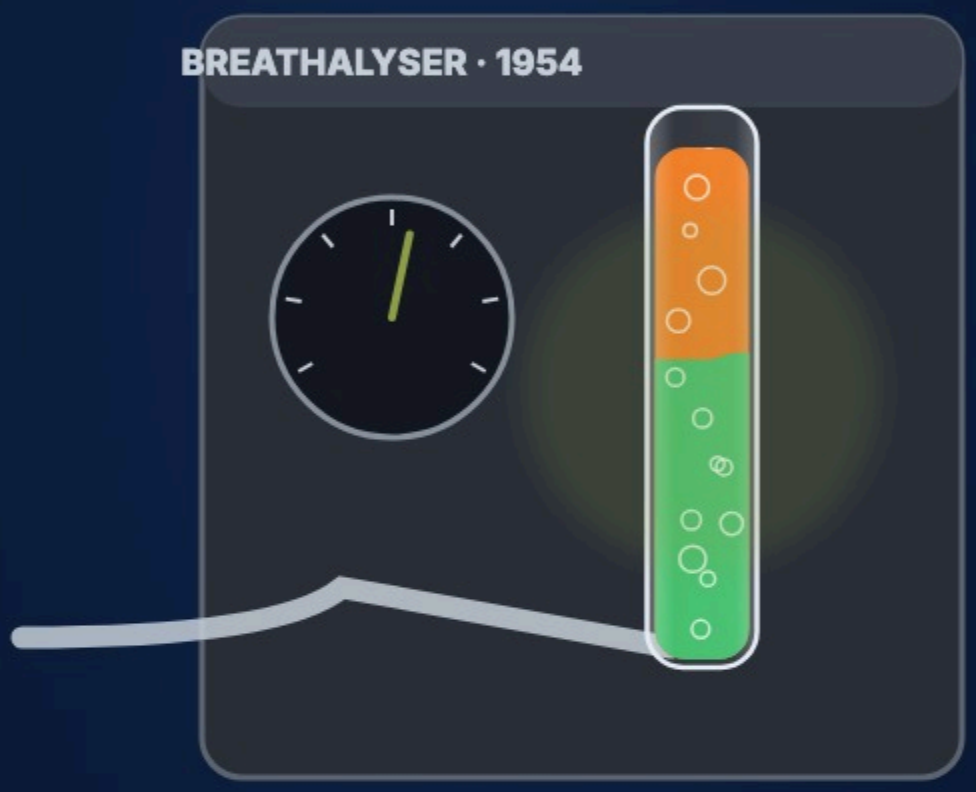
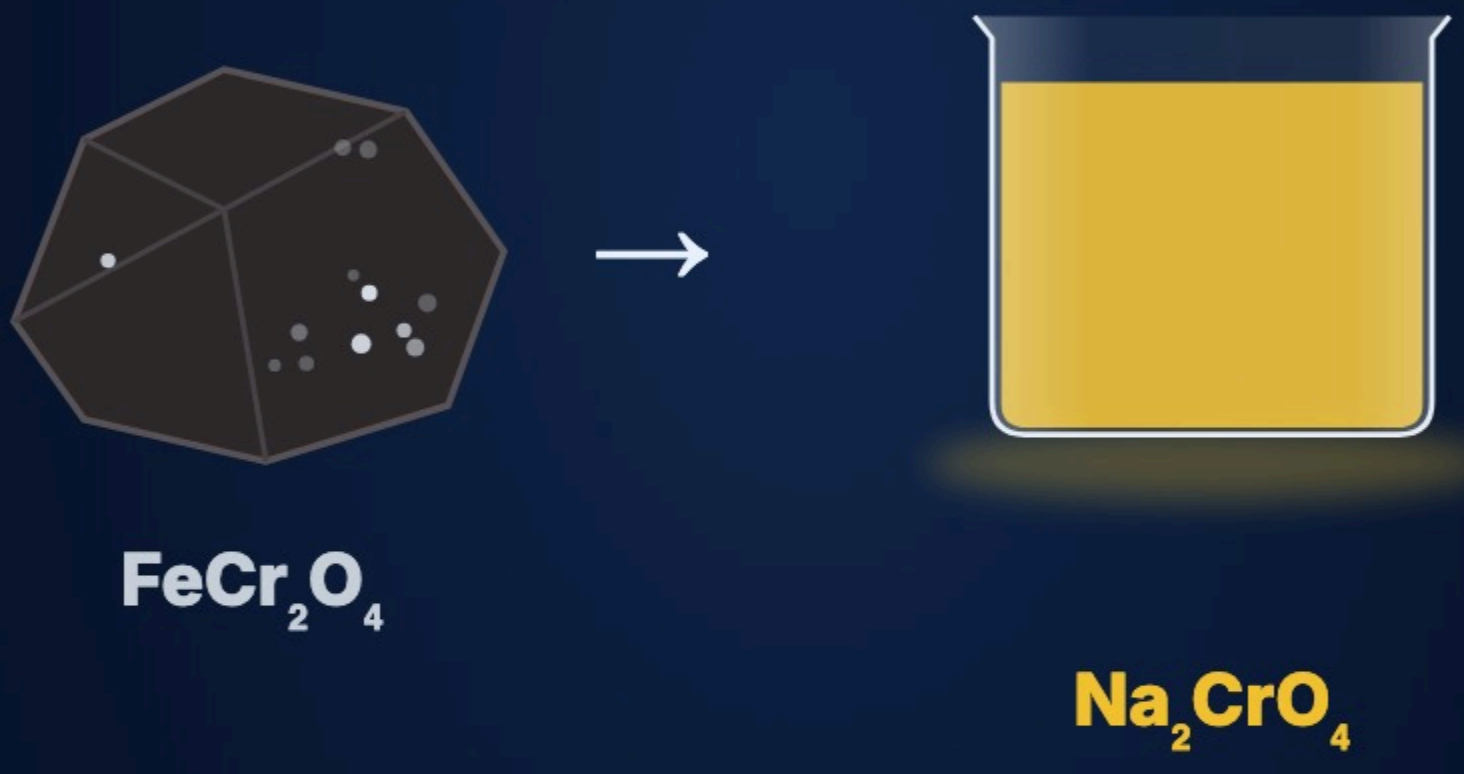
The orange that turns green



