

Reactivity Series of Metals

1. Preliminary work

Theory: reactivity series of metals
metal + hydrochloric acid → metal chloride + hydrogen
“pop” test for hydrogen gas
rate of evolution of hydrogen as a measure of reactivity
reaction in cold or warmed acid as a measure of reactivity

Practical: test-tube reactions of magnesium, zinc and copper with dilute hydrochloric acid

2. Planning

Students to make their own **predictions** about the reactions aluminium and iron with dilute hydrochloric acid (suggest they write these in their books). Predictions should be in the form of:

- will it react in cold and/or warm acid?
- what is the expected rate of bubbling, if any (i.e. slow, steady, rapid, vigorous, etc.)?
- will hydrogen gas be detectable?

Addressing whole class, begin completing Planning Sheets. Emphasise that these are not marked, but allow the students to get their ideas organised. Boxes in **bold** must be completed individually, the others may be completed during a class “brainstorming”.

Title: Yours, or one of their own.

Box A: Studying the reactions of five metals with hydrochloric acid to produce a reactivity series.

Box B: Copy, or summarise, their predictions for all five metals.

Box C: Reasons for their predictions:

- for magnesium, zinc and copper it is sufficient to write that they have done these before, and so it is reasonable to expect them to react in the same way next time;
- for aluminium and iron reasons must be based on their positions in the reactivity series relative to the other three.

Emphasise that predictions without (scientific) reasons will not attract a mark.

Box D: All variables, e.g.

- identity of metal
- volume of acid
- concentration of acid
- cold or warm acid used
- amount of metal
- type of apparatus used
- metal disappearing or not
- rate of production of bubbles (if any)

Box E: Variables to change, e.g.

- identity of metal
- cold or warm acid used

Box F: Variables to keep the same (fair test), e.g.

- volume of acid
- concentration of acid
- amount of metal
- type of apparatus used

Note: This leaves two dependent variables (helps to remind them for Box G):

- metal disappearing or not
- rate of production of bubbles (if any)

Box G: Observations and measurements, e.g.

- where a volume or amount is involved, what apparatus will be used?
- how will they warm the acid?
- how will they assess the rate of bubbling (i.e. visually)?
- how many times should they do each metal (is once enough)?

Take in completed planning sheets for checking.

Using *Guide to writing up*, transfer plans to file paper. This should be an individual activity.

Take work in for checking. On Post-It labels, make “enabling comments”, e.g. “Are you sure that 30cm³ of acid will get into a test tube?”, and so on (but do not tell them what to write!)

3. Carrying out experiment

They can do this individually or in pairs (but satisfy yourself that each student in a pair is doing enough). Emphasise **safety** (no marks for an unsafe procedure, e.g. not wearing goggles, boiling the acid, and so on). Be on the look out for improper measurements or faked results (aluminium is a good tell-tale). Results to be written directly into the blank tables at the end of the plan.

Students **must** keep to their plan – any changes must be checked with you.

Take in work for checking at the end of each session.

4. Concluding

This must be an individual activity. As with planning, enabling comments/questions are allowed, but do not lead them.

5. Sheets available for this assessment

[N-Sc1-03-01](#) Reactions of metals with dilute hydrochloric acid – Your Task

[N-Sc1-03-02](#) Reactions of metals with dilute hydrochloric acid – Conclusions

[N-Sc1-03-03](#) Reactions of metals with dilute hydrochloric acid – Emergency Plan
(could be used as a standalone Skill O)

[N-Sc1-03-04](#) Reactions of metals with dilute hydrochloric acid – Emergency Results
(could be used as a standalone Skill A)

Reactions of metals with dilute hydrochloric acid

Your task

You have studied the reactions of magnesium, zinc and copper with hydrochloric acid. You also know about the Reactivity Series of metals. Your task is to plan, and carry out, an experiment to investigate the reactions of two other metals (aluminium and iron) with dilute hydrochloric acid. It would be best to do all five metals.

To gain high marks, your plan should include:

- a prediction of the reactions of these metals with hydrochloric acid, based on your scientific knowledge;
- a clear description of the method you will use (including details of all apparatus needed);
- details of what you will measure and/or observe;
- details of how many measurements and/or observations you intend to make;
- an explanation of how you will make it a fair test; and
- how you will carry out your investigation safely.

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Reaction of metals with dilute hydrochloric acid: Conclusions

Skills A and E (Analysing and Evaluating Evidence) are your **Conclusions**. They form **one half of the marks** in Sc1 investigations. They are usually badly done, so take time to consider the following points:

- Take each metal in turn and compare your Results with your Predictions:
 - were you right, or were you wrong?
 - if you were wrong, try to explain why you were wrong (a text book might help, but remember to write down the title of any book you use at the end of your conclusions)
- Try to draw up a Reactivity Series for the five metals:
 - explain why each metal has been put in its particular place (use some of your results to help)
 - compare this reactivity series to the one you predicted, and discuss any differences
- Discuss any limitations to the experiment. For example, you might have:
 - planned to weigh your pieces of metal but found it very difficult to do
 - had to repeat some experiments to be sure of your findings
 - had difficulty working out which of two metals was the most reactive
- Was your design a good one?
Explain any improvements that you might make to your design, if you had to do it all again.

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Reaction of metals with dilute hydrochloric acid

Emergency Plan

Introduction

In this practical you will study the reaction of five metals with dilute acid.

Make sure that you work **carefully** and **safely**, and that you record all your observations accurately.

Try to make your tests **fair**.

You are responsible for writing up the experiment in **your own words**.

You will have to work on your own, so if you need help **ask your teacher**.

Your task

1. Collect the equipment and chemicals that you need.

You need: copper
magnesium
aluminium
zinc
iron
dilute hydrochloric acid

You also have access to: bench mat, goggles, test-tubes, splints, Bunsen burner, test-tube rack and holder, pipettes and beakers

2. Put some hydrochloric acid in a test-tube (no more than $\frac{1}{4}$ full).
Add one of the metals.
Observe what happens, and make a note of your observations.
If a gas is given off, try to identify it with a simple test.
Make a note of the results of any test and what they mean.
3. If no gas is given off, heat **gently** for a short time.
Make a note of your observations, and the results of any test you do **if** a gas is given off.
4. Repeat steps 2 and 3 for each of the remaining metals.
5. Wash and tidy your equipment away carefully.
Dispose of the metals and chemicals properly.

Writing up your experiment

Write up your experiment onto file paper.

Make sure that you include all the relevant things about your experiment – particularly any precautions that you took to make your experiment safe, accurate, and fair.

What does your experiment show?

Reaction of metals with dilute hydrochloric acid

Emergency Results

If you were unable to do the experiment for some reason, you will not be able to get a mark for Skill O (Obtaining Evidence). However, you can do Skills A and E (Analysing and Evaluating evidence) by using the Emergency Results in the table below.

Results

Metal	Reaction with cold acid	Reaction with warm acid
Copper	No reaction. No bubbles of gas. No colour change seen.	No reaction. No bubbles of gas. No colour change seen.
Magnesium	Vigorous reaction. Rapid fizzing. A lot of gas given off. Squeaky pop with lighted splint.	Not done.
Iron	No reaction. No bubbles of gas given off.	Rapid reaction. Bubbles of gas given off. Squeaky pop with lighted splint.
Aluminium	No reaction seen.	Vigorous reaction with a lot of gas given off. Metal disappears. Acid turns murky grey. Squeaky pop with lighted splint.
Zinc	Some bubbles of gas given off.	Rapid reaction with a lot of gas given off. Squeaky pop with lighted splint.