



Practical Guide – Displacement Reactions

Practical activity: Displacement Reactions

Aim: To investigate competition reactions of metals and determine the reactivity series of the metals used.

Notes and guidance

This practical is best carried out with spotting tiles to reduce the volume of chemicals used and to make clean-up easier, but it can also be carried out with test-tubes.

If you wish to add a fourth metal, lead and lead nitrate(V) solution work well. However, these are toxic and introduce an additional level of hazard into the experiment.

Speak with your technician colleague ahead of this practical. They may be able to pre-cut small squares of the metals so students do not need to cut the metal themselves.

Risk Assessment Notes

A risk assessment must be completed for this practical. The risk assessment should be specific to the class involved and written only by the teaching member of staff. For more guidance refer to CLEAPSS. It is good practice for students to wear safety spectacles during all class practicals and demos.

- Copper(II) sulfate solution, $\text{CuSO}_4(\text{aq})$ – refer to CLEAPSS Hazcard HC027c
- Magnesium sulfate solution, $\text{MgSO}_4(\text{aq})$ – refer to CLEAPSS Hazcard HC059c
- Zinc sulfate solution, $\text{ZnSO}_4(\text{aq})$ – refer to CLEAPSS Hazcard HC108b

- Copper foil, Cu(s) – refer to CLEAPSS Hazcard HC026
- Magnesium ribbon, Mg(s) – refer to CLEAPSS Hazcard HC059a
- Zinc foil, Zn(s) – refer to CLEAPSS Hazcard HC017

Equipment

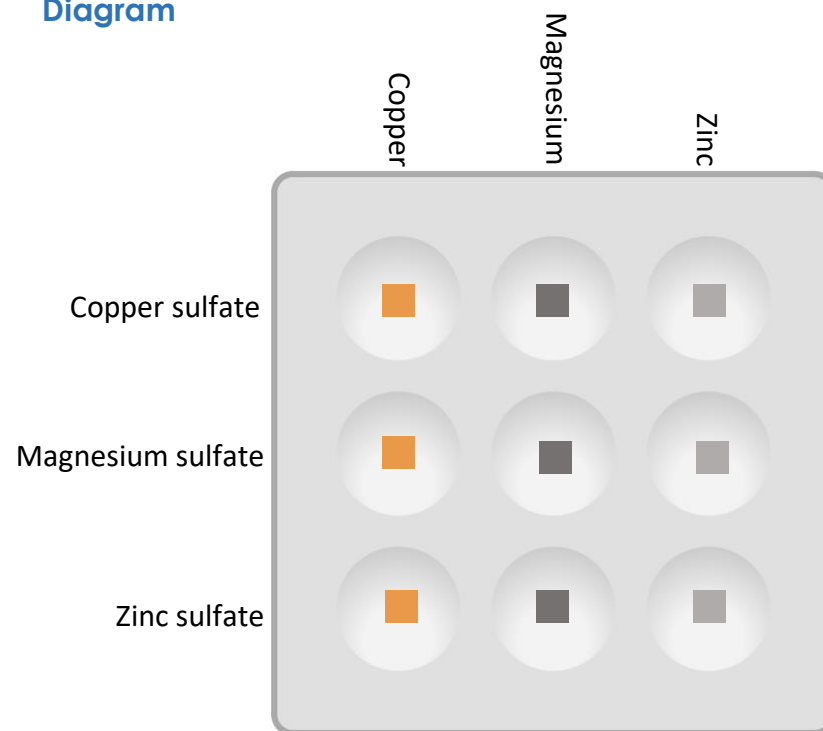
Apparatus:

- Spotting tile (3x3 or larger)
- Dropping pipettes
- Forceps

Chemicals:

- 1 cm x 1 cm squares of: copper foil, magnesium ribbon, zinc foil
- 0.1 M copper(II) sulfate
- 0.1 M magnesium sulfate
- 0.1 M zinc sulfate

