



NOTES AND RECORDING



This sheet is for students to record their results in various activities and draw graphs if needed.

Background Information

It was known in the 18th century that when two dissimilar metals were placed in an electrolyte [eg silver and copper coins in a lemon] that *electricity* flowed in a wire connecting the two metal rods [electrodes]. This simple electrochemical cell was refined into a battery by Volta. In 1819 Oersted showed that when electricity flowed it affected a magnetic compass needle.

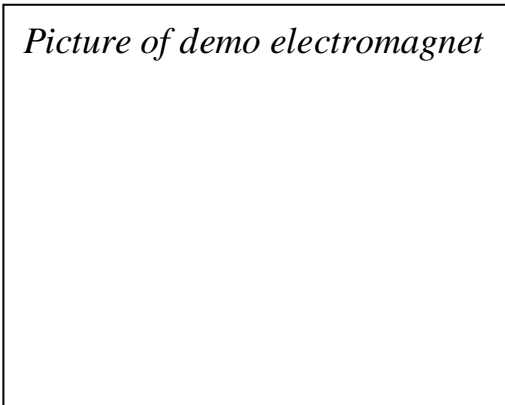
Picture of Volta's or Oersted's experiment



The relationship between electricity and magnetism had begun to be investigated and two of Nature's *fundamental forces* were linked.

The magnetic effect caused by electric current flowing is the physics behind the *electromagnet* and you will see one in the GDC display. Its strength is controlled by the amount of current passing through the coils.

Picture of demo electromagnet



Faraday in 1831 investigated the effect of passing a changing electric current through a coil and this led to the concept of *induction*. There is a danger of trying to run before walking and the concept of *field* needs to be introduced. You are aware of the *gravitational field of the earth*. It affects [any] object and attracts it to the earth *without contact*. This is a key feature of *induction*, it is an effect without contact. A skill all school teachers should have!

Maxwell discovered that a changing electric current produced a *changing magnetic field* and this changing magnetic field could be transmitted through space [or better iron] to another coil or piece of metal. This changing magnetic field in a local coil or piece of metal is the principle behind the transformer, the induction coil in your car, induction cooking, magnetic levitation in trains, a guitar pick up and how a speedometer works. There are posters to help you understand this.

The physics behind electromagnetic induction is contained in Faraday's Law and is a Year 12 Physics topic, interestingly this induced magnetism has some strange consequences. They too are contained in a Law -Lenz's Law and this is nicely shown in the model pictured here, and displayed on the GDC floor.



Background Information



For teacher use "ideal" answers provided and background information that could be discussed before the visit.

It was known in the 18th century that when two dissimilar metals were placed in an electrolyte (eg silver and copper coins in a lemon) that *electricity* flowed in a wire connecting the two metal rods (electrodes). This simple electrochemical cell was refined into a battery by Volta. In 1819 Oersted showed that when electricity flowed it affected a magnetic compass needle.

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Picture of demo electromagnet

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SITE ACTIVITY



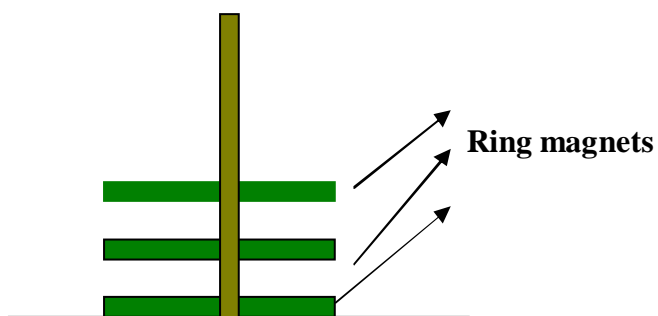
1. You will see a tray with a variety of magnets in it and also a variety of metals, you should be familiar with some of the ideas in this **introductory activity**.
 - 1.1 List the materials that are **attracted** to a magnet

 - 1.2 Where there any surprises?

