

Reactivity series of metals

1. Metals and water

Equipment (demonstration only)

- forceps
- filter paper
- ceramic tile
- scalpel or sharp knife to cut the metals
- three large glass troughs (5 dm³ capacity), or one trough to be rinsed out between metals
- access to small pieces of alkali metals and universal indicator

Safety equipment: safety goggles or face shield for the demonstrator; safety spectacles for the audience. At least two safety screens around the demonstration area.

Small container of clean, dry sand to use if sodium or potassium metal catch fire.

Small container of dry sodium chloride to use if the lithium metal catches fire.

Preparation

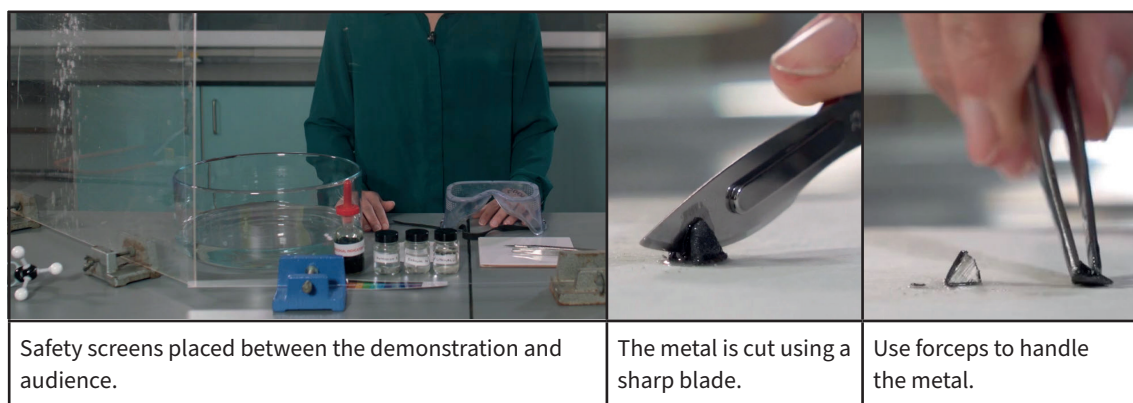
- universal indicator solution in a dropper bottle

Small bottles of paraffin liquid containing small pieces of the following metals:

- piece of lithium metal – 5 mm cubes
- piece of potassium metal – 3 mm cubes
- piece of sodium metal – 4 mm cubes

Only supply the minimum amount of each metal needed for the demonstration.

Equipment set-up and tips



Safety

[Read our standard health & safety guidance](#) and carry out a risk assessment before running any live practical.

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical

Preparation

Lithium metal

Li (s)

**DANGER**

Reacts violently with water

In contact with water releases flammable gases which may ignite spontaneously

Causes severe skin burns and eye damage

Sodium metal

Na (s)

**DANGER**

Reacts violently with water

In contact with water releases flammable gases which may ignite spontaneously

Causes severe skin burns and eye damage

Potassium metal

K (s)

**DANGER**

Reacts violently with water

In contact with water releases flammable gases which may ignite spontaneously

Causes severe skin burns and eye damage

Universal indicator solution

**DANGER**

Highly flammable liquid and vapour

May cause damage to organs

Ready to use solutions are usually available but you can check CLEAPSS / SSERC for a recipe to prepare universal indicator using different dyes.

Alkali metals need to be stored away from water/water-based reagents. Do not store in the flammables cupboard or with flammable liquids. Stand bottles of alkali metals inside another clean, dry container (labelled) to keep it upright. A clean and dry metal tin, such as a biscuit tin, is a suitable storage container.

The pieces of metal need to be stored under liquid paraffin; check regularly and top up the level of liquid paraffin or change if the liquid is no longer clear or starts to solidify. **Never supply pieces larger than 5 mm³. A coating of yellow superoxide may develop on potassium metal over time. Do not use the potassium metal if this happens as it may explode under the pressure of a scalpel blade. Contact CLEAPSS/ SSERC or your health and safety advisor if you find potassium coated with superoxide.**

Cutting the alkali metal: Wear goggles. All equipment must be dry. Place all the equipment in a tray as you might get tiny pieces projected when cutting harder metal such as lithium. Use forceps to place the larger piece of metal onto a tile. Use a sharp knife to cut off the required piece. Immediately return the unwanted alkali metal to its bottle and close the lid. Place the smaller piece of metal in a labelled container of liquid paraffin. Immerse the tray with water to dispose of any small piece of unreacted alkali metal.

Use filter paper to remove the oil from the surface of the alkali metal, do not use organic solvents such as petroleum spirit or hexane, this has caused fires.

