40 Science in Society Assessment Task

THE NATURE OF SCIENCE Science in Society; Investigating in Science; Communicating in Science

Objectives:

- To give students an understanding of how to carry out research on a Science in Society topic
- To make students familiar with the various categories of data that can be collected during a research project
- To give students an appreciation of the need to evaluate claims and opinions studied in a research project

Keywords in this chapter:

Evidence
Primary
Secondary
Research
Reliability
Bias

40.1 Science in Society Assessment Task

The State Examinations Commission (SEC) examination paper that you will undertake at the end of Third Year is worth 90 per cent of the marks awarded to you by the SEC. The remaining 10 per cent of marks are awarded by the SEC based on the answers that you write in the SEC Assessment Task booklet. When you complete this booklet, it is sent to the SEC to be marked with your written examination. A copy of the Assessment Task booklet is printed in the *Assessment Skills Book* accompanying this textbook.

The questions in the Assessment Task booklet are based on the Science in Society Investigation that you completed as part of the second Classroom-Based Assessment (CBA) that you undertook in Third Year. You will recall that the first CBA, undertaken in Second Year, was an Extended Experimental Investigation (EEI). The EEI involved laboratory practical work. The Science in Society Investigation does not involve any laboratory practical work. Instead, you will carry out research on a Science in Society issue. You may recall that we discussed Science in Society in Chapter 1. There are hundreds of Science in Society issues that you could investigate. Your teacher will guide you in choosing a suitable topic.

40.2 Primary and secondary data

When you carried out your Extended Experimental Investigation, you collected data yourself rather than use data that had been collected by somebody else. Data collected by the researcher him or herself are called primary data. The word *data* means 'factual information'. *Data* is the plural of *datum*.

Primary data are data collected by the researcher him or herself.

Primary data are commonly collected by students for research projects (Figure 40.1). The data are often used when reporting the results of research projects carried out by the researcher.

Data that have not been collected by the researcher him or herself are called **secondary data**.

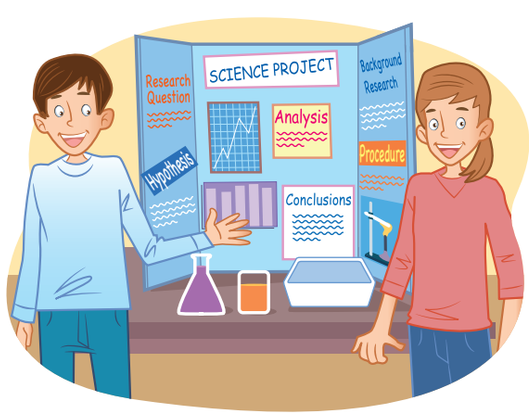


Figure 40.1 Primary data are data that you have collected yourself as part of carrying out an investigation or a research project.

Secondary data are usually available from a number of sources, such as websites, books, journals and government records (Figure 40.2). Secondary data have already been collected at some time in the past. For example, census data of the population of Ireland are available from government organisations. Also, data on examinations are available from the State Examinations Commission. A great deal of secondary data are available online.

Secondary data are data collected by somebody other than the researcher.

Figure 40.2 Secondary data are data collected by somebody other than the researcher. A lot of secondary data are available online.

40.3 The research question

When choosing a Science in Society topic to research, you should choose one in which you are interested. If you are interested in the topic, it will help to motivate you to work hard on it. When thinking about the topic, consider some of the following areas:

- An application of science that has an effect on **human health**.
- An application of science that has an effect on the **environment**.
- An application of science that has an effect on **society in general**.

When you have decided on the topic on which you wish to carry out research, you need to draw up a research question.

A **research question** is the question that an investigative study sets out to answer.

It is important to choose a research question carefully. Never choose a research question that can be answered by a 'yes' or 'no' answer.

Bad research question: Is a diet of junk food damaging to your health?

Good research question: How does a diet of junk food damage your health?