1954 breathalyser: breath through **acidified** $K_2Cr_2O_7$; alcohol turns it **orange → green**.

The orange chemical is **potassium dichromate**.

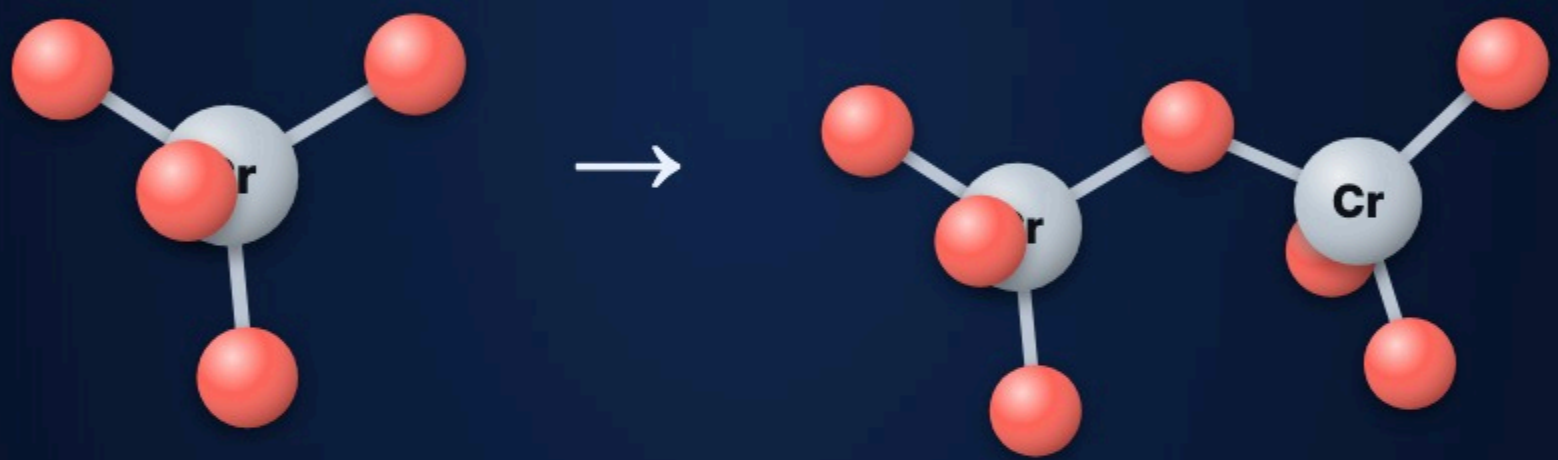
From chromite ore



Chromite is **fused with Na_2CO_3 in air**; Fe goes to Fe_2O_3 (filtered off).

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$ (**yellow** chromate).

