Dyes

Many chemical changes cause changes in colour.

- Acid/base or base/acid - pH can cause colour changes (indicators)
- Ligand exchange - Complexes can change colour when their ligands are swapped.
- Oxidation/reduction - transiton metal ions change colour with oxidation state.
- precipitation - related to ligand exchange but when it precipitates out.
- polymorphism - where a compounds crystal structure affects colour

↓

(Van Gogh used Lead chromate polymorphs for sunflowers - bright yellow - red.)

AZO DYES

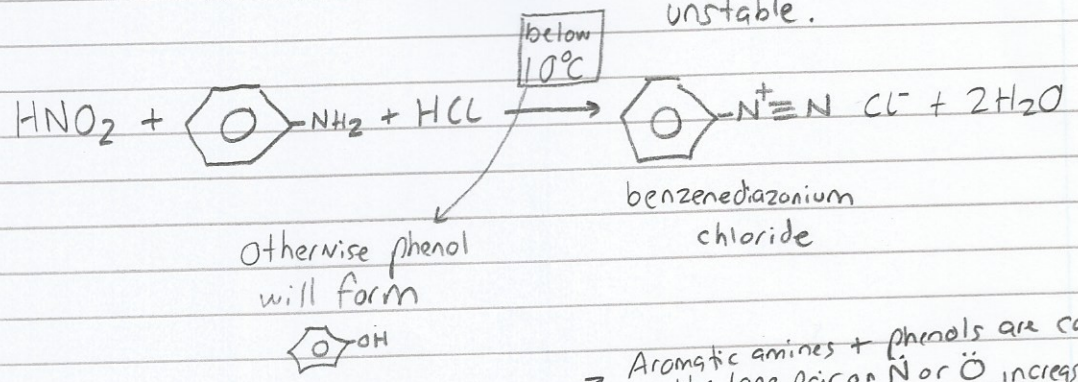
This is a two step process:

1. Make a diazonium salt (these contain -N=N-)

$$NaNO_2 + HCl \longrightarrow HNO_2 + NaCl$$

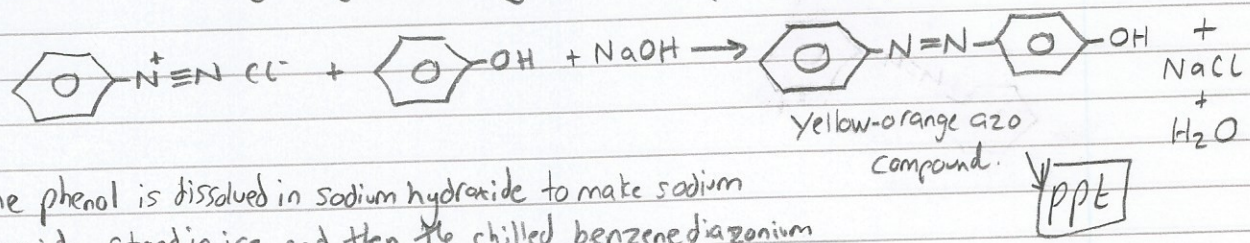
Sodium nitrite

nitrous acid → this is made in situ as it is unstable.



2. Make the azo dye by a coupling reaction.

Aromatic amines + phenols are coupling agents. the lone pair on N or Ö increase electron density of ring giving the diazonium ion (a weak electrophile something to attack).



- The phenol is dissolved in sodium hydroxide to make sodium phenoxide, stood in ice and then the chilled benzenediazonium chloride is added.
- Different coupling agents give different colours! Red/orange/yellow most common but blue + green exist.

· Aromatic azo compounds are stable because the azo functional group becomes part of the delocalised system and the dyes do not fade!

The dyes need to be colourfast (wash out or fade in light), and be able to attach themselves to fibres - so being soluble at first is important!

Often azo dyes have sodium sulphonate groups ($-SO_3^-Na^+$) to increase solubility.

Some ways they can attach themselves to fibres:

· Hydrogen bonding - cotton fibres have hydroxyl groups. (not very colourfast).

· Ionic attractions - bind to polar fibres, nylon, wool and silk can be protonated (amino groups $-NH_3^+$) interact with sulphonate groups ($-SO_3^-$)

· Mordant dyes - A mordant is a fixing agent that attaches to fibres and dyes attach to them.

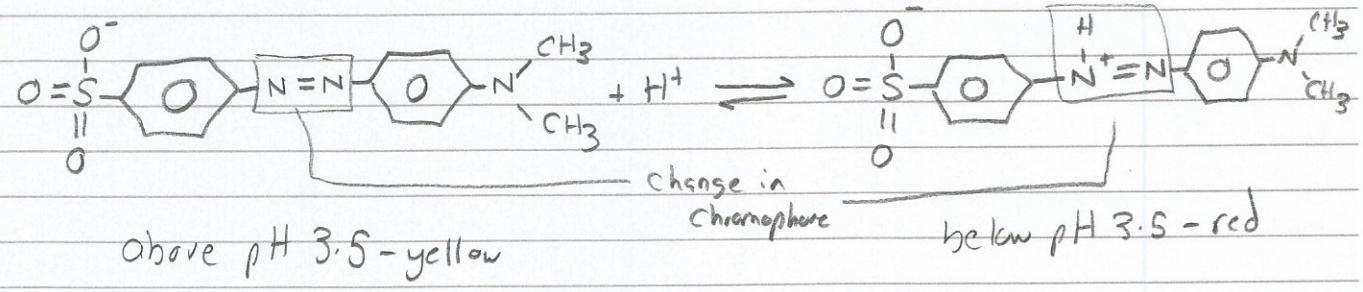
· Reactive dyes - strong covalent bonds between fibre + dyes (colourfast)

<u>CHROMOPHORES</u> - the structure in the molecule responsible for colour.

· Can be double/triple bonds, a delocalised system or lone pair.

· Light hits chromophore and certain wavelengths absorbed causing excited electrons to jump into a higher energy level. The light that is <u>NOT</u> absorbed will be seen (invisible spectrum).

· Adding or removing a group from a chromophore changes the colour.



above pH 3.5 - yellow

below pH 3.5 - red

This is methyl orange indicator!