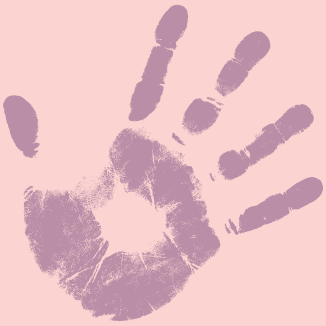
Science Photo Library: Martin Shields

DRAFT

Science Investigation Skills 3

Getting started

Science investigation involves many skills: planning, recording, processing, analysing and evaluating scientific findings, and using primary and secondary data. Make a list of everything you need to include when planning a scientific investigation. After you have planned your first investigation, see if you can add anything which you overlooked to your list.



A Planning a scientific investigation

Before undertaking a scientific investigation, it is important to write a detailed plan. In this section you will learn about what you need to include in your plan and all the factors you must take in to account when writing your plan.

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Writing a hypothesis for an investigation

Key term

Hypothesis – a prediction, based on scientific ideas, made as a starting point for further investigation.

When starting to plan a scientific investigation you need to think about what you are trying to find out from the investigation. You should also think about what type of trend you would *expect* to see from your results and make a prediction based on this expected trend. This prediction is your **hypothesis**. In most cases, a hypothesis is an assumption based on your knowledge, understanding of the topic and observations.

Discussion

Say you have been asked to plan an investigation to study the effect of temperature on the rate of reaction between magnesium ribbon and hydrochloric acid. What would be your hypothesis for this investigation?

For example, in an investigation into which chemical elements are necessary for plant growth your hypothesis could be: 'Nitrogen is needed for plant growth.' Your observations will show that other elements are also needed, so you might need to change your hypothesis and carry out further investigations.

In some cases you may wish to make a **null hypothesis**. This applies to situations where you do not expect to find a particular trend or pattern in your results.

Key term

Null hypothesis – a prediction which states that there is no relationship between two variables or no difference among groups.

Selection of appropriate equipment, techniques and standard procedures

When planning both qualitative and quantitative scientific investigations, you need to know what equipment to use and how to use it. You should also familiarise yourself with any standard procedures which are necessary.

Discussion

What piece of equipment would you use to measure out 25 cm^3 of acid?

Equipment

When writing a plan for your investigation you need to be able to choose appropriate equipment to use in your investigation and explain why you have chosen to use this equipment. For example, when doing an acid-base titration it would not be appropriate to use a measuring cylinder to measure out 25 cm^3 of acid as the measurement would not be precise enough.

Practical techniques

You must also be able to describe any practical techniques that you intend to use in your investigation. For example, when purifying a solid by re-crystallisation, the technique you need to use is shown by the following steps:

Heat the solvent. → Add hot solvent to the solid until it just dissolves. → Allow the solution to cool – crystals will appear. → Place in an ice-bath so that more crystals will form. → Filter and wash the crystals in the filter paper with a small amount of cold solvent. → Scrape the crystals onto a watch glass. → Leave them in a warm place to dry.

Standard procedures

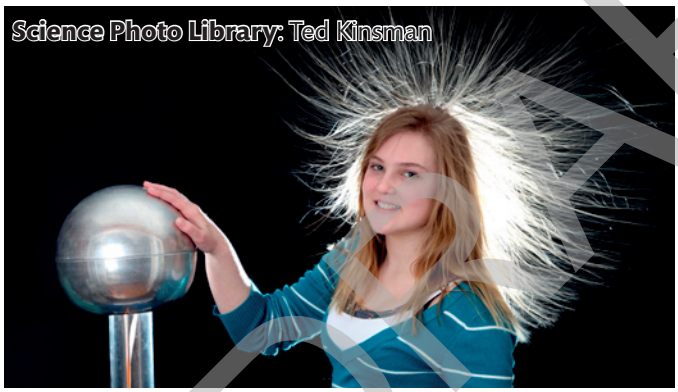
When planning your investigation you need to be aware of any relevant standard procedures.

Standard operating procedures (SOPs) are in place in many laboratories and can cover many different aspects of the work. These could include:

- How tests are carried out.
- How chemicals should be handled.
- How waste should be disposed of.
- How equipment should be used and maintained.

Health and safety issues

When planning an investigation you need to carry out a **risk** assessment. This involves identifying the **hazards** and risks associated with the method you are using for the investigation and then deciding on the best way to minimise the risk.



Example

If you are using a Van de Graaff generator to learn about electrostatics, you would need to consider the following:

- Hazard – static electricity.
- Risk – possibility of electric shock.

When a person is being charged by placing their hand on the dome of the Van de Graaff generator, you would need to minimise the risk by making sure they follow the safety tips shown here. To avoid a serious accident, do not allow a person with a heart condition or anyone fitted with a pacemaker or other electronic medical appliance to touch either the Van de Graaff generator or any other person who has been charged by the generator.

Key term

Hazard – something which has the potential to cause harm.

Key term

Risk – the harm that could be caused by a hazard and the chances of it happening.

Safety tip

When placing your hand on the dome of a Van de Graaff generator you should:

- Stand on an insulating material.
- Not touch another person.
- Touch a wooden bench after removing your hand from the dome.
- Not touch a metal object after removing your hand from the dome.

PAUSE POINT

In your investigation to study the effect of temperature on the rate of reaction between magnesium ribbon and hydrochloric acid, you need to do a risk assessment before starting your investigation.

Hint Identify two hazards in this investigation.

Extend What are the risks associated with these two hazards?

What could you do to minimise these risks?

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THINK FUTURE

Gemma Richardson

Polymer research scientist

When I started this job I did not realise how many uses there were for polymers. Insulation of electric cables, cling film and artificial limbs are just some of the uses. The project I have been working on involves a newly discovered group of polymers. I find my job really exciting as the polymers I am making can be used to make different coloured LEDs (light emitting diodes) which produce the colours in a brand new type of flat-screen TV. LEDs made from these polymers are easier and cheaper to make than conventional LEDs.

An important part of my job is to write scientific papers about my research. I also need to work as part of a team and discuss my research with the engineers involved in design and construction of the LED TVs. Recently I had to give a presentation about my work to a group of school and college students. It was great to be able to inspire young people and spark their interest in taking up a career in scientific research. I find it very satisfying that the work I am doing is at the forefront of many new technologies and is of real benefit to society.

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Focussing your skills

Using your science investigation skills

The skills you have learned in this unit should prepare you for laboratory-based research similar to the job that Gemma has.

Imagine you were part of a team asked to test several LEDs made from different new polymers to see which one would be best to use.

- Think about what research you would need to do before planning your practical work.
- What would you need to include when writing your plan?
- How would you test the different LEDs?
- How would you record your results and observations?
- What factors would you take into account when deciding which polymer LEDs were the best to use? (Remember: economic considerations are also important.)

Working as part of a team

Research scientists do not normally work alone. Before embarking on a project it is important that the team discuss the work and each individual's role in carrying out the research.

- Discuss the project with other members of your group.
- Decide how you would share out the work.
- When you have your results you would need to discuss your findings and pool all your results.
- Finally you should aim to reach a conclusion which is agreed by all members of the team.