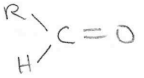
- empirical → molecular → structural → displayed → skeletal

alkanes $-\overset{|}{\underset{|}{C}}-$ C_nH_{2n+2} alkenes $>C=C<$ C_nH_{2n} arenes  C_6H_6

halogenoalkanes $-\overset{|}{\underset{|}{C}}-X$ alcohols $R-OH$ aldehydes 

ketones $>C=O$ carboxilic acids $R-C(=O)-OH$ esters 

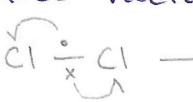
amines $R-NH_2$ nitriles $R-C\equiv N$ amide $>N-C(=O)<$

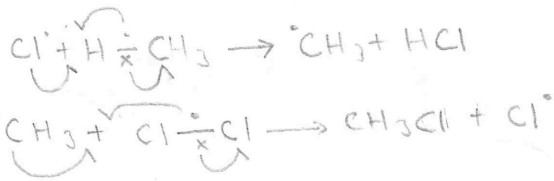
- functional group - group responsible for chemical characteristics

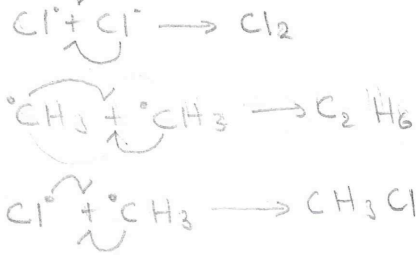
- isomerism - structural - position
  - functional group
  - chain
  - stereo - geometrical - cis/trans E/Z (must be about C=C)
  - optical - chiral centre C, enantiomers
  - racaemic mixture 50% to 50%

- Alkanes - generally unreactive - low $\Delta\chi$ so non-polar
  - combustion + halogenation with $Cl_2/Br_2/F_2$

↳ homolitic free radical substitution

initiation: 

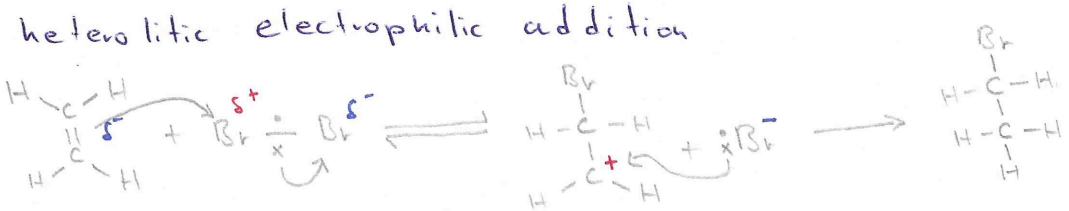
propagation: 

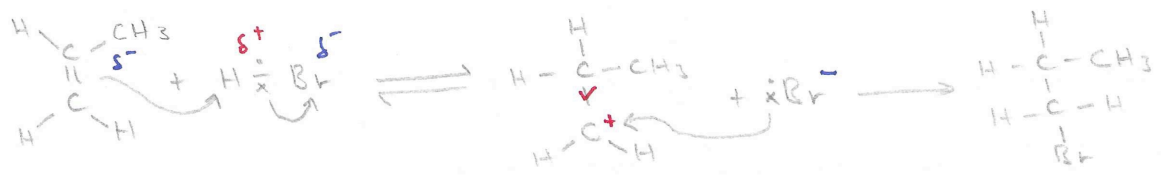
termination: 

multisubstitution if $[Cl]\uparrow$ $[CH_4]\downarrow$

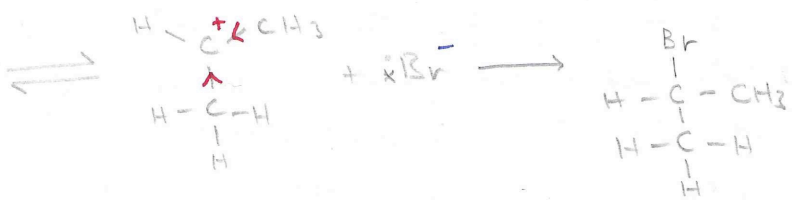
- Alkenes - e^- density around C=C — HX or X_2 (aq)