Keep a container of dry sand (to smother fires from sodium or potassium metals) and a container of dry sodium chloride (to smother fire from lithium metal) at close proximity.

Disposal

The hydrogen gas and metal hydroxides produced are not a large quantity and do not require any special disposal method. Take care when handling the used equipment in case there are small bits of unreacted alkali metals; wear gloves and safety goggles and submerge in water. Clean the demonstration area with water.

If you need to dispose of small pieces of alkali metals work in a fume cupboard, ask a colleague to supervise:

Sodium: add the metal (no more than 5 g) in small pieces (~4 mm sides) a few at a time, to 100 cm³ of propan-2-ol in a glass beaker. Place a heatproof mat over the beaker to extinguish any flames caused by the propan-2-ol vapour catching fire. Allow the reaction to subside before adding more pieces of sodium. Once reaction is complete, carefully add solution to a bucket of cold water and pour down a foul-water drain.

Lithium: add only a few small pieces of lithium at a time to 1.0 mol dm⁻³ ethanoic acid solution and allow reaction to subside before adding further pieces. The reaction is not usually violent.

Potassium: add up to 2 g cut into small pieces (~3 mm sides), one at a time, to 100 cm³ of 2-methylpropan-2-ol in a 400 cm³ glass beaker, labelled with a warning sign and this information: 'hydrogen gas given off which ignites – corrosive liquid may spit out.' There may be sparks/flames. Place a heatproof mat over the beaker to prevent alcohol vapour catching fire or to extinguish any flames. Allow reaction to finish before adding more pieces of potassium (up to 10 g max). Once reaction is complete, carefully add mixture to a bucket of cold water and pour away down a foul-water drain.

2. Metals and acid

Equipment (per group)

- 1 x polystyrene cup minimum
- 1 x 250 cm³ or 400 cm³ beaker to stand the polystyrene cup in for support
- 1 x 25 cm³ measuring cylinder
- 1 x dropping pipette
- 1 x thermometer (-10–110 °C)
- 4 x spatulas
- absorbent paper to dry the cup and thermometer if rinsed between each use
- access to 2.0 mol dm⁻³ hydrochloric acid solution (100 cm³)
- access to closed containers of metals in a powdered forms (two spatulas of each metal)
- access to a waste buckets filled with tap water

Optional (demonstrator only): test tubes, splints and matches to demonstrate that hydrogen gas is produced in some reactions.

Safety equipment: safety spectacles

Preparation

- 2.0 mol dm⁻³ hydrochloric acid solution
- magnesium metal powder
- zinc metal powder
- iron metal powder
- copper metal powder

Equipment set-up and tips



Equipment required.







Dispose of all waste in waste container and separate the metal powders.

Safety

Read our [standard health & safety guidance](#) and carry out a risk assessment before running any live practical.

Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical	Preparation
2.0 mol dm ⁻³ hydrochloric acid solution Currently not classified as hazardous	Hydrochloric acid concentrated solution HCl (aq) MW = 36.46 g mol ⁻¹   DANGER Causes severe skin burns and eye damage May cause respiratory irritation
Magnesium metal powder Mg (s)  DANGER Flammable solid Self-heating in large quantities*; may catch fire In contact with water releases flammable gases *large quantities refers to kg amounts	
Zinc metal powder Zn (s)   DANGER In contact with water, releases flammable gases which ignite spontaneously Catches fire spontaneously if exposed to air Very toxic to aquatic life with long lasting effects	
Iron metal filings Fe (s)  WARNING Flammable solid	
Copper metal powder Cu (s) Currently no classified as hazardous	

Keep the equipment away from fire and naked flames. The squeaky pop demonstration is for the teacher only.

Provide metal powders in closed containers.

Keep a container of clean, dry sand at close proximity to smother small zinc fires.

Polystyrene cups can be re-used but need to be checked as thermometers can sometimes create a small hole at the bottom of the cup.

Disposal

Polystyrene cups need to be emptied quickly after each reaction to avoid too much hydrogen being released in the room.

Once the maximum temperature is reached, students should dispose of content of the polystyrene cup in a waste bucket containing cold tap water.

Water can be decanted and the waste metal powders need to be rinsed further with water followed by filtration. If sieves with small mesh are available, you can place one on top of each waste bucket.

The waste metal powders should be small amounts and can be disposed of in the general waste bin.