When writing a research question, use words such as *How? What? Why?* and *To what extent?*

Other examples of good research questions are:

- Why is burning fossil fuels bad for the environment?
- Why should our government consider allowing a nuclear power plant to be built in Ireland?
- What are better alternatives to incinerators for disposing of our waste?
- How can the level of recycling be improved in my neighbourhood?
- How can I reduce my carbon footprint?
- What effects on our health are caused by the frequent use of mobile phones?
- In what ways do the benefits of space travel outweigh the hazards?
- Why is alcohol consumption so high in Ireland and what strategies are needed to reduce it?
- How can we reverse the decline in our bee population?
- How does the frequent playing of computer games affect our health?
- Why are obesity levels high among teenagers in Ireland and how can we address the problem?
- To what extent can wind farms solve Ireland's energy problems?

40.4 Completing the SEC Science in Society Investigation Task booklet

There are four questions in the SEC booklet. Each question is worth 10 marks. It is important to ensure that you answer each question fully, as shown in worked example 40.1. To help you understand what is required in each question, a sample Science in Society topic on electric cars is given.

WORKED EXAMPLE 40.1

Section A: Investigation and Research

Question 1

(a) State your research question.

In this section, just write a sentence stating your research question.

To what extent do electric cars contribute to improving the quality of air?

(b) Why did you choose this research question?

In this section, give a reason why you are interested in this topic.

I became interested in the topic of electric cars because our neighbour recently purchased an electric car. He told me that it was less polluting than the diesel-powered car that we have.

(c) Name any two specific research resources that you used during your investigation.

The word specific is important. You must give precise details of research resources. For example, instead of saying 'I searched the internet', give details of the actual website that you visited.

Examples of some specific research resources that I used:

- *I used the internet to find out about the benefits of electric cars to the environment.*
- *I studied the information given on the Sustainable Energy Authority of Ireland website (www.seai.ie/sustainable-solutions/electric-vehicles/).*
- *I watched a YouTube video comparing electric cars and petrol cars (www.youtube.com/watch?v=ewcWN-rHQ6Q).*

EXAM TIP!

Other research resources that you could use are:

- A named newspaper article
- A named article in a science journal or a magazine
- A named TV programme that you viewed
- A named podcast that you listened to.

Section B: Knowledge, Reliability and Bias

Question 2

(a) Outline some scientific knowledge you learned during your investigation.

In this section, give some factual knowledge that you learned. Make sure that you use scientific language or terminology. You should write a minimum of two sentences.

In the YouTube video, I learned that combustion of petrol provides pressure inside a piston in the engine. This transfers energy to a transmission unit, which turns the wheels and causes the car to move.

In an electric car, the power source is a battery pack. An inverter converts the direct current into alternating current. This causes an induction motor to turn the wheels of the car.

Burning petrol produces CO_2, which harms the environment. The batteries in an electric car do not produce CO_2 since the energy comes from a battery and no fuel is burned. Therefore, I concluded that electric cars make a positive contribution to improving the quality of air.

(b) Do you think this knowledge is reliable? Explain your answer.

In this section, give reasons why you feel the knowledge you have gained can be trusted. Does the person giving the information have a qualification in the subject? Have you checked the knowledge supplied by comparing it to other sources or to information supplied by other experts in the area? Is the material up to date?

Yes, I think that the knowledge is reliable because the video was produced by the Learn Engineering organisation. The person who presented it is a qualified engineer with a degree in engineering. Also, the video received very good comments from other engineers around the world who viewed it.

Also, I compared the knowledge that I gained about electric cars in the video with information that I found on the Sustainable Energy Authority of Ireland website. This website is an official website set up by the Irish government to inform citizens about sustainability. Both sources gave similar information, so I feel that the knowledge that I gained can be trusted and is therefore reliable.

Question 3

(a) Name one research resource which you found to be reliable (or unbiased). Explain why.

In this section, find a research resource in which the material is written by professional people who are not trying to sell you something. In other words, it is unbiased. The views given should be balanced views and should outline both sides of an argument.

One research resource that I found to be unbiased was the Sustainable Energy Authority of Ireland website. This was unbiased because the website gave good advice about buying an electric car but did not recommend any particular brand of electric car. The website was giving information about electric cars in general. It was left to the individual to choose the electric car that he or she felt was the best.

(b) Name one research resource which you found to be unreliable (or biased). Explain why.

