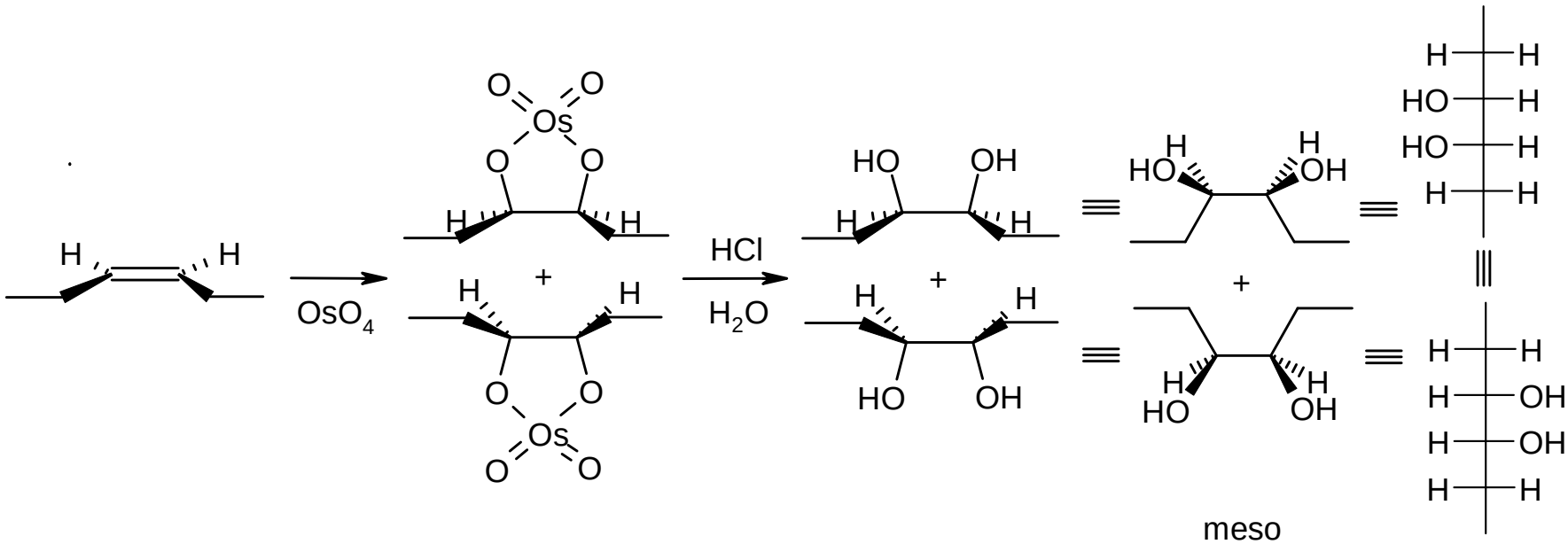
Addition reaction

Oxidation (cleavage) of double bond



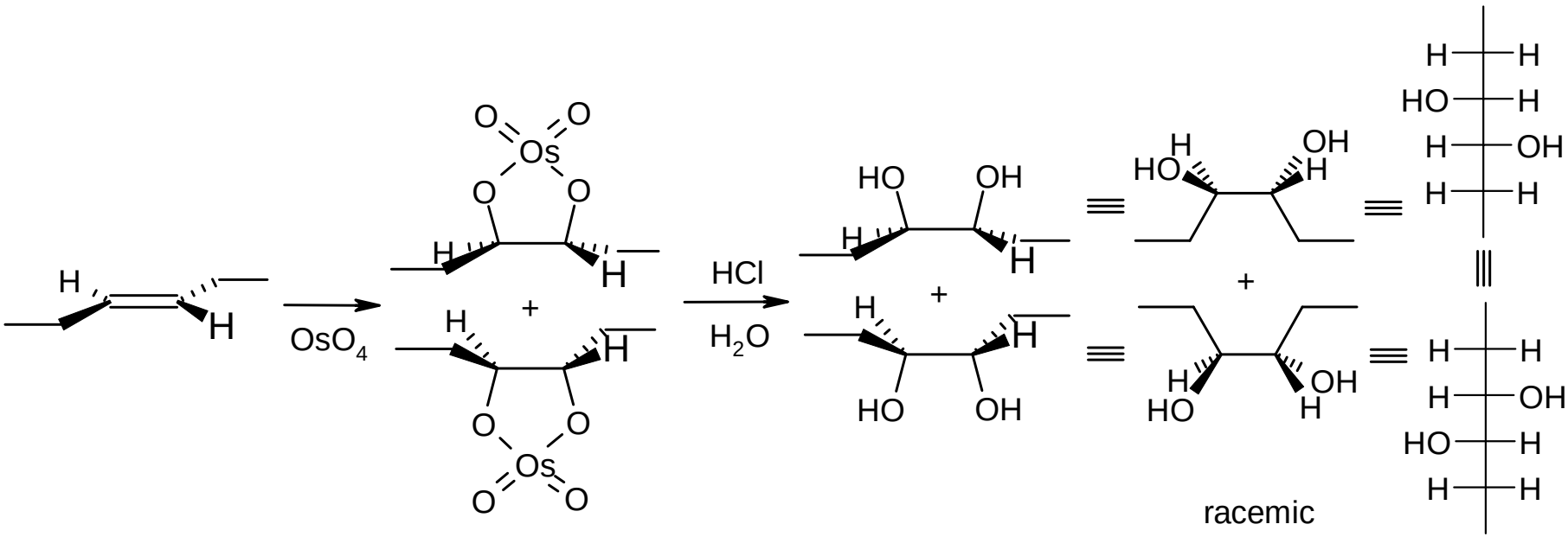
Alkenes

Addition reaction - stereochemistry



