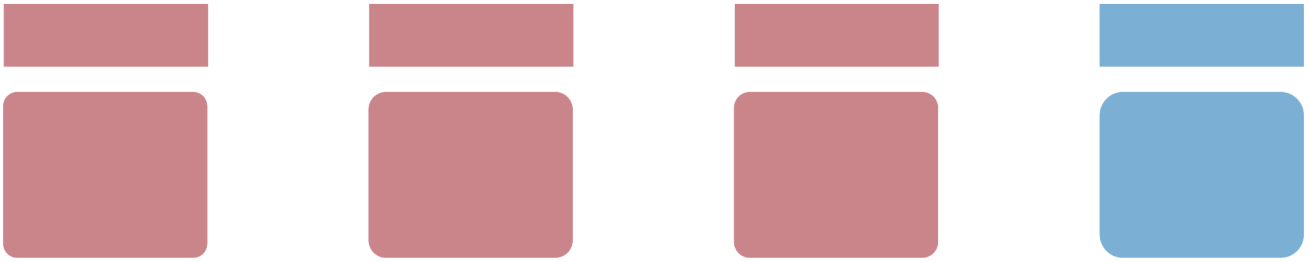
ACIDS & BASES

Acid: A substance that produces H^+ ions in an ……, pH < 7

Base: A substance that produces OH^- ions in an ……, pH > 7

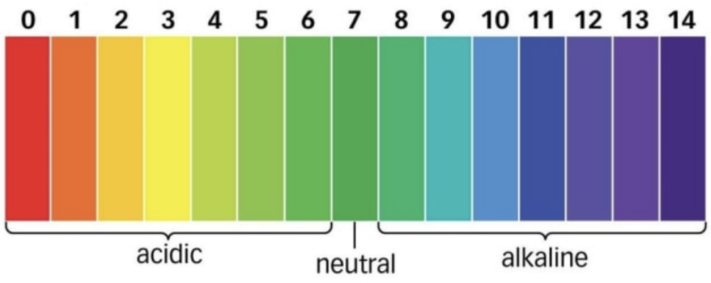
ACIDS

BASES



APPLICATIONS

Uses of Acids (Sulfuric Acid)	Uses of Bases
Manufacture of …….. Sulfuric acid is used in the production of detergents and other cleaning agents. It is used to neutralise the alkaline solutions that are used in soaps and detergents to make them more acidic, which improves their cleaning ability. **…… production** Sulfuric acid is used in the production of fertilisers. These fertilisers are used to provide essential nutrients, such as nitrogen, phosphorus, and sulfur, to plants and improve crop yields. **…… acid** Sulfuric acid is used as a component in lead-acid batteries, which are commonly used in automobiles, boats, and other applications. The acid serves as the electrolyte in the battery, which helps to generate electricity through a chemical reaction.	**Controlling soil pH with ……..** The pH of the soil affects the availability of nutrients to plants. Ideally, most plants prefer a slightly acidic soil with a pH between 6 and 7. Excess acidity in soil can occur due to various reasons such as acid rain, excessive use of fertilisers, or the presence of acidic minerals. This can result in decreased plant growth and yield as well as soil degradation. To treat excess acidity in soil, farmers can use calcium hydroxide, also known as slaked lime to help to neutralise the soil and improve its fertility.



a note on pH

- pH is a comparison between the concentration of H^+ and OH^- ions.
    - pH can only be affected by an increase or decrease in H^+ and OH^- ions.
- In neutralisation, H+ from the acid and OH– from the alkali come together to produce water at pH where the concentration of H+ and OH– is equal.

