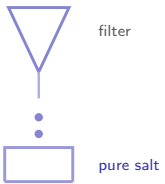
# Acids, Bases & Salts

IGCSE Chemistry ▪ Topic 7

IGCSE Chemistry

# What we will cover

1. Acids & their reactions
2. Indicators
3. Strong vs weak acids
4. The pH scale
5. Oxides
6. Preparing salts




*preparing salts*

# 1 Acids and bases

# Acids and their reactions

An **acid** 酸 forms $H^+$ in water.

- metal → **salt** 盐 + hydrogen (effervescence)
- **base** 碱 → salt + water (**neutralisation** 中和)
- **carbonate** 碳酸盐 → salt + water + $CO_2$

> You cannot *see* hydrogen – write effervescence, not "hydrogen is given off".

# Describing what you see

Naming the products is only half of what the exam wants.

> "State the observations" asks what you would **see with your eyes**, and it carries its own marks – so learn the words on the next slide.

# Indicators

An **indicator** 指示剂 is a dye that changes colour.

- **litmus** 石蕊 – red in acid, blue in alkali
- methyl orange – red in acid, yellow in alkali
- thymolphthalein – colourless in acid, blue in alkali

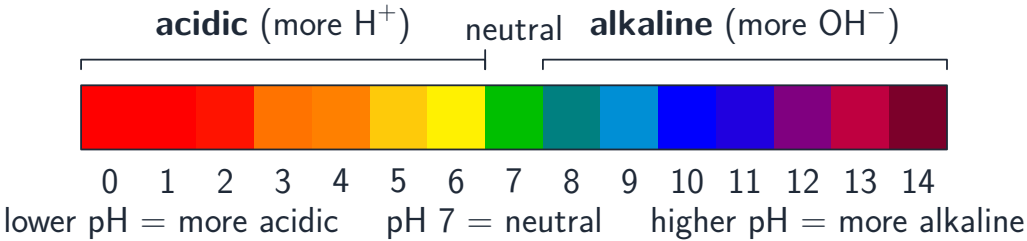
# Strong vs weak acids

A **strong acid** 强酸 (HCl, $H_2SO_4$, $HNO_3$) is fully ionised. A **weak acid** 弱酸 (ethanoic) is only partly ionised, so at the same concentration it has a higher pH and reacts more slowly.

# The pH scale

- with **metals** 金属: acid + metal → a **salt** 盐 + **hydrogen** 氢气
- with bases: acid + **base** 碱 → a salt + water (this is **neutralisation** 中和)
- with **carbonates** 碳酸盐: acid + carbonate → a salt + water + **carbon dioxide** 二氧化碳

# The pH scale, in detail




Universal indicator turns red in a strong acid, green at neutral (pH 7), and purple in a strong alkali

# 2 Oxides and salts

# Oxides

**acidic**

non-metal oxides
($SO_2$, $CO_2$)

**basic**

metal oxides
(CuO, CaO)

**amphoteric 两性**

react with both
($Al_2O_3$, ZnO)

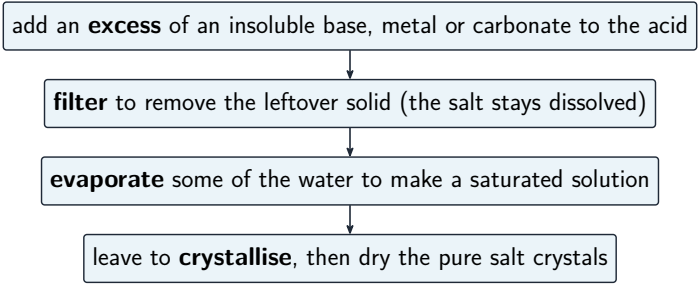
Metal oxides tend to be basic; non-metal oxides tend to be acidic.

# Making a soluble salt

React acid with excess solid (metal, base or carbonate):

1. add excess, then **filter** 过滤
2. **evaporate** 蒸发 some water
3. **crystallise** 结晶

An alkali needs **titration** 滴定 instead.



# Describing what you see, and water in salts

| | |
|---|---|
| **bubbles of gas** | say **effervescence** 泡腾 – fizzing and bubbling are also accepted |
| **the solid getting smaller** | say the solid dissolves or disappears |
| **a colour change** | name both colours – from blue to colourless, not just "it changes" |
| **heat given out** | the mixture warms – an exothermic reaction |
| **hydrated** 水合 | a substance chemically joined with water – blue copper(II) sulfate crystals |
| **anhydrous** 无水 | a substance containing no water – the same salt, white, after heating |

Observations are marked separately from equations. Write what a person watching would actually be able to report.

# Making an insoluble salt


By **precipitation** 沉淀: mix two solutions that each carry one needed ion.

> The insoluble salt appears as a solid – then filter, wash & dry it.

# Bases and alkalis


pH strips: alkalis turn universal indicator purple or blue (pH $> 7$)

# Acids, bases, and the proton

**An acid**

An acid is a **proton** 质子 donor – it gives away $H^+$ ions, and a hydrogen ion is just a proton.

**A base**

Bases are **oxides** 氧化物 or **hydroxides** 氢氧化物 of metals; an alkali is a soluble base.

**Strong and weak**

**Hydrochloric acid** 盐酸 is strong – fully ionised. **Ethanoic acid** 乙酸 is weak, so its equation takes the reversible arrow.

