CHEMISTRY

QUALITATIVE ANALYSIS

Qualitative Analysis is using your powers of observation to analyze chemical reactions with your five senses and draw conclusions without the use of technical apparatus.

Metal Ion Flame Tests

When an aqueous solution is placed in a flame, the metal cation will burn a specific colour. Note, a flame test is only useful for figuring out the metal, and cannot be used to determine the non-metal.

ION	SYMBOL	COLOUR
Lithium	Li^+	Red
Sodium	Na^+	Yellow
Potassium	K^+	Violet
Cesium	Cs^+	Violet
Calcium	Ca^{2+}	Red
Strontium	Sr^{2+}	Red
Barium	Ba^{2+}	Yellowish-Green
Copper	Cu^{2+}	Bluish-Green
Boron	B^{2+}	Green
Lead	Pb^{2+}	Bluish-White

CHEMISTRY

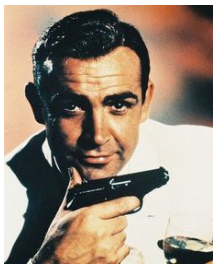
QUALITATIVE ANALYSIS

The Activity Series

Through experimentation, chemists have ranked the relative reactivity of the metals (including hydrogen) in an ***activity series***. The reactive metals such as potassium are at the top of the activity series and the unreactive metals, like gold, are at the bottom.

See the Back of your Periodic Table

Lithium →
Potassium
Barium
Calcium
Sodium
Magnesium
Aluminum
Zinc
Chromium
Iron
Cadmium
Cobalt
Nickel
Tin
Lead
Hydrogen
Copper
Mercury
Silver
Platinum
Gold →



CHEMISTRY

QUALITATIVE ANALYSIS

The Activity Series - Cont

In a single displacement reaction, the reaction will only occur if the "displacer" is more reactive than the metal in the compound.

For example, consider the following equation:

$Fe_{(s)} + CuSO_{4(aq)} \rightarrow$

Since, iron is higher on the activity series than copper, the reaction will proceed. If it were the other way around, there would be no reaction.

Examples:

$Ag_{(s)} + CaCl_{2(aq)} \rightarrow$

$H_2SO_{4(aq)} + Na_{(s)} \rightarrow$

CHEMISTRY

QUALITATIVE ANALYSIS

Solubility

Many factors affect solubility. Thus, predicting solubility is neither straightforward nor simple. Nevertheless, the following table is a useful summary of ionic-compound interactions:

SOLUBILITY CHART

	NO_3^{1-}	SO_4^{2-}	OH^{1-}	F^{1-}	Cl^{1-}	Br^{1-}	I^{1-}	S^{2-}	$C_2H_3O_2^{2-}$	CO_3^{2-}	PO_4^{3-}
Na^+	S	S	S	S	S	S	S	S	S	S	S
K^+	S	S	S	S	S	S	S	S	S	S	S
NH_4^+	S	S	S	S	S	S	S	S	S	S	S
Ag^+	S	S	--	S	I	I	I	I	S	I	I
Al^{3+}	S	S	I	S	S	S	S	S	S	--	I
Ba^{2+}	S	I	S	I	S	S	S	S	S	I	I
Ca^{2+}	S	I	S	I	S	S	S	S	S	I	I
Co^{2+}	S	S	I	I	S	S	S	I	S	I	I
Cu^{2+}	S	S	I	I	S	S	--	I	S	--	I
Fe^{2+}	S	S	I	I	S	S	S	I	S	I	I
Fe^{3+}	S	S	I	I	S	S	S	I	--	I	I
Hg^{2+}	S	S	I	I	S	S	S	I	S	--	I
Mg^{2+}	S	S	I	I	S	S	S	S	S	I	I
Pb^{2+}	S	I	I	I	I	I	I	I	S	I	I
Sr^{2+}	S	I	S	I	S	S	S	I	S	I	I
Zn^{2+}	S	S	I	I	S	S	S	I	S	I	I

Examples:

1. Describe what would happen (with descriptive subscripts) if Iron(III)chloride reacted with Silver nitrate.

2. Barium chloride and Lead(II) hydroxide

CHEMISTRY

QUALITATIVE ANALYSIS

4. Predict the result of mixing each pair of aqueous solutions. Write a balanced chemical equation if you predict that a precipitate forms. Write "NR" if you predict that no reaction takes place.
   (a) sodium sulfide and iron(II) sulfate
   (b) sodium hydroxide and barium nitrate
   (c) cesium phosphate and calcium bromide
   (d) sodium carbonate and sulfuric acid
   (e) sodium nitrate and copper(II) sulfate
   (f) ammonium iodide and silver nitrate
   (g) potassium carbonate and iron(II) nitrate
   (h) aluminum nitrate and sodium phosphate
   (i) potassium chloride and iron(II) nitrate
   (j) ammonium sulfate and barium chloride
   (k) sodium sulfide and nickel(II) sulfate
   (l) lead(II) nitrate and potassium bromide

3 K/U Which of the following compounds are soluble in water?
   (a) calcium sulfide, CaS (used in skin products)
   (b) iron(II) sulfate, $FeSO_4$ (used as a dietary supplement)
   (c) magnesium chloride, $MgCl_2$ (used as a disinfectant and a food tenderizer)

4 MC Which of the following compounds are insoluble in water? For each compound, relate its solubility to the use described.
   (a) barium sulfate, $BaSO_4$ (can be used to obtain images of the stomach and intestines because it is opaque to X-rays)
   (b) aluminum hydroxide, $Al(OH)_3$ (found in some antacid tablets)
   (c) zinc carbonate, $ZnCO_3$ (used in suntan lotions)

1. Decide whether each of the following salts is soluble or insoluble in distilled water. Give reasons for your answer.
   (a) lead(II) chloride, $PbCl_2$ (a white crystalline powder used in paints)
   (b) zinc oxide, ZnO (a white pigment used in paints, cosmetics, and calamine lotion)
   (c) silver acetate, $AgCH_3COO$ (a whitish powder that is used to help people quit smoking because of the bitter taste it produces)
2. Which of the following compounds are soluble in water? Explain your reasoning for each compound.
   (a) potassium nitrate, KNO_3 (used to manufacture gunpowder)
   (b) lithium carbonate, Li_2CO_3 (used to treat people who suffer from depression)
   (c) lead(II) oxide, PbO (used to make crystal glass)
3. Which of the following compounds are insoluble in water?
   (a) calcium carbonate, $CaCO_3$ (present in marble and limestone)
   (b) magnesium sulfate, $MgSO_4$ (found in the hydrated salt, $MgSO_4 \cdot 7H_2O$, also known as Epsom salts; used for the relief of aching muscles and as a laxative)
   (c) aluminum phosphate, $AlPO_4$ (found in dental cements)