↳ heterolitic electrophilic addition





20%

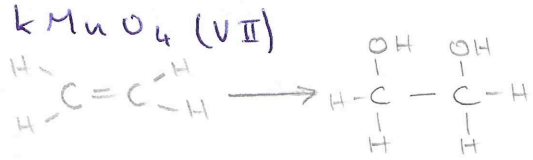


80%

- +ve inductive effect – alkyl groups are e^- releasing ∴ stabilise carbocation in intermediate
- results in regio selectivity (markovnikov rule)

↳ oxidation with $KMnO_4$ (VII)

↳ cold dilute:

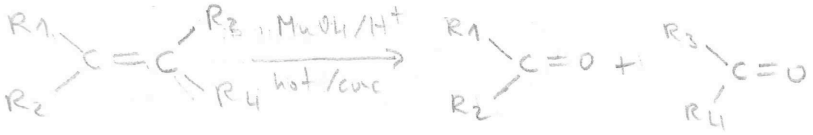


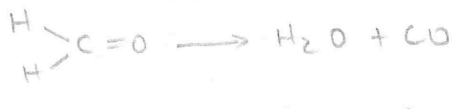
diol

acidic: $MnO_4^- \longrightarrow Mn^{2+}$
purple → colourless

alkaline: $MnO_4^- \longrightarrow MnO_2$
dark green → dark brown

↳ hot acidified concentrated: reflux!





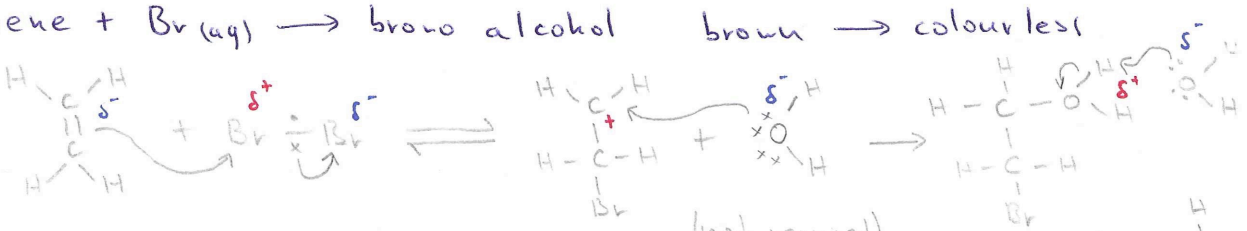
no further reaction with ketone

↳ cracking – heat in absence of O_2
with zeolite catalyst
– alkane → alkene + alkane

↳ hydrogenation – addition of H_2 – nickel catalyst 140°C

↳ hydration – addition of $H_2O_{(g)}$ – H_3PO_4 conc catalyst 330°C 6MPa

↳ alkene + $Br_{(aq)}$ → bromo alcohol brown → colourless



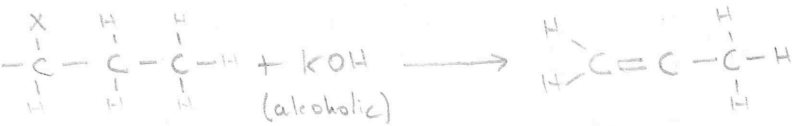
(not required)

↳ addition polymerisation:

monomer repeat unit

– Halogeno alkanes – polar primary 1°, secondary 2°, tertiary 3°
– reactivity increases going down the group
since BE ↓

↳ electrophilic elimination:



(alcoholic)

sometimes not possible since 2nd C can't loose the H to form C=C

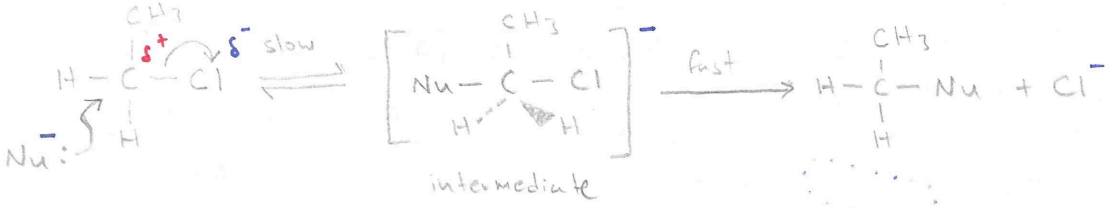
– CFCs – chemically inert – non flammable – non toxic
– used as aerosol propellants + solvents + refrigerants