Neutralising soil with calcium hydroxide / calcium oxide

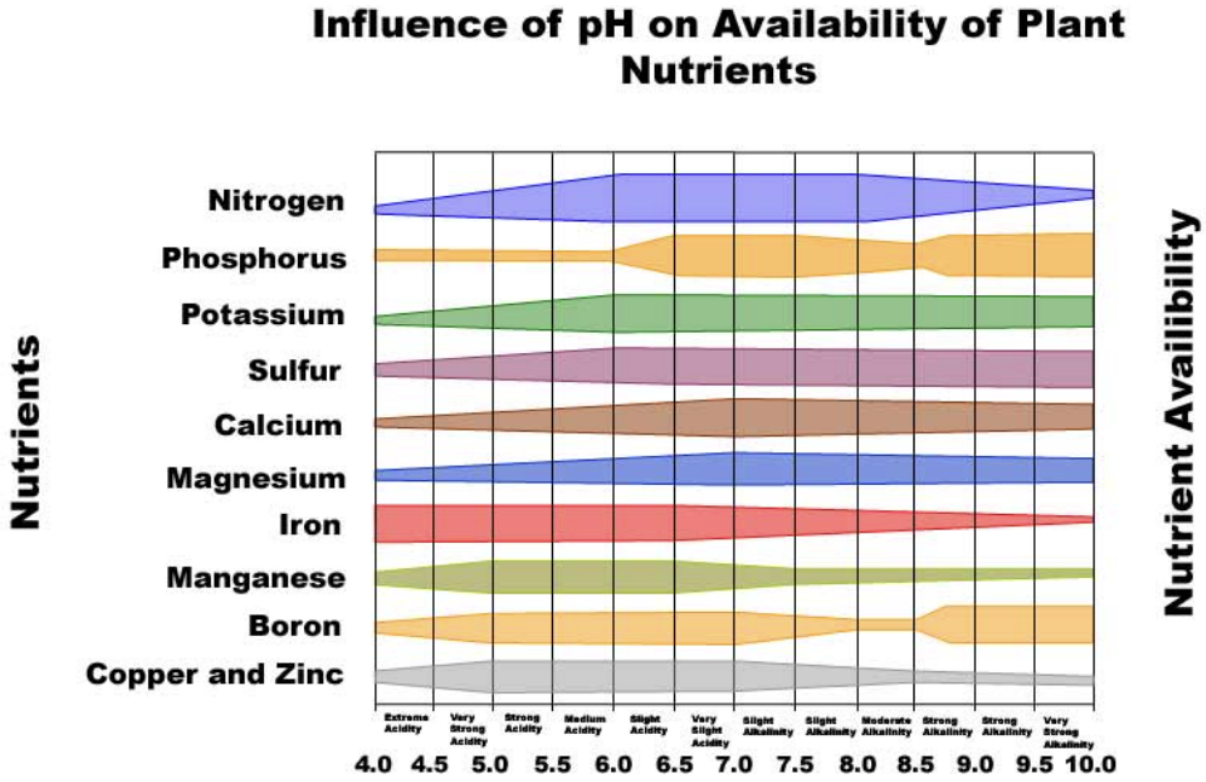
Soil can become too acidic due to acid rain (when …… gas and …… gas in the air mix with rainwater)

Why is it important to neutralise soil that is too acidic?

- When the soil gets **too** acidic, essential **nutrients become less available to the plants**, affecting their growth.
- Calcium hydroxide can neutralise the pH of soils that are too acidic, which improves the availability of these nutrients and allows the plant to grow better. (always link back to how the plant benefits)

Precautions when using calcium products to increase soil pH

- Do not use calcium containing products at the same time as ammonium fertilisers.
- As calcium hydroxide will react with ammonium based fertilisers to produce ammonia, which will result in a loss of nitrogen and wastes the fertiliser.



At pH that is too low, plants are unable to get certain essential minerals from the soil.
Using calcium hydroxide can increase the pH of the soil and improve the availability of these minerals, improving plant growth.

step 1: knowing the ions

Write down the chemical formulae of the following ions:

1. nitrate ion …….
2. carbonate ion …….
3. phosphate ion …….
4. sulfate ion …….
5. ammonium ion …….
6. magnesium ion …….
7. zinc ion …….
8. aluminium ion …….
9. oxide ion …….
10. chloride ion …….
11. hydroxide ion …….

step 2: putting the ions together to form compounds

Write down the chemical formulae of the following compounds:

