The reaction of magnesium with steam

Burning magnesium ribbon is plunged into the steam above boiling water in a conical flask.

In the first method, the hydrogen that is formed is allowed to burn at the mouth of the flask.

In the second method, the hydrogen is collected over water and tested with a lighted spill.

Apparatus and chemicals

Eye protection

Method 1

- Bunsen burner, tripod and gauze
- Tongs
- One 250 cm^3 conical flask

Method 2

- Bunsen burner, tripod and gauze.
- One 1 dm^3 conical flask with a one-holed rubber bung to fit.
- Glass trough or washing up bowl.
- One boiling tube.
- One short length of glass tube of approximately 1 cm diameter.
- About half a metre of rubber tubing.
- Wooden spills.

Each method needs the following chemicals. The quantities given are for one demonstration.

- About 45 cm of magnesium ribbon (**Flammable**)
- A little Universal indicator solution (**Flammable**) with appropriate colour chart.

Technical notes

Magnesium ribbon (**Low hazard**) Refer to SSERC or CLEAPSS Hazcard.

Universal indicator solution (**Highly flammable**) Refer to SSERC or CLEAPSS Recipe and Hazcards.

Procedure

HEALTH & SAFETY: Wear eye protection

Looking at burning magnesium is hazardous due to a significant amount of UV light emitted.

Before the demonstration

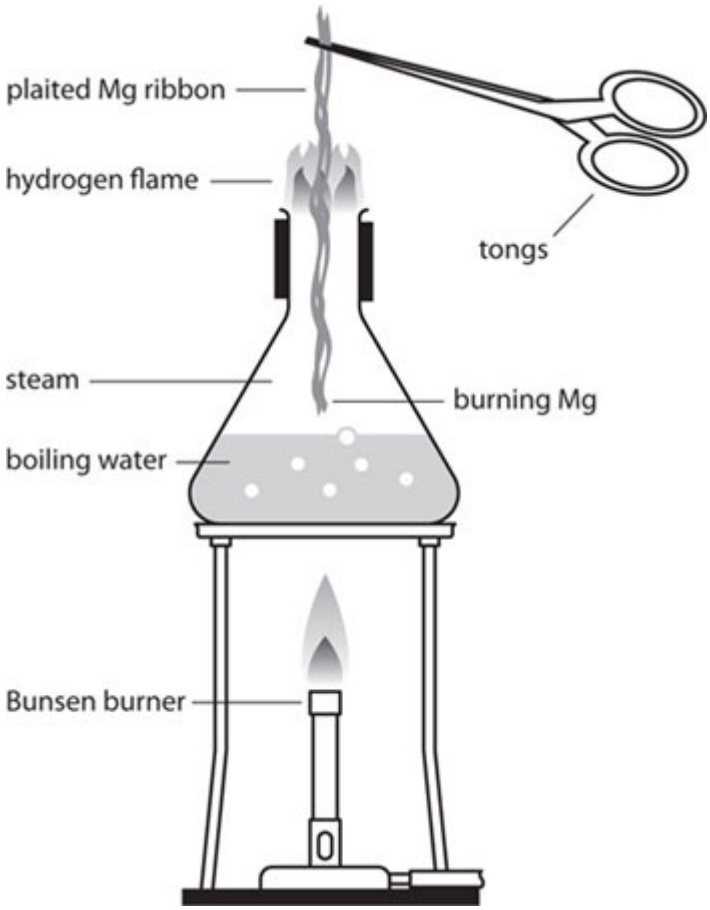
For method 2

a Enlarge the hole in the rubber bung so that it will take a piece of glass tubing of diameter about 1 cm. Attach about half a metre of rubber delivery tube to this glass tube. This will be of similar bore to the tubing used for a Bunsen burner. The reason for this unusually wide tubing is so that it can cope with the rapid evolution of hydrogen that occurs in this demonstration.

The demonstration

Method 1

a Stand the 250 cm^3 conical flask on the tripod and clamp its neck to steady it. Place about 50 cm^3 of water in the flask. Bring this to the boil and allow it to boil for at least five minutes to displace all the air from the flask and replace it with steam. Take three 15 cm lengths of magnesium ribbon and twist them together to form a length of plaited ribbon of the same length. This is more rigid than a single strand and can therefore be manoeuvred more easily when held in a pair of tongs. Take care that the ribbon does not break during plaiting. Leave the Bunsen burner on, boiling the water.