– O_3 layer – absorbs UV – UV brakes C–Cl in CFC giving $Cl^\cdot$ which reacts with 10^6 O_3 molecules

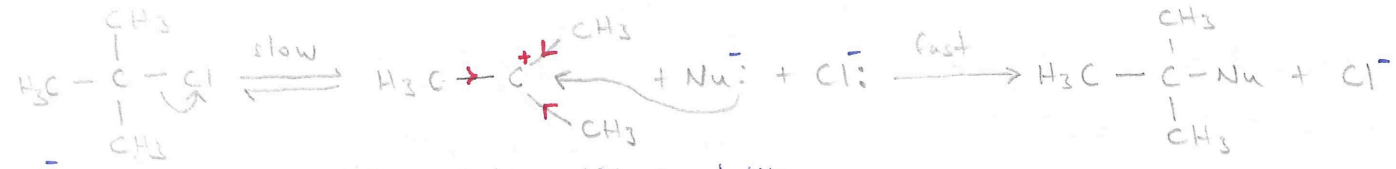
– solution – HFC + HFE – hydro fluoro ethers / carbons higher bond strength C–F

- Halogenoalkanes

↳ bimolecular nucleophilic substitution – S_N2 – only 1° halogenoalkanes



↳ mononolecular nucleophilic substitution – S_N1 – only 3° halogenoalkanes



↳ 2° go by mix of S_N1 and S_N2

OH^- in H_2O
CN^- in EtOH
NH_3 in EtOH
$NH_{3(g)}$
} substitution

OH^- in EtOH – elimination

- Alcohols – H bonds so ↑ bp + mix with H_2O

↳ substitution to give halogenoalkane

use: halogen gas, PCl_3, PCl_5, $SOCl_2$

↳ test for OH use PCl_5 $R-OH + PCl_5 \xrightarrow{rtp} R-Cl + HCl + POCl_3$ (white steamy fumes)

↳ alcohol + Na – similar to H_2O + Na but less vigorous

– releases $H_{2(g)}$ and sodium alkoxide (basic salt)

ethanol + Na ⟶ H_2 + sodium ethoxide

↳ oxidation – 1° and 2° only oxidised 3° not

– done by $K_2Cr_2O_7$ acidified with dil H_2SO_4 heated

– $Cr_2O_7^{2-}$ ⟶ Cr_2O_3
orange → green

1° alcohol: alcohol ⟶ aldehyde ⟶ carboxilic acid

2° alcohol: alcohol ⟶ ketone

3° alcohol: not oxidised

↳ dehydration – elimination reaction with Al_2O_3 hot (alcohol vapour passed over) or H_2SO_4

– alcohol $\xrightarrow{Al_2O_3}$ alkene + H_2O

- Carboxilic acids – made by oxidising 1° alcohols or nitriles from ketones

↳ with alkalis give H_2O + salt

carbonates give CO_2 + H_2O + salt

↳ reduced with $LiAlH_4$ in dry ether at rtp adds H ∴ reduction

$LiAlH_4$ reacts violently with water

- Esterification – alcohol + carboxilic acid $\overset{H_2SO_4\ conc}{\rightleftharpoons}$ ester + H_2O
  - under reflux with strong acid catalyst
  - H_2SO_4 also removes H_2O shifting the equilibrium
  - sweet fruity smells

ethyl ethanoate

↳ hydrolisis of esters – heat under reflux with acid or base

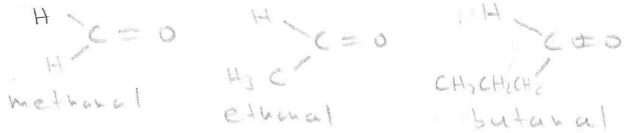
↳ acid: dynamic eqb in reverse giving alcohol + acid

↳ alkali: fully hydrolised – acid reacts with alkali to give salt of carboxilic acid

