

14–16 years

# Displacement reactions between metals and their salts



# Learning objectives

1. Safely carry out microscale displacement reactions.
2. Make inferences about reactivity from displacement reactions.
3. Represent and explain displacement reactions using equations and particle diagrams.
4. Plan a practical to allow further inferences to be made from data.

# Introduction

The reactivity of metals varies significantly depending on their position on the periodic table. The most reactive metals are found in group 1, the alkali metals, whereas the least reactive metals are found in the transition metals.

The periodic table is shown with two specific groups highlighted by black boxes and arrows. The first box, labeled 'Alkali metals', encompasses the elements in Group 1: Hydrogen (H), Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs), and Francium (Fr). The second box, labeled 'Transition metals', encompasses the d-block elements from Scandium (Sc) to Zinc (Zn) in the first row, and from Yttrium (Y) to Cadmium (Cd) in the second row, continuing through the lanthanide and actinide series. The rest of the periodic table is shown in a standard color-coded layout.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og
		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

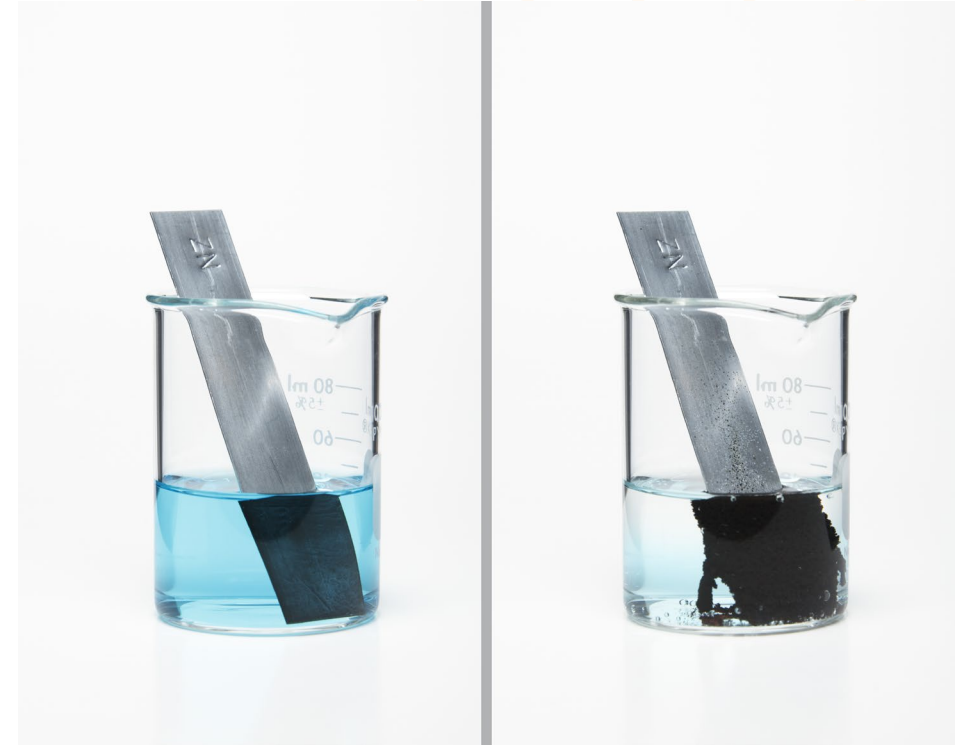


# Introduction

In this experiment, you will use a series of reactions to write a reactivity series for four metals, putting them in order from most to least reactive. A strip of metal is added to a solution of a compound of another metal.

A more reactive metal will displace (push out) a less reactive metal from its compound.