 - 1.3 Arrange the magnets roughly in order of their strength

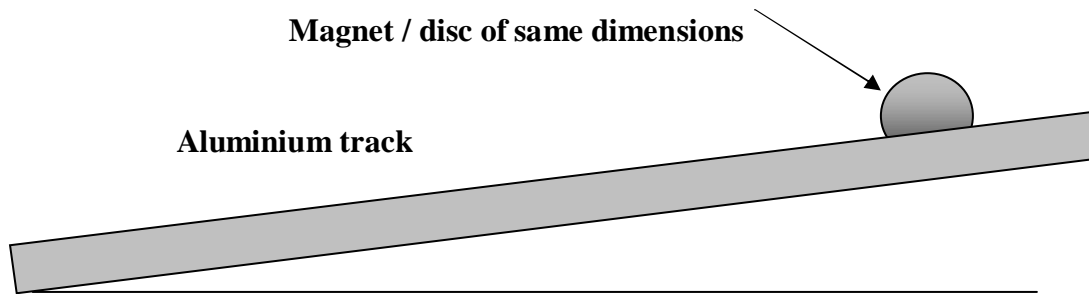
 - 1.4 How did you do this?

 - 1.5 Set up the magnets as shown below,



1.6 Can you make the magnets not float?

1.7 Make a conclusion about magnetic poles.



2. Introduction to Magnetic induction

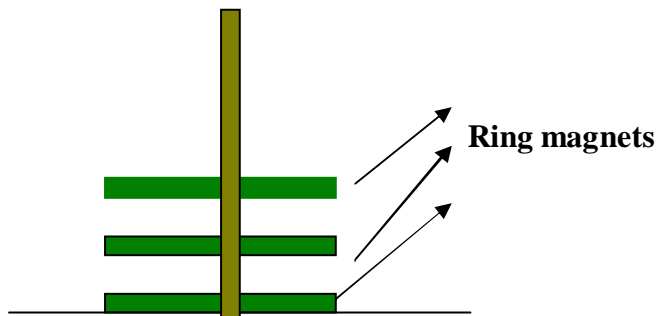
Roll both "discs" down the aluminium track and notice how different the motion of the magnet is to that of a similar disc when allowed to roll down the slope. Friction is not a contributing factor here.

2.1 What do you notice?

Now you are in a position to investigate the *magnetic pendulum / floating ring* and compare its motion to that of a nearby pendulum with no magnetic field. This effect has application in braking of trains and cars and is the physics behind why you cannot fool a soft drink machine!

MAGNETISM AND ENERGY ABSORPTION

3. Magnetic Balance Poles



This is an easy introduction to magnetism by way of the “floating ring” toy.

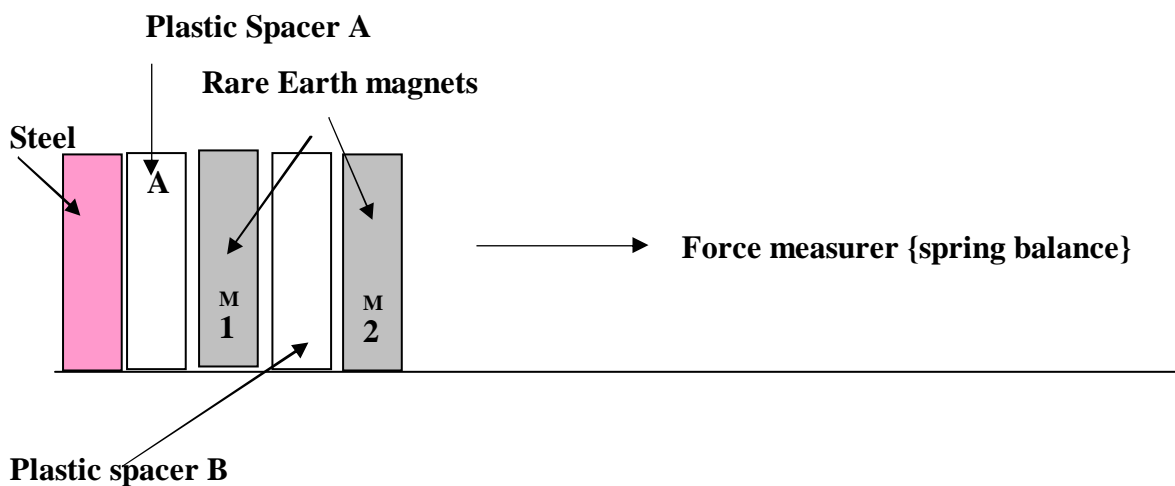
- 3.1 What happens if you invert any of the ring magnets?