12. phosphoric acid …….
13. nitric acid …….
14. sulfuric acid …….
15. hydrochloric acid …….
16. magnesium carbonate …….
17. sodium carbonate …….
18. calcium carbonate …….
19. lithium carbonate …….
20. sodium hydroxide …….
21. potassium hydroxide …….
22. calcium hydroxide …….
23. calcium oxide …….
24. magnesium oxide …….
25. sodium oxide …….

step 3: identifying the reaction and writing balanced equations

helpful ideas

1. **The three types of reactions**
   a. acid-base
   b. acid-metal
   c. acid-carbonate
2. **The three common acids produce H+ in aqueous solutions**
   a. hydrochloric acid
   b. nitric acid
   c. sulfuric acid

26. Sodium hydroxide and hydrochloric acid Type of reaction: ……

……

27. Calcium carbonate and sulfuric acid Type of reaction: ……

……

28. Zinc and nitric acid Type of reaction: ……

……

29. Phosphoric acid and calcium hydroxide Type of reaction: ……

……

30. Nitric acid and potassium hydroxide Type of reaction: ……

……

31. Hydrochloric acid and sodium carbonate Type of reaction: ……

……

32. Acetic acid (CH_3COOH) and sodium hydroxide Type of reaction: ……

……

33. Sulfuric acid and zinc metal Type of reaction: ……

……

34. Sulfuric acid and calcium carbonate Type of reaction: ……

……

35. Nitric acid and copper Type of reaction: ……

……

summary on writing chemical equations

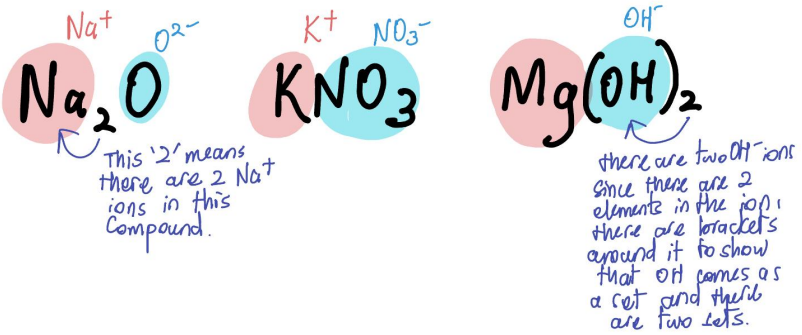
STEP 1: knowing the ions
It's ***very*** important that you get the ions right because using incorrect ions will cause you to form incorrect compounds and lead you to write incorrect equations.

STEP 2: forming the compounds
When forming the compound, your goal is to put the ions (from step 1) together and make the overall charge of the compound zero. You are using positive and negative ions to form **ONE** compound.

- If the ions have the same but opposite charge, they are perfect for each other; just put the ions together to get the compound. E.g. magnesium oxide comprises Mg^{2+} and O^{2-} . Since the charges are 2+ and 2–, just put them together to get magnesium oxide.

- However, when considering sodium oxide, Na^+ and O^{2-} are not perfect for each other. You need two Na^+ ions to balance out the 2– of O^{2-} so the compound you get is Na_2O.

- A note on subscripts and brackets:



- **STEP 3: writing the equation**
  3.1 identify the type of reactions as this will let you know the products
  3.2 write down the reactants and products
  - How to form the salt: take the metal cation and the anion of the other compound and put them together to form an uncharged compound

  3.3 balance the equation
  After you are done forming the compounds and you're writing the entire chemical equation, balance by adding large numbers in front.

Eg. $HCl + Mg(OH)_2$

step 1: Write out the products Mg^{2+} Cl^-

$HCl + Mg(OH)_2 \rightarrow MgCl_2 + H_2O$

a. this is an acid-base reaction so salt and water is produced

step 2: Balance the equation

Mg ✓

Cl ✗

$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + H_2O$

adding 2 here balances the 'H' as well
all problems solved !!

