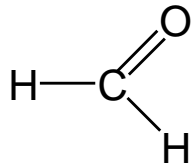
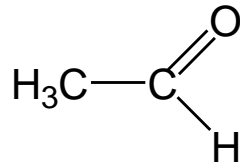


# Aldehyde und Ketone

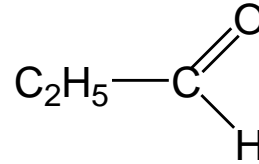
## Aldehyde



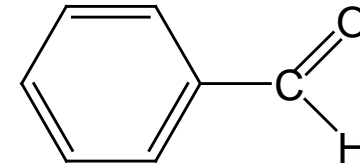
Methanal  
Formaldehyd



Ethanal  
Acetaldehyd

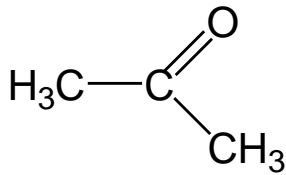


Propanal  
Propionaldehyd

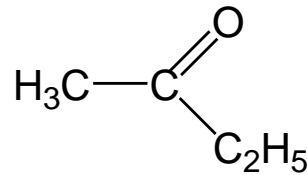


Benzaldehyd

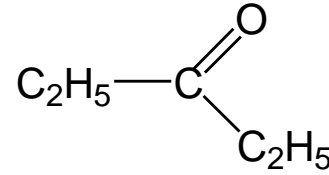
## Ketone



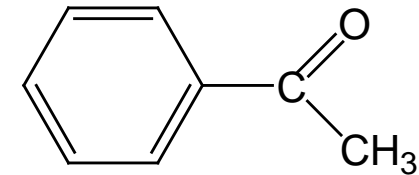
Propanon  
Aceton



2-Butanon

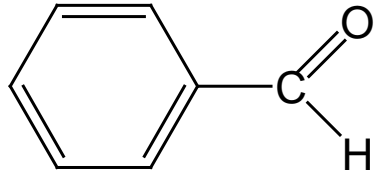


3-Pentanon

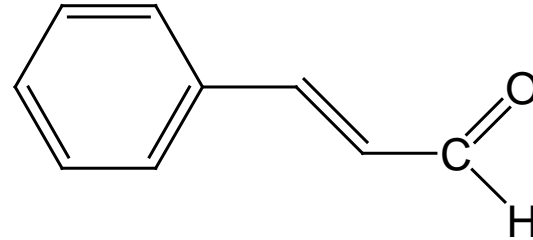


Acetophenon

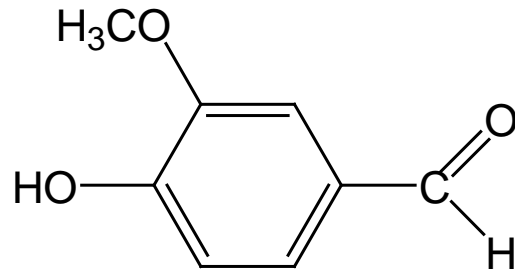
# Natürliche Aldehyde und Ketone



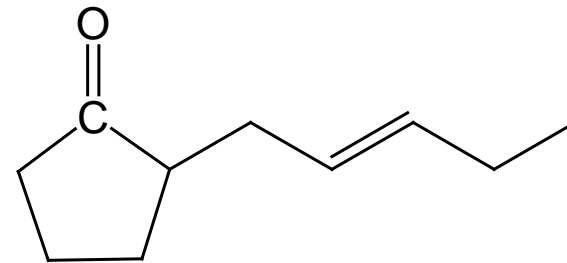
Benzaldehyd  
(Mandelöl)



Zimtaldehyd (Zimt)



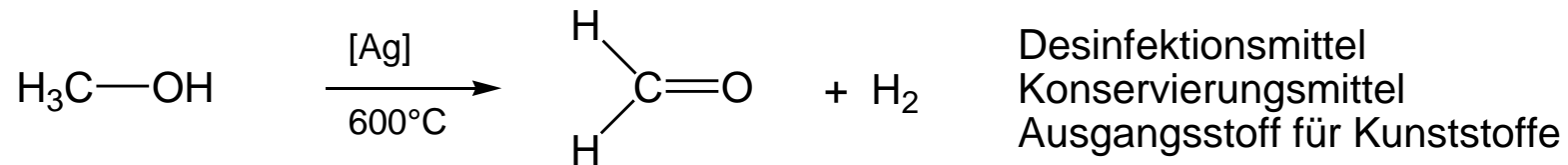
Vanillin  
(Vanilleschote)



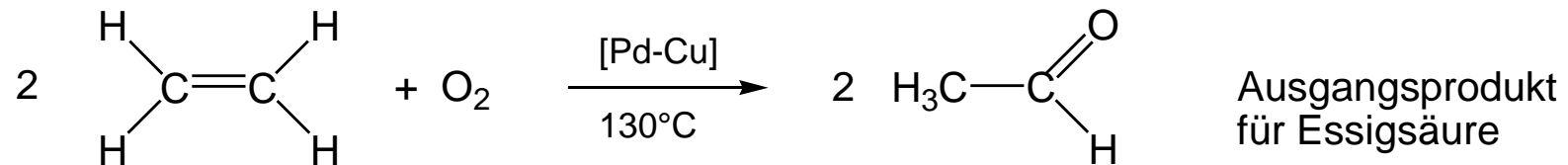
Jasmon  
(Jasminöl)