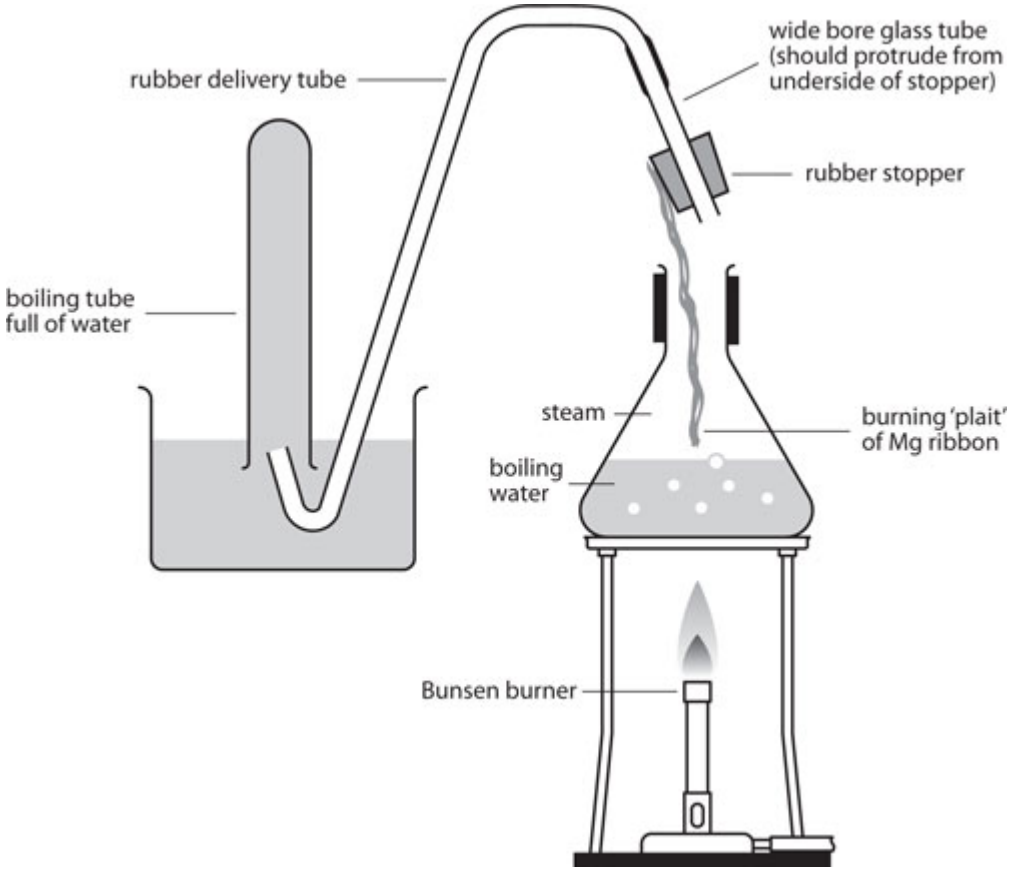


b Holding the plaited magnesium ribbon in tongs by one end, light the other end in the Bunsen flame (a second Bunsen burner may be helpful) and hold the burning end in the steam inside the flask. Avoid looking directly at the burning ribbon. The ribbon will continue to glow brightly, forming hydrogen by reaction with steam. This ignites and burns at the mouth of the flask with a slightly yellowish flame. The magnesium oxide falls into the water and a little dissolves. Turn off the Bunsen burner and add a few drops of Universal indicator to the water. It will be significantly alkaline due to dissolved magnesium hydroxide.

Method 2

b Stand the 1 dm^3 conical flask on the tripod and clamp its neck to steady it. Place about 200 cm^3 of water in the flask. Bring this to the boil and allow it to boil for at least five minutes to displace all the air from the flask and replace it with steam. Plait the magnesium as described above and attach it to the

underside of the bung on the wide bore delivery tube. The easiest way to do this is to cut a small slit in the rubber with a scalpel and insert one end of the plaited ribbon into the slit.
c Fill a trough with water and clamp a boiling tube full of water in an inverted position with its mouth under water. Place the free end of the rubber delivery tube in the mouth of the boiling tube. Clamp the delivery tube if necessary to prevent it coming out of the mouth of the boiling tube as the other end, attached to the bung, is moved (see diagram).



d Leave the Bunsen burner on, boiling the water. Light the end of the plaited magnesium ribbon and lower it into the steam in the flask until the bung is fitted into the mouth of the flask. The magnesium will continue to glow brightly in the steam, forming hydrogen. This will be forced along the delivery tube and some will be collected in the boiling tube, although much will overflow. Remove the bung and delivery tube from the flask to prevent suck-back and test the gas in the boiling tube with a lighted spill. It will 'pop' showing it to be hydrogen. The magnesium oxide will have fallen into the water and a little will have dissolved.
e Turn off the Bunsen burner and add a few drops of Universal indicator to the water. It will be significantly alkaline due to dissolved magnesium hydroxide.

