ACIDS, BASES AND SALTS

Ionic equations

only ionic (aq) compounds

1) write out equation with state symbols
2) cancel out spectator ions
3) simplify coefficients to simplest form

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

$Na^+(aq) + OH^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(l)$

spectator ions (stay the same)

$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

for all neutralizations

Eg

$H_2SO_4(aq) + CuO(s) \rightarrow CuSO_4(s) + H_2O(l)$

$2H^+(aq) + SO_4^{2-}(aq) + CuO(s) \rightarrow CuSO_4(s) + SO_4^{2-}(aq) + H_2O(l)$

$2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$

ammonia + sulfuric acid ——

$2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$

Concentration

- how much of a substance is dissolved in 1 dm^3 of a solution

Strength

↗ strength of bonds

→ can't be changed

- how easily an acid/alkali dissociates into ions when dissolved in water

dissolved in water — partial dissociation

weak acid: $CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$ ↖ mostly molecules

strong acid: $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

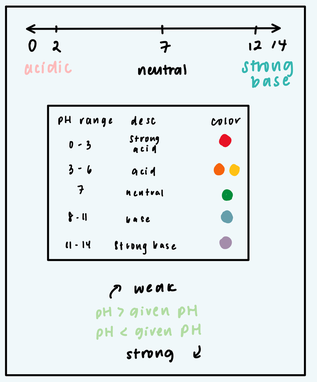
weak alkali: $NH_3(g) + H_2O(l) \rightleftharpoons OH^-(aq) + NH_4(aq)$

strong alkali: $NaOH(aq) \rightarrow OH^-(aq) + Na^+(aq)$

$pH + pOH = 14$

pH — 25°C, 298K

$pH = -\lg[H^+(aq)]$ → conc of H^+ ions



too acidic: $Ca(OH)_2$ / CaO

Liming: react w excess acid in the soil

▲ to note

"which indicators can be used to determine its pH val if its pH is n?

Find 2 values such that $V_1 < n < V_2$

All acids, regardless of strength, will react completely with a base/alkali

Both CH_3COOH and HNO_3 will require the same amt of NaOH for complete neutralisation if they have the same concentration

Acids + Bases

neutralization (both aqueous)

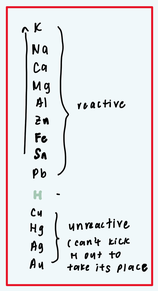
alkali — base that is soluble

	Acids	Bases
Arrhenius (aqueous only)	An acid is a substance that when dissolved in water produces H+ ions	A base is a substance that, when dissolved in water, produces OH- ions (Limits to only metal oxides and hydroxides)
Bronsted-Lowry (H+ ion is simply a proton) • **Acids and bases must always work together**	A substance (molecule or ion) that donates a proton to another substance (must have H+ ion) • Must have a hydrogen atom that can be lost as an H+ ion	A substance that accepts a proton (must have non-bonding pairs) - must have a non-bonding pair of electrons that it can use to bind the H+ ion

reactions

* metals have to be reactive! (not gold, silver, copper)

1) acids + metals → salt + $H_2(g)$
2) acids + metal (OH/O) → salt + H_2O
3) acids + metal(HCO_3) → salt + H_2O + CO_2



Properties

1) **Sour taste**
Due to the presence of acids such as citric acid ($C_6H_7O_7$) malic acid ($C_2H_6O_5$) and oxalic acid ($H_2C_2O_4$)

2) **Color of indicator**
Acids turn most blue litmus paper red

3) **Conducts electricity**
Aqueous solutions of acids conduct electricity due to the presence of ionis that act as mobile charge carriers

Basicity/proticity	
Monoprotic/monobasic (1)	H^+
Diprotic/dibasic (2)	$2H^+$
Triprotic /tribasic (3)	H3PO4

# of replaceable hydrogens in the formula of an organic acid

reactions

1) alkali + ammonium salt ⇌ NH_3 + salt + H_2O

ammonia
- $NH_3(g)$ (default)
- $NH_3(aq)$ Bronsted Lowry Base

react with acid

Properties

1) Has bitter taste and feels soapy
2) Turns red litmus paper blue
3) Dissolve in water to form solutions that conducts electricity

