Observing chemical changes

Topic

Displacement, redox and precipitation reactions. Chemistry and colour.

Timing

20 min.

Apparatus (per group)

- One student worksheet
- One clear plastic sheet (*eg* ohp sheet)
- Magnifying glass.

Chemicals (per group)

Solutions contained in plastic pipettes, see 'Apparatus and techniques for microscale chemistry' handout.

- Barium nitrate 0.2 mol dm^{-3}
- Sodium sulphate 0.5 mol dm^{-3}
- Lead nitrate 0.5 mol dm^{-3}
- Ammonia solution 3 mol dm^{-3}
- Ammonium vanadate(V) 0.2 mol dm^{-3} (acidified with sulphuric acid)
- Hydrochloric acid 1 mol dm^{-3}
- Sodium hydroxide 1 mol dm^{-3}
- Potassium manganate(VII) 0.01 mol dm^{-3}
- Silver nitrate 0.1 mol dm^{-3}
- Copper(II) sulphate 0.2 mol dm^{-3}
- Iron(II) sulphate 0.2 mol dm^{-3}
- Iron(III) nitrate 0.2 mol dm^{-3}
- Potassium thiocyanate 0.2 mol dm^{-3}
- Zinc metal granules.

Observations

1. A dense white precipitate of barium sulphate forms. Barium sulphate is used as a barium meal in medicine since it is opaque to X-rays. Because it is very insoluble it is non-toxic, unlike other, soluble, barium compounds.
2. A bright yellow precipitate of lead nitrate forms. Lead nitrate is a very effective pigment but it is toxic.
3. A deep red colour is produced due to iron(III) thiocyanate ions . This reaction is used to test for the presence of iron.
4. A deep blue colour of tetra-amminocopper(II) forms. There may also be some light blue precipitate of copper(II) hydroxide.
5. Bubbles (of hydrogen) are seen. The yellow colour of the ammonium vanadate gradually changes (as the vanadium is reduced) to blue owing to the formation of the vanadium(IV) ion (VO^{2+}). The colour then changes to green due to the vanadium(III) ion (V^{3+}) and finally to lilac due to the

vanadium(II) ion (V^{2+}). The changes in oxidation states of vanadium salts have been investigated for applications in battery technology.
6. A greenish precipitate of iron(II) hydroxide forms. This gradually changes to the brown iron(III) hydroxide as the iron is oxidised.
7. The deep purple colour of the potassium manganate(VII) gradually fades first to the brown manganese(IV) dioxide and then to the pale pink manganese(II) ion (Mn^{2+}). Manganese(II) compounds in solution usually appear virtually colourless. However, a solid manganese(II) salt is pink.
8. Barium hydroxide forms. This is soluble so nothing is seen at first. Barium hydroxide is alkaline and gradually absorbs carbon dioxide from the air to form the insoluble barium carbonate. The drop takes on a hazy appearance as a skin of barium carbonate forms on the surface.
9. A glittering of metallic silver forms as the iron(III) reduces the silver nitrate. This is seen clearly using a magnifying glass.
10. The surfaces of the pieces of zinc turn red-brown as copper metal deposits via a displacement reaction. The blue colour of the copper(II) sulphate solution fades.

Note

Both procedure 9 and procedure 10 involve the displacement of a valuable, but less reactive, metal using a less valuable, but more reactive, metal. This could be used as a topic for discussion.

Health & Safety

Students must wear suitable eye protection. (Splash proof goggles to BS EN166 3).

Barium nitrate, 0.2 mol dm^{-3} $Ba(NO_3)_2$ (aq), Sodium sulphate, 0.5 mol dm^{-3} Na_2SO_3 (aq), Hydrochloric acid, 1 mol dm^{-3} HCl (aq), Iron(II) sulphate, 0.2 mol dm^{-3}, $FeSO_4.7H_2O$ (aq), Iron(III) nitrate, 0.2 mol dm^{-3}, $Fe(NO_3)_3.9H_2O$ (aq), potassium manganate(VII) 0.01 mol dm^{-3} zinc metal granules and Potassium thiocyanate, 0.2 mol dm^{-3}, KSCN (aq) are all of low hazard.

Silver nitrate, 0.1 mol dm–3, AgNO3 (aq) is an eye irritant. Keep separate from organic waste containers.

Lead nitrate, 0.5 mol dm^{-3} $Pb(NO_3)_2$ (aq) is a reproductive toxin, causes eye damage, causes damage to organs (especially the CNS) and is harmful to the aquatic environment. Avoid inhalation and skin contact.

Ammonia solution, 3 mol.dm^{-3} NH_3 (aq) is CORROSIVE.

Ammonium vanadate(V), 0.2 mol dm^{-3} NH_4VO_3 (acidified with sulphuric acid) is a mutagen and extremely toxic if inhaled – but not by any other route.

Sodium hydroxide solution, 1 mol dm^{-3} NaOH (aq), is corrosive

Copper(II) sulphate solution, 0.2 mol dm^{-3}, $CuSO_4$ (aq) causes eye damage and is HAZARDOUS to the aquatic environment.

Credits

Health & safety checked May 2018

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