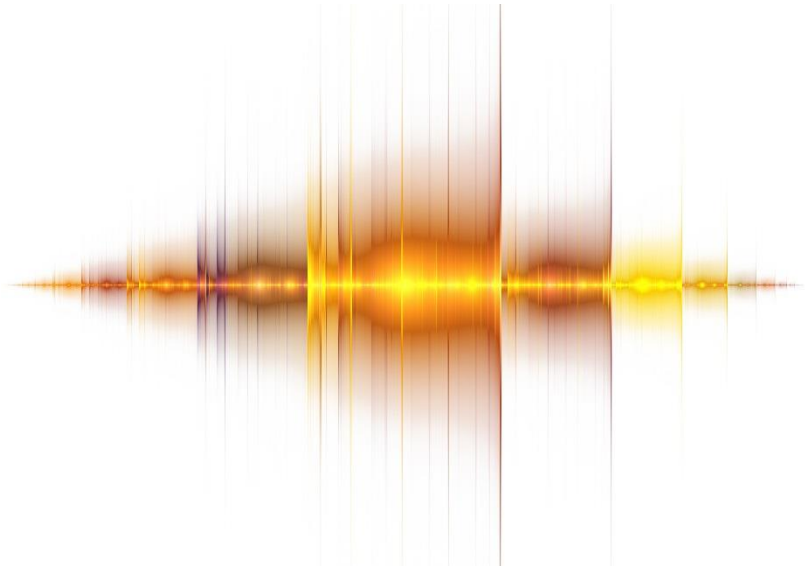
Cambridge Assessment International Education

Teaching Pack

How to make an electromagnet

Cambridge O Level

Physics 5054



Version 2.0

Cambridge Pathway

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We invite you to complete our survey by visiting the website below. Your comments on the quality and relevance of our resources are very important to us.

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 **Briefing lesson**

 **Lab lesson: Option 1 – run the experiment**

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 **Debriefing lesson**

Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)	
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.	
Lab lesson (1 hour*)	
Option 1: run the experiment	**Option 2: virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.
Debriefing lesson (1 hour*)	
This lesson consolidates and builds on the progress learners have made. In some cases, it will also provide the opportunity to practise extended writing skills.	

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this *Teaching Pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: How to make an electromagnet

This *Teaching Pack* focuses on an investigation to measure the strength of an electromagnet.

An electromagnet is a coil of conducting material wound around a magnetically soft material. In this experiment, your learners will construct a simple electromagnet and investigate the factors affecting its strength.

This experiment has links to the following syllabus content (see syllabus for detail):

- 17.1 Laws of magnetism
- 17.2 Magnetic properties of matter
- 17.3 Electromagnetism
- 23.1 Principles of electromagnetic induction

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations** (see syllabus for assessment objectives):

- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- demonstrate knowledge of how to safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate).

Prior knowledge

Knowledge from the following syllabus topics is useful for this experiment.

- 3.1 Balanced and unbalanced forces
- 8.2 Energy forms
- 17.1 Laws of magnetism

Going forward

The knowledge and skills gained from this experiment could be useful for when you teach a.c. generation, transformers, the magnetic effect of a current and d.c. motors.

Briefing lesson: Planning an investigation

Resources	• A selection of magnets of different strengths (it does not matter if you do not have these). • Worksheets A and B • Suggested answers for Worksheet B
Learning objectives	By the end of the lesson: • ***all*** learners should understand that an electric current in a conductor produces a magnetic field around it • ***most*** learners should be able to plan an experiment to investigate the strength of an electromagnet • ***some*** learners should be able to evaluate their plan and suggest feedback to another learner.

