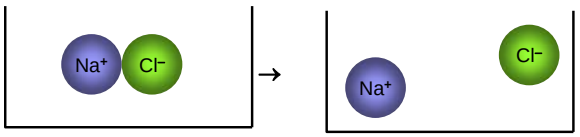
1: Common Reactions: Dissolution

Some ionic compounds dissolve when added to water and form aquated cations & anions

$NaCl_{(s)} \rightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$



NaCl has 'dissociated' or 'ionised' : this is a **dissolution reaction**

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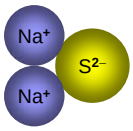
1: Common Reactions: Dissolution

Sodium sulfide is a soluble salt

$Na_2S_{(s)} \rightarrow 2\ Na^{+}_{(aq)} + S^{2-}_{(aq)}$



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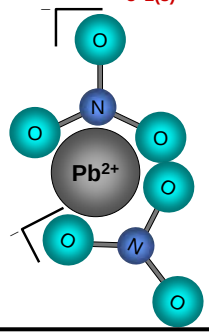
1: Common Reactions: Dissolution

Lead(II) nitrate is a soluble salt

$Pb(NO_3)_{2(s)} \rightarrow Pb^{2+}_{(aq)} + 2\,NO_3^{-}_{(aq)}$



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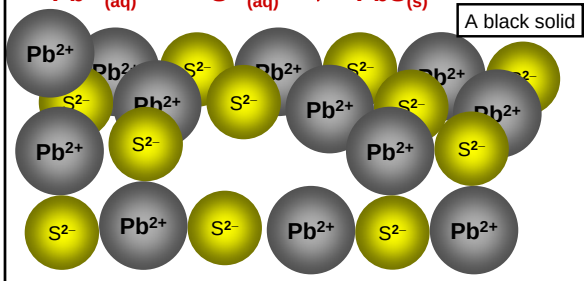
2: Common Reactions: Precipitation

When Lead(II) ions meet sulfide ions, they form a precipitate

$Pb^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow PbS_{(s)}$

A black solid



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2: Common Reactions: Precipitation

$Pb^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow PbS_{(s)}$

A **precipitation reaction** has occurred, solid lead(II) sulfide has precipitated out of solution.

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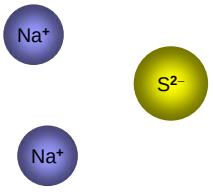
2: Common Reactions: Precipitation

$2\ Na^{+}_{(aq)} + S^{2-}_{(aq)} \rightarrow$ no precipiate

No Reaction



If an aqueous solution of Na^{+} is added to an aqueous solution of S^{2-} **no precipitation** occurs.

These ions coexist in solution.

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3: Solubility Rules

Sodium sulfide is water soluble.

Lead sulfide is water insoluble. When lead ions and sulfide ions are brought together, solid lead sulfide is formed.

Solubility rules: for a summary of soluble and insoluble ionic compounds, see bridging manual

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4: Types of equations: Molecular

Add a solution of lead nitrate, $Pb(NO_3)_2$ to a solution of sodium sulfide, Na_2S to obtain solid lead(II) sulfide and sodium nitrate solution.

$$Pb(NO_3)_{2\,(aq)} + Na_2S_{\,(aq)} \rightarrow PbS_{(s)} + 2\,NaNO_{3\,(aq)}$$

(aq) Implies all ***ionic*** bonds are broken

$$Pb^{2+}_{(aq)} + 2\,NO_3^-{}_{(aq)}$$

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5: Types of equations: Full Ionic

Add a solution of lead nitrate, $Pb(NO_3)_2$ to a solution of sodium sulfide.

$$Pb^{2+}_{(aq)} + 2\,NO_3^-{}_{(aq)} + 2\,Na^+_{(aq)} + S^{2-}_{(aq)}$$

$$\rightarrow PbS_{(s)} + 2\,NO_3^-{}_{(aq)} + 2\,Na^+_{(aq)}$$

When all ***aqueous*** species are explicitly dissociated, this is a **full ionic** equation

Cannot dissociate solids, liquids or gases

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6: Types of equations: Nett Ionic

Add a solution of lead nitrate, $Pb(NO_3)_2$ to a solution of sodium sulfide, Na_2S.

$$Pb^{2+}_{(aq)} + 2\,NO_3^-{}_{(aq)} + 2\,Na^+_{(aq)} + S^{2-}_{(aq)} \rightarrow PbS_{(s)} + 2\,NO_3^-{}_{(aq)} + 2\,Na^+_{(aq)}$$