- 3.2 What does this tell you about magnets and the Law of magnetism?

- 3.3 Add more magnets and observe the spacing between the magnets. What happens and why?

4. Magnetic force investigation

In this experiment you will investigate the attractive force that two magnets can have on each other in a more mathematical way. I am sure you have been told that “**maths is the language of science**”.



4.1 Table of Results

Number of plastic spacers B	Force measure reading (N)
1	
2	
3	
4	

Processing of results

4.2 Plot a graph of separation between the magnets M_1 and M_2 (x axis) v Force measure reading (y axis).

4.3 What is the purpose of plastic spacer at A?

4.4 Why was no data taken for zero plastic spacing labelled B?

4.5 Make a **conclusion** from your graph

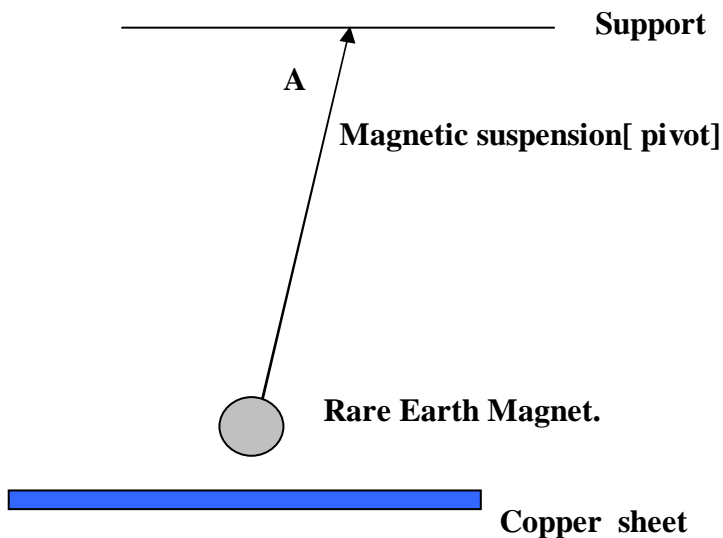
4.6 These magnets are very strong. They are called **Rare Earth magnets**.

Back at school research these magnets,

- Find out what they are made of.
- If there are varieties of Rare Earth Magnets.
- Why they are so powerful.
- And what uses they have.

4.7 Submit your findings as a class presentation.

5. Magnetic Pendulum



Procedure

Allow the magnet to swing freely and observe its motion, it seems that it will oscillate forever. This is due, in part, to the magnetic pivot at A. Introduce a copper sheet as shown in the diagram above.

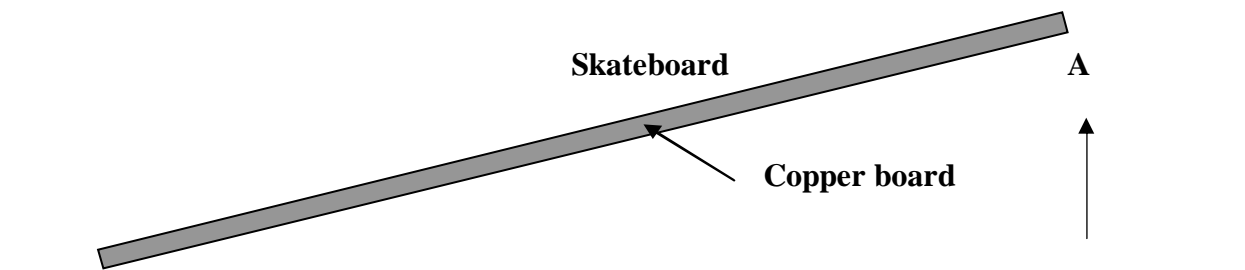
5.1 What do you now observe about the pendulum's motion?