Timings	Activity
5 min	**Starter/Introduction** If you have some examples, show your learners a selection of magnets of different sizes and strengths. If not, this can just be done as a discussion. Ask your learners what they could do to rank the magnets in order of decreasing strength. Allow some thinking time for about a minute. Learners can then share their ideas.
10 min 20 min 15 min	**Main lesson** Remind your learners that when a current is applied to a wire, a magnetic field is induced. Ask them to complete Worksheet A by filling in the plotting compasses to show the direction of the induced magnetic fields in each case. Give your learners Worksheet B. They should use this to consider the variables they might alter to test the strength of an electromagnet under different conditions. They will need to answer some initial questions about induced magnetic fields and electromagnets in order to build up some background information. Give them the suggested answers to Worksheet B and ask them to swap their plans with a partner. Using the suggested answers, they should provide feedback about how their partner could improve their plan. When they get their work back they should read and act upon the feedback by adding to, or improving their work.
10 min	**Plenary** Ask your learners to write a list of FAQs about electromagnets that they would put on an online learning platform. Collect their suggestions as a whole-class activity. Conclude by highlighting the questions you want them to be able to answer by the end of the lab lesson.

Lab lesson: Option 1 – run the experiment

Resources	• Equipment as outlined in Teacher notes • Worksheets C, D and E
Learning objectives	By the end of the lesson: • ***all*** learners should understand the how the electric current in a conductor produces a magnetic field around it • ***most*** learners should be able to identify that the current and number of turns in the solenoid conductor affect the strength of an electromagnet • ***some*** learners will be able to make a quantitative prediction for the strength of an electromagnet, linked to current and number of turns.

Timings	Activity
5 min	**Starter/Introduction** Ask your learners to suggest the advantages of using magnets. They can then move on to consider the advantages of using electromagnets.
5 min	**Main lesson** Show your learners the equipment available to them. Ask them to make some qualitative, and if possible quantitative predictions about what they would expect to see in this experiment.
30 min	Your learners will need to work in small groups. They can use the ideas they developed last lesson to complete their investigation. They can also use Worksheet C which gives them a method they can follow. They can record their results using Worksheet D. **Safety** Circulate the classroom at all times during the experiment so that you can make sure that your learners are safe and that the data they are collecting is accurate. Make sure your learners are aware that the solenoids can become hot. They should turn off the power supply between readings.
15 min	Once your learners have completed their practical work, they can plot graphs to show the relationship between the variables they altered and the strength of the electromagnet. Graph outlines are available on Worksheet E if learners need them.
5 min	**Plenary** Last lesson your learners generated a series of FAQs. Can they now answer all of them? Would they add any different ones based on their experience of the experiment?

Teacher notes

Watch the teacher walkthrough video and read these notes.

Each group will require:

- a power pack with variable current
- insulated wire, about 200 cm
- wire cutters and wire strippers
- a large iron nail or iron core (about 15cm)
- crocodile clips
- connecting leads
- a large supply of magnetic paper clips.

Safety

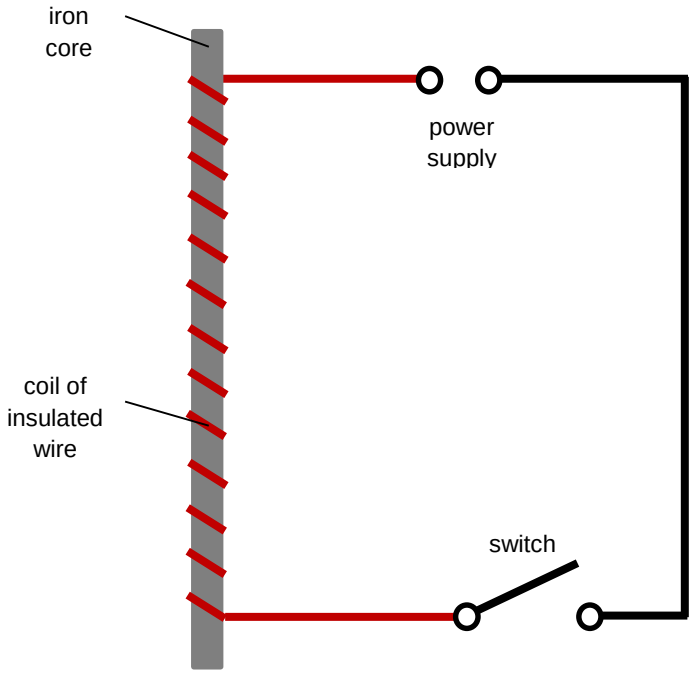
The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
—	Electrocution	**If casualty is in contact with live electricity supply:** break contact by switching off or removing the plug. If this is not possible, use a wooden broom handle or wear rubber gloves to pull the casualty clear. See a doctor. If the casualty is unconscious, check that airways are clear and that the casualty is breathing and has a pulse. If so, place the casualty in the 'recovery position'. If a pulse is found but the casualty is not breathing, artificial ventilation is necessary. If no pulse is found and the casualty is not breathing, cardio-pulmonary resuscitation is necessary.
—	Burns	Flood burnt area with water for at least 10 minutes. For serious injuries see a doctor.