# Technisch wichtige Aldehyde und Ketone

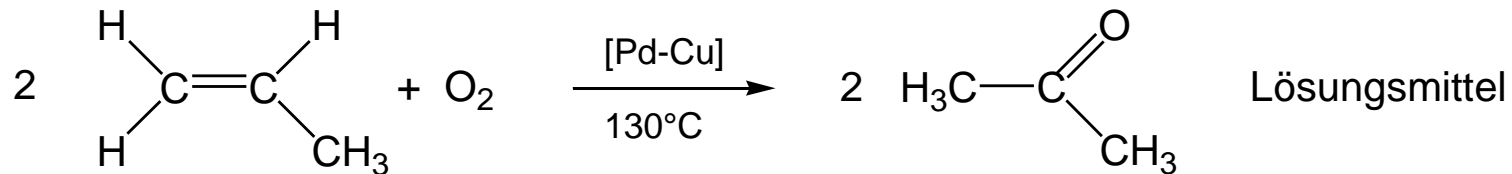
Formaldehyd



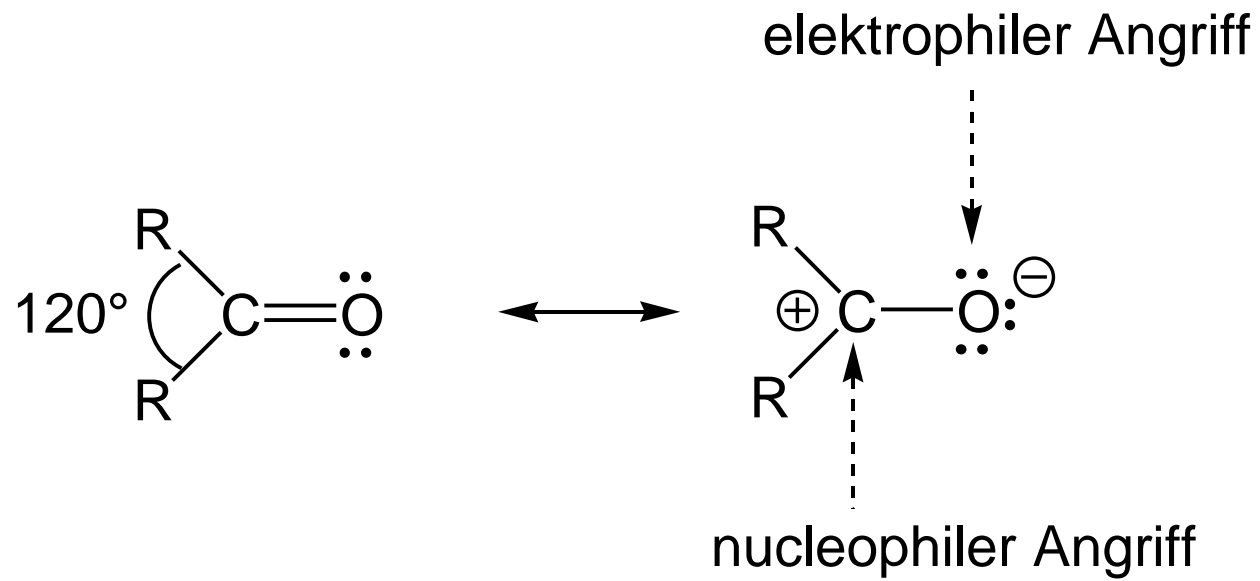
Acetaldehyd



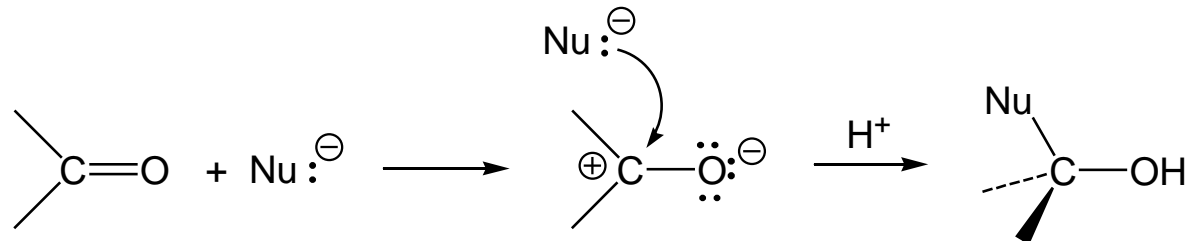
Aceton



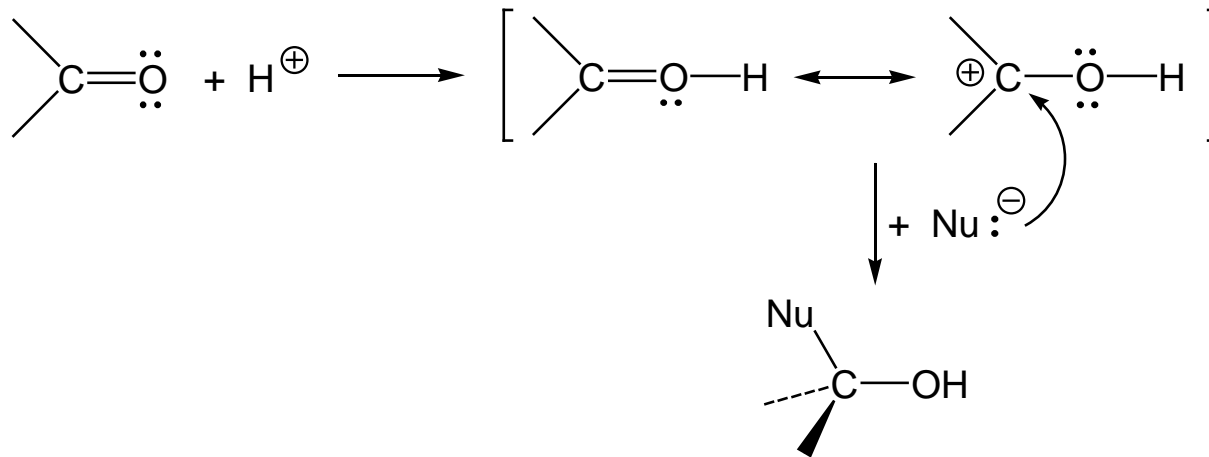
# Die Carbonylgruppe



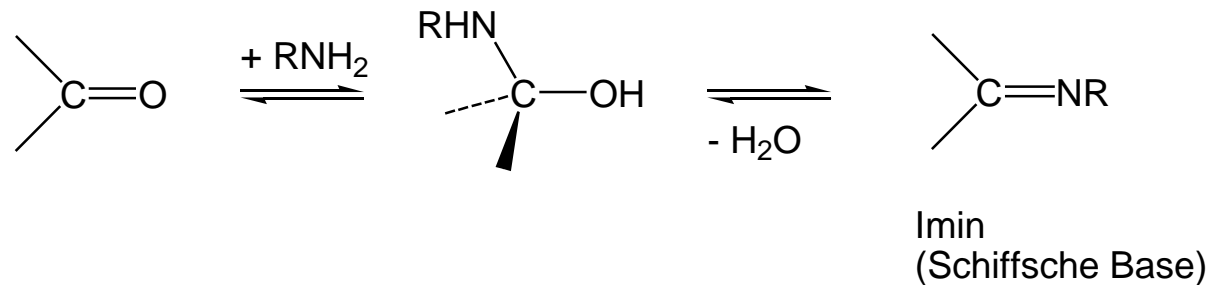
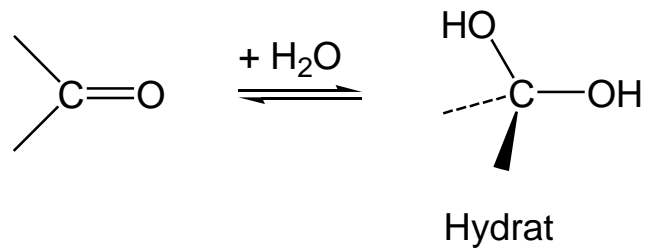
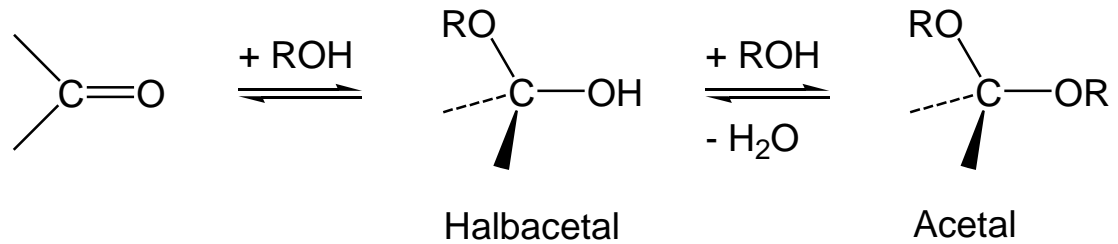
# Nucleophile Addition an eine Carbonylgruppe



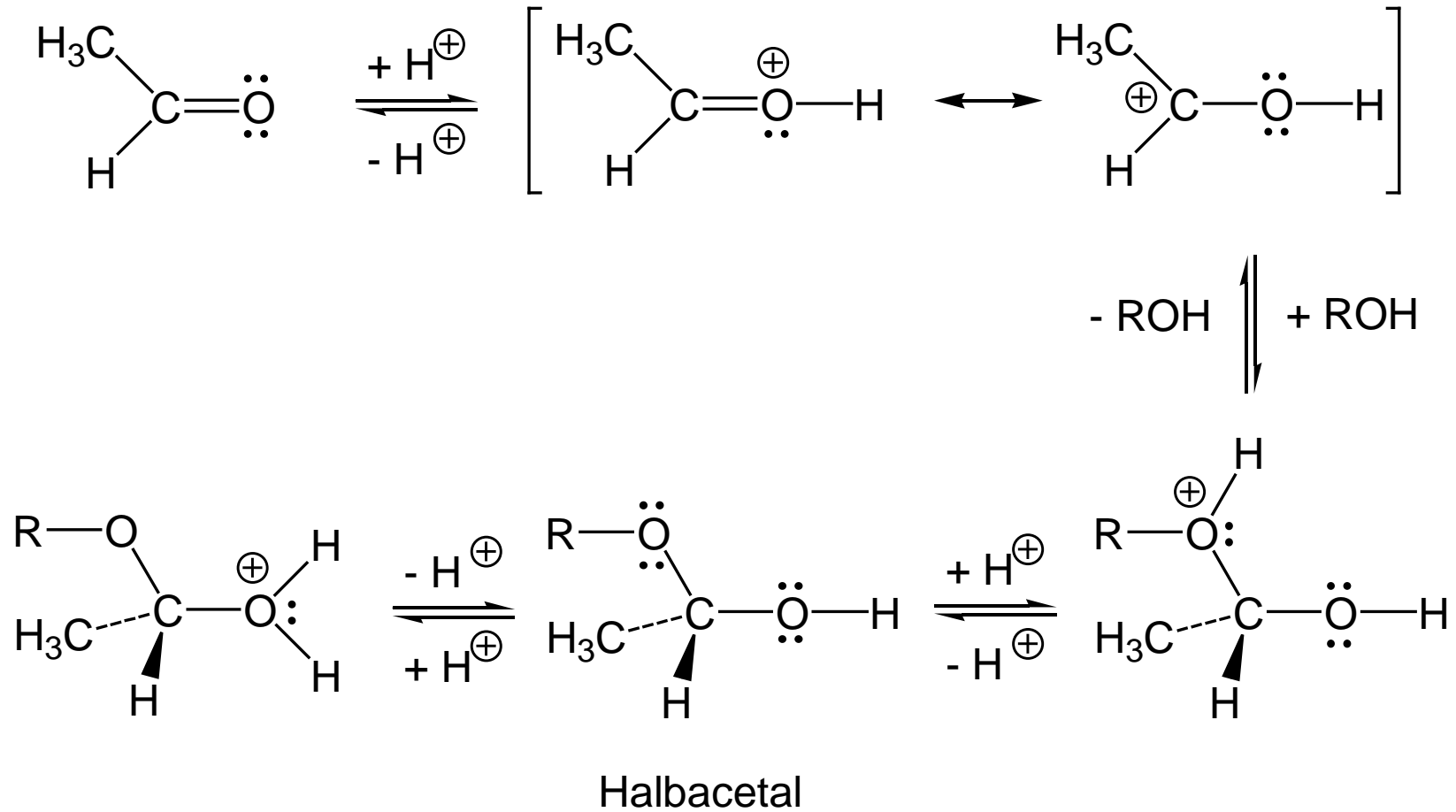
Protonenkatalyse begünstigt die nucleophile Addition:

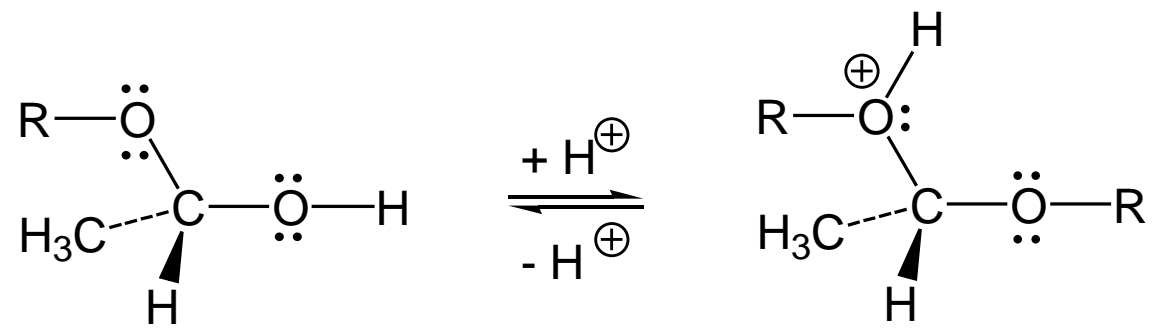
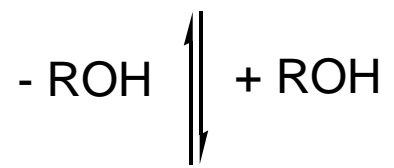
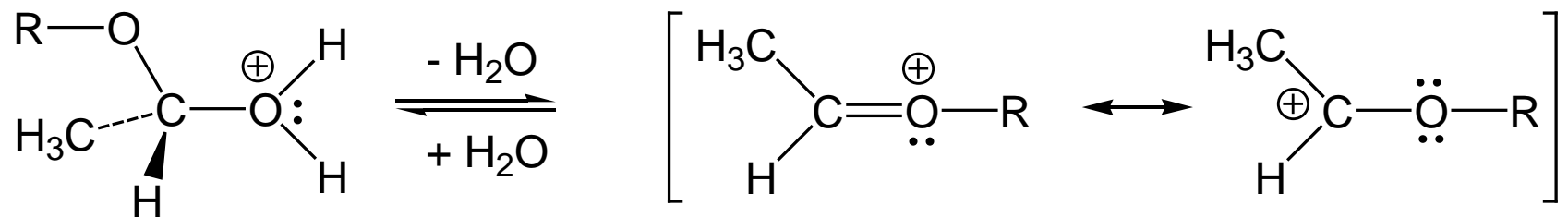