5.2 Replace the copper plate by one of aluminium. What changes do you observe?

5.2 Discuss with your teacher / guide where you think the energy (kinetic) of motion has gone?
Write your answers here.

5.3 Your answer to Q3 is known as a **hypothesis**. How could you test if your **hypothesis** is true?

6. Magnetic Skateboard



Try riding the magnetic skateboard down the copper slope.

6.1 Is it different from that what you expected?

6.2 Now try rolling the skateboard on the plywood board. What difference does it make?

Investigation using the magnetic skateboard on the copper track: It is important in any science experiment to only change **one variable** at a time. That is known as your **control**. First, investigate the effect of increasing the mass on the time taken to travel the entire slope.

6.3 Fill in the table below with your results.

Mass [kg]	Time taken for "journey" on copper track

6.4 Can you think of a “real life” experiment where only **one** variable was changed and a **conclusion** was made?

6.5 Make a **conclusion** that relates mass and "journey time"



Optional Site Activity



1. **Magnetic Skateboard:** Keep the **mass** of the skateboard constant and change the slope by adding blocks of equal size to A.

1.1 Fill in the table below.

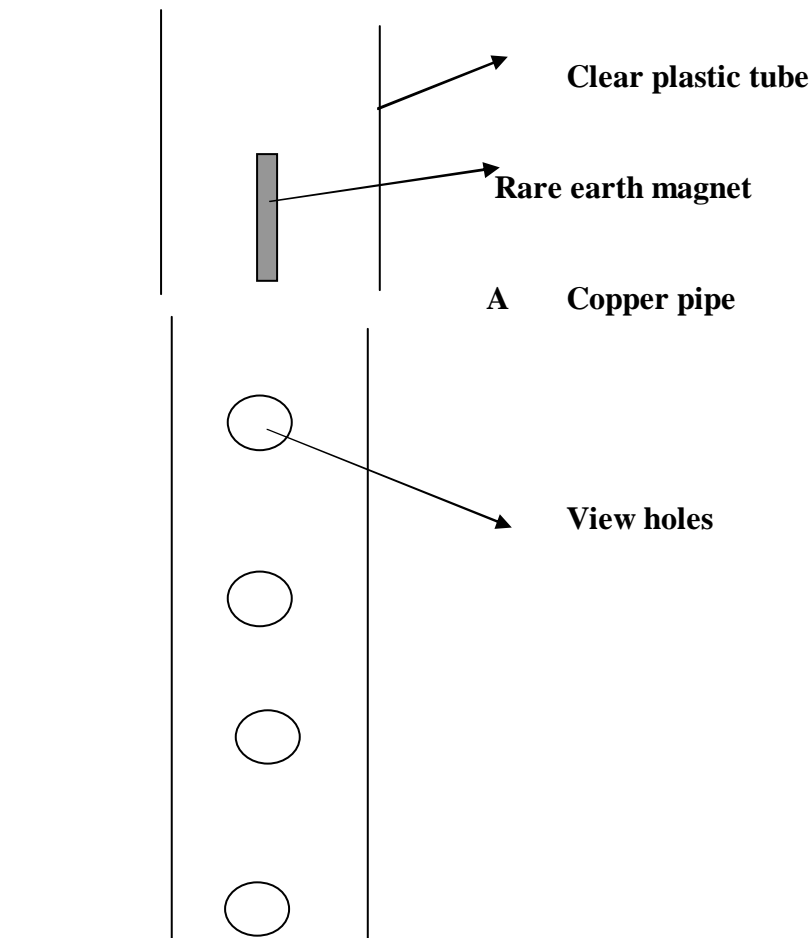
Slope (blocks)	Time taken for "journey" on copper track

1.2 From your data make a **conclusion** that relates "journey time" and slope.

1.3 We hope that you are curious as to why the skateboard travels so slowly along the copper but behaves 'normally' on the wooden surface. Ask your guide / teacher to explain.