Oxides

oxide + H_2O → hydroxide

- **Basic oxide**
  - all other metals: Na_2O, CaO, K_2O, MgO, CuO
  - react with acids to form salt + H_2O
- **Amphoteric oxides**
  - only 3: Al_2O_3, PbO, ZnO
  - reacts with both acid and alkali to form salt
  - Zn, Al, Pb
- **Acidic oxides** (O > 1)
  - CO_2, SO_2, NO_2
  - react with alkali to form salts + H_2O
- **Neutral oxide**
  - H_2O, CO, NO, N_2O
  - does not react

SALTS

"ionic compounds formed when a metallic ion or an ammonium ion (NH_4^+) replaces 1 or more H^+ ions of an acid"

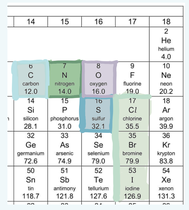
https://quizizz.com/join/quiz/6677ddceac8ff66056137b582?studentShare=true

Anion	Soluble	Insoluble
Nitrate (NO_3^-)	All	None
Nitrite (NO_2^-)	All others	Ag^+
Chloride (Cl^-)	All others	Ag^+, Pb^{2+}
Bromide (Br^-)	All others	Ag^+, Pb^{2+}
Iodide (I^-)	All others	Ag^+, Pb^{2+}
Sulfate (SO_4^{2-})	All others	Pb^{2+}, Ba^{2+}, Sr^{2+} and Ca^{2+}
Sulfite (SO_3^{2-})	Na^+, K^+, NH_4^+	All others
Carbonate (CO_3^{2-})	Na^+, K^+, NH_4^+	All others
Oxide (O^{2-})	Na^+, K^+, NH_4^+, Ba^{2+}, Sr^{2+}, Ca^{2+}	All others
Hydroxide (OH^-)	Na^+, K^+, NH_4^+, Ba^{2+}, Sr^{2+}, $^*Ca^{2+}$	All others

*if not told

Solubility table of common ionic compounds

Na^+, K^+, NH_4^+ ∀ all soluble



water of crystallization

(molecules surrounding salt)

ionic compounds crystallise, combine with water molecules to form a crystalline structure.

↳ salts w this = hydrated salts
↳ salts w/o = anhydrous salts

hydrated salts

$CuSO_4 \cdot 5H_2O$

↳ given off when heated

anhydrous salts

- salts w/o water of crystallization

Preparation of salts

soluble in water?

soluble

are starting materials soluble in water?

yes — **titration**
- acid + base
- no metals as too reactive

1) Dilute acid is titrated with the alkali using a suitable indicator to obtain the exact proportions
2) Titration is repeated without the indicator (contamination)
3) Solution is obtained and heated to the point of saturation
4) Mixture of crystals and water is filtered again to obtain crystals and the crystals dried.

no — **reaction of acid with**
- acid + base
- carbonate is rare cuz soluble

1) Add excess (metal powder) by stirring not dilute (acid) until it no longer reacts
2) Excess (metal) is removed by filtering
3) Water from solution is evaporated using an evaporation dish, producing a saturated solution
4) Allow to cool and filter salt crystals and dry by squeezing between sheets of filter paper.

(now spot)

↓ salt solution

insoluble

↓ precipitate

1) 2 sols of soluble salt are mixed
2) insoluble salt appears as the precipitate
3) resultant solution is filtered to obtain the salt
4) ppt washed with deionised water and dried between sheets of filter paper

If metal forms an insoluble salt with acid → coat formed around metal preventing further reaction

Anion

(don't decompose)

Anion	Stable salts	Unstable salts & decomposition
O^{2-}	stable	
CO_3^{2-}	K^+ Na^+	all else will: $XCO_3 \rightarrow XO + CO_2$
NO_3^-	NA	K^+ and Na^+: $KNO_3 \rightarrow KNO_2 + O_2$; else: $\rightarrow O_2 + N_2 + XO$
SO_3^{2-}	$K^+ + Na^+$	$XSO_4 \rightarrow XO + SO_n$