

### Definitions

**Acids** Acids are compounds which ionise/dissociate in water to produce hydrogen ions ( $H^+$ ).

**Bases** Bases are compounds that are metal oxides or hydroxides that react with an acid to give a salt and water only.

**Alkalis** Alkalis are bases that ionise/dissociate in water to produce hydroxide ions ( $OH^-$ ).

### Examples of Acids & Bases

Acid	Chemical Formula	Base	Chemical Formula
Hydrochloric Acid	HCl	Magnesium Oxide	MgO
Sulfuric Acid	H <sub>2</sub> SO <sub>4</sub>	Copper (II) Oxide	CuO
Nitric Acid	HNO <sub>3</sub>	Sodium Hydroxide	NaOH
Citric Acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	Potassium Hydroxide	KOH
Ethanoic Acid	CH <sub>3</sub> CO <sub>2</sub> H	Calcium Hydroxide	Ca(OH) <sub>2</sub>
Lactic Acid	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	Aqueous Ammonia	NH <sub>3</sub>

Acids 1 to 3 are known as mineral / inorganic acids while Acids 4 to 6 are known as organic acids.

Bases 1 & 2 are insoluble bases while Bases 3 to 6 are soluble bases / alkalis.

### Metal Reactivity Series

Reactivity Series of Metals			
	<b>Potassium</b>	<b>K</b> (Most reactive metal)	
	Sodium	Na	
	Calcium	Ca	
These metals are more reactive than hydrogen	Magnesium	Mg	
	Aluminium	Al	
	Zinc	Zn	
	Iron	Fe	
	Tin	Sn	
	Lead	Pb	
	<b>[Hydrogen]</b>	<b>[H]</b>	
These metals are less reactive than hydrogen	Copper	Cu	
	Mercury	Hg	
	Silver	Ag	
	Gold	Au	(Least reactive metal)

### Types of Reactions

Metal + Acid → Salt + Hydrogen Gas  
 Metal Carbonate + Acid → Salt + Water + Carbon Dioxide  
 Metal Oxide + Acid → Salt + Water  
 Metal Hydroxide + Acid → Salt + Water  
 Base + Acid → Salt + Water (Neutralisation)  
 Alkali + Acid → Salt + Water (Neutralisation)  
 Alkali + Ammonium Salt → Salt + Water + Ammonia Gas  
 Alkali + Salt → Metal Hydroxide + Salt

#### Tests for Gases:

Hydrogen Gas - Extinguishes a lighted splinter with a 'pop' sound.  
 Carbon Dioxide Gas - Released as effervescence. Reacts with limewater to form a white precipitate.  
 Ammonia Gas - Pungent odour. Turns red litmus paper blue.

#### Notes:

Base / Alkali + Acid is an exothermic reaction.  
 $Pb(s) + H_2SO_4 / HCl \rightarrow PbSO_4 / PbCl_2 + H_2$   
 Lead reacts slowly then stops. Salt forms on the surface of the lead. The salt formed is insoluble.

### pH Scale

Acidic solutions have pH values < 7. They contain **more**  $H^+$  ions and **fewer**  $OH^-$  ions.  
 Neutral solutions have pH values = 7. They contain **equal amounts** of  $H^+$  ions and  $OH^-$  ions.  
 Alkaline solutions have pH values > 7. They contain **more**  $OH^-$  ions and **fewer**  $H^+$  ions.

### Ionic Equations

- Write a balanced chemical equation with state symbols.
- Check which reactants and products can form ions in water. (Aqueous)
- Split up these reactants and products into their respective ions.
- Check for ions that appear in both LHS & RHS of the equation, these are spectator ions that can be removed from the equation.
- For those reactants and products which are unable to form ions, do not split the compounds.
- What is left will be the net ionic equation. The coefficients must be in the lowest ratio.

### Polyatomic Ions

Charge	Name	Chemical Formula
1+	Ammonium	NH <sub>4</sub> <sup>+</sup>
	Hydronium	H <sub>3</sub> O <sup>+</sup>
1-	Nitrate	NO <sub>3</sub> <sup>-</sup>
	Hydroxide	OH <sup>-</sup>
	Ethanoate	CH <sub>3</sub> COO <sup>-</sup>

### Polyatomic Ions (cont)

2-	Carbonate	$\text{CO}_3^{2-}$
	Sulfate	$\text{SO}_4^{2-}$
3-	Phosphate	$\text{PO}_4^{3-}$

#### Notes:

Silver ion:  $\text{Ag}^+$

Zinc ion:  $\text{Zn}^{2+}$

### Properties of Acids

1. Acids are corrosive.
2. Acids have a sour taste.
3. Acidic solutions conduct electricity. (Electrolytes)
4. Acids change the colour of indicators.