3. Metal displacement reactions

Equipment (per group)

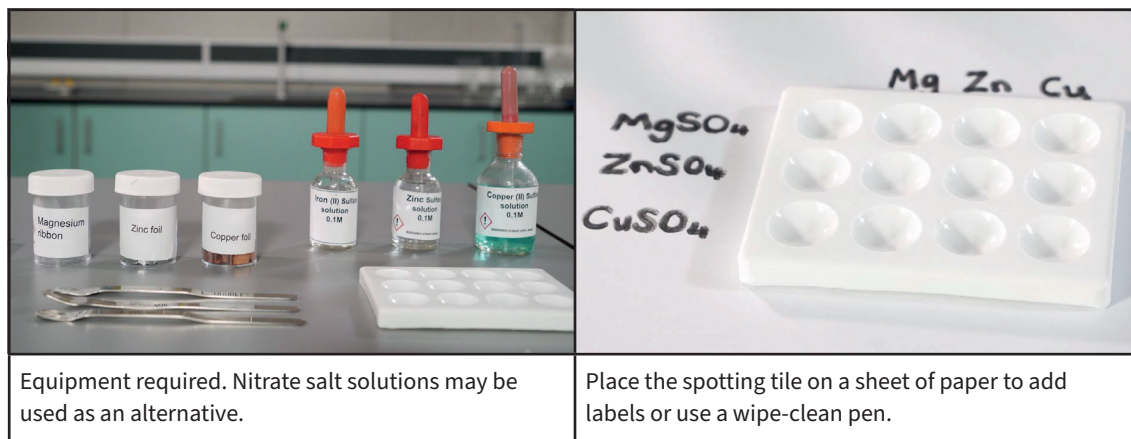
- 1 x spotting tile
- one piece of A4 paper and marker pen
- 3 x spatulas or forceps to dispense metals (magnesium ribbon, zinc foil, copper foil) from containers
- 3 x solutions (magnesium sulfate, zinc sulfate, copper sulfate) in dropper bottles or in small beakers (50–100 cm³) and dropping pipettes

Safety equipment: safety spectacles

Preparation

- 0.1 mol dm⁻³ magnesium sulfate solution (2 cm³ per group)
- 0.1 mol dm⁻³ zinc sulfate solution (2 cm³ per group)
- 0.1 mol dm⁻³ copper sulfate solution (2 cm³ per group)
- magnesium ribbon (1 cm long x 2 pieces per group)
- zinc foil (1 cm square x 2 pieces per group)
- copper foil (1 cm square x 2 pieces per group)

Equipment set-up and tips



Equipment required. Nitrate salt solutions may be used as an alternative.










Place the spotting tile on a sheet of paper to add labels or use a wipe-clean pen.

Safety

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Refer to SSERC/CLEAPSS Hazcards and recipe sheets.

Hazard classification may vary depending on supplier.

Chemical supplied for the practical	Preparation
0.1 mol dm ⁻³ magnesium sulfate(vi) solution MgSO ₄ (aq) Currently not classified as hazardous	Magnesium sulfate (vi)-7-water MgSO ₄ ·7H ₂ O (s) MW = 246.47 g mol ⁻¹ Currently not classified as hazardous
0.1 mol dm ⁻³ zinc sulfate(vi) solution ZnSO ₄ (aq)  WARNING Irritant (eyes)	Zinc sulfate (vi)-7-water ZnSO ₄ ·7H ₂ O (s) MW = 287.54 g mol ⁻¹    DANGER Harmful if swallowed Causes serious eye damage Very toxic to aquatic life with long lasting effects
0.1 mol dm ⁻³ copper(II) sulfate(vi) solution CuSO ₄ (aq)  WARNING Irritant (skin, eyes)	Copper(II) sulfate(vi)-5-water CuSO ₄ ·5H ₂ O (s) MW = 249.68 g mol ⁻¹    DANGER Harmful if swallowed Causes severe skin burns Causes serious eye irritation Very toxic to aquatic life with long lasting effects
Magnesium ribbon Mg (s)  DANGER Flammable solid	
Zinc foil Zn (s) Currently not classified as hazardous	
Copper foil Cu (s) Currently not classified as hazardous	

Clean the pieces of metals using emery paper.

Disposal

This is a microscale method so a minimum amount of waste is produced.

Unreacted pieces of metals can be cleaned using distilled water, dried and re-used. Pieces of zinc and copper foil can be disposed of in the normal waste bin.

Used pieces of magnesium ribbon can be added to 1 mol dm⁻³ ethanoic acid solution. Heat or spray may be produced. Test the solution with indicator and add more ethanoic acid until the mixture is just acidic. Pour the neutralised mixture down a foul-water drain with further dilution.

All solutions can be kept in the bottles to be used at a later date; the spotting tiles can be rinsed with plenty of water.