

- Alkanes - homolytic free radical substitution

- Alkenes

↳ heterolytic electrophilic addition with Br_2 or HBr

↳ oxidation with KMnO_4 (VII) cold dilute or hot conc

↳ oxidation with $\text{K}_2\text{Cr}_2\text{O}_7$

↳ cracking - heat with zeolite without O_2

↳ hydrogenation - nickel catalyst - 140°C

↳ hydration - H_3PO_4 330°C 6MPa

↳ alkene + Br_{aq} $\rightarrow$ Bromoalcohol

OH^- in EtOH - elimination

OH^- in H_2O

CN^- in EtOH

NH_3 in EtOH

conc NH_3

} S_N

- Halogenoalkanes

↳ electrophilic elimination

↳ nucleophilic substitution: $\text{S}_\text{N}2$ - bimolecular $\text{S}_\text{N}1$ - monomolecular

- Alcohols

↳ halogenoalkane with PCl_5 , PCl_3 , SOCl_2

↳ oxidised by $\text{K}_2\text{Cr}_2\text{O}_7$

↳ dehydration with Al_2O_3 or H_2SO_4

- Carboxylic acids

↳ reduced with LiAlH_4 in dry ether

↳ esterification with H_2SO_4 catalyst

reflux with HCl to give COOH

- Carboniles

↳ nucleophilic addition of HCN give nitrile

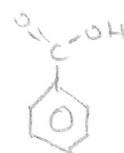
- Benzene

$\approx 55^\circ\text{C}$

↳ electrophilic substitution $\text{Cl}-\text{Cl}$ $\text{FeCl}_3 \rightarrow \text{Cl}^+ + [\text{FeCl}_4]^-$

$\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightarrow \text{NO}_2^+ + 2\text{HSO}_4^- + \text{H}_2\text{O}$

↳ oxidation of side chains - reflux with $\text{KMnO}_4 + \text{H}_2\text{SO}_4$



↳ if carboxyl added to benzene gives acyl

- Phenol

- ↳ dissolves in alkaline solution to give salt
- ↳ reacts vigorously with Na
- ↳ halogenated under mild conditions Br_2
- ↳ nitrated under mild conditions dil HNO_3

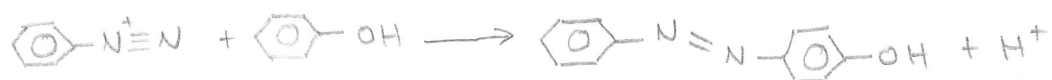
- amines - NH_2

phenyl amine acts like phenol

- ↳ react with HCl to give salt
- ↳ made by ethanolic conc NH_3
- ↳ phenyl amine: nitrophenol + Sn + conc HCl

- Diazotisation

- ↳ $\text{NaNO}_2 + \text{HCl}$ give nitrous acid HONO temp $< 5^\circ\text{C}$



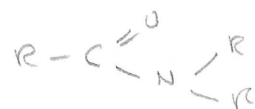
4 hydroxy Phenyl azo benzene

- Nitriles - CN

- ↳ reduction - nitrile vapor passed over H_2 + Nickel catalyst
- LiAlH_4 in dry ether

- Amides - CONH

- ↳ made by acid chloride + NH_3 or 1° amine
- ↳ reduction - LiAlH_4 give amines
- ↳ hydrolysis - acid - carboxylic acid + salt
- base - salt + amine / ammonia



- Acyl chlorides

- ↳ made by carboxylic acid + $\text{PCl}_5 / \text{PCl}_3 / \text{SOCl}_2$
- ↳ hydrolysis - H_2O , + acyl chloride $\longrightarrow$ carboxylic acid + HCl
- ↳ react vigorously with amines to give amides

- halide tests - add silver nitrate with nitric acid

$\text{Cl}^- \rightarrow$ white ppt (soluble in $\text{NH}_3(aq)$)

$\text{Br}^- \rightarrow$ cream ppt (partially soluble in $\text{NH}_3(aq)$)

$\text{I}^- \rightarrow$ yellow ppt (insoluble in $\text{NH}_3(aq)$)

- Test for sulfate (SO_4^{2-}) - add Barium nitrate or Barium hydroxide

$\rightarrow$ gives white ppt

- Cobalt:

$[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ - red $[\text{CoCl}_4]^{2-}$ - purple $[\text{Co}(\text{H}_2\text{O})_4(\text{OH})_2]^{2+}$ - blue

$[\text{Co}(\text{NH}_3)_6]^{2+}$ - brown/orange CoCO_3 - pink

- Copper:

$[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ - blue $[\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2]^{2+}$ - pale blue $[\text{CuCl}_4]^{2-}$ - yellow

$[\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+}$ - dark blue

$\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$ orange $\rightarrow$ green

- Aldehydes - Fehling's - $\text{Cu}^{2+} \rightarrow \text{Cu}_2\text{O}$ red ppt

Tollen's - $\text{Ag}^+ \rightarrow \text{Ag}$ silver mirror

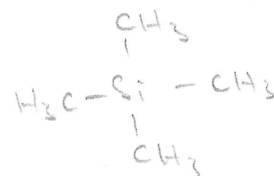
- Iodoform - I_2 / OH^-



$\rightarrow$ yellow ppt + antiseptic smell

- phenol - white ppt with $\text{Br}_2(aq)$

- TMS - Tetramethyl silane



- Nernst equation $E = E^\circ + \frac{RT}{zF} \ln \left(\frac{[\text{oxidised}]}{[\text{reduced}]} \right)$