Experiment set-up

Your learners should set up the equipment as shown below. They will need to do some preliminary tests to work out the current and number of turns of wire needed to make the electromagnet pick up an initial number of paper clips.



Teacher method

This is your version of the method for this experiment that accompanies the *Teacher walkthrough* video.

Do not share this method with learners. Give them Worksheet C.

Before you begin

Plan how you will group your learners during the experiment.

Think about:

- the number of groups you will need (group size 2–4 learners)
- the amount of equipment required.

Experiment

Circulate during the experiment in case learners encounter any difficulties.

Steps	Notes
1. Learners should set up the equipment as shown.	
2. They will need to set the power pack to a low current setting and test the magnet with different numbers of turns of wire until it begins to pick up paper clips.	*Starting with 0.5 A is a good point to begin. Learners must keep count of the number of turns. They can try 50 to begin with and then add 10 at a time until their electromagnet works.*
3. Now they have a baseline they can run a series of tests where they increase the current and test the strength of the magnet each time.	*Ensure that learners do not increase the current too much. Set a limit for this.*
4. They should return the current setting to its start position.	
5. Having completed the tests where current is altered, learners can now go onto altering the number of turns of wire.	*Encourage your learners to increase the number of turns in set amounts, e.g. 50 or 20 at a time.*
6. As they increase the turns they should record their results in the table on Worksheet D.	

Clear-up

After the experiment learners should:

- switch off all equipment and return it to the front of the class
- tidy up their work space

Lab lesson: Option 2 – virtual experiment

Resources	• Virtual experiment video • Worksheets E, F and G
Learning objectives	By the end of the lesson: • ***all*** learners should understand how an electric current in a conductor produces a magnetic field around it • ***most*** learners should be able to identify that the current and number of turns in the solenoid conductor affect the strength of an electromagnet • ***some*** learners will be able to make a quantitative prediction for the strength of an electromagnet, linked to current and number of turns.

Timings	Activity
5 min	**Starter/Introduction** Ask your learners to suggest the advantages of using magnets. They can then move on to consider the advantages of using electromagnets.
5 min	**Main lesson** Use Worksheet F to show your learners the equipment for the experiment. Ask them to make some qualitative and if possible quantitative predictions about what they would expect to see in this experiment.
20 min	Your learners now need to watch the virtual experiment video. They should complete Worksheet G as the video plays. It will automatically stop and prompt them at the appropriate point.
10 min	Discuss the importance of identifying variables in any investigation and of keeping the control variable unchanged. Lead a discussion on why the current through the coils needs to be kept constant while the effect of different numbers of turns of the wire are investigated.
15 min	Once your learners have watched the video, they can plot graphs to show the relationship between the variables and the strength of the electromagnet. Graph outlines are available on Worksheet E if learners need them.
5 min	**Plenary** In the last lesson your learners generated a series of FAQs. Can they now answer all of them? Would they add any different ones based on their experience of the virtual experiment?

Debriefing lesson: Evaluating the experiment

Resources	• Data collected from the experiment • Worksheets H, I and J
Learning objectives	By the end of the lesson: • ***all*** learners should be able to summarise their findings • ***most*** learners will be able to review their work, improving it in line with the success criteria • ***some*** learners will be able to evaluate methods and suggest several possible improvements.