In this section, refer to a research resource that may be biased, is trying to sell you something or just gives one side of an argument. Does the person giving the information have any expertise or qualification in the subject? Do they refer you to other sources to back up their views? Is the person in the video or blog being paid by the manufacturer of the product to influence you?

I searched the DoneDeal website (www.donedeal.ie) to learn about the distance that different brands of electric cars can travel on one charge.

Some of the people selling cars were giving ranges of electric cars that were very high. I feel that the information was biased, as they were trying to sell their own cars.

When I compared the ranges in the adverts with the ranges on the official website of the car manufacturers, I found that some of the ranges quoted on the adverts were incorrect and therefore are unreliable.

Section C: Communicating

Question 4

As you conducted your research, you may have come across information presented using methods that did not use words alone. Such methods include diagrams, photographs, tables, graphs, charts and audio/visual recordings.

(a) Did any of these communication methods help you understand the information presented? Explain your answer using a relevant example.

In this section, refer to any diagrams, photos, tables, charts or audio/visual aids that helped you to understand the knowledge being provided.

I found the Learn Engineering YouTube video of great help in understanding the differences between petrol-driven cars and electric cars. The video showed lots of simple diagrams to explain how each type of car worked. It also included animations showing what happens inside the engine of the petrol-driven car and showed how the combustion of the petrol caused the car to move.

When explaining how the electric car worked, I found the diagram of the rotating magnetic field a great help to me in understanding how the wheels of the car turn.

(b) Did you use any of these communication methods to present information in your own research report? Explain why you chose to use or not use these communication methods in your report.

In this section, explain why you presented information using diagrams, charts, photos, tables or any audio/visual aids in your report.

In my report, I used labelled diagrams and tables to discuss electric cars.

I used a labelled diagram to explain how an electric car works. This is easier to explain using a diagram than by writing a lot of text.

I used some photos of an electric car to show that it does not have an exhaust pipe.

I also included a table summarising the ranges of four models of electric cars that are for sale in Ireland.

I used my smartphone to make a short video showing what an electric car looks like under the bonnet.

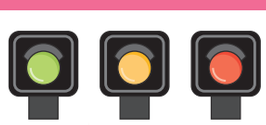
I did not use any animated videos like the ones that I saw on YouTube as I do not have the skill or equipment to produce these.

Test yourself: An SEC Assessment Task booklet is reproduced in Chapter 40 of your *Assessment Skills Book*. This will help you to practise writing an account of your own Science in Society research project.

Summary: What I should know

- Primary data are data collected by the researcher him or herself.
- Secondary data are data collected by someone other than the researcher.
- A research question is the question that an investigative study sets out to answer.
- Never choose a research question that can be answered by a 'yes' or 'no' answer.
- When writing a research question, use words such as *How? What? Why?* and *To what extent?*

Learning outcomes



Now I am able to:

Distinguish between primary data and secondary data.			
Analyse information and secondary data that I have collected.			
Evaluate claims and opinions that I have studied.			
Draw conclusions based on evidence that I have studied about Science in Society issues.			

41 Extended Experimental Investigations

THE NATURE OF SCIENCE Understanding about Science; Investigating in science; Communicating in Science

Objectives:

- To make students familiar with the concept of an investigation in science
- To give students an understanding of the different categories of variables
- To ensure that students know the steps needed to carry out an Extended Experimental Investigation

Keywords in this chapter:

Investigation
Quantitative
Independent variable
Dependent variable
Controlled variable
Fair test

41.1 Carrying out investigations in science

When studying this science course, you will carry out two types of laboratory practical work. In the first type, you learn to follow instructions to perform various tasks, such as using a microscope, making new substances and setting up electrical circuits. These experiments help you to develop important laboratory skills, such as handling apparatus, measuring, observing and drawing conclusions from results of experiments.

In addition to the above type of experiments, you will now carry out experiments where you will not have a set of instructions. You yourself will have to plan how to carry out the experiment. Also, you will not know the 'right' answer before you begin the experiment. This type of experiment is called an **investigation**.

An **investigation** is a task for which the student cannot immediately see an answer or recall a routine method for finding it.