1.4 When you return to class, present your findings appropriately.

2. Eddy currents in long copper pipe.



2.1 Allow the magnet to fall down the copper pipe and notice the time it takes to complete the journey.

2.2 This is not easy, view the journey through the "port holes". Does it look as if the speed is **constant**?

Investigate how the initial speed at A affects this "journey time". Allow the magnet to fall through different lengths of clear plastic pipe. This will change the entry speed at A.

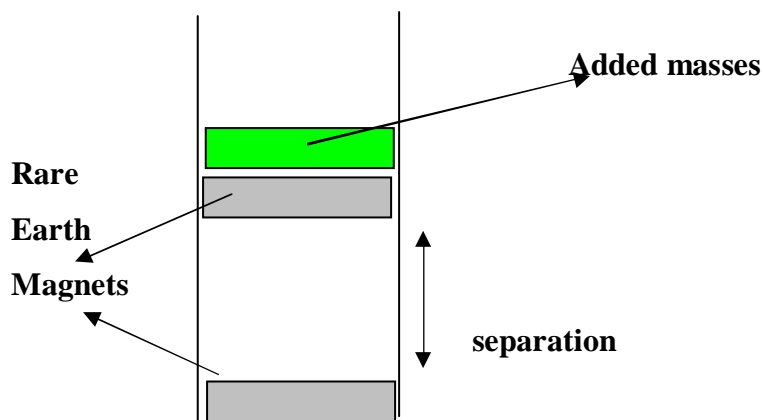
2.3 Measure the journey time and complete the table below.

Length of plastic pipe (cm)	Time to travel down the copper pipe (sec)
0	
10	
20	
30	

2.4 Make a **conclusion** that relates entry speed and time to travel the entire length of the copper tube.

2.5 Now, we hope this will surprise you. **Tilt** the copper tube and drop the magnet in at the top of the tube, observe the **trajectory** of the magnet by viewing through the "port holes." What do you notice?

3. Magnetic Balance Poles



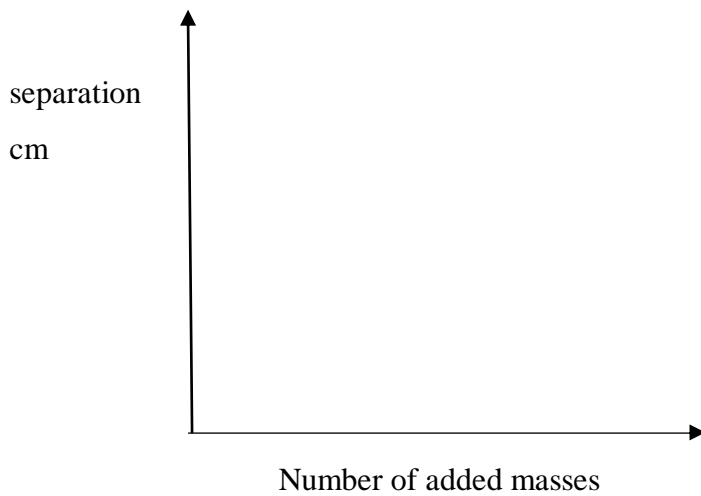
Observe the "floating magnets" display.
Push down on the top magnet with your finger and appreciate the force needed.

3.1 Add masses to the top magnet and measure the separation. Fill in the table below.

Number of added masses	Separation (cm)
0	
1	
2	
3	
4	

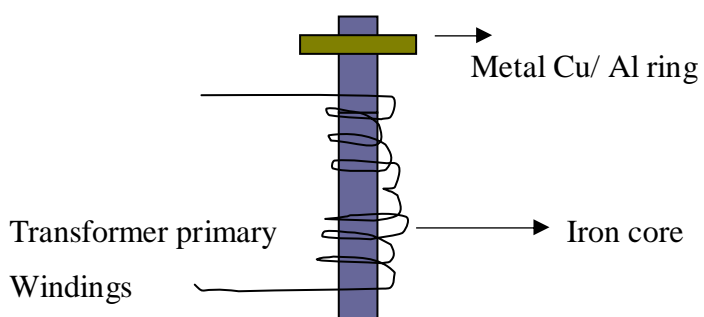
3.2 Make a **conclusion** from your observations.