# Nucleophile Addition an Aldehyde und Ketone



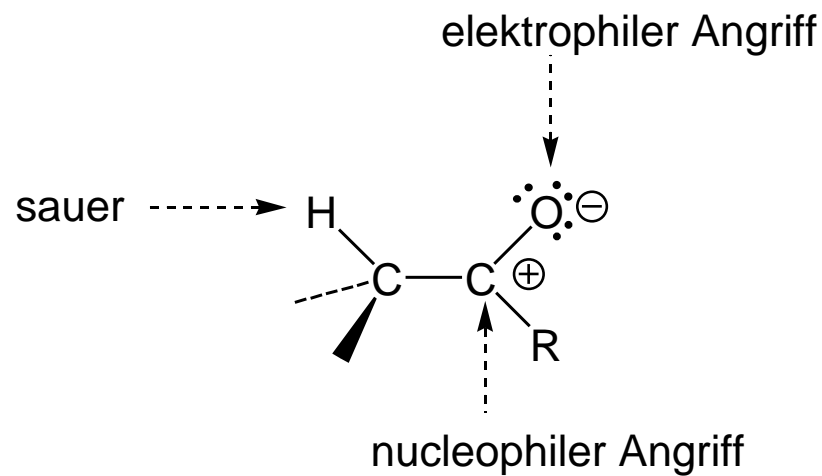
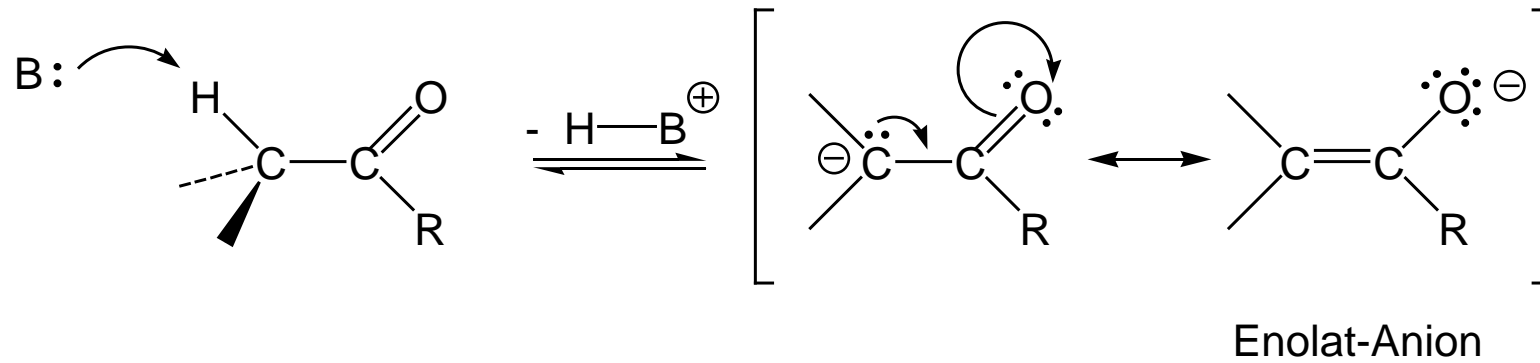
# Protonenkatalysierte Addition von Alkoholen an Acetaldehyd



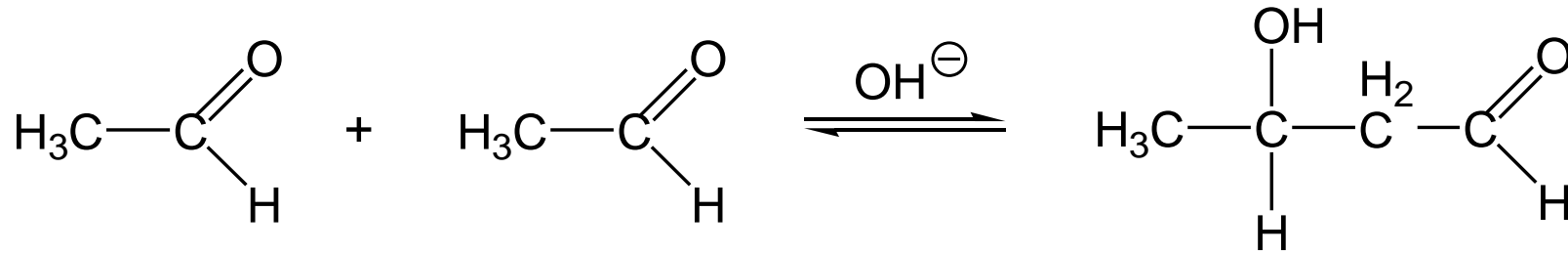


Acetal

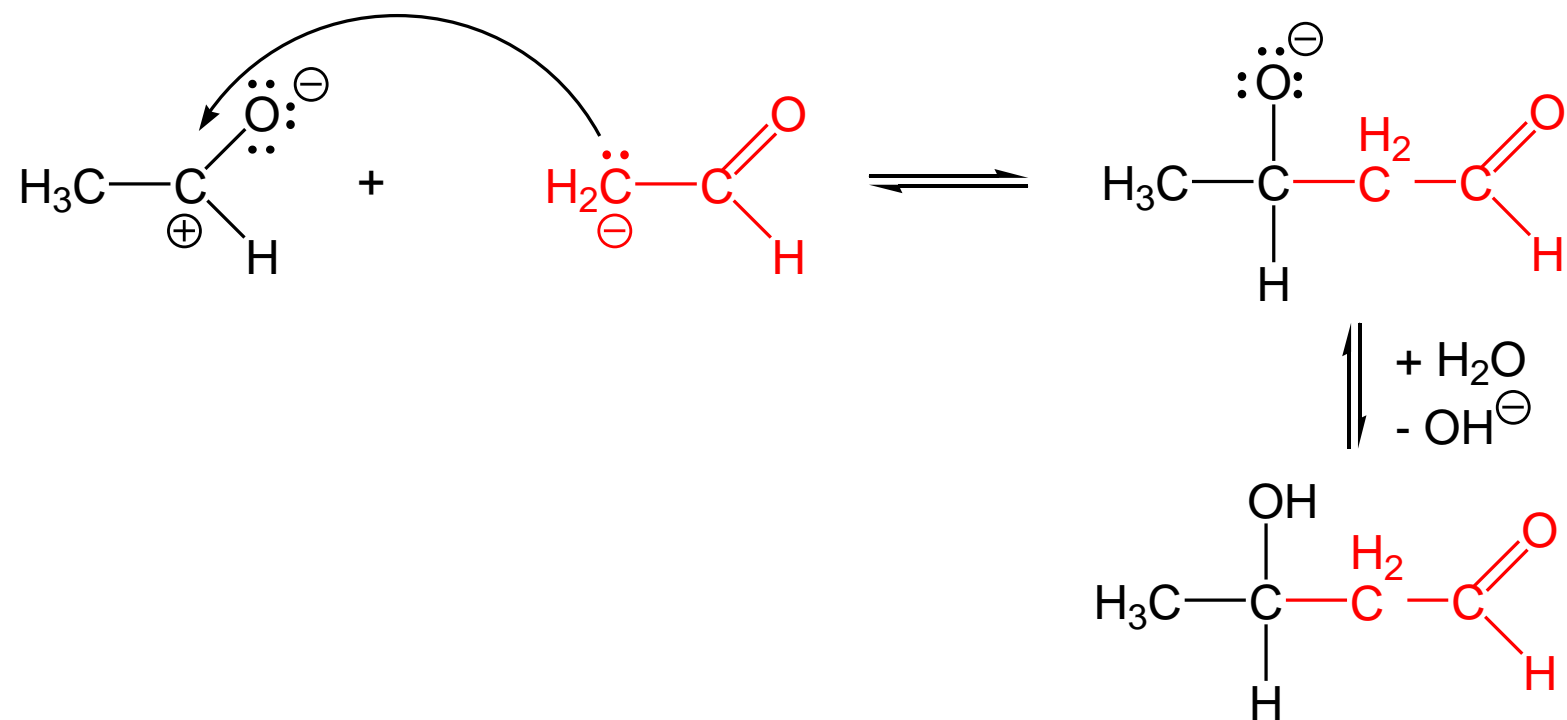
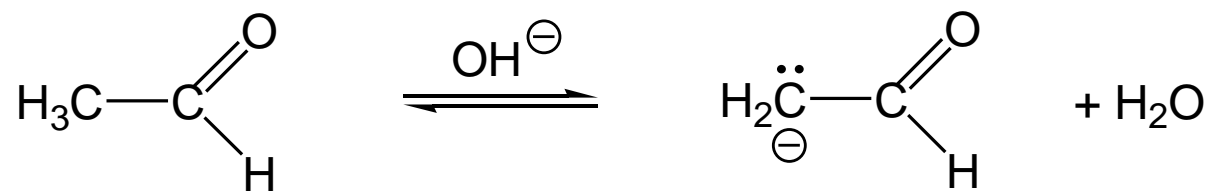
# Acidität des $\alpha$ -Wasserstoffatoms einer Carbonylverbindung



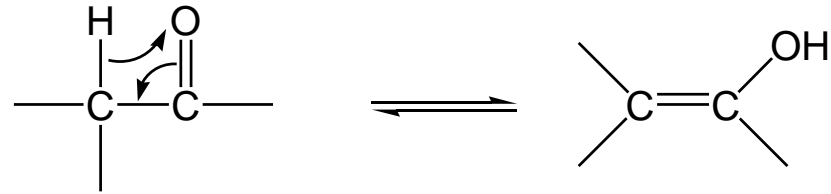
## Enolat-Anionen als Kohlenstoffnucleophile (Aldolreaktion)



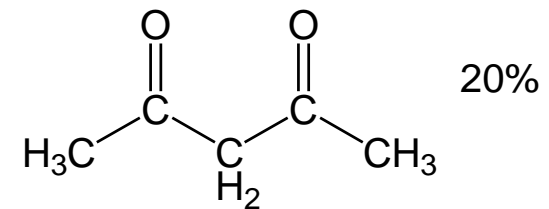
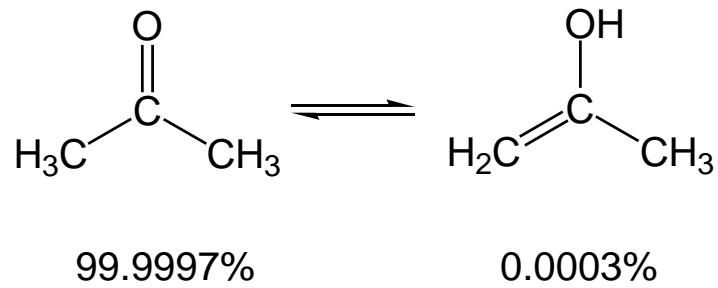
"Aldol"  
(Aldehydalkohol)