There are two types of investigation in science:

- **Exploratory-type investigation:** This type of investigation involves an exploratory-type activity. A scientific study of a particular situation is carried out, then a report is written based on the study's findings. An example of an exploratory-type investigation is a survey of the plant species in a local habitat. In this investigation, you would be expected to study a local habitat and write an account of the work under various headings.
- **Variable-type investigation:** The word *variable* refers to something that can be changed. An example of a variable-type investigation could involve studying how well sound is absorbed by different types of materials. We will now study this investigation in detail to help you learn how a variable-type investigation is carried out.

A **variable** is anything that can be changed.

The investigation that you will carry out in this chapter is called a Classroom-Based Assessment (CBA). This means that the investigation will be marked by your own teacher rather than being sent to the State Examinations Commission.

WORKED EXAMPLE 41.1

To investigate and compare the quantitative effects of changing material type on the level of sound insulation provided by a range of materials

We apply the scientific method to carry out this investigation.

1. Identify the research question

- How does the type of material affect the amount of sound absorbed by that material?

2. Carry out background research

In your background research, you might learn that:

- The decibel scale is used to compare the loudness of different sounds.
- The sound level of various sounds can be measured using a sound-level meter (Figure 41.1).

Figure 41.1 A sound-level meter is used to compare the loudness of different sounds.

3. Construct a hypothesis

- You might make an 'educated guess' that some materials are good absorbers of sound. For example, you may have observed that closing a window helps to lessen the noise from traffic outside your house. Therefore, your hypothesis might be: 'If I put a sheet of glass in front of something giving out sound, then the glass will absorb some of the sound.'
- Based on other everyday experiences, you could choose other materials through which you will pass sound. For example, you may have noticed that the sound coming from your ringing mobile phone is not as loud when it is in the pocket of your jeans as when it is held in your hand. Therefore, you may wish to test how easily sound passes through denim.

When writing a hypothesis, always use a sentence with an IF THEN statement: I think that IF I do something, THEN something else will happen.

An example of a hypothesis for this investigation might be:

I think that IF I pass sound through various materials, THEN denim will absorb the most sound compared to other materials.

Other examples of research questions and hypotheses are:

- **Research question:** How does physical exercise affect heart rate?
- **Hypothesis:** I think that IF I carry out physical exercise such as running, THEN my heart rate will increase.
- **Research question:** How does the temperature of a coil of wire depend on the electric current flowing through the wire?
- **Hypothesis:** I think that IF I increase the electric current flowing through the wire, THEN the temperature will increase.
- **Research question:** How does the rate of reaction of hydrogen peroxide to form water and oxygen depend on the amount of catalyst added?
- **Hypothesis:** I think that IF I add more catalyst, THEN the rate will increase.

EXAM TIP!

In an examination, it does not matter whether or not your hypothesis is correct. You will only find out if your hypothesis is correct when you carry out the experiment. The important thing is that you can write a hypothesis correctly.

4. Carry out an experiment to test your hypothesis

The title of the investigation contains the word **quantitative**.

Quantitative means that we must take measurements of quantities or amounts. In other words, we must collect data containing numbers. This should not be confused with **qualitative**, which means 'descriptive'. In other words, you do not have to collect any numbers, but simply give a description.

To collect quantitative data, you could set up an apparatus similar to that shown in Figure 41.2.

This experiment is a variable-type investigation.

In this investigation, you change one variable. The one variable that you change is the material through which you pass the sound (cardboard, plastic, denim, foam and bubble wrap). The variable that you change is called the **independent variable**.

The **independent variable** is the variable that you **change**.

You measure the second variable. The second variable is the quantity of sound that has passed through the material. The variable that you focus your attention on to see how it responds to change is called the **dependent variable**. For example, in this experiment you measure the quantity of sound that has passed through each material.

The **dependent variable** is the variable that you **measure** in order to see how it has responded to the change.