concept check: acids & bases, formulas & equations

1. Which substance is used to decrease the acidity in soil?

   A ammonium nitrate

   B calcium hydroxide

   C magnesium sulfate

   D potassium chloride

2. Which substance will not react with dilute sulfuric acid to produce zinc sulfate?

   A zinc

   B zinc chloride

   C zinc hydroxide

   D zinc oxide

3. Which set of numbers will balance the equation shown below?

   $$\boldsymbol{p}\ C_4H_{10} + \boldsymbol{q}\ O_2 \rightarrow \boldsymbol{r}\ CO_2 + \boldsymbol{s}\ H_2O$$

	p	***q***	***r***	***s***
A	1	10	4	5
B	1	13	4	5
C	2	13	8	10
D	2	26	8	10

4. Potassium chlorate has the formula KC/O_3.
   What is the chemical formula of copper(II) chlorate?

   A CuC/O_3

   B Cu_2C/O_3

   C $Cu_3(C/O_3)_2$

   D $Cu(C/O_3)_2$

5. Which statement about acids and bases is not correct?

   A Acids do not contain hydroxide ions.

   B An acidic solution has a pH value of less than 7 at 25°C.

   C Basic oxides can be formed from metals reacting with oxygen.

   D Soluble bases that dissolve in water and producing hydroxide ions are called alkalis.

oxides

Oxides can be classified as ……..……, ……, …..……, or ……..…… based on the nature of the oxide and the metallic/non-metallic character of the element it is bonded with.

	Basic oxides	Amphoteric oxides	Acidic oxides	Neutral oxides
Notes	Formed when **metallic** elements combine with oxygen	**ZAP** oxides are amphoteric.	Formed when **non-metallic** elements combine with oxygen	They do not react with acids or bases
Examples	Na_2O, MgO	ZnO, Al_2O_3, PbO	SO_2, NO_2, CO_2	CO, NO, H_2O

SUMMARY

- When a ……. combines with oxygen, **basic** oxides are formed.
  For example, ……. is basic.
- When ……. combine with oxygen, **amphoteric** oxides are formed.
  For example, ……. is amphoteric
- When a ……. combines with oxygen, **acidic** oxides are formed.
  For example, ……. is acidic
- ……., ……. and ……. are **neutral**

6. Which oxide reacts with both dilute hydrochloric acid and aqueous ammonia?

   A aluminium oxide

   B carbon monoxide

   C copper(II) oxide

   D sulfur dioxide

7. Aluminium oxide, calcium oxide and phosphorus(V) oxide are formed when the element is reacted with excess oxygen gas in each case.

   Tests were carried out on the oxides by adding them to dilute hydrochloric acid and dilute sodium hydroxide separately.

   Put a tick (✓) where the reaction will take place.

	Aluminium oxide	Calcium oxide	Phosphorus (V) oxide
Addition of oxide to dilute hydrochloric acid			
Addition of oxide to dilute sodium hydroxide			

[3]

salt prep

Salts are ionic compounds which, when dissolved in water, break up completely into ions. They arise by the reaction of acids with bases, and they always contain either a metal cation or a cation derived from ammonium (NH_4^+).

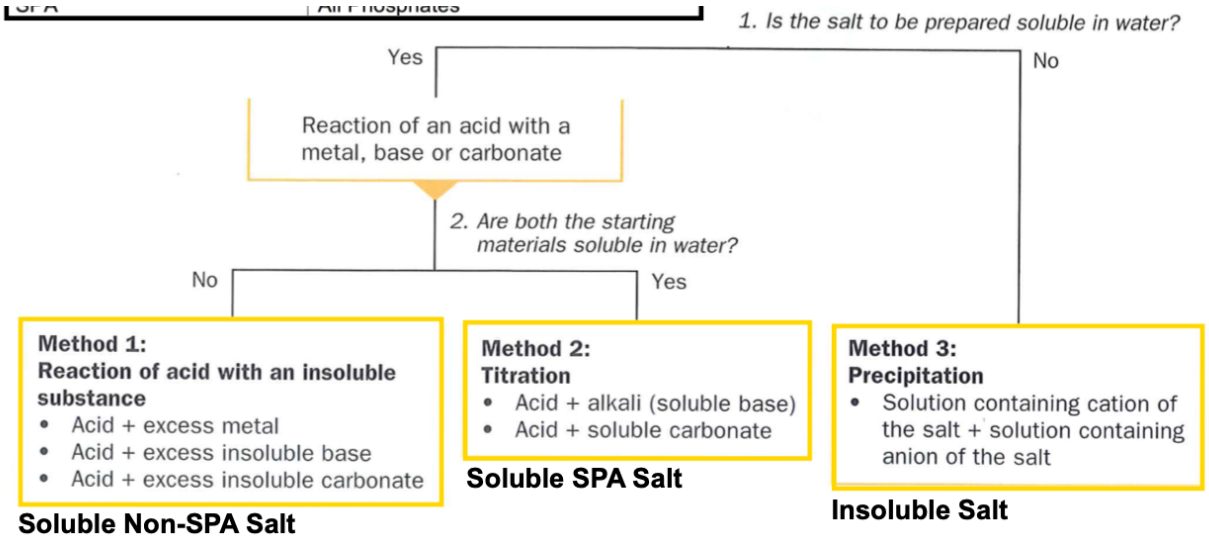
In a salt, the positive ion comes from a base or a metal, while the negative ion comes from an acid. For example, sodium chloride (NaC*l*) is a salt formed when hydrochloric acid (HC*l*) reacts with sodium hydroxide (NaOH). Na^+ comes from the base while Cl^- comes from the acid to form NaCl.

