# Bases, alkalis and proton transfer

Student activity • desk-based review

YEAR 10 / LESSON 54 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

## The question

**Must every base contain hydroxide ions?**

Use equations and particle reasoning to compare an insoluble oxide, a soluble hydroxide and ammonia. Explain salt formation without assuming every base reaction produces water.

## Equipment

- Booklet, pencil and periodic table
- Optional reusable particle counters; no chemicals are issued

No laboratory chemicals or heating are used. Keep any small reusable model pieces away from mouths.

Course coverage: Shared core: 2.35–2.38. Proton donors/acceptors; metal oxides, hydroxides and ammonia as bases; alkalis as soluble bases.

## Plan, model or apparatus sketch

**Draw and label a proton-transfer model.**

# Method and reasoning

Read the whole sequence before starting

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**1.** Classify CuO, NaOH and $NH_3$ as an oxide, hydroxide or molecular base. These are written examples, not reagents to handle.

**2.** Draw a proton-transfer model for $H^+ + OH^- \rightarrow H_2O$, showing the charges before and after.

**3.** Complete $CuO + 2HCl \rightarrow CuCl_2 + H_2O$ and $NaOH + HCl \rightarrow NaCl + H_2O$. Identify which species accepts protons and check atom counts.

**4.** Complete $NH_3 + H^+ \rightarrow NH_4^+$. Compare $NH_3 + HCl \rightarrow NH_4Cl$ with the other reactions: water is not a product of this equation.

**5.** Model $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ to explain why aqueous ammonia is alkaline even though $NH_3$ contains no OH group. The reversible arrow matters.

**6.** Correct the claims in the questions. Use proton transfer and solubility as your reasons rather than memorising only one reaction pattern.

## Cleanup

- Return counters, retain corrections and clear the desk.

# Record your evidence

Blank spaces are for your own work

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## Reference and task data

Reference: a Brønsted base accepts a proton; an acid donates a proton. An alkali is a base soluble in water and producing $OH^-$ in aqueous solution. CuO is an insoluble basic oxide. NaOH dissolves and dissociates into ions. Ammonia reacts reversibly with water. Do not write $NH_4OH$ as if aqueous ammonia were a fully dissociated hydroxide salt.

| Example base | Classification / solubility | Acid reaction / explanation |
|---|---|---|
| CuO | | |
| NaOH | | |
| $NH_3(aq)$ | | |

**Show your calculations, labelled model or correction here.**

# Explain and evaluate

Use evidence and show calculation steps where relevant

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**1.** Correct: “All bases are alkalis, but not all alkalis are bases.” Give an example.

**2.** Balance $CuO + HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$ and name the salt.

**3.** Write the net ionic equation for HCl reacting with NaOH, including states.

**4.** Explain why ammonia is a base even though its formula has no oxygen.

**5.** Write the equation for ammonia with hydrochloric acid and explain why “acid + base always makes water” is too broad.

**6.** Explain why aqueous ammonia is alkaline without claiming that $NH_3$ molecules already contain hydroxide ions.