Acid joins two chromates

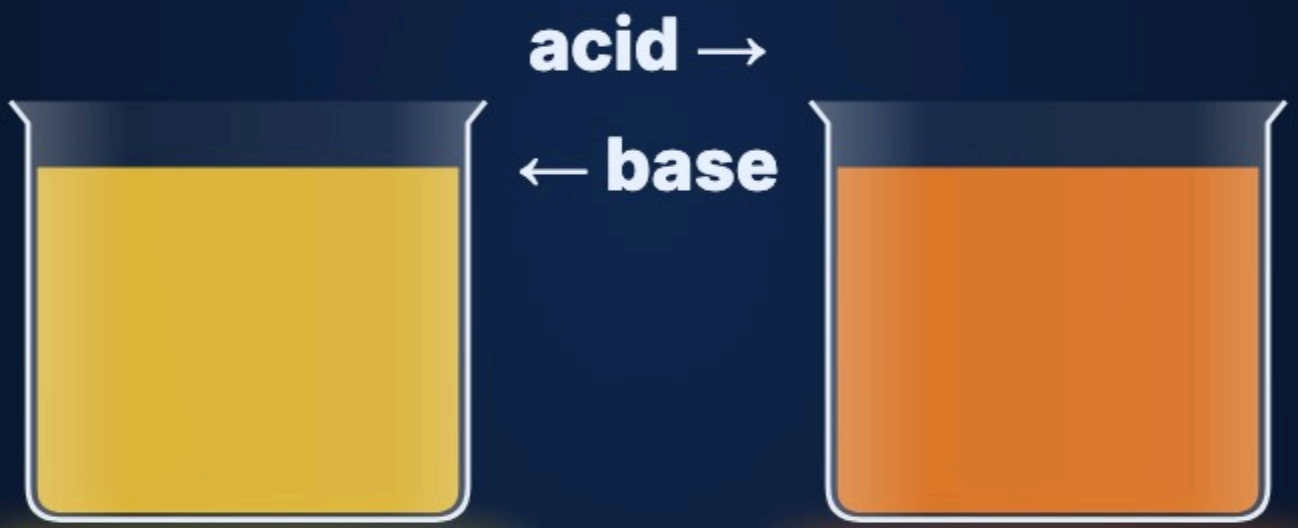


$2\,CrO_4^{2-}$ $Cr_2O_7^{2-}$ (126°)

$2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$: two tetrahedra **share one O**.

Yellow chromate becomes **orange dichromate**.

Just pH, not redox



Cr is +6 in both

Add **base**: orange dichromate goes back to **yellow chromate**.

The oxidation state of Cr stays **+6**: an acid–base change.

Crystals with KCl

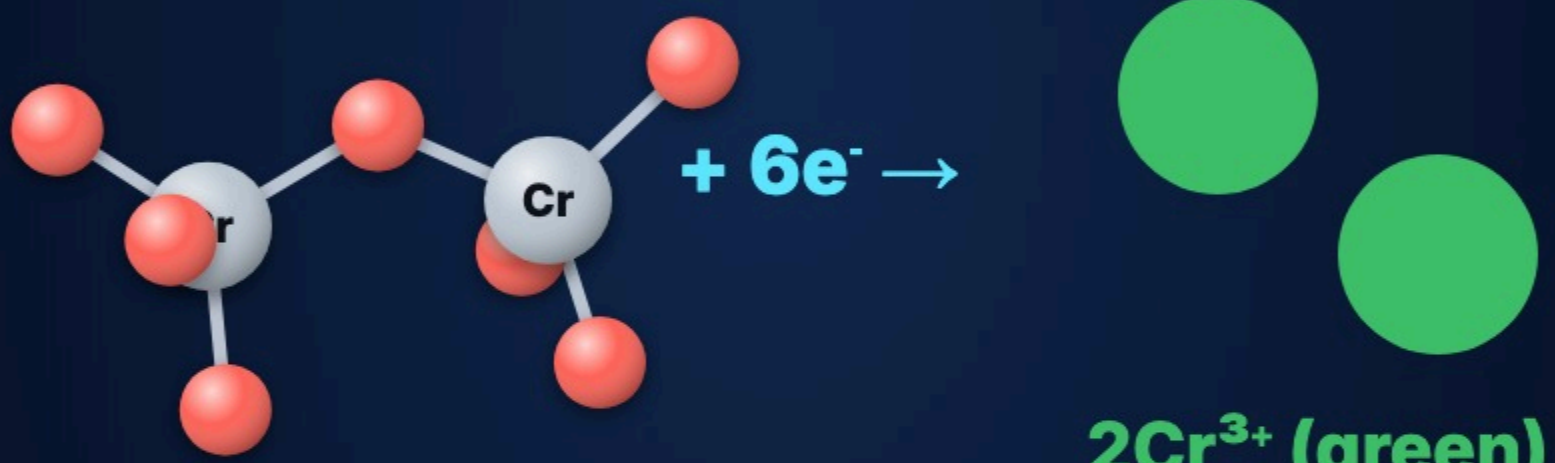


$$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$$

Sodium dichromate is **very soluble**; potassium dichromate is **less soluble**.

So adding KCl gives **orange crystals** of $K_2Cr_2O_7$.

A strong oxidising agent



$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

In acid each Cr goes **+6 → +3** (E° = 1.33 V): orange → green.

It is used as a **primary standard** in volumetric analysis.

What it oxidises

- $Fe^{2+} \rightarrow Fe^{3+}$
- $I^{-} \rightarrow I_2$
- $H_2S \rightarrow S$
- $Sn^{2+} \rightarrow Sn^{4+}$

$$Cr_2O_7^{2-} + 14H^{+} + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

In the breathalyser, **ethanol** is oxidised and the solution turns green.

Remember



$$\text{chromite} \rightarrow CrO_4^{2-} \rightarrow Cr_2O_7^{2-} \rightarrow Cr^{3+}$$

Yellow chromate, **orange dichromate**, green Cr^{3+}.

Your turn: orange dichromate + NaOH, what colour?