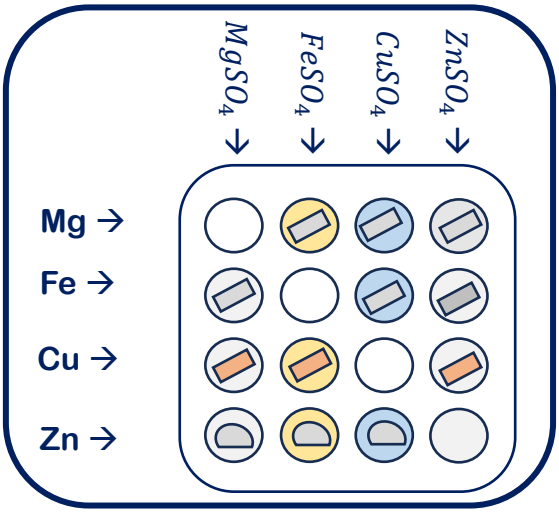
Mission Assignment: Describe the reactivity series and its uses

KS3-17-01

Determining reactivity - In this experiment, you will be reacting metals and metal sulfates to determine their order in the reactivity series.

Equipment

- 0.1 mol dm^{-3} magnesium sulfate solution
- 0.1 mol dm^{-3} iron sulfate solution
- 0.1 mol dm^{-3} copper sulfate solution
- 0.1 mol dm^{-3} zinc sulfate solution
- 1cm pieces of magnesium ribbon
- Small iron nails or 1cm pieces of iron
- 1 cm pieces of copper
- 1 cm pieces of zinc
- Spotting tiles
- 4 pipettes



Method

1. Take 3 pieces of magnesium and place in the second, third and fourth dimple of the first row of a spotting tile, as shown in the diagram above
2. Repeat for the other metals iron, copper and zinc, make sure that the correct dimple is empty and matches the diagram.
3. Using a pipette add a few drops of magnesium sulfate ($MgSO_4$) solution to each of the metals down the first column of metals in the spotting tile.
4. Repeat with clean pipettes using iron sulfate ($FeSO_4$) solution down the second column of metals, copper sulfate ($CuSO_4$) solution down the third column and finally zinc sulfate ($ZnSO_4$) down the last column.
5. Observe carefully for any reaction. Some of the reactions may be small, so look carefully for any colour changes or bubbles.
6. If no reaction occurs, then mark the reaction in the table with an X.
7. If a reaction occurs record what you observed.
8. After you have collected all your data count the number of reactions that occurred and record in final column.

SAFETY

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Determining Reactivity

Results	Magnesium sulfate	Iron sulfate	Copper sulfate	Zinc sulfate	Number of reactions
Magnesium	X				
Iron		X			
Copper			X		
Zinc				X	

1. Rank the metals from most reactive to least reactive, i.e. the metal that had the most reactions → the metal that had the least reactions.

Most reactive _____

_____

_____

Least reactive _____

2. Magnesium displaces iron from iron sulfate forming magnesium sulfate and iron. The word and balanced chemical equation are shown below:

magnesium + iron sulfate → magnesium sulfate + iron

$Mg + FeSO_4 \rightarrow MgSO_4 + Fe$

Write the word equations and balanced chemical equations for the reactions that have taken place.

3. Explain why we didn't test magnesium with magnesium sulfate.

4. Describe what the student would observe in the reaction of iron and copper sulfate.

5. A student places aluminium foil into copper sulfate. Explain why the aluminium reacts with copper sulfate.

Challenge

Part of the reactivity series is shown on the right. Use it to help you answer the questions below.

Most reactive
Potassium – K
Calcium – Ca
Aluminium – Al
Carbon – C
Zinc – Zn
Iron – Fe
Lead – Pb
Copper – Cu
Gold – Au
Least reactive

6. Lead pipes have been known to cause poisonous lead compounds in the water supply.

Explain which metal would be a more appropriate metal to use for piping.

7. Galvanisation is the process of coating iron with a layer of zinc to prevent rusting. Suggest why this process helps prevent against rusting.

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ANSWERS

KS3-17-01

Determining Reactivity

Results	Magnesium sulfate	Iron sulfate	Copper sulfate	Zinc sulfate	Number of reactions
Magnesium	X				3
Iron	X	X		X	1
Copper	X	X	X	X	0
Zinc	X			X	2

1. Rank the metals from most reactive to least reactive, i.e. the metal that had the most reactions → the metal that had the least reactions.

Most reactive — magnesium
zinc
iron
Least reactive — copper

2. Magnesium displaces iron from iron sulfate forming magnesium sulfate and iron. The word and balanced chemical equation are shown below:

magnesium + iron sulfate → magnesium sulfate + iron

$Mg + FeSO_4 \rightarrow MgSO_4 + Fe$

Write the word equations and balanced chemical equations for the reactions that have taken place.

magnesium + copper sulfate → magnesium sulfate + copper

$Mg + CuSO_4 \rightarrow MgSO_4 + Cu$

magnesium + zinc sulfate → magnesium sulfate + zinc

$Mg + ZnSO_4 \rightarrow MgSO_4 + Zn$

iron + copper sulfate → iron sulfate + copper

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

zinc + iron sulfate → zinc sulfate + iron

$Zn + FeSO_4 \rightarrow ZnSO_4 + Fe$

zinc + copper sulfate → zinc sulfate + copper

$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

3. Explain why we didn't test magnesium with magnesium sulfate.
It is the same metal so no displacement reaction would take place

4. Describe what the student would observe in the reaction of iron and copper sulfate.
Would see an orange brown solid forming on the iron and the copper sulfate turning colourless

5. A student places aluminium foil into copper sulfate. Explain why the aluminium reacts with copper sulfate.
Aluminium is above copper in the reactivity series and can therefore displace copper from its compound.

Challenge

Part of the reactivity series is shown on the right. Use it to help you answer the questions below.

Most reactive
Potassium – K
Calcium – Ca
Aluminium – Al
Carbon – C
Zinc – Zn
Iron – Fe
Lead – Pb
Copper – Cu
Gold – Au
Least reactive

6. Lead pipes have been known to cause poisonous lead compounds in the water supply.

Explain which metal would be a more appropriate metal to use for piping.
Copper as it will not react with water and is cheaper than gold.

7. Galvanisation is the process of coating iron with a layer of zinc to prevent rusting. Suggest why this process helps prevent against rusting.
Zinc is more reactive than iron. When the iron surface is coated with a layer of zinc, the zinc atoms form a protective layer on the surface of the iron. This layer of zinc reacts with oxygen and water in the atmosphere to form zinc oxide and zinc hydroxide, respectively, which further protects the iron from rusting.
This process is also known as sacrificial protection, as the zinc layer corrodes instead of the iron. In the event of damage to the zinc coating, the zinc will still protect the iron, since the exposed zinc will still be more reactive than the iron and will preferentially corrode instead.