- solubility of group 2 hydroxides $\uparrow$ going down

- solubility of group 2 sulfates $\downarrow$ going down

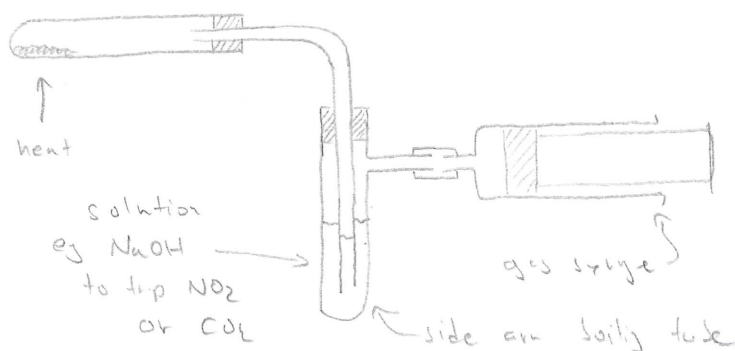
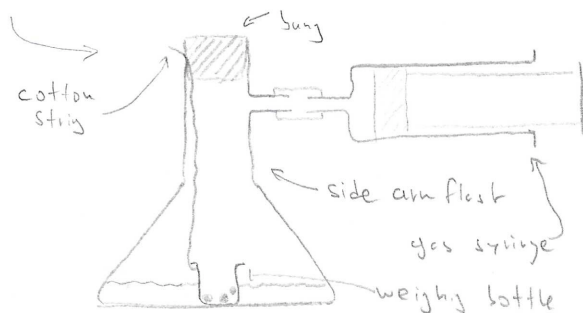
- Thermal stability $\uparrow$ going down



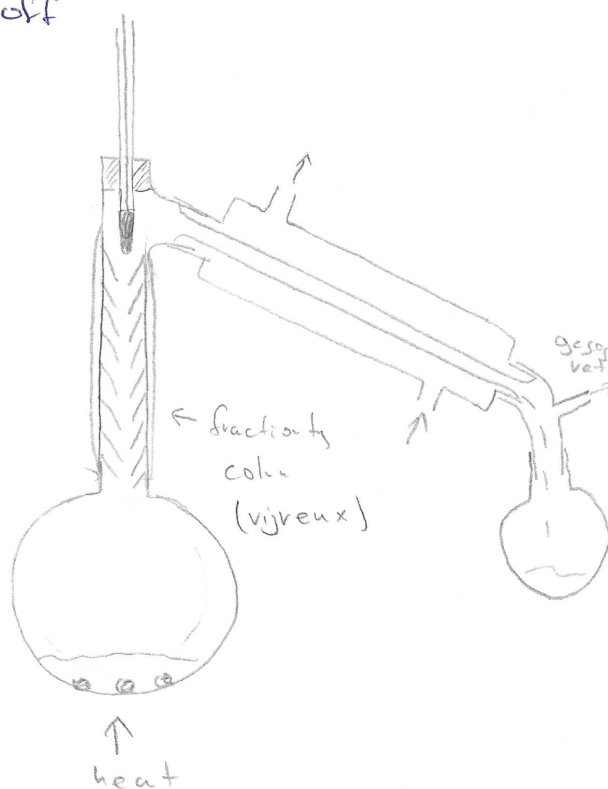
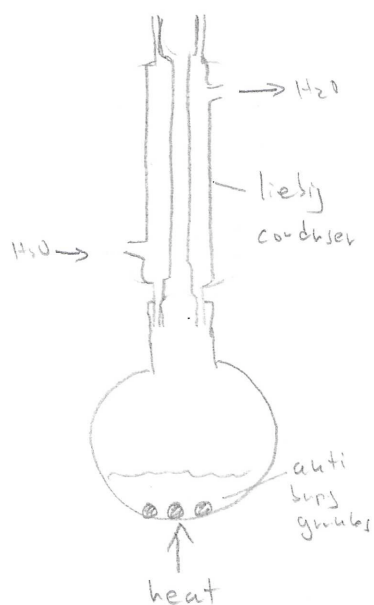
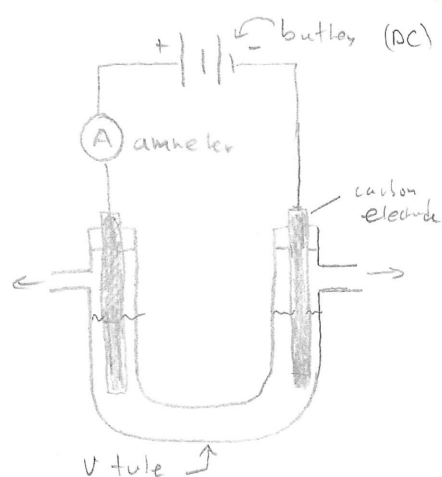
$$\Delta S_{tot}^{\circ} = \Delta S_{sys}^{\circ} - \frac{\Delta H_r^{\circ}}{T}$$

$$\Delta G_r^{\circ} = \Delta H_r^{\circ} - T \Delta S_{sys}^{\circ}$$

- Volumetric apparatus:
- Volumetric flasks - making up fixed volumes to obtain known conc
- pipettes - measure out fixed volume of liquid accurately
- burettes - measure out variable volumes of liquid accurately $\times 2 \text{ mm}$
- measuring cylinders - not accurate enough only add ca. vol
- wash out with distilled H_2O or reagent depending on situation
- add liquid dropwise till colour change is observed
- reliability - repeat titration until 2 concordant titres within 0.10 cm^3
- adding solid to liquid and measuring vol of gas given off



- heating solid to measure vol of gas given off
- measuring volume of gas given off in electrolysis



$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$$

- safety considerations

- toxic - poisonous harmful - less poisonous

↳ use gloves and wash them before taking off to prevent contact with skin