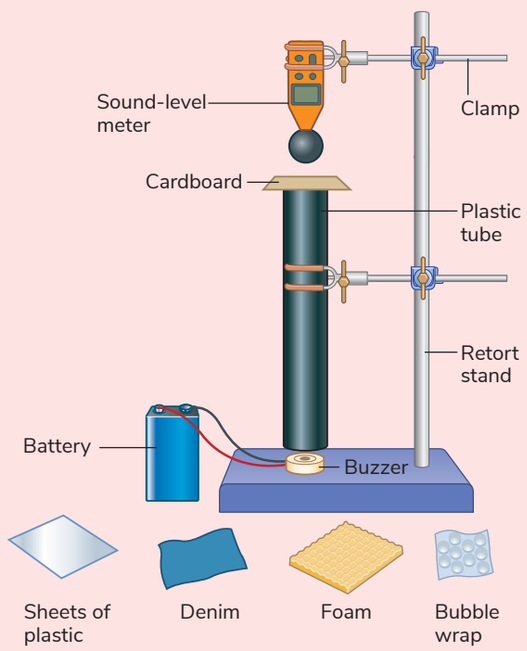


Figure 41.2 An investigation to study how well different materials absorb sound

There is a third type of variable, called the **controlled** or **control variable**.

Control variables are the variables that are **not changed** by you but are kept constant.

For example, in this investigation the control variables are:

- The sound source
- The plastic tube used to channel the sound
- The size and thickness of the piece of material being tested
- The distance from the sound source to the sound-level meter
- The distance from the sound source to the material
- The room conditions.

All the above variables must be kept constant. The reason for this is because when you carry out an investigation, you must always ensure that it is a **fair test**.

A **fair test** is one in which only one variable at a time is changed while keeping all other conditions the same.

To understand this, imagine you wished to investigate the speed of various runners. If you carried out this investigation under the conditions shown in Figure 41.3, it would not be a fair test.

- To make sure that the investigation on absorption of sound is a fair test, you must change only one variable: the type of material through which the sound is passed. You then measure the amount of sound that has passed through each material. All other variables must be controlled.
- To make sure that the results are reliable, you must repeat each experiment a few times.

A measurement is **reliable** if you repeat the same experiment and you get the same or similar results over and over again.

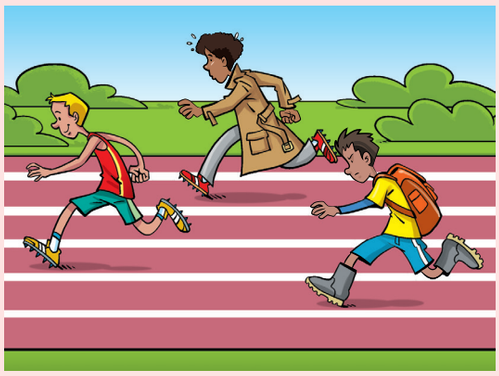


Figure 41.3 This is not a fair test to measure how fast each person can run since the conditions are not the same for all runners.

In other words, reliable results are similar to each other every time an experiment is repeated. For example, in the above investigation the piece of cardboard should absorb the same amount of sound each time you test the cardboard to measure the amount of sound absorbed by it. Therefore, you should get a similar reading on the sound-level meter each time.

Reliability also means that if the experiment is repeated by other scientists, they should obtain the same results. Therefore, it is important that we ensure that experiments are reliable by repeating them to make sure that we get similar results each time. This is why scientific research should never be published until the experiments described have been repeated many times to check the reliability of the results.

In addition to reliability, remember that we have already learned (Chapter 29) that when measurements are repeated, the **accuracy** of an experiment is improved by taking an average of the measurements that are close to each other. Measurements that are clearly not accurate are ignored.

When carrying out laboratory practical work, you must ensure that all **safety precautions** are implemented. For example, in this investigation you would need to use ear protection to avoid damage to your hearing. Also, you should not leave items on the floor in case somebody trips over them.

Also, when carrying out an investigation, you need to try to avoid sources of error. For example, in this investigation you need to choose a room in which noise from outside does not interfere with the results of your experiment.

5. Analyse the data and draw conclusions

The results of the experiment could be summarised as shown in Table 41.1.

The results could also be summarised in the form of a bar chart (Figure 41.4). Note that the type of material (the independent variable) is placed on the x-axis. Note also that the dependent variable is placed on the y-axis.