Preparation of Salts

How do you know which salt prep method to use? There are two questions to be asked.

1. **Is the salt to be prepared soluble in water?**
    - If the salt is insoluble, definitely choose precipitation as it is the only method that yields an insoluble salt. Since the salt is a solid in an aqueous solution (insoluble), it can be easily obtained by filtration.

2. **Are the starting materials both soluble?**
    - If starting materials are all **soluble**, the method to be used is titration. Titration requires the starting materials to be in aqueous states so that they can be used in the burette and conical flask.
    - If the starting materials are **insoluble** (metal, insoluble base, insoluble carbonate), just react it in a vessel.



If the product is insoluble → precipitation

If the product is a soluble non SPA salt → reaction of acid with insoluble BCM

If the product is soluble spa → titration

There are 5 methods of salt prep: PTMBC (precipitation, titration, metal, base and carbonate). Which method to use depends on the solubility of the product formed or your starting materials.

Solubility of Salts (Pure Chemistry only)

Soluble salts	Insoluble salts
SPAN Sodium salts Potassium salts Ammonium salts Nitrates salts	
Chlorides	Lead (II) chloride Silver chloride
Sulfates	Barium sulfate Calcium sulfate Lead (II) sulfate
Sodium carbonate Potassium carbonate Ammonium carbonate	Carbonates
Sodium hydroxide Potassium hydroxide Calcium hydroxide (sparing soluble) Magnesium hydroxide (very sparingly soluble)	Hydroxides

concept check: salt prep

State the suitable method to prepare the following salts:

	Salt	Soluble?	SPA salt?	Salt Prep Method	Reactant 1	Reactant 1
1.	Sodium carbonate					
2.	Calcium carbonate					
3.	Potassium carbonate					
4.	Barium sulfate					
5.	Potassium hydroxide					
6.	Potassium chloride					
7.	Sodium nitrate					
8.	Iron (III) hydroxide					
9.	Ammonium chloride					
10.	Silver chloride					

concept check: salt prep mcq

1. Which reagent is added to aqueous potassium chloride to prepare lead(II) chloride?

   A lead

   B lead(II) carbonate

   C lead(II) nitrate

   D lead(II) oxide

2. Which salt is incorrectly matched with its method of preparation?

	salt	method of preparation
A	ammonium nitrate	titrate aqueous ammonium carbonate with dilute nitric acid
B	copper(II) sulfate	add excess copper(II) carbonate to warm dilute sulfuric acid
C	lead(II) nitrate	add excess lead(II) oxide to dilute nitric acid
D	silver chloride	add excess silver to warm dilute hydrochloric acid