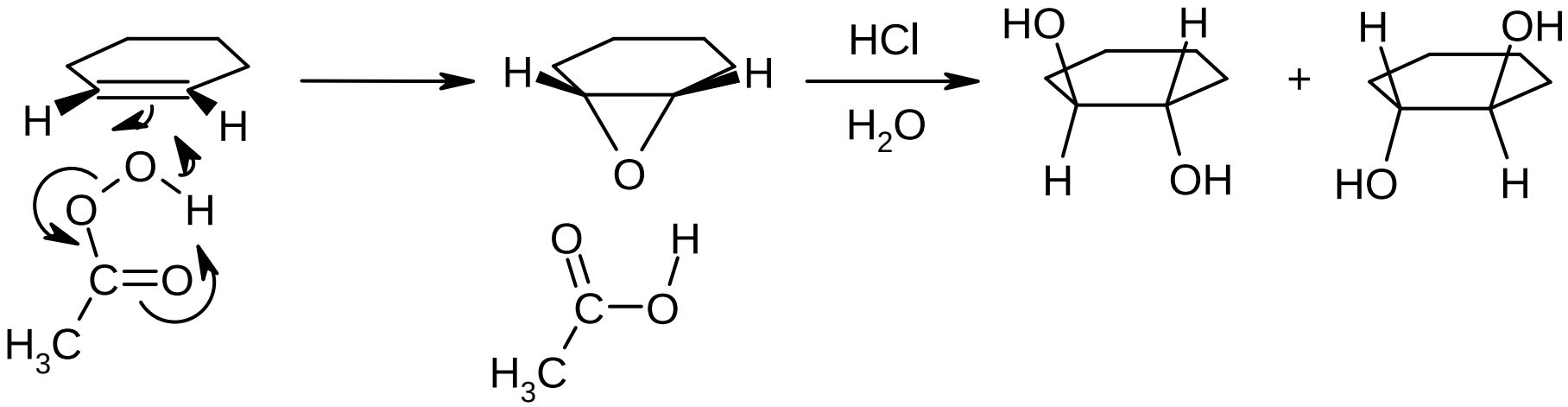
Alkenes

Addition reaction - stereochemistry



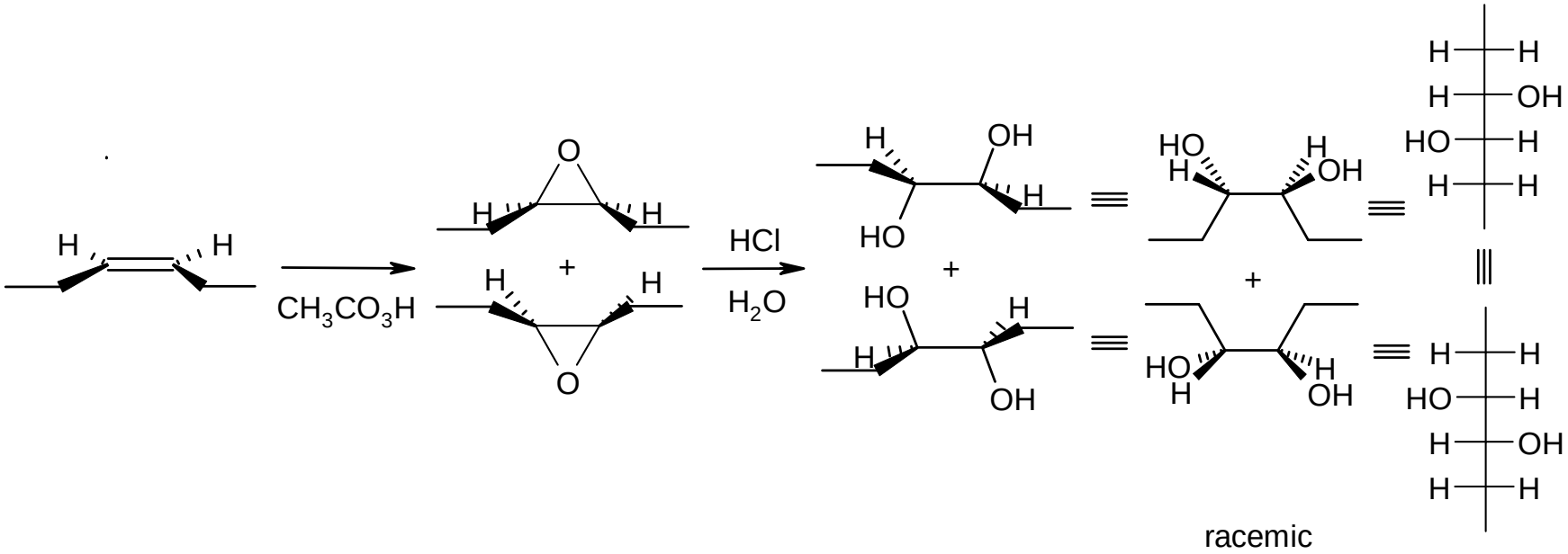
Alkenes

Addition reaction - stereochemistry