Material	Average sound detected when each experiment is repeated three times (dB)
None	93.1
Denim cloth	74.9
Cardboard	73.3
Bubble wrap	86.9
Plastic sheet	83.3
Foam	92.1

Table 41.1 Results obtained from the investigation

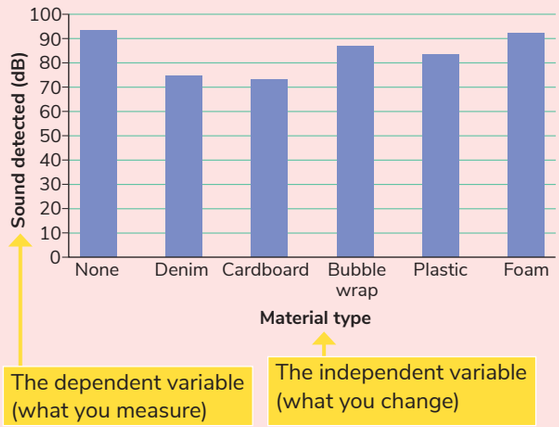


Figure 41.4 This bar chart summarises the data obtained in the investigation of the abilities of various materials to absorb sound.

Conclusion

From the results of the experiment, we see that different materials absorb sound to different extents. The best absorber of sound is cardboard, since only 73.3 dB is detected on the sound-level meter. The next best sound insulator is denim, followed by the plastic sheet and then by the bubble wrap. Foam is found to be the worst sound insulator since almost all the sound passed through it.

The results show that my hypothesis was not correct. I thought that denim would absorb sound better than any of the other materials. In fact, cardboard is better at absorbing sound than denim.

6. Communicate your results

Communicating the findings of your investigation can be carried out in several ways. Since this is a Classroom-Based Assessment, your own teacher will advise you on how to present the report. For example, you may have to present a written report, make a PowerPoint presentation to your fellow students, produce a podcast, design a web page or present a display at a science exhibition. Your teacher will tell you how your report should be presented. An example of a written format for presenting your report is given in the *Student Laboratory Notebook* accompanying this textbook.

In some cases, scientists are expected to comment on ethics. This means presenting all the data fully and fairly and not being dishonest in reporting the results. As discussed in Chapter 9, in the case of experiments involving human beings or animals, ethical guidelines must be followed.

As Extended Experimental Investigations are part of the Classroom-Based Assessment, you will not be asked any question about your own particular Extended Experimental Investigation on the SEC examination paper. You may be asked a general question to test the skills (writing a hypothesis, collecting data, analysing data, drawing conclusions) you acquired when carrying out an investigation. You should also make sure that you can explain all the key terms highlighted in this chapter.

*When studying investigations, you may come across the term **control group** or **comparison group**. Control groups are commonly used in investigations such as medical research to compare the effect of new drugs being tested. One group (the experimental group) is given the drug being tested. The second group (the control group) is given something harmless, such as water or sugar. This harmless substance is often called a **placebo**. The inclusion of the control group helps the researchers to conclude if the treatment actually has an effect on the experimental group.*

SEC examination question

A student was asked to investigate what effect adding salt has on the boiling point of water.

(a) Write a suitable hypothesis for this investigation.

I think that if I add salt to water, then the boiling point of the water will increase.

EXAM TIP!

Your hypothesis does not need to be correct to get full marks. The main thing is that you show you understand the meaning of the word *hypothesis*. When writing the hypothesis, it is important that you state what you think and **do not ask a question**.

(b) Suggest a reason why the student repeated the investigation five times for each mass of salt used.

The student repeated the investigation five times for reliability. In other words, they wanted to check that they would get the same or very similar results each time the experiment was performed.

EXAM TIP!

You had to mention the word **reliability** in order to get full marks. To remember that **r**eliability is about **r**epeating, think of the two Rs: **r**eliability **r**epeating.

Test yourself: Now attempt questions 41.1–41.3.