Diagram





Method	Questions To Ask Students During The Demonstration																																								
<div>1. Use dropping pipettes to put a small amount of the metal compound solutions into the spotting tile dimples as per the diagram. Ensure you use different pipettes for different solutions and you rinse the pipettes with water afterwards.</div> <div>2. Use the forceps to gently place a square of metal into each spotting tile dimple as per the diagram.</div> <div>3. Observe the dimples over the course of a few minutes and note what displacement reactions take place in your table.</div>	<div>• Why is it important to use different pippettes for different solutions? (To avoid contamination.)</div> <div>• Why do the magnesium and zinc in the copper sulfate get a brown coating? (They displace the copper from the solution.)</div> <div>• Why does the copper sulfate's blue colour fade in these cases? (the blue copper sulfate is replaced by colourless magnesium sulfate.)</div> <div>• Why does the magnesium in the zinc sulfate get a black coating? (It displaces the zinc from the solution.)</div> <div>• What does the magnesium in the zinc sulfate get a black coating? (It displaces the zinc from the solution.)</div> <div>• What can we conclude about the reactivity of these metals from our results? (The order of reactivity is: magnesium > zinc > copper.)</div>																																								
Results Table	Expected Results																																								
<table><tr><th></th><th>Copper</th><th>Magnesium</th><th>Zinc</th></tr><tr><th>Copper sulfate</th><td></td><td></td><td></td></tr><tr><th>Magnesium sulfate</th><td></td><td></td><td></td></tr><tr><th>Zinc sulfate</th><td></td><td></td><td></td></tr><tr><th>Number of displacement reactions</th><td></td><td></td><td></td></tr></table>		Copper	Magnesium	Zinc	Copper sulfate				Magnesium sulfate				Zinc sulfate				Number of displacement reactions				<table><tr><th></th><th>Copper</th><th>Magnesium</th><th>Zinc</th></tr><tr><th>Copper sulfate</th><td>-</td><td>Brown coating, solution's blue colour fades</td><td>Brown coating, solution's blue colour fades</td></tr><tr><th>Magnesium sulfate</th><td>No reaction</td><td>-</td><td>No reaction</td></tr><tr><th>Zinc sulfate</th><td>No reaction</td><td>Black coating</td><td>-</td></tr><tr><th>Number of displacement reactions</th><td>0</td><td>2</td><td>1</td></tr></table>		Copper	Magnesium	Zinc	Copper sulfate	-	Brown coating, solution's blue colour fades	Brown coating, solution's blue colour fades	Magnesium sulfate	No reaction	-	No reaction	Zinc sulfate	No reaction	Black coating	-	Number of displacement reactions	0	2	1
	Copper	Magnesium	Zinc																																						
Copper sulfate																																									
Magnesium sulfate																																									
Zinc sulfate																																									
Number of displacement reactions																																									
	Copper	Magnesium	Zinc																																						
Copper sulfate	-	Brown coating, solution's blue colour fades	Brown coating, solution's blue colour fades																																						
Magnesium sulfate	No reaction	-	No reaction																																						
Zinc sulfate	No reaction	Black coating	-																																						
Number of displacement reactions	0	2	1																																						



Clearing up

It is important that equipment is returned to the prep room in good order. If safe to do so, rinse used equipment and put it in the used equipment tray. If the trays arrived on a trolley, students must return all trays and equipment to that trolley. Anything dirty needs to be placed into a separate container for washing up. Never put dirty equipment back into a tray with clean equipment.

Rinse spotting tiles over a sieve so intact metal samples can be saved for future experiments or disposed of correctly. Solid metals should not be poured into sinks. If any metal does fall into a sink, ensure it is cleaned out before the end of the lesson.

Technician Notes

Ensure the solutions you provide are free from contamination and the equipment is as clean as possible.

Discuss this practical with the class teacher ahead of time. Ensure they have considered the risks of this practical and are confident with the techniques used. If necessary, provide them with the appropriate CLEAPSS so they are comfortable with the chemicals to be used and how to use and dispose of them safely.

Ensure the class teacher is familiar with the clearing. Up instructions above. Metal solids should not go down sinks, they can be cleaned for use in future experiments.