Possible contexts

This investigation can be used at KS3 or 4 in the context of the reactivity series or alternatively exothermic and endothermic reactions and redox reactions.

Risks

Copper sulfate solution is an irritant. Make sure that the proper risk assessment is carried out before allowing students to carry out the investigation.

Apparatus

- 1M copper sulfate solution
- magnesium turnings
- zinc granules
- data loggers with temperature probes
- boiling tubes
- measuring cylinders
- digital balances
- stopwatches

Investigation

The students will be using temperature changes in a competition reaction to establish which is more reactive, magnesium or zinc.

1. Ask students to measure out two separate samples of 20 cm^3 of 1M copper sulfate solution and put it in two boiling tubes.

2. Record the initial temperature of both solutions.

3. Measure, using a digital balance 0.24 g of magnesium and 0.65 g of zinc.

4. Ask students - if we are making the experiment a fair test why are we using different masses of the two metals?

   We are doing this so that we are adding the same (approximately!) number of atoms of both metals ($6x10^{21}$ of them give or take….). Remember, zinc atoms are heavier than magnesium atoms.

5. Add the two metals to the two separate boiling tubes and start the stop watch. Every thirty seconds stir the solutions and take the temperature. Repeat for five minutes.

6. Ask students to suggest a suitable results table:

Time (seconds)	Temperature copper sulfate solution and magnesium (°C)	Temperature copper sulfate solution and zinc (°C)

7. Ask students to suggest why stirring is important.

   To make the temperature the same throughout the solution.

Representing results

Suggested questions:

- Would it be better to show how the temperature changes from the beginning of the experiment in the graph rather than the actual temperature?
- What sort of graph should be used? Why?
- How will the two different metals be shown?

Interpreting the results

More able students can calculate the heat transferred to the solution using:

energy transferred (J) = mass (g) x specific heat capacity temperature change (°C)

Assume that the specific heat capacity of copper sulfate solution is identical to water (4.2 J/g/°C) and the density of copper sulfate solution is identical to water (1 g/cm^3)

Suggested questions:

1. What differences are there between the two sets of results and how does this relate to differences in reactivity between magnesium and zinc?
2. What observations can be made by looking at the boiling tubes. Which metal has been formed in ***both reactions?***
3. Construct word (at KS3) or symbol equations at KS4 to describe the reactions.
   Extension: If symbol equations have been used what has been ***reduced*** and what has been ***oxidised***?
4. Are the reactions exothermic or endothermic? What is the evidence for this?
5. Extension. Sketch a reaction profile for both reactions. (You don't know the activation energy for the reaction but you do have a measure of the energy transferred.)

Evaluating the Results

Suggested questions:

1. The graph for magnesium is likely to be a curve while for zinc it is likely to be a line. Why is this?
   As soon as something becomes hotter than the surrounding it will start to transfer heat to it. The bigger the temperature difference, the faster the rate of heat transfer.
2. How could we improve the experiment to minimise heat losses?
3. Find iron in the reactivity series. If this experiment was to be carried out using iron what mass would be used? Sketch the graph expected and explain the choice of graph.