3. Calcium sulfate is an insoluble salt.
   Which method is most suitable for preparing calcium sulfate?

   A adding calcium metal to dilute sulfuric acid

   B adding aqueous calcium nitrate to dilute sulfuric acid

   C titrating calcium hydroxide solution with dilute sulfuric acid

   D warming solid calcium carbonate with dilute sulfuric acid

4. Which set of reagents is the most appropriate to prepare a pure, dry sample of copper(II) sulfate?

   A copper and dilute sulfuric acid

   B copper(II) carbonate and dilute sulfuric acid

   C copper(II) chloride solution and sodium sulfate solution

   D copper(II) oxide and sodium sulfate solution

5. Which of the following combinations of reactants is most suitable for the preparation of the given salt?

	reactants	salt to be prepared
A	calcium carbonate and sulfuric acid	calcium sulfate
B	copper(II) oxide and hydrochloric acid	copper(II) chloride
C	magnesium nitrate and sulfuric acid	magnesium sulfate
D	sodium and nitric acid	sodium nitrate

1. Two indicators, bromophenol blue and Congo red, show the following colours in acidic solutions and in alkaline solutions.

indicator	acid	alkali
bromophenol blue	yellow	blue
Congo red	violet	red

A few drops of each indicator are added to separate samples of a solution of pH 2.
What are the colours of the indicators in this solution?

	colour of indicator in a solution of pH 2	
	bromophenol blue	Congo red
A	blue	red
B	blue	violet
C	yellow	red
D	yellow	violet

2. Choose from the following oxides to answer the questions.

aluminium oxide
calcium oxide
carbon monoxide
copper(II) oxide
magnesium oxide
sodium oxide
sulfur dioxide

Each oxide may be used once, more than once or not at all.
Identify an oxide which:

(a) is amphoteric ……..…

(b) contains ions with a 1+ charge ……..…

(c) is formed during the incomplete combustion of carbon-containing fuel ……..…

(d) contributes to acid rain ……..…

(e) is a product of the thermal decomposition of calcium carbonate ……..…

(f) is a black solid ……..…

[Total: 6]

3. Fig. 7.1 shows some reactions of dilute nitric acid.
Five substances **A**, **B**, **C**, **D** and **E** are shown in the chart.

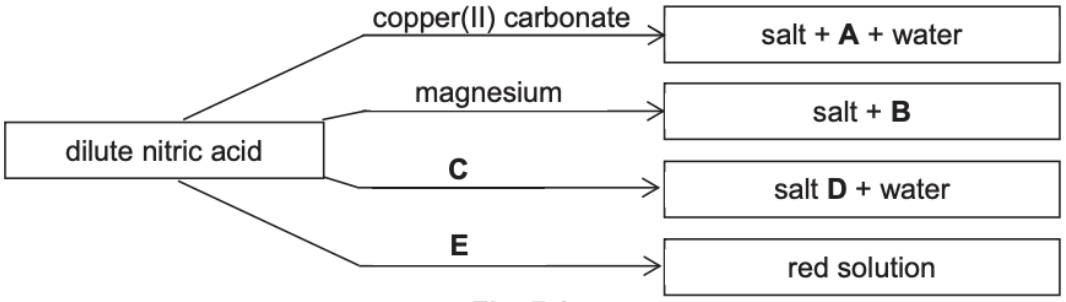


Fig. 7.1

(a) Use the substances A to E to answer the following questions.

(i) Which substance could be Universal Indicator? ……. [1]

(ii) Which substance is carbon dioxide? ……. [1]

(iii) Which substance gives a 'pop' sound with a lighted splint? ……. [1]

(b) Dilute nitric acid was titrated against alkali C to produce a soluble salt D and water.

(i) Suggest the two apparatus and the indicator used in this experiment. [1]

apparatus: …….. and ……..

indicator: ……..……..……

(ii) What is the name of the reaction when alkali C reacts with nitric acid? [1]

……..……..……

(iii) State an ion that alkali C would produced when it is dissolved in water [1]

……..……..……

(iv) What type of bonding would salt D have? [1]

……..……..……

(c) Write the ionic equation of the reaction between nitric acid and copper(II) carbonate.

……

(d) A student would like to confirm the presence of the carbon dioxide gas produced after a chemical reaction. Describe a test to identify carbon dioxide gas.

Test: ……

Observations: ……

……