**Water of crystallisation**

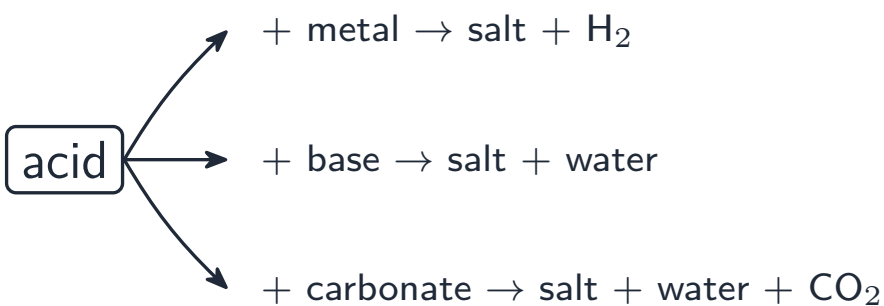
The water molecules trapped inside hydrated crystals are the **water of crystallisation** 结晶水 – driven off by heating, and taken back on cooling.

Strong is not the same as concentrated: strong is how far it ionises, concentrated is how much is dissolved.

# Making a soluble salt, continued

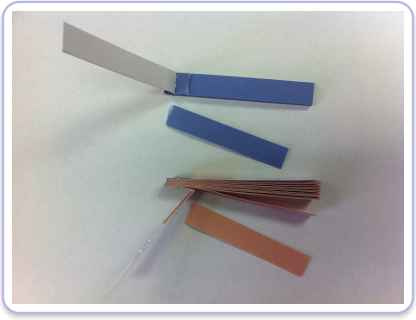
Letting the solution crystallise slowly gives well-shaped crystals – here, the blue crystals of copper(II) sulfate

# Acids




Acids react with metals, bases and carbonates to give different products

# Indicators, continued



Litmus paper: blue litmus turns red in an acid, and red litmus turns blue in an alkali

# Oxides, continued

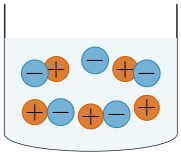
Limestone is mostly calcium carbonate – a metal carbonate that acts as a base and neutralises acids

# Sorting oxides, and the solubility rules

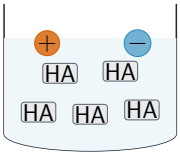
| | |
|---|---|
| **basic oxides** | metal oxides – they react with acids to give a salt and water |
| **acidic oxides** | non-metal oxides – they react with alkalis |
| **amphoteric oxides** | react with both – aluminium and zinc oxide |
| **neutral oxides** | react with neither – carbon monoxide, water |
| **always soluble** | all sodium, potassium and **ammonium salts** 铵盐, and all nitrates |
| **chlorides** 氯化物 | soluble except lead and silver; sulfates soluble except barium, calcium and lead; carbonates insoluble except sodium, potassium and ammonium |

The solubility rules decide the method: a soluble salt is made by titration or by adding excess solid; an insoluble one by precipitation.

# Strong and weak acids



**strong acid**
fully split into ions (e.g. HCl)




**weak acid**
mostly molecules, few ions (e.g. ethanoic acid)

A strong acid is fully split into ions; a weak acid stays mostly as molecules (only partly dissociated)

# Exam tips

- Learn the three acid reactions: acid + metal → salt + hydrogen; acid + base → salt + water (neutralisation); acid + carbonate → salt + water + carbon dioxide.
- **Strong** and **weak** describe how much the acid splits into ions (dissociation), *not* how concentrated it is. A strong acid is fully dissociated; a weak acid only partly.
- A lower **pH** means a higher hydrogen-ion concentration. pH 7 is neutral, below 7 is acidic, above 7 is alkaline.
- Choose the salt method by solubility: a **soluble** salt is made from an acid + excess solid (then filter, evaporate, crystallise), or by titration with an alkali; an **insoluble** salt is made by precipitation (mix two solutions, then filter).
- Learn the solubility rules – all sodium, potassium, ammonium and nitrate salts are soluble.

# 3 Recap

# Worked example – choosing a salt preparation

**How would you prepare (a) copper(II) sulfate and (b) lead(II) sulfate?**

- (a) Copper(II) sulfate is soluble: add excess insoluble copper(II) oxide to warm sulfuric acid.
- Filter off the excess, then crystallise the filtrate.
- (b) Lead(II) sulfate is insoluble: mix two solutions (lead nitrate + sodium sulfate).
- Precipitation: filter, wash and dry the solid.

Ask "is the salt soluble?" first. Soluble $\Rightarrow$ acid + excess solid, filter, crystallise. Insoluble $\Rightarrow$ mix two solutions and filter the precipitate.

# Topic 7 – key takeaways

**1 Acids**

make $H^+$; react with metals, bases, carbonates

**2 Strong/weak**

full vs partial dissociation (not conc.)

**3 pH**

$< 7$ acid, 7 neutral, $> 7$ alkali

**4 Salts**

soluble: filter/evaporate;
insoluble: precipitate

# Check yourself

1. What gas forms when an acid reacts with a metal?
2. What does “strong acid” mean?
3. What is the pH of a neutral solution?
4. How do you make an insoluble salt?


**Answers** **1.** hydrogen **2.** fully dissociated into ions **3.** 7 **4.** precipitation – mix two solutions