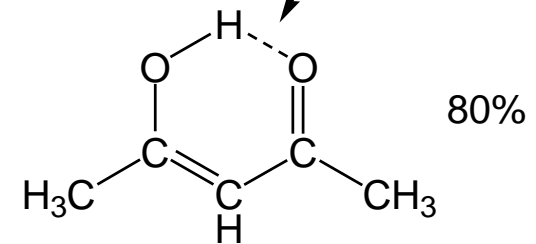
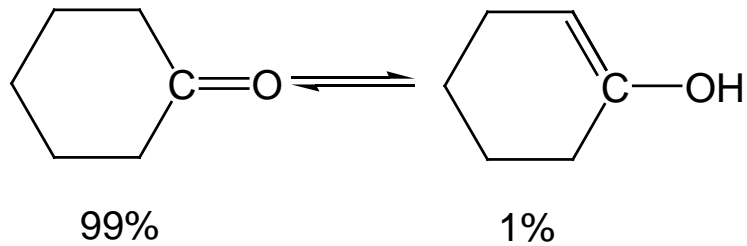
# Keto-Enol-Tautomerie



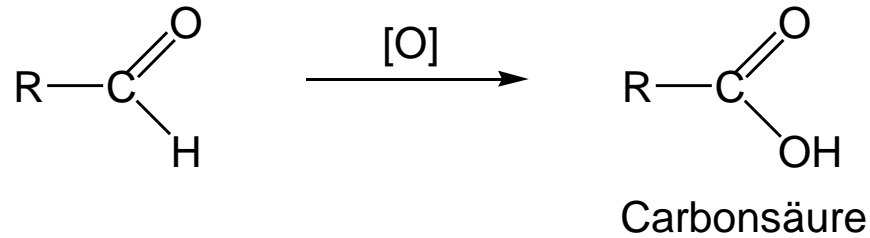
Gleichgewicht, keine Mesomerie!



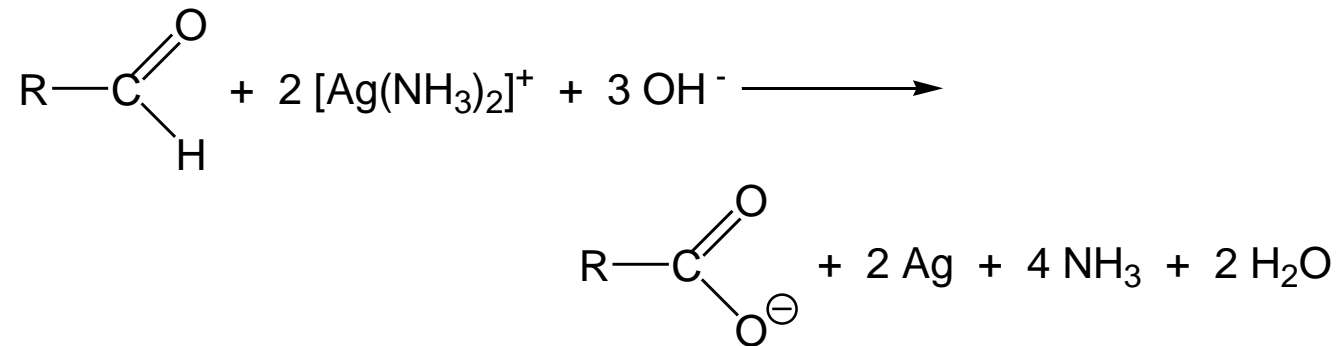
Wasserstoffbrücke



## Oxidation von Aldehyden



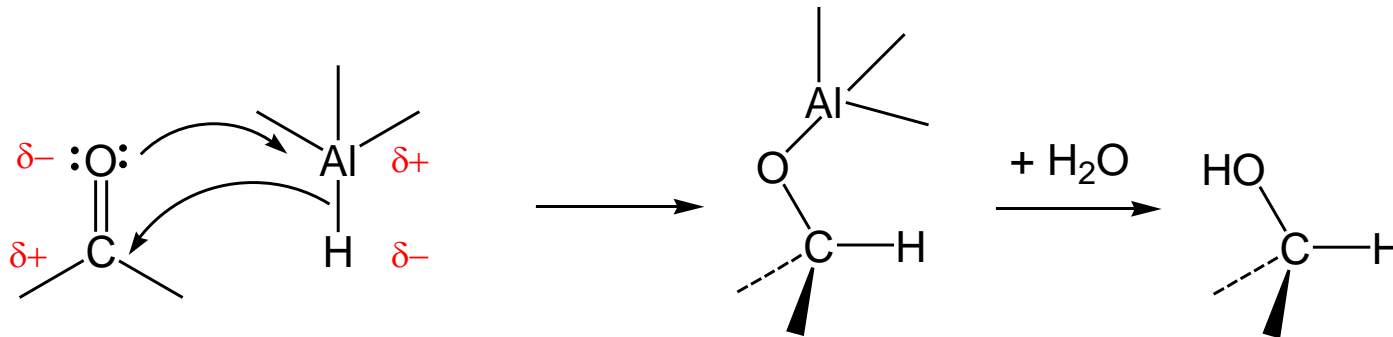
Beispiel:



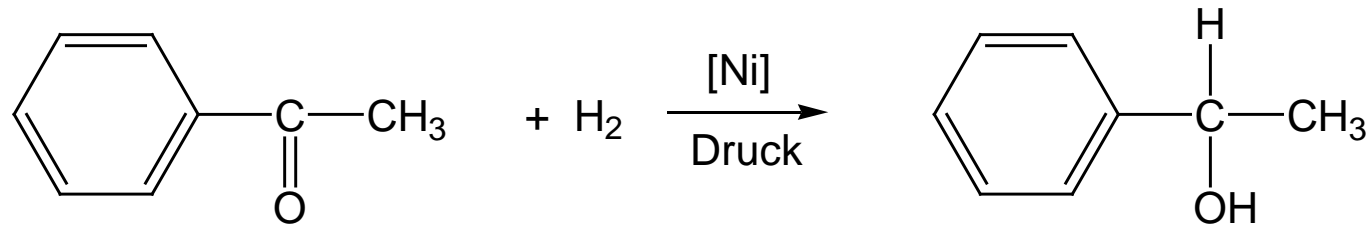
aber: Ketone können nur unter Zersetzung des organischen Moleküls zu  $\text{CO}_2$  und  $\text{H}_2\text{O}$  oxidiert werden.

# Addition von Wasserstoff (Reduktion)

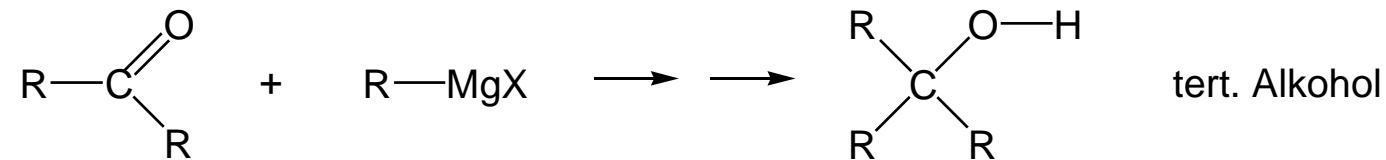
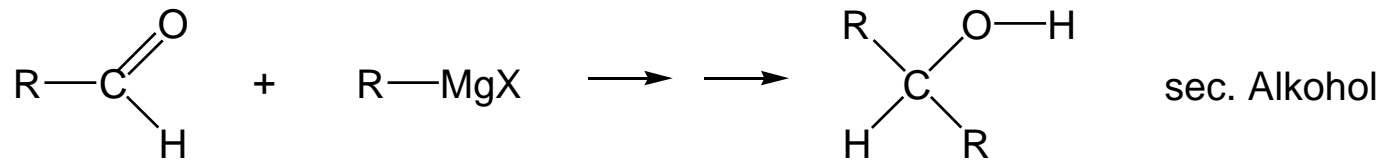
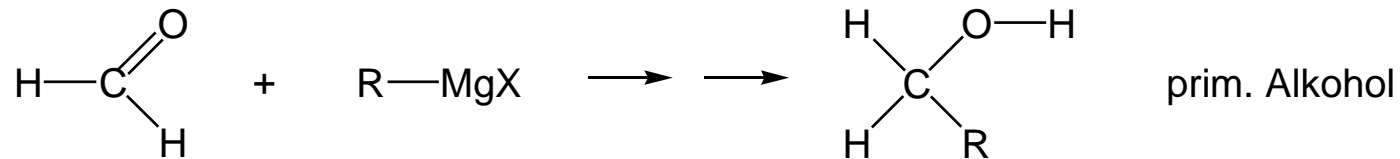
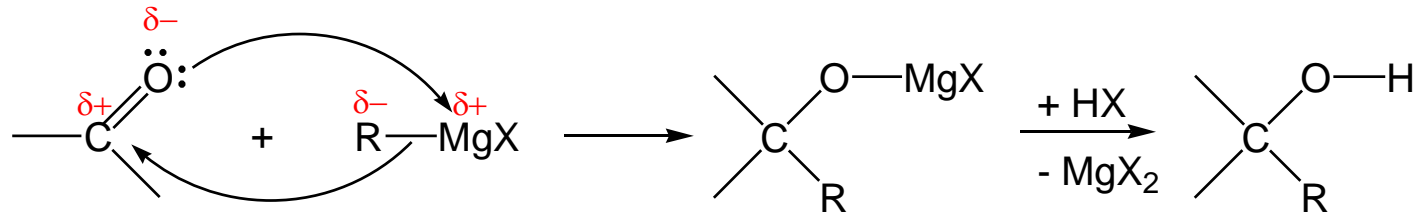
Reduktion mit Lithiumaluminiumhydrid  $\text{LiAlH}_4$



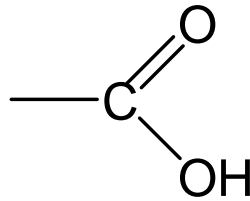
Reduktion mit Wasserstoff



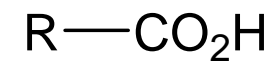
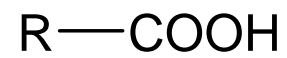
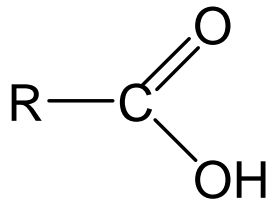
# Reaktion von Aldehyden und Ketonen mit R-MgX