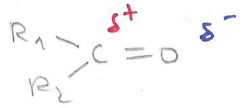
sodium ethanoate

- Carbonyles – large dipole = very polar

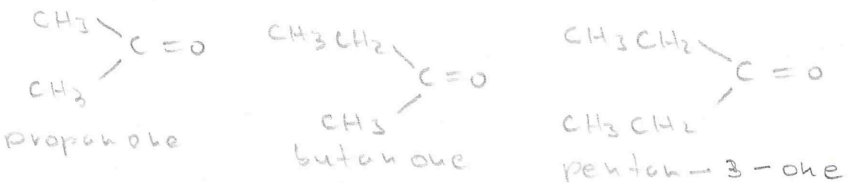
↳ aldehydes – al



methanal ethanal butanal



↳ ketones – one

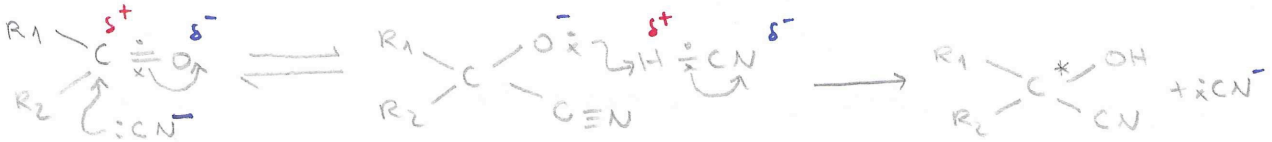


propanone butanone pentan-3-one

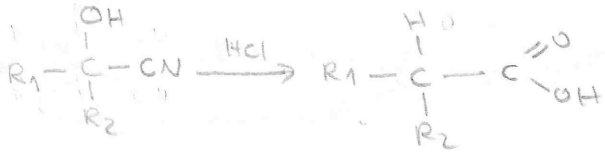
↳ when preparing aldehyde 1° alcohol oxidised and product immediately distilled off to avoid further oxidation

↳ can be reduced with $LiAlH_4$ in dry ether

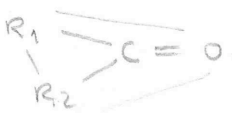
↳ nucleophilic addition of HCN – CN^- nucleophile attacks C=O



- nitrate refluxed with dil HCl produces carboxilic acid but there is 1 more C in the chain



- always 2-hydroxi nitrile formed

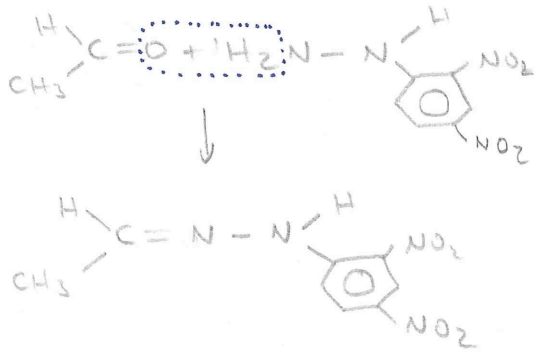


trigonal planar

so CN^- approaches from top or bottom giving a 50% : 50% racaemic mixture

- Testing carbonyles

↳ 2,4-DNPH (2,4-di nitro phenyl hydrazine)



- test for both aldehyde + ketones
- add 2,4-DNPH solution gives orange ppt
- recrystalise ppt and measure mp used to find identity of carbonyl
- condensation reaction

↳ Tolls reagent – test for aldehyde – aqueous $AgNO_3$ in excess NH_3

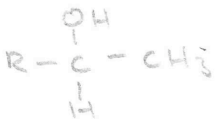
(warm) – Ag^+ acts as mild oxidising agent aldehyde → COOH

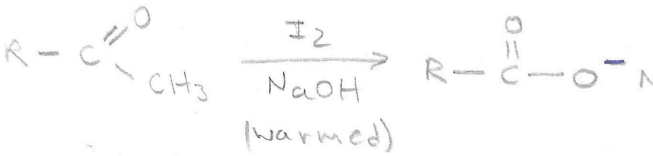
$Ag^+ \longrightarrow Ag$ – mirror on test tube

↳ Fehlings solution – test for aldehyde – alkaline Cu^{2+} solution

(warm) – Cu^{2+} act as mild oxidising agent aldehyde → COOH

$Cu^{2+} \rightarrow Cu^+$ blue → red/orange (opaque)

↳ tri-iodomethane – iodo form – test for  or 



← yellow ppt
antiseptic smell
Mp = 119°C

- alkaline solution of I_2
- with  first oxidised to