Litmus Paper: Blue to Red

Methyl Orange Solution: Orange to Red

Universal Indicator Paper: Orange to Red

Universal Indicator Solution: Green to Red

### Properties of Alkalis

1. Alkalis have a soapy feeling and a bitter taste.
2. Alkaline solutions conduct electricity. (Electrolytes)
3. Alkalis change the colour of indicators.

Litmus Paper: Red to Blue

Methyl Orange Solution: Orange to Yellow

Universal Indicator Paper: Orange to Violet

Universal Indicator Solution: Green to Violet

### Balancing Chemical Equations

Step 1: Write down the chemical equation.

Step 2: List down the atoms (or polyatomic ions) involved in both sides.

Step 3: Count the number of atoms on both sides.

Step 4: Compare both sides and change the coefficients (not subscripts) so that the atoms on the left side are equal to the atoms on the right side.

(Tip: Balance the **Metals** first, then the **Non-Metals**, and then the **Oxygen** atoms and **Hydrogen** atoms.)

Step 5: Double check both sides to make sure the atoms on both sides are equal.

### Soluble Salts

Soluble	Insoluble
All nitrates	None
Most sulfates	Lead sulfate, barium sulfate and calcium sulfate
Most chlorides, bromides and iodides	Silver chloride, silver bromide, silver iodide, lead chloride, lead bromide, lead iodide
Sodium carbonate, potassium carbonate, ammonium carbonate	Most other carbonates
Sodium hydroxide, potassium hydroxide, ammonium hydroxide	Most other hydroxides

### Uses of Acids

Citric Acid	Used as a sour flavouring agent in food
Hydrochloric Acid	Used as a rust remover
Sulfuric Acid	Used in car batteries
Nitric Acid	Used in fertilisers
Ethanoic Acid	Used as a food preservative
Carbonic Acid	Used in making soft drinks

### Uses of Alkalis

Sodium Hydroxide	Used in making soap
Calcium Hydroxide	Used in making toothpaste and to reduce acidity in soil
Aqueous Ammonia	Used in making fertilisers and as a bleaching agent
Aqueous Ammonia	Used in making fertilisers and as a bleaching agent
Potassium Hydroxide	Used in electroplating and in making cement and plaster
Magnesium Hydroxide	Used as a detergent

### Strength of Acids

Strong Acids	Weak Acids
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Hydrochloric Acid	Citric Acid
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Sulfuric Acid	Tartaric Acid
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Nitric Acid	Ethanoic Acid
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#### Strong Acids:

React very fast & vigorously

Ionise completely to produce large amounts of  $H^+$  ions

#### Weak Acids:

React slowly & less vigorously

Ionise partially to produce small amounts of  $H^+$  ions

*Do not confuse the strength of an acid with the concentration of an acid. The strength tells you how many  $H^+$  ions are produced while the concentration tells you how much of an acid is dissolved in water.*

### Strength of Alkalis

Strong Alkalis	Weak Alkalis
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Sodium Hydroxide	Aqueous Ammonia
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Potassium Hydroxide	
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Calcium Hydroxide	
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Strong Alkalis ionise completely to produce large amounts of  $OH^-$  ions.

Weak Alkalis ionise partially to produce small amounts of  $OH^-$  ions.

### How to Carry Out Titration

1. For solid samples, weigh the solid and dissolve in a known volume of solution (usually  $100\text{cm}^3$ ).

2. Use a pipette to measure a known volume of the solution (e.g  $10\text{cm}^3$ ) and empty into an Erlenmeyer flask.

3. Add a few drops of indicator into the solution.

### How to Carry Out Titration (cont)

4. Put the second chemical into a burette.

This other solution will react with the synthesised chemical sample in the flask. Often the solution in the burette is an acid or alkali, and it must be of a precise, known concentration.

5. Drop by drop, mix the chemical in the burette into the Erlenmeyer flask until the end point is reached. A colour change indicates the correct amount has been added to react completely with the chemical in the sample.

6. Take note of the volume of the solution added from the burette.