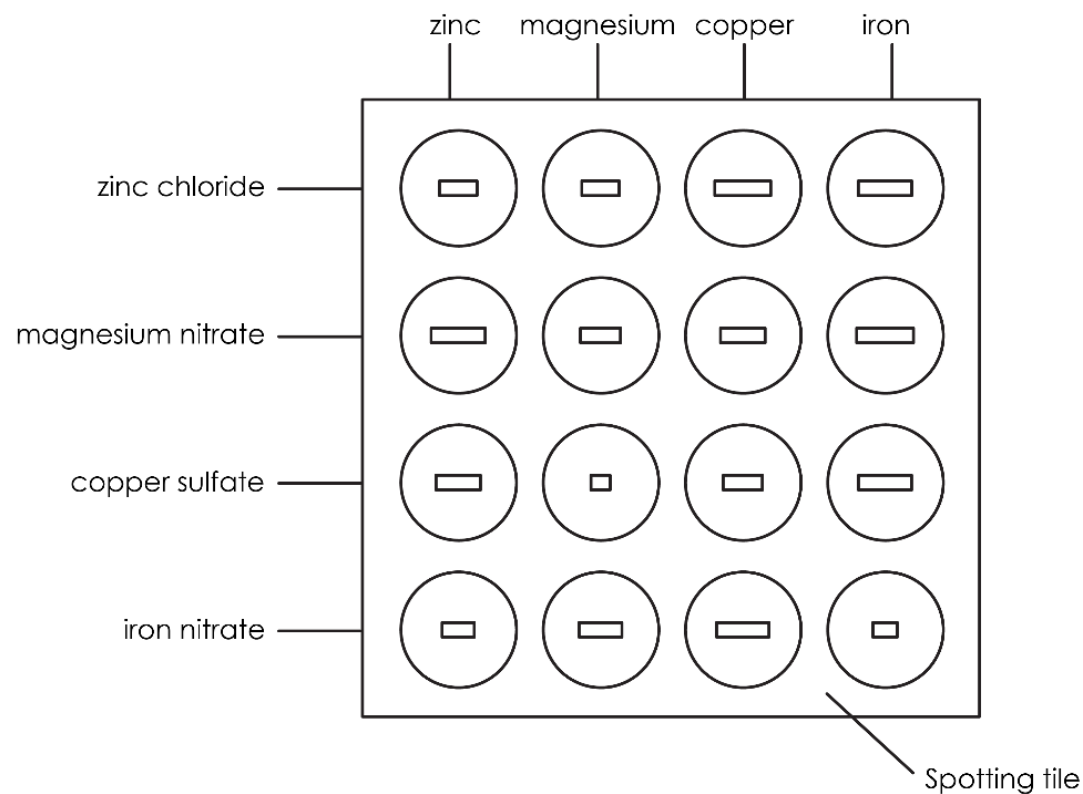
You will add the metal to the metal compound and make observations on whether a reaction occurs or not.



*Solid silver zinc metal displaces copper from blue copper sulfate solution, resulting in clear zinc sulfate solution and reddish-brown copper solid. Large scale version of the experiment*

# Method

1. Using a dropping pipette, put a little of the zinc chloride solution in four of the depressions in the spotting tile, using the illustration opposite as a guide. Label this row with the name of the solution. Rinse the pipette well with water afterwards.
2. Do this for each metal ion solution in turn, rinsing the pipette when you change solution.
3. Put a piece of each metal in each of the solutions, using the illustration as a guide.
4. Over the next few minutes observe which mixtures have reacted and which have not.