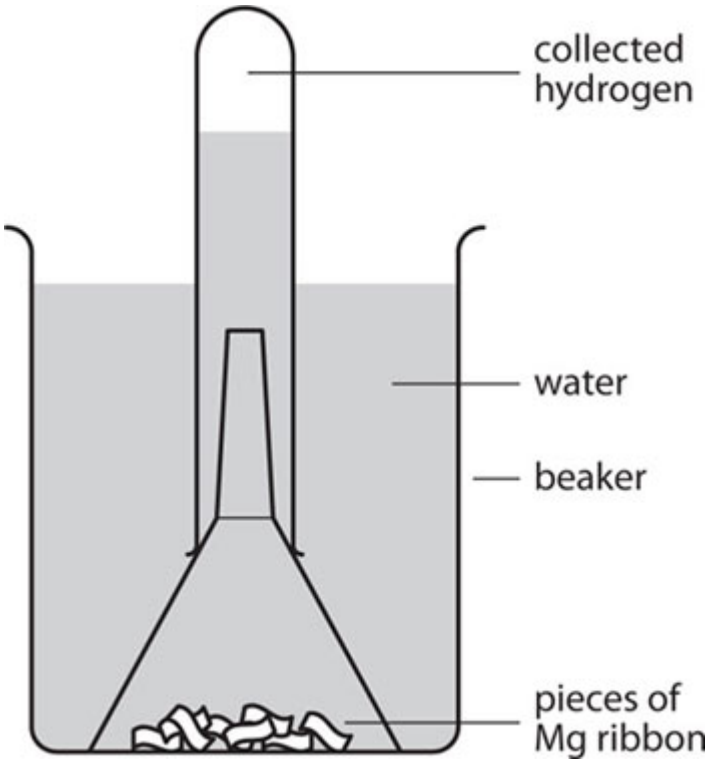
Visual tips

The hydrogen flame in method 1 would be more easily seen in a slightly darkened room.

Teaching notes

Do not allow the burning magnesium to touch the side of the flask. This can be a difficult task if you are dazzled by its flame. Wearing sunglasses might help.

Compare the reaction of magnesium with steam with its reaction with cold water using the apparatus shown in the diagram. Very small bubbles will be seen on the surface of the magnesium but it will take several days before a significant volume can be collected.



Theory

The reaction is $Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

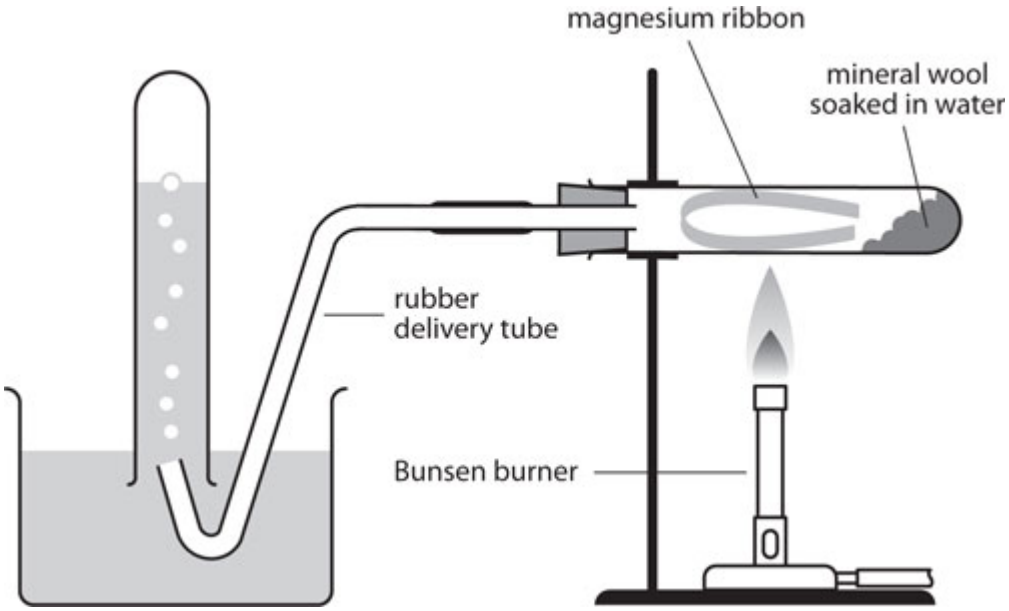
Followed by $MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(aq)$

Reference

This experiment has been adapted from *Classic Chemistry Demonstrations*, Royal Society of Chemistry, London, p.199-203

Useful resource

Another method for this reaction (see diagram) is described in Nuffield combined science teachers' guide II, Sections 6 – 10. London: Longman/Penguin, 1970, 62. This may be suitable as a class experiment. The steam is generated by heating mineral wool soaked with water. However, the test-tubes (which must be of borosilicate glass) often crack and are ruined by the reaction of the hot magnesium with the glass.



Credits

Health & safety checked January 2018

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