3.3 Represent this data on the graph below.



4. Applications of Induction. This is a demonstration.

AC and do floating ring and heating of ring?



- 4.1 Can you explain why the ring “floats”?

- 4.2 What do you observe when you touch the ring?

- 4.3 Can you identify any applications for this demonstration?

Web based Resources

Below are some web sites you might find useful.



Appendix 1



Links to Outcomes Education

Reference Science Student Outcome Statements p 6-9

Overarching Major learning Outcomes

There are opportunities to assess students in the following outcomes when taking part in this program.

OLO 7 Students understand and appreciate the physical, biological and technological world and have the knowledge and skills to make decisions in relation to it.

OLO 5 Students describe and reason about patterns, structures and relationships in order to understand, interpret, justify and make predictions.

OLO 6 Students visualise consequences, think latterly, recognise potential and are prepared to test options.

Science Major Learning Outcomes

Working Scientifically

1. Investigating skills

Students investigate and answer questions about the natural and technological world. They use the skills of scientific investigation, reflection and analysis to prepare a plan for their investigation; to collect, process and interpret data: to communicate their conclusions

2. Communicating Scientifically

Students communicate scientific understandings to different audiences for a range of purposes.

3. Applying Science in Daily Life

Students apply and evaluate scientific knowledge, skills and understanding across arrange of contexts.

3. Using Science in Society

Science understand that science is a human activity which influences all people as a part of their daily lives.

Understanding concepts

1. Earth and Beyond

Students understand the physical world around them and its impact on the way we live.

2. Energy and Change

3. Students understand the scientific concept of energy and explain that energy is vital to our existence and quality of life.

Student Outcome Statements

Students typically in years 8-10 will be performing at levels (3) 4-6. The following examples demonstrate outcomes for levels 4 and 5

Investigating scientifically

Planning

4. Identifies the variables to be changed, the variable to be measured and at least one variable to be controlled. In a descriptive study plans are made for the necessary types of observations
5. Analyses problems, formulates a question or hypothesis for testing and plans an experiment in which several variables are controlled.

Conducting

4. Takes care with data collection so that data is accurate, uses repeated trials and uses independent variables that are usually continuous.
5. Uses equipment that is appropriate for the task and uses preliminary trials of the investigative procedure to improve the procedure or measurement techniques.

Processing Data

4. Calculates averages from repeated trials, plots data as line graphs where appropriate and makes conclusions which both summarise and explain the patterns in the data.
5. Makes conclusions which are consistent with the data and explains the patterns in the data in terms of scientific knowledge

Evaluating

4. Makes general suggestions for improving the data
5. Suggests aspecific changes that would improve the techniques used or the design of the investigation.

Earth and Beyond

4. Understands processes that can explain and predict interactions and changes in physical systems and environments
4. Understands models and concepts that explain earth and space systems and that resource use is related to the geological and environmental history of the earth and universe.

Energy and Change

4. Understands that energy interacts differently with different substances and this can affect the use and transfer of energy
5. Understand models and concepts used to explain the transfer of energy in an energy equation.



Rubric Appendix 2



Need “rubric questions” and suggested answers to different levels.