Any ions that remain unchanged are **spectator ions**

Cancelling these from a full ionic equation yields a **nett ionic equation**

$$\mathbf{Pb^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow PbS_{(s)}}$$

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7: Dissolution / precipitation

A solution of sodium sulfate and a solution of barium nitrate are mixed. What, if anything will happen?

$$Na_2SO_{4\,(aq)} + Ba(NO_3)_{2\,(aq)} \rightarrow ?$$

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7: Dissolution / precipitation

A solution of sodium sulfate and a solution of barium nitrate are mixed. What, if anything will happen?

$$Na_2SO_{4\,(aq)} + Ba(NO_3)_{2\,(aq)} \rightarrow BaSO_{4\,(s)} + \mathbf{2}\,NaNO_{3\,(aq)}$$

$$2\,Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} \quad + \quad Ba^{2+}_{(aq)} + 2\,NO_3^-{}_{(aq)}$$

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7: Dissolution / precipitation

A solution of sodium sulfate and a solution of barium nitrate are mixed. What, if anything will happen?

$Na_2SO_{4\,(aq)} + Ba(NO_3)_{2\,(aq)} \rightarrow BaSO_{4\,(s)} + \mathbf{2}\ NaNO_{3\,(aq)}$

Molecular Equation

$2\ Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} + 2\ NO_3^-{}_{(aq)} \rightarrow BaSO_{4\,(s)} + 2\ Na^+_{(aq)} + 2\ NO_3^-{}_{(aq)}$

Full Ionic Equation

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7: Dissolution / precipitation

A solution of sodium sulfate and a solution of barium nitrate are mixed. What, if anything will happen?

$SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} \rightarrow BaSO_{4\,(s)}$

Nett Ionic Equation

$2\ Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} + 2\ NO_3^-{}_{(aq)} \rightarrow BaSO_{4\,(s)} + 2\ Na^+_{(aq)} + 2\ NO_3^-{}_{(aq)}$

Full Ionic Equation

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8: Acids: How do you spot one?

Acids are substances that react with water to form hydronium ions H_3O^+

$HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

The hydronium ion H_3O^+, is usually assumed

Therefore, acids are generally referred to as substances that form H^+ or protons

$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$

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8: Binary Acids

Binary compounds of hydrogen and non metals are generally acidic

HF	**hydro**fluor**ic acid**
HCl	**hydro**chlor**ic acid**
HBr	**hydro**brom**ic acid**
HI	**hydro**iod**ic acid**

RULE for naming
Hydro- prefix / stem of anion name / add suffix **-ic**

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8: Hydroxo Acids

These acids contain hydrogen, oxygen, plus another element (generally non metal)

Acid	Formula	Anion
Sulfuric acid	H_2SO_4	SO_4^{2-}
Sulfurous acid	H_2SO_3	SO_3^{2-}
Nitric acid	HNO_3	NO_3^-
Nitrous acid	HNO_2	NO_2^-

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8: Polyprotic Acids

Polyprotic acids have more than one acidic H^+

$H_2SO_{4\,(aq)} \rightarrow H^+_{(aq)} + HSO_4^-{}_{(aq)}$

$HSO_4^-{}_{(aq)} \rightarrow H^+_{(aq)} + SO_4^{2-}{}_{(aq)}$

Other examples: Phosphoric H_3PO_4
Carbonic H_2CO_3

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9: Common Acid reactions: Acid + Metal

Not all metals react with acids, but those that do form a **salt and hydrogen gas**

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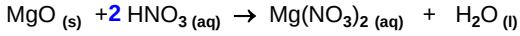
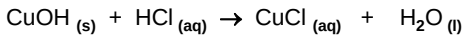
9: Acid + Oxide or Hydroxide

Many oxide, hydroxide and carbonate compounds are insoluble in water, but do react with acid.

Acid + Oxide → Salt + Water



Acid + Hydroxide → Salt + Water



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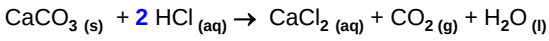
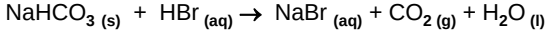
9:Acid + Carbonate or Hydrogencarbonate

Acid + Carbonate → Salt + Carbon dioxide + Water



Acid + Hydrogencarbonate → Salt + Carbon dioxide + Water



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BORING ROTE LEARNING – DO IT!!!!!!!!!!

COMMON TYPES OF REACTIONS

1) acid + base → salt + water

2) acid + carbonate →
   salt + water + carbon dioxide

3) acid + hydrogencarbonate →
   salt + water + carbon dioxide

4) acid + reactive metal →
   salt + hydrogen gas

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