# Carbonsäuren und ihre Derivate

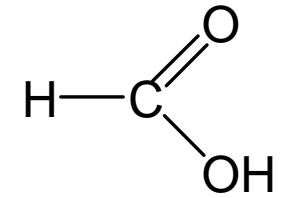


Carboxygruppe  
(Carbonylhydroxygruppe)



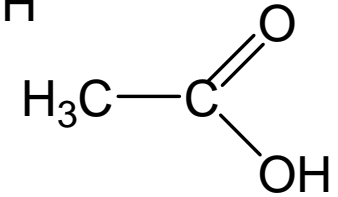
Methansäure

Ameisensäure



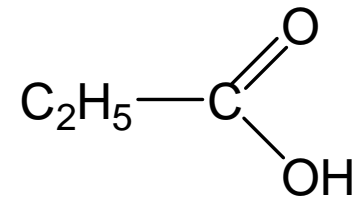
Ethansäure

Essigsäure



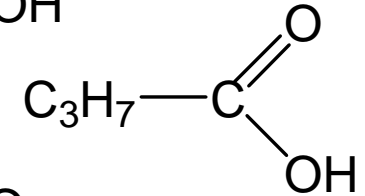
Propansäure

Propionsäure



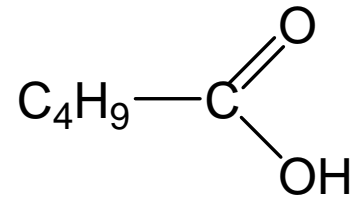
Butansäure

Buttersäure



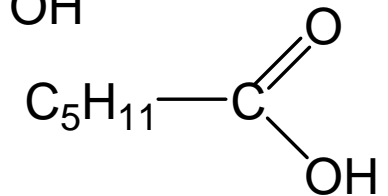
Pentansäure

Valeriansäure



Hexansäure

Capronsäure



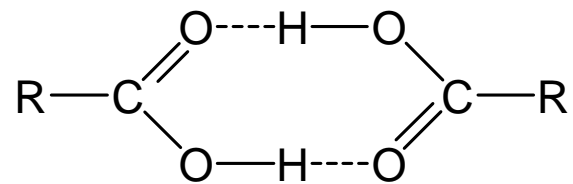
# Physikalische und chemische Eigenschaften

farblose Flüssigkeiten

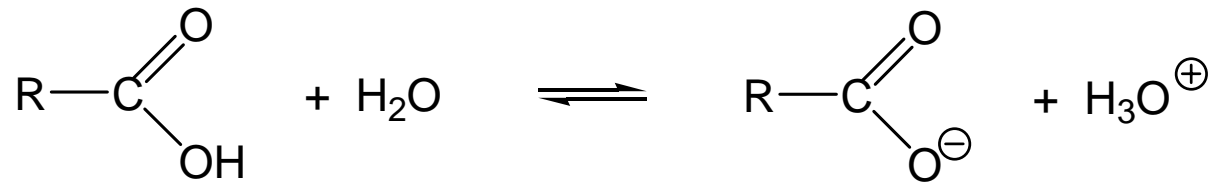
scharfer, oft unangenehmer Geruch

wasserlöslich

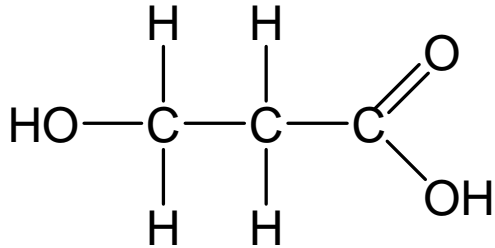
relativ hohe Schmelz- und Siedepunkte (Wasserstoffbrücken)



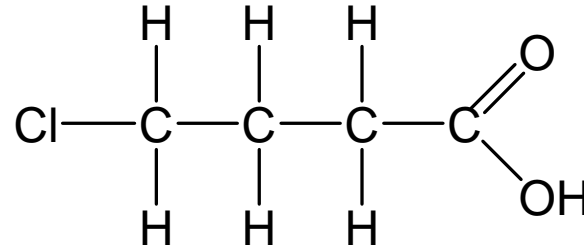
starke bis mittelstarke Säuren



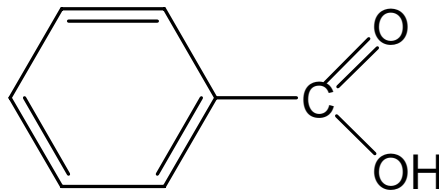
## Nomenklatur



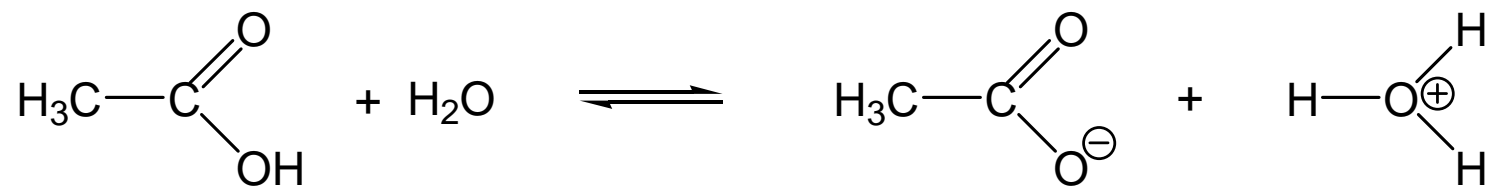
3-Hydroxypropansäure  
β-Hydroxypropionsäure



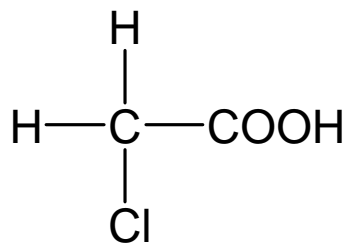
4-Chlorbutansäure  
γ-Chlorbuttersäure



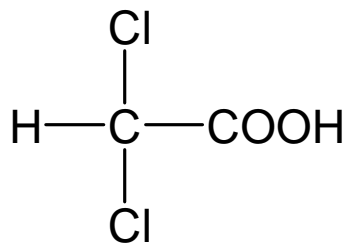
Benzolcarbonsäure  
Benzoesäure



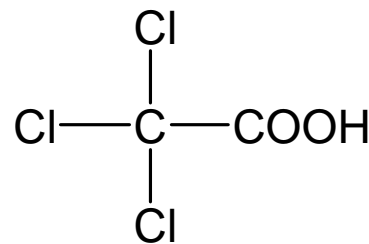
pKa: 4.74



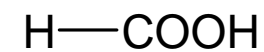
2.82



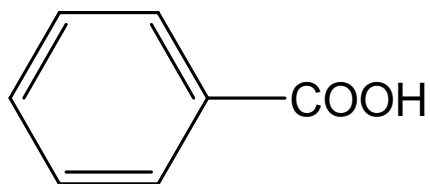
1.30



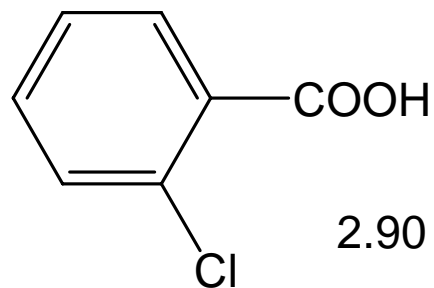
0.70



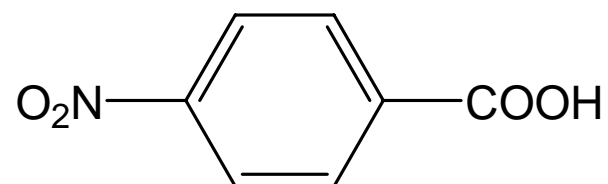
3.68



4.18



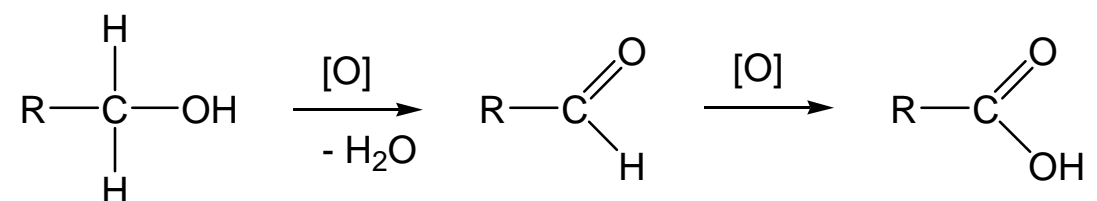
2.90



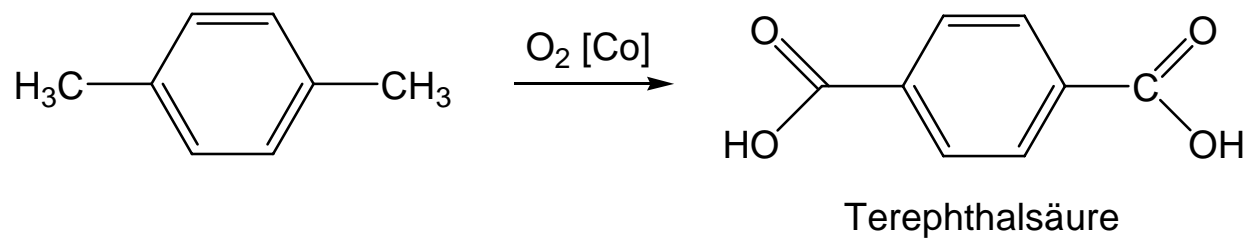
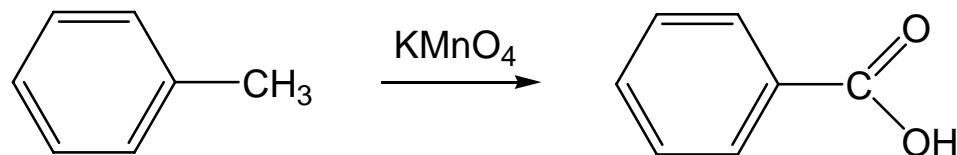
3.40