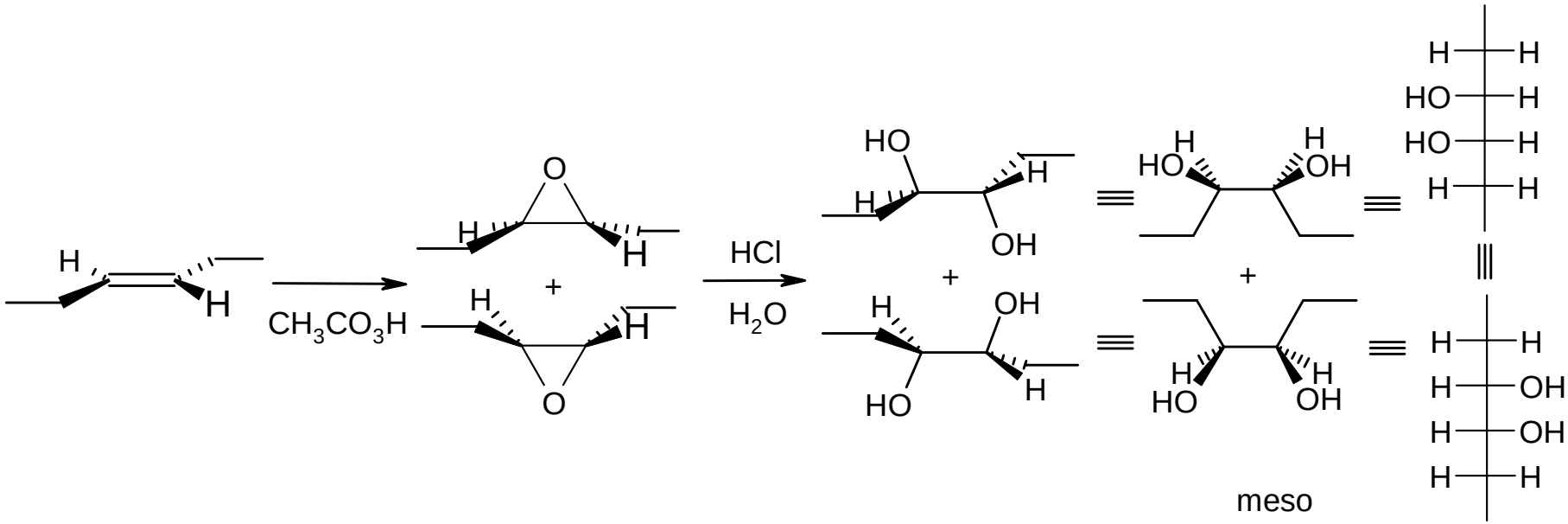
Alkenes

Addition reaction - stereochemistry



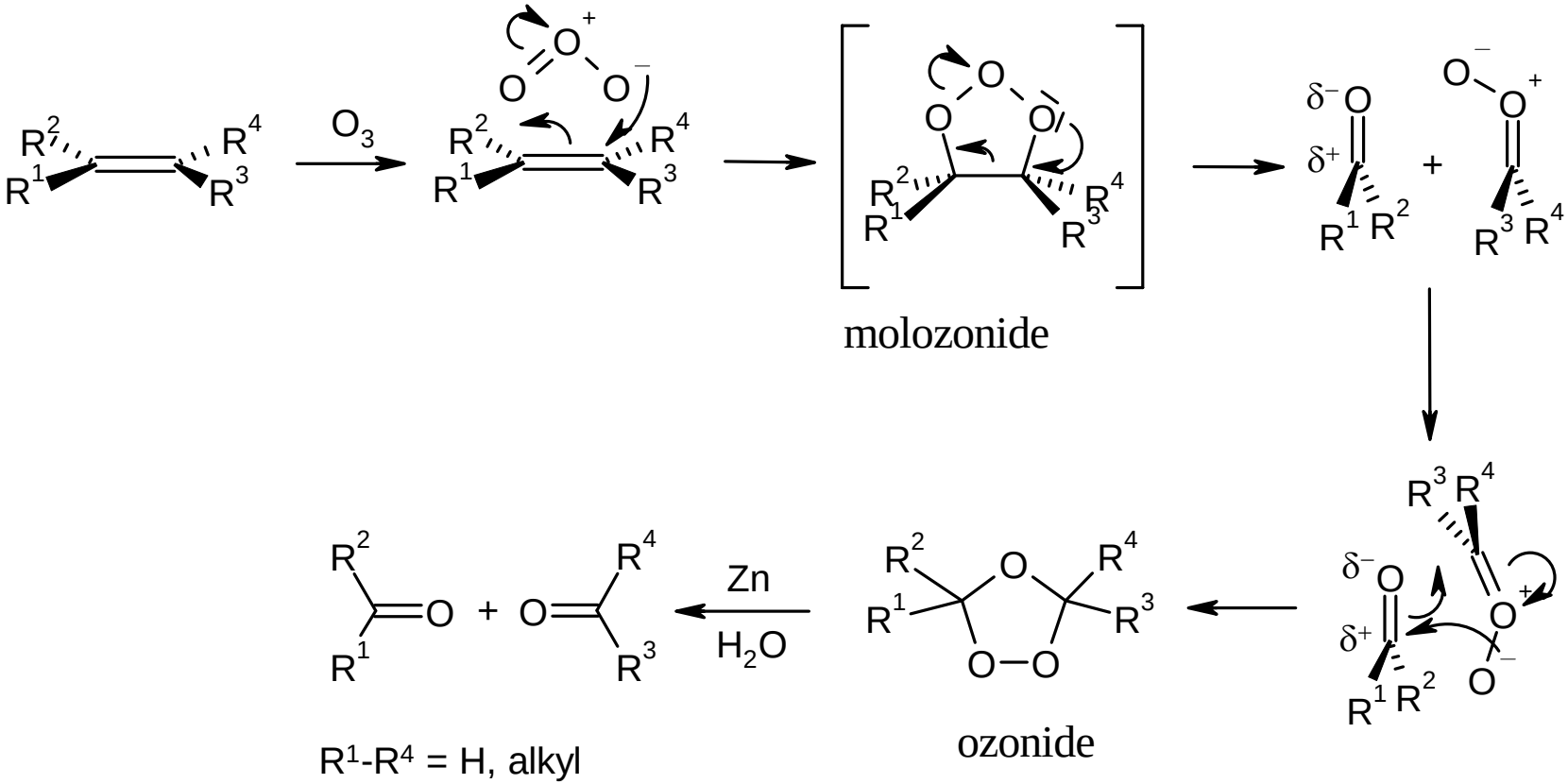
Alkenes

Addition reaction - stereochemistry



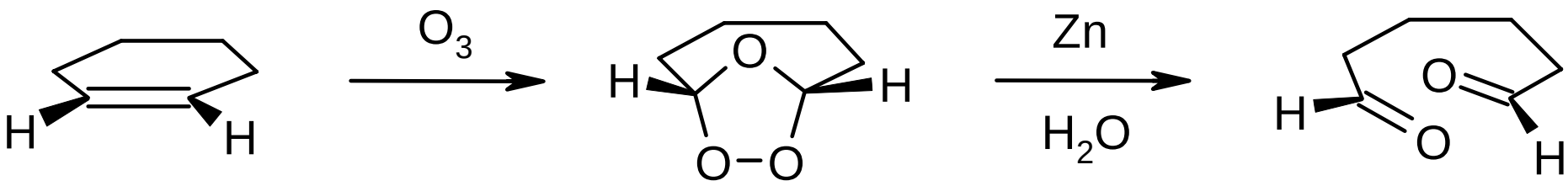
Alkenes

Addition reaction - cleavage



Alkenes

Addition reaction – cleavage – synthetic application



Alkenes

Substitution(S_R) – synthetically important application