Summary: What I should know

- An investigation is a task for which the student cannot immediately see an answer or recall a routine method for finding it.
- A variable is anything that can change or be changed.
- The independent variable is the variable that you change.
- The dependent variable is the variable that you measure in order to see how it has responded to the change.
- Control variables are the variables that are not changed by you but are kept constant.
- A fair test is one in which only one variable at a time is changed while keeping all other conditions the same.

Learning outcomes

Now I am able to:

Explain the meaning of the term *investigation*.			
Explain the meanings of the terms *independent variable*, *dependent variable* and *controlled variable*.			
Carry out an Extended Experimental Investigation.			
Write a hypothesis for an Extended Experimental Investigation.			
Collect, analyse and present data in a report.			

Questions

41.1

Explain the meaning of the following terms: **(a)** investigation **(b)** variable **(c)** fair test and **(d)** reliable measurement.

41.2

Seán and Máire carried out an Extended Experimental Investigation to study how the height of bounce of a squash ball depends on the temperature of the squash ball. They heated the squash ball to various temperatures and dropped it from the same height (Figure 41.5) each time. The height of the bounce was measured each time after the ball was dropped.

(a) Is this investigation an exploratory-type investigation or a variable-type investigation? Explain your answer.

(b) Name the independent variable in this investigation.

(c) Name the dependent variable in this investigation.

(d) Name the control variables in this investigation.

(e) Why was the ball dropped from the same height each time the experiment was carried out?

(f) What type of graph could be used to summarise the data?

(g) Suggest a suitable hypothesis for this investigation.

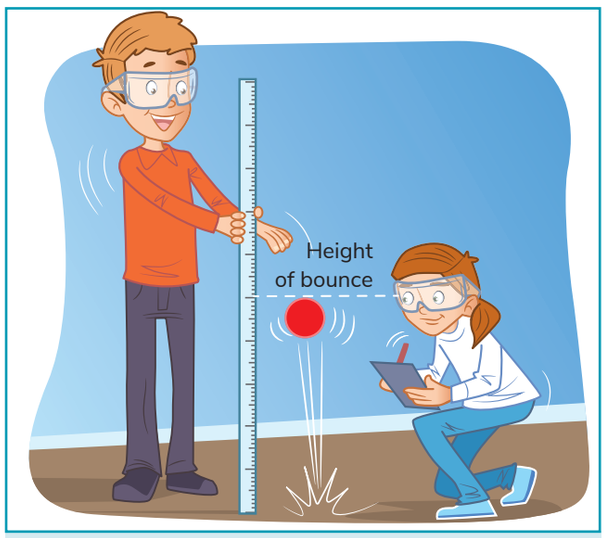


Figure 41.5

41.3

For each of the examples of Extended Experimental Investigations listed in Table 41.2, complete the following five statements in your homework copybook:

(a) My hypothesis is that ...

(b) The independent variable is ...

(c) The dependent variable is ...

(d) The control variables are ...

(e) To ensure that this is a fair test, I will ...

No.	Extended Experimental Investigation
1	A gardener suggests that the length of time taken for marrowfat peas to germinate is decreased if they are soaked in water in advance. Carry out a quantitative investigation of this suggestion.
2	Investigate the effectiveness of a method of preventing an object containing iron from corroding.
3	Investigate a factor that determines the rate at which heat is lost from different types of drinking cups that contain hot liquid.
4	Florists often supply a sachet of flower food/preservative with bunches of cut flowers. Carry out an investigation to compare the effectiveness of using a commercially supplied flower food/preservative with two other household substances as additives to prolong the life of cut flowers in a container of water.
5	Compare by way of investigation the abilities of different indigestion remedies to neutralise excess stomach acid.
6	Investigate a factor that affects the distance taken for a toy car to stop after rolling down a ramp.
7	Compare by means of investigation the vitamin C content of a number of commercial and fresh fruit juices.
8	Compare by means of investigation methanol, propan-1-ol and candle wax in terms of their effectiveness as fuels.
9	Investigate and compare how the rates of flow of powdered or granulated solids through a funnel are affected by the size of the solid particles.
10	Investigate and compare the quantitative effects of changing the duration of light physical exercise on the pulse rate of a person.

Table 41.2 Examples of Extended Experimental Investigations