# Darstellung von Carbonsäuren

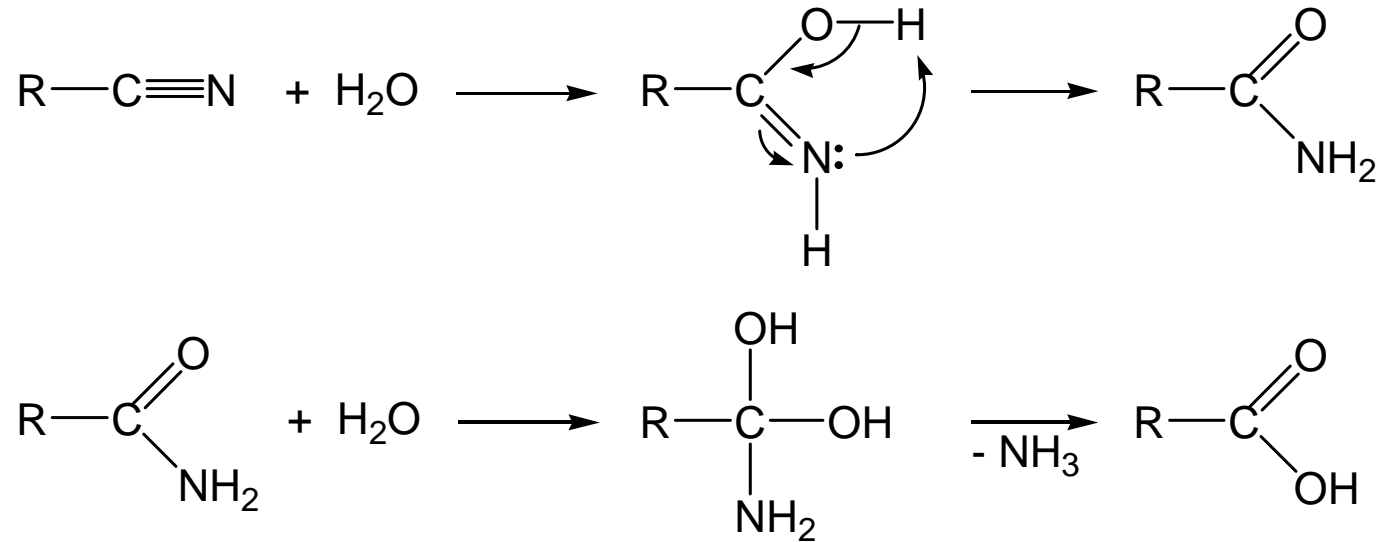
Oxidation von prim. Alkoholen oder Aldehyden



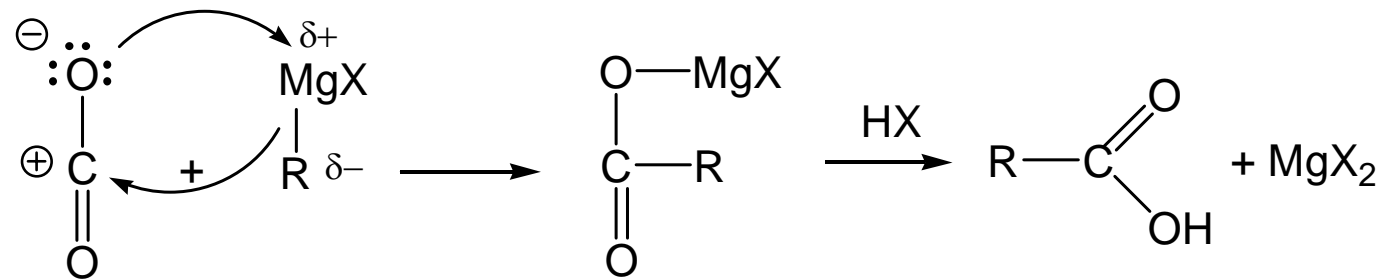
Oxidation alkylierter Aromaten



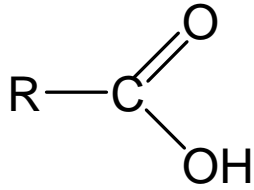
## Hydrolyse organischer Cyanide (Carbonsäurenitrile)



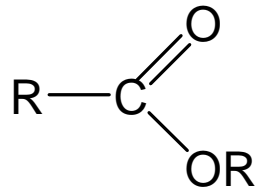
## Reaktion von Grignard-Reagenzien mit Kohlendioxid



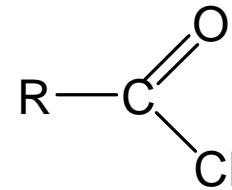
## Carbonsäurederivate



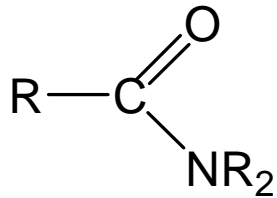
Carbonsäure



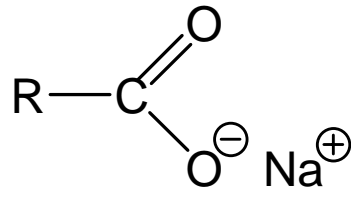
Carbonsäureester



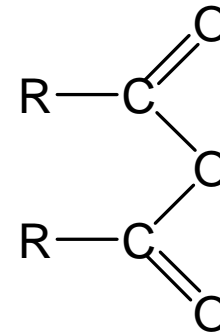
Carbonsäurehalogenid  
(Acylhalogenid)



Carbonsäureamid



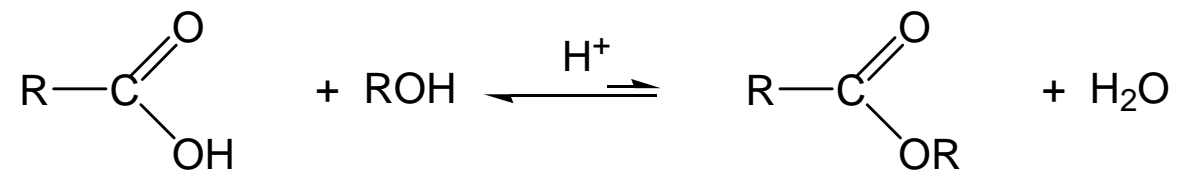
Carbonsäuresalz  
(Carboxylat)



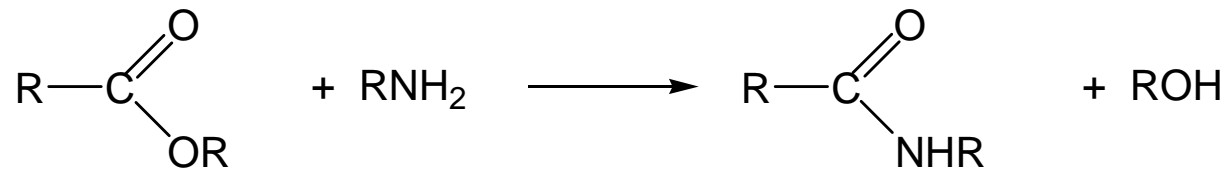
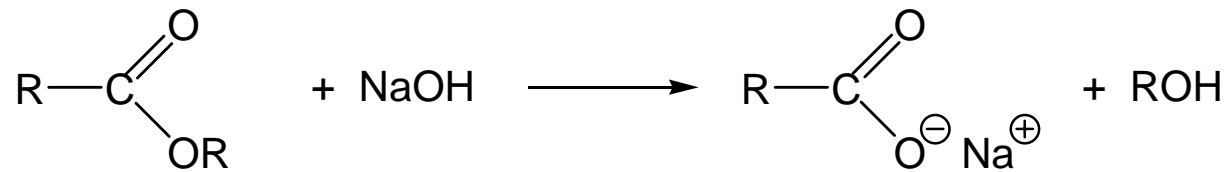
Carbonsäureanhydrid

# Herstellung und Reaktivität von Carbonsäureestern

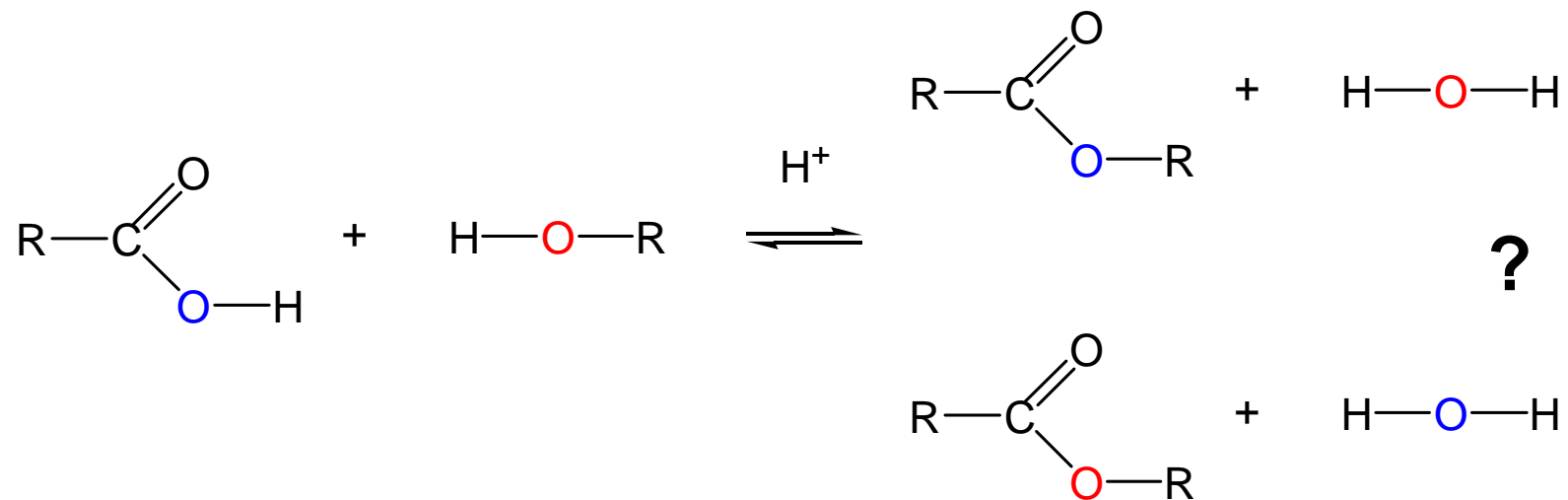
Säurekatalysierte Veresterung von Carbonsäuren