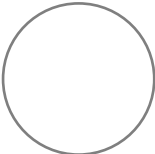
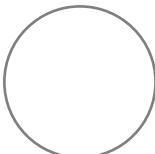
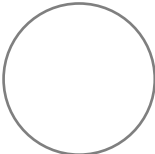
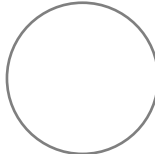
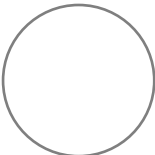
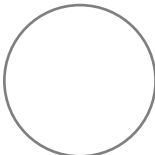
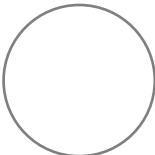
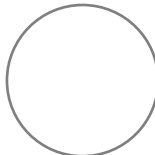
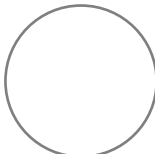
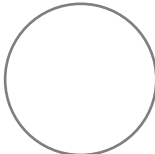
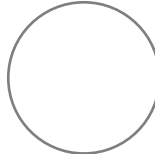
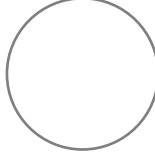
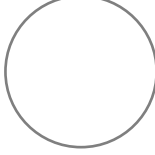
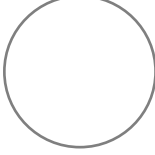
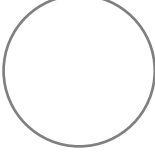
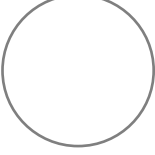


**1** A few granules of zinc

**2** Small piece of magnesium

**3** A copper turning

**4** An iron nail

	zinc	magnesium	copper	iron
zinc chloride				
magnesium nitrate				
copper sulfate				
iron nitrate				

**5** 2 drops zinc chloride

**6** 2 drops magnesium nitrate

**7** 2 drops copper sulfate

**8** 2 drops iron nitrate

**9** Observe any colour changes



# Results

Add a tick (✓) or cross (x) to the table to denote whether a chemical reaction was observed.

	zinc	magnesium	copper	iron
zinc chloride				
magnesium nitrate				
copper sulfate				
iron nitrate				

# Follow-up questions

1. Below are a series of chemical reactions that you completed. For each one, state whether they did or did not react.
  - a) zinc + copper sulfate →
  - b) copper + iron nitrate →
  - c) iron + copper sulfate →
2. Describe the observations you made when magnesium reacted with copper nitrate that showed that a chemical reaction was occurring. Use the headings to support your answer.

**Colour**

**State of substances**
3. Place the following metals in order of reactivity from most reactive to least reactive: **zinc, magnesium, copper, iron**

## Follow-up questions

4. Complete the following word equations from your reactions:

a) magnesium + copper sulfate  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_

b) zinc + copper sulfate  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_

c) magnesium + iron nitrate  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_

5. A student performs the experiment using a different metal, W. A reaction is seen between metal W and zinc chloride, iron nitrate and copper sulfate but not with magnesium nitrate. Determine whether metal W is more, or less, reactive than magnesium. Explain your answer.

*Metal W is more/less reactive than magnesium as....*

## Follow-up questions

6. A student wants to determine which metal salts metal X will react with. Metal X is more reactive than copper but less reactive than zinc. State which metal salts it will react with. Explain your answer.

*Metal X would react with \_\_\_\_\_ as....*

*We don't know if metal X would react with \_\_\_\_\_ as...*

## Mini whiteboard activity

On your mini whiteboard, read the statement and write your answer to each of the following questions:

Metals which are more reactive than copper will react exothermically with copper sulfate in displacement reactions. A temperature increase would be observed.

a) Complete the sentence to define the term 'exothermic'.

*A chemical reaction which \_\_\_\_\_ energy into the surroundings.*

b) State the independent variable (the one you change) in this experiment.

c) State the dependent variable (the one you measure to give you results) in this experiment.

## Mini whiteboard activity

- d) State the two control variables (the ones you keep the same) in this experiment.
- e) Name the piece of equipment used to measure temperature.
- f) Write a method for this experiment (6 marks).
- g) Metal X had a temperature change of  $0^{\circ}\text{C}$ . Explain this result.
- h) Metal Y reacted and had a temperature change of  $1.5^{\circ}\text{C}$  and Metal Z had a temperature change of  $14.3^{\circ}\text{C}$ .

State which metal was the most reactive. Explain your answer.

*Metal \_\_\_\_\_ is the most reactive. I know this because...*