Questions

QUESTION	POSSIBLE ANSWERS	LEVEL
Magnetic force Make a conclusion from your graph	<ul style="list-style-type: none"> As the spacing changes the force changes 	2
	<ul style="list-style-type: none"> As the spacing increases then the magnetic force decreases 	3
	<ul style="list-style-type: none"> The relationship between the spacing and magnetic force is not linear. 	4
Magnetic pendulum Discuss where the motion energy has gone to.	<ul style="list-style-type: none"> The energy has been lost 	2
	<ul style="list-style-type: none"> It has been changed into a different form of energy 	3
	<ul style="list-style-type: none"> Because the plate became warm, I suspect the motion energy has been changed into heat energy 	4
Magnetic Skateboard [a] Make a conclusion that relates journey time and slope	<ul style="list-style-type: none"> the slope changes the "journey time" 	2
	<ul style="list-style-type: none"> as the slope increases then the 'journey time' decreases 	3
[b] Why does it behave differently on copper as opposed to plywood.	<ul style="list-style-type: none"> .Copper is smoother/ harder/more shiny than plywood 	2
	<ul style="list-style-type: none"> Copper is a metal and plywood is not and because they have different features. 	3
	<ul style="list-style-type: none"> The reason that the copper behaves differently is that induction currents can only be produced in a metallic conductor as copper is. 	5
Eddy currents in long copper pipe Why does the magnet travel so slowly down the pipe	<ul style="list-style-type: none"> There is a force stopping it 	2
	<ul style="list-style-type: none"> There must be an equal or nearly equal force acting in the opposite direction 	4
	<ul style="list-style-type: none"> The opposing force is due to due to magnetic repulsion. 	4
Magnetic Balance poles	<ul style="list-style-type: none"> 	

General notes on 'levelling''

Level	Descriptors
2	Describes a number of features but does not relate them
3	Describes patterns and makes generalisations from concrete experience
4	Describes non observable properties or events
5	Explains in terms of a concept .



Rubric
Appendix 3 - Links to Investigating Scientifically

Planning

	<i>LEVEL</i>	<i>POINTERS</i>	<i>DEMONSTRATED</i>
IS 3.1	The student plans for investigations, showing some awareness of the need for fair testing; and makes simple predictions (not guesses) based on personal experience.		
IS 4.1	The student identifies the variables to be changed, the variable to be measured and at least one variable to be controlled or, in a descriptive study, plans for the type of observations that need to be made.		
IS 5.1	The student analyses problems, formulates a question or hypothesis for testing, and plans an experiment in which several variables are controlled.		

Conducting

‘Students conduct and collect a variety of information relevant to their investigations.’

	<i>LEVEL</i>	<i>POINTERS</i>	<i>DEMONSTRATED</i>
IS 3.2	The student uses simple equipment in a consistent manner; and records data in simple tables, diagrams or observations.		
IS 4.2	The student takes care with data collection so that data are accurate; uses repeated trials or replicates; and uses independent variables that are usually continuous.		
IS 5.2			

Processing data

‘Students translate and analyse information to find patterns and draw conclusions to extend their understanding.’

<i>LEVEL</i>		<i>POINTERS</i>	<i>DEMONSTRATED</i>
IS 3.3	The student displays numerical data as tables or bar graphs, and identifies patterns in data and summarises the data.	•	
IS 4.3	The student calculates averages from repeated trials or replicates; plots data as line graphs where appropriate; and makes conclusions that summarise and explain patterns in the data.	•	
IS 5.3	The student makes conclusions that are consistent with the data and explains patterns in the data in terms of scientific knowledge.	•	