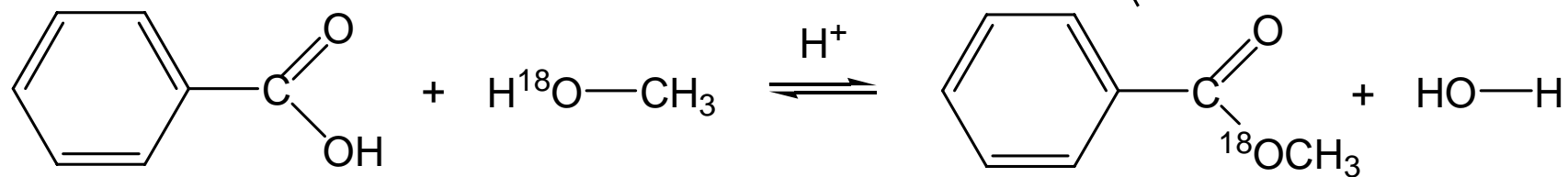
Verseifung und Ammonolyse von Estern

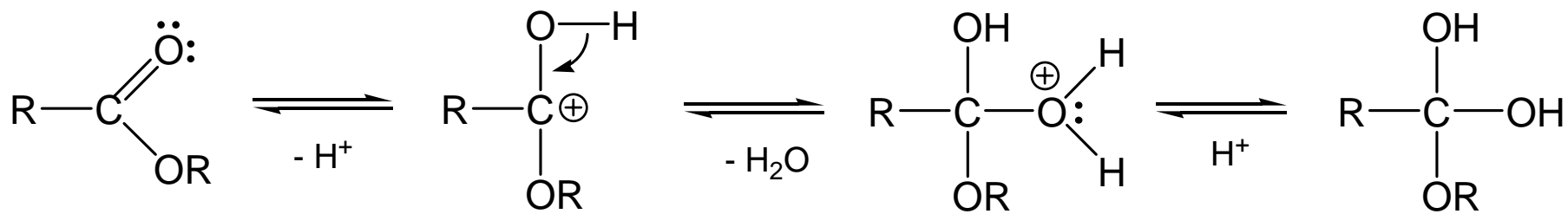
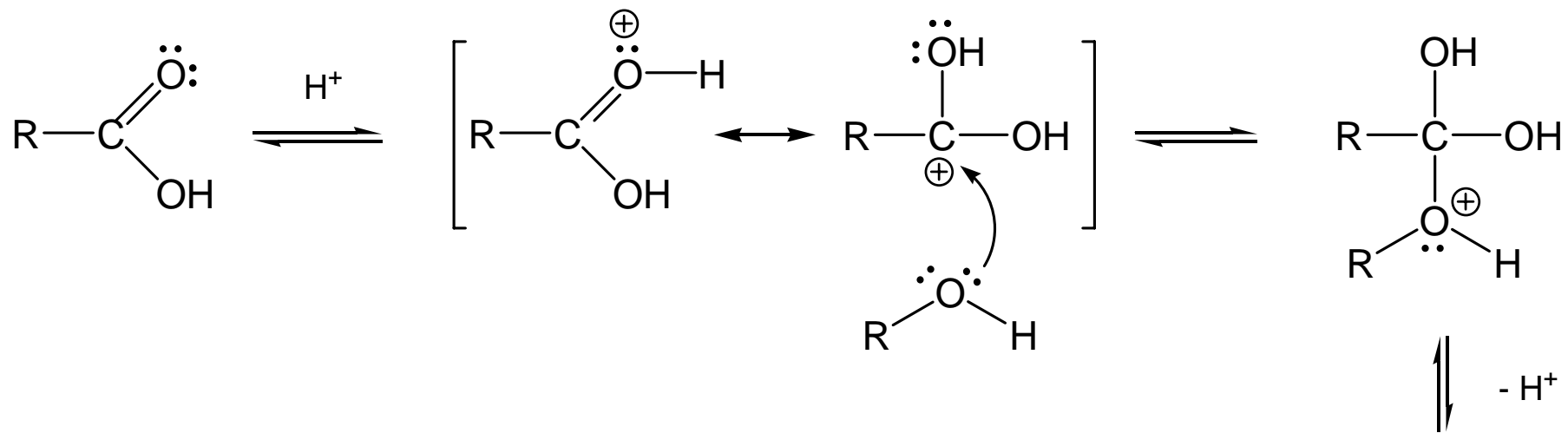


# Mechanismus der protonenkatalysierten Veresterung

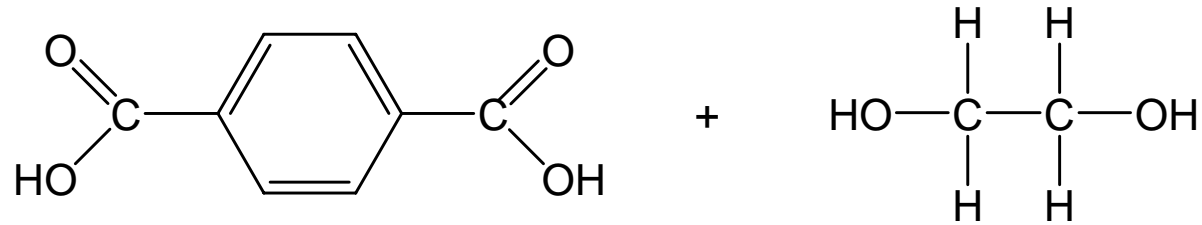


Experiment:



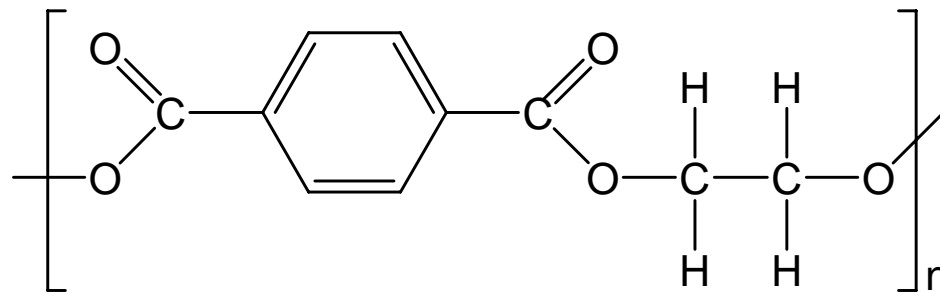
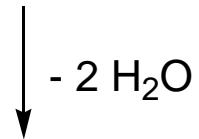


# Polyester



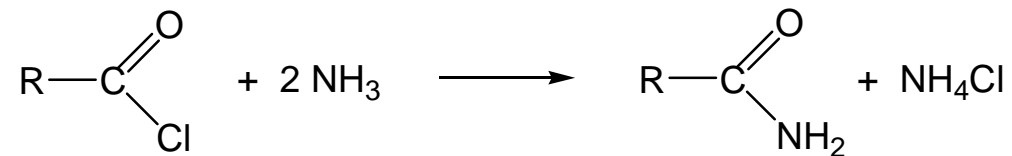
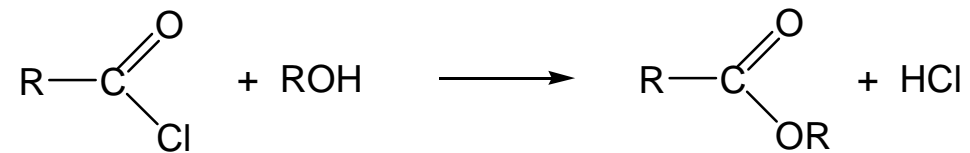
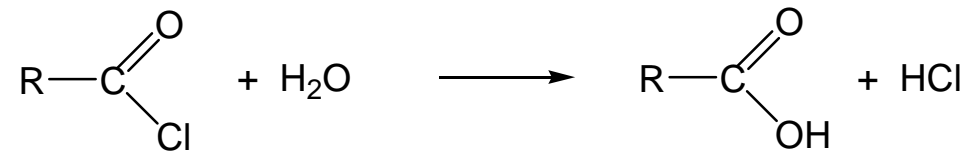
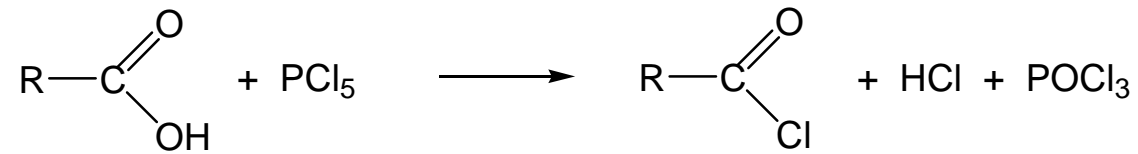
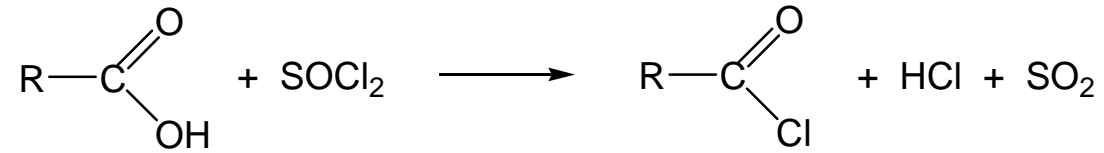
Terephthalsäure

Ethylenglykol

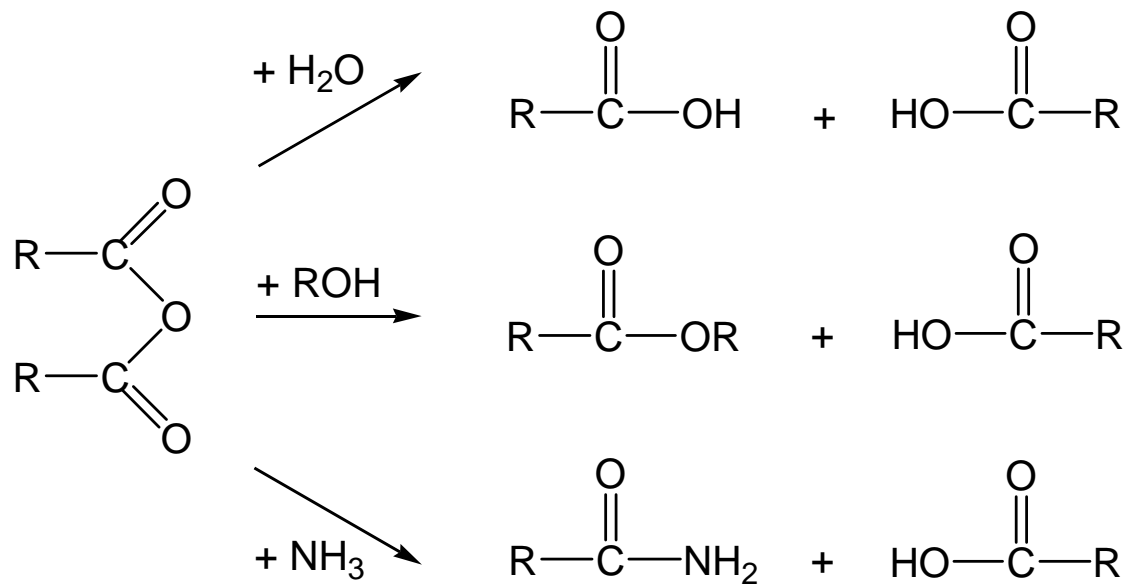
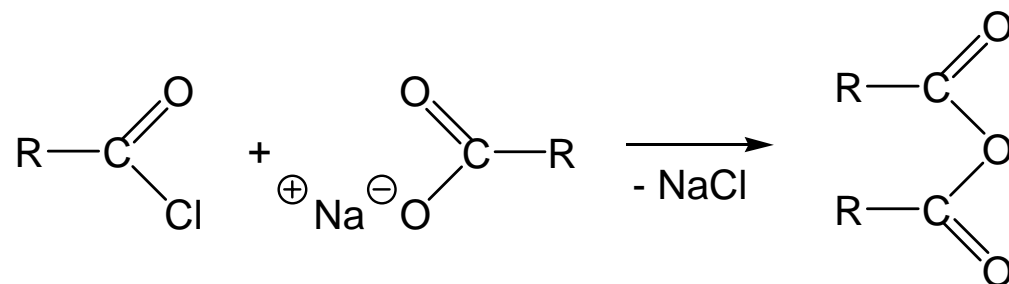


