

Incendiary silver

Education in Chemistry

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Calcium carbide and the ethyne gas it produces on contact with water are a rich source of exciting demonstrations.

Technicians notes

Kit

- Calcium carbide, c.1 g (highly flammable) (*Hazard 19C*)
- Silver nitrate solution, 0.25 mol dm⁻³, 15 cm³ (irritant) (*Hazard 87, Recipe 77*)
- Sodium hydroxide solution, 1 mol dm⁻³, c.5 cm³ (corrosive) (*Hazard 97a, Recipe 85*)
- Ammonium hydroxide solution, 2 mol dm⁻³, c.5 cm³ (corrosive, irritant) (*Hazard 6, Recipe 6*)
- Copper(II) sulfate solution, 0.1 mol dm⁻³, c.20 cm³ (*Hazard 27c, Recipe 31*)
- 2 side-arm boiling tubes with delivery tubes
- Bungs
- 1 boiling tube
- Filter paper and funnel
- Bunsen burner, heat-resistant mat, tripod and gauze
- Boiling tube rack
- Optional large sheet of hardboard for protecting the bench

Safety and disposal

This demonstration is unlikely to be covered by your school's model risk assessments and a special risk assessment may be required. CLEAPSS members can obtain one by contacting them. This procedure is designed to ensure that no more than 0.5 g of explosive is produced to comply with the UK Explosives Regulations 2014 – producing larger amounts should not be attempted and is illegal in the UK without an explosives certificate issued by the police.

Calcium carbide will burn the skin and is harmful if swallowed or inhaled. Solid CaC₂ reacts with moisture in the air to produce gas, so pressure may build up in sealed containers containing the solid. Open containers with care. Ethyne forms explosive mixtures with air.

Do not add the calcium carbide to the silver nitrate solution directly or bubble the gas directly through silver nitrate solution – explosive double salts will be produced.

Following the demonstration, unreacted solid can be disposed of by passing a Bunsen flame over the surrounding area. This should be repeated the following morning as small fragments of damp powder can be thrown out by larger detonations, dry overnight to become contact sensitive, and startle other lab users.

Preparation

Wear eye protection. Prepare ammoniacal silver nitrate in a boiling tube by adding sodium hydroxide solution (1 mol dm⁻³) dropwise to 15 cm³ of 0.25 mol dm⁻³ silver nitrate until a precipitate of silver oxide forms. Add ammonia solution (2 mol dm⁻³) dropwise, stirring thoroughly until the precipitate re-dissolves to form a colourless solution.

Set up a chain of boiling tubes and delivery tubes in a boiling tube rack. The first side-arm boiling tube should contain approx. 15–20 cm³ of water (leaving a gap to the side-arm so liquid will not bubble over once the calcium carbide is added). The delivery tube from the side-arm of the first tube should be set up to bubble gas through the copper sulfate solution in the second tube to absorb hydrogen sulfide gas. The purified acetylene gas then bubbles through the ammoniacal silver nitrate prepared in the previous step. Cutting the teat off a plastic dropping pipette and inserting into the end of the rubber tubing can help keep the tube out of the liquid and deliver a controlled flow of bubbles to the bottom of the liquid.

In front of the class

Do the demonstration at the start of the class to leave time for cleaning up. Add the calcium carbide chips to the water in the first tube and replace the bung – acetylene gas will bubble through the final tube generating a precipitate of silver acetylide. Wear a face shield when working with the precipitate. Filter the solution and while still damp, transfer the residue to a gauze on a tripod placed behind two safety screens – one for the audience and one for the demonstrator. Students should sit well back, wear eye protection, and be warned about a loud bang. Place a lit Bunsen under the gauze and retreat to a safe distance. As the precipitate dries, the explosive detonates with a number of bangs, each accompanied by a small flash and a tiny puff of soot.

Tips

Setting up the demonstration on a large sheet of hardboard can protect the bench and make burning up unreacted powder with a flame a lot easier. A cylinder of wire mesh (such as insect mesh) can be placed around the precipitate before heating – this will contain most powder fragments and make cleaning up much quicker.

For more spectacular demonstrations, take a look at the Exhibition Chemistry archive on the Education in Chemistry website: <https://eic.rsc.org/exhibition-chemistry>