Evaluating

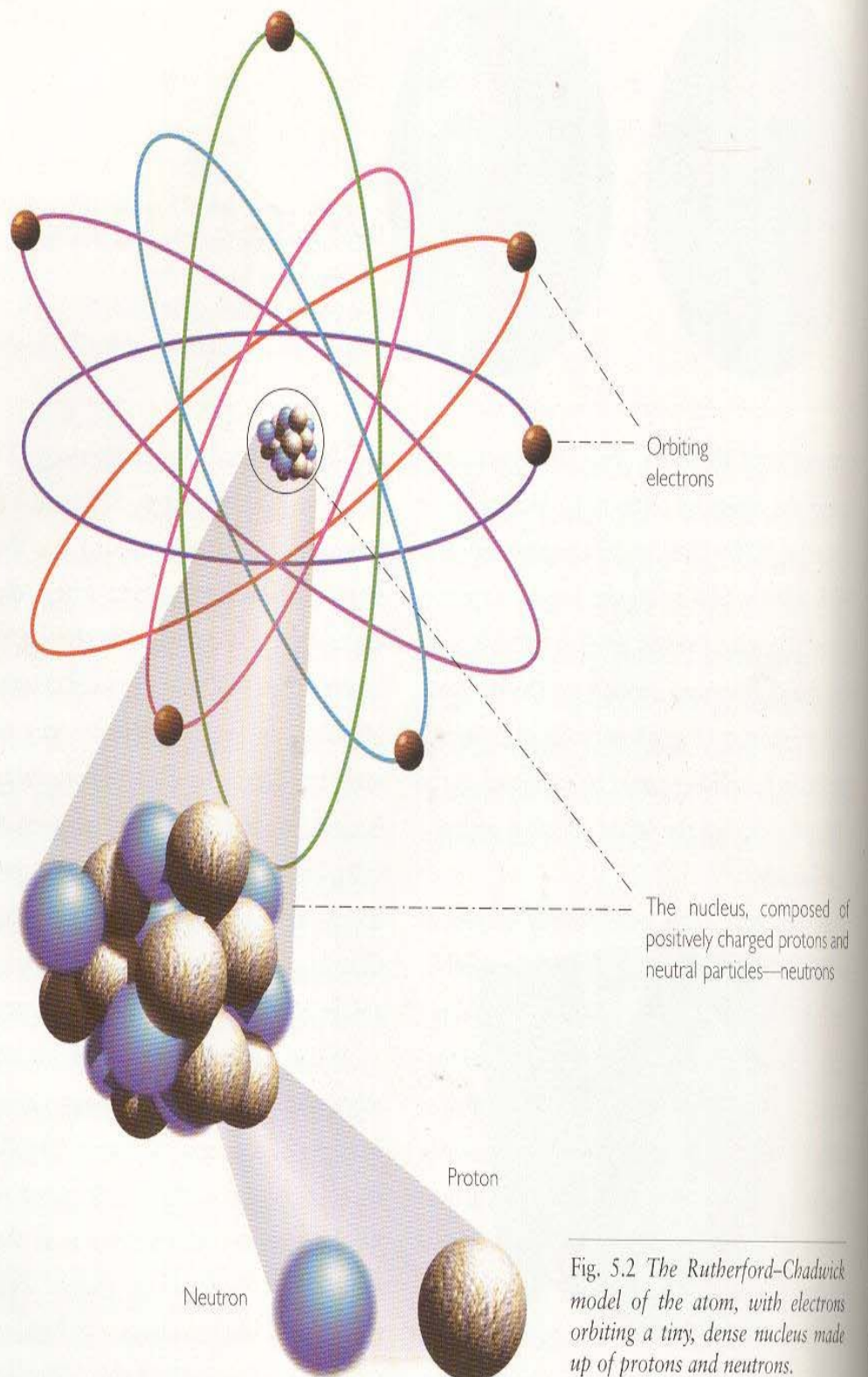
‘Students reflect on an investigation, evaluate the process and generate further ideas.’

<i>LEVEL</i>		<i>POINTER/S</i>	<i>DEMONSTRATED</i>
IS 2.4	The student comments on what happened and can say whether what happened was expected.	•	
IS 3.4	The student identifies difficulties experienced in doing the investigation.	•	
IS 4.4	The student makes general suggestions for improving the investigation.	•	
IS 5.4	The student suggests specific changes that would improve the techniques used or the design of the investigation.	•	
IS 6.4	The student recognises inconsistencies in the data, identifies the main sources of error and suggests improvements that would reduce the source of error.	•	

This sheet could be reproduced and provided to your students before they conduct the activity, or used by you to assess their performance, once the activity has been completed



THE ILLUSTRATED A BRIEF HISTORY OF TIME



Orbiting electrons

The nucleus, composed of positively charged protons and neutral particles—neutrons

Proton

Neutron

Fig. 5.2 *The Rutherford-Chadwick model of the atom, with electrons orbiting a tiny, dense nucleus made up of protons and neutrons.*