Polyethylenterephthalat (PET)

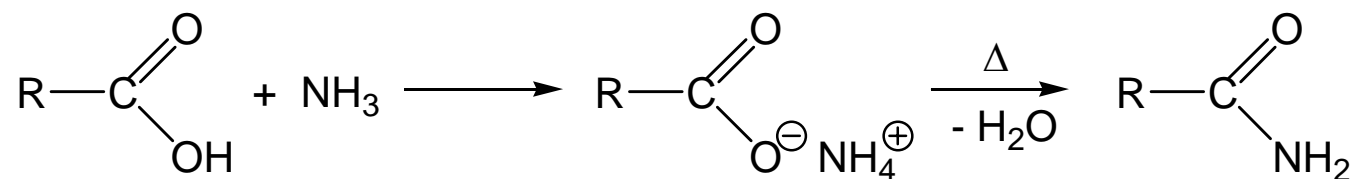
## Carbonsäurehalogenide



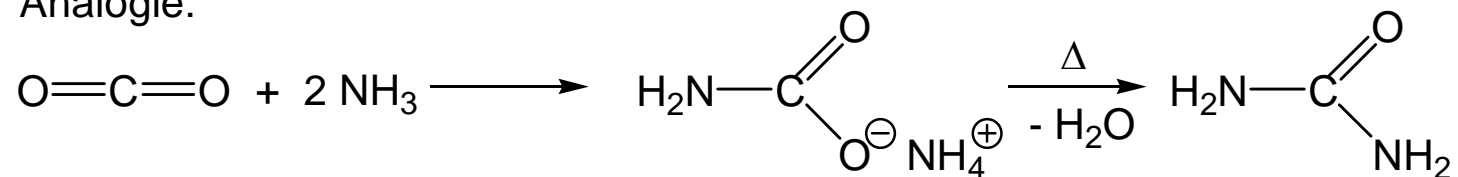
# Carbonsäureanhydride



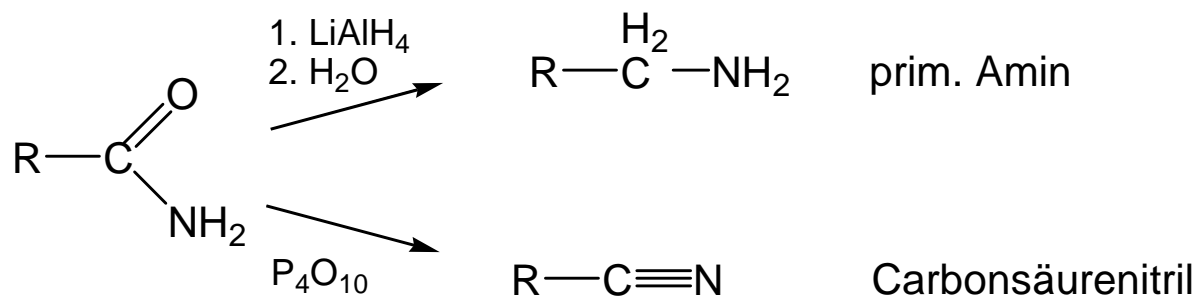
## Carbonsäureamide



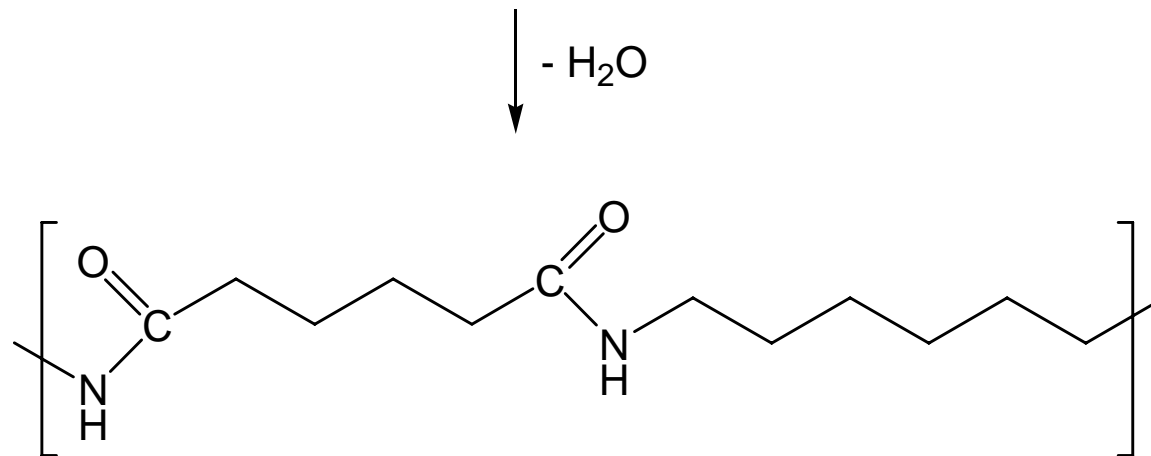
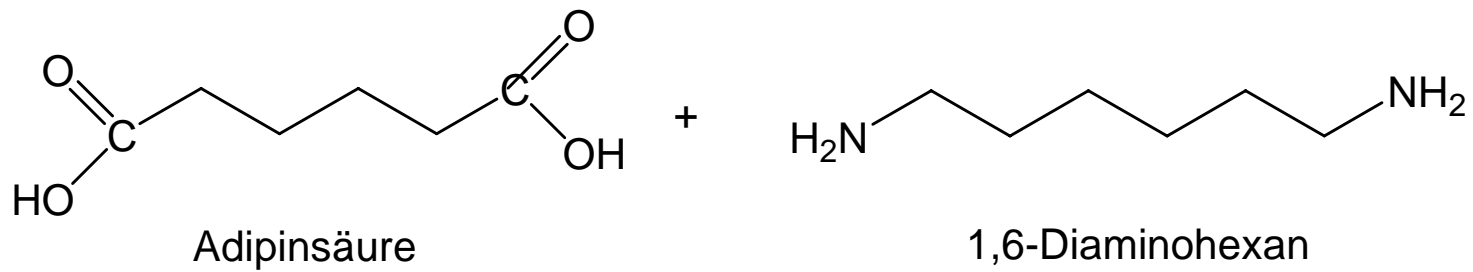
Analogie:



Harnstoff

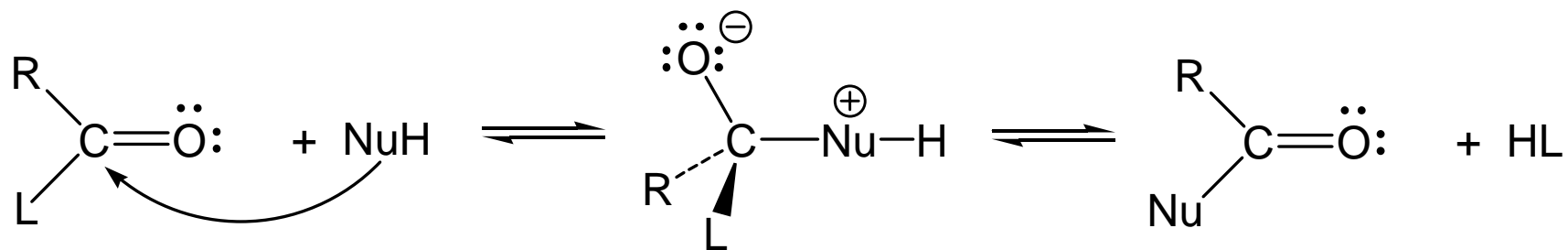
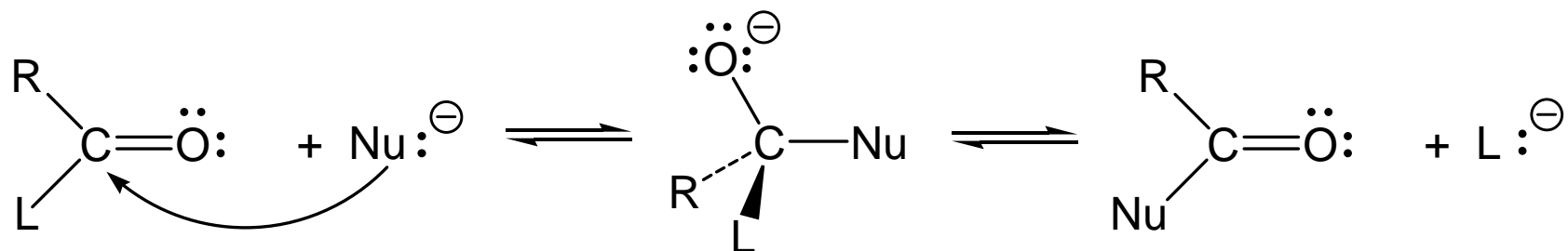


# Nylon – ein polymers Carbonsäureamid



PA 66

## Mechanismus der nucleophilen Substitution an Carbonsäurederivaten



L = Cl, RCOO, OR, NHR, OH, O<sup>-</sup>

NuH = RCOOH, ROH, RNH<sub>2</sub>, H<sub>2</sub>O

## Reaktivitätsabstufung der Carbonsäurederivate