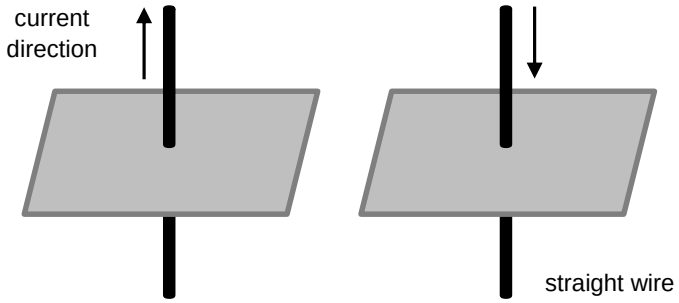
Timings	Activity
5 min 10 min	**Starter/Introduction** Ask learners to review their findings from the experiment. You may want them to share their work with other learners. Following this, ask pairs of learners to discuss what characterises a good science write-up. They are likely to suggest things like: explains processes, uses clear language, is concise, uses technical language, data is presented clearly. Show them Worksheet H which provides suggestions to help learners to write scientifically.
20 min 10 min 10 min	**Main lesson** Learners now need to write an interpretation and evaluation of the experiment. Worksheet H is available to help them plan their writing and identifies the key points learners need to include. It also shows learners the success criteria for the task. Before they begin, you may also want to share Worksheet I to help them focus on words and phrases that they can use to improve their extended writing. For weaker learners, there are sentence starter suggestions on Worksheet J. Now that learners have written up their interpretations and evaluation of the experiment, they are going to formatively assess their work. They should swap their writing with the person next to them. Using the success criteria, they should give each other feedback. There is a section on Worksheet H that has space for them to identify three things their partner has done well and one thing they need to improve. They can complete this, then cut it out and glue it in their partner's lab book, or simply write the feedback straight in. Learners should return the work to their partner. Each learner should read the feedback they have received. They need to act on this by rewriting a section of their work, including the improvements that their partner has suggested.
5 min	**Plenary** Ask learners to share the improvements they suggested in their evaluations. Ask them to critique each other's suggestions.

Worksheets and answers

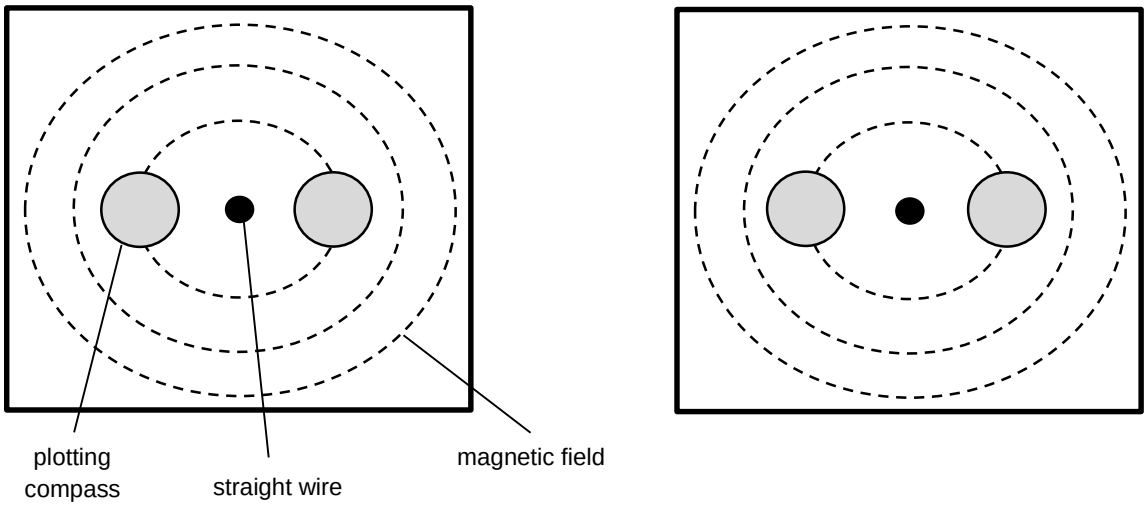
	Worksheets	Answers
For use in the *Briefing lesson*:		
A: Field line patterns	**14–15**	**29–30**
B: Planning an investigation	**16–17**	**31–32**
For use in *Lab lesson: Option 1*:		
C: Method	**18**	**—**
D: Data collection	**19**	**—**
E: Graphs	**20–21**	**—**
For use in *Lab lesson: Option 2*:		
E: Graphs	**20–21**	**33–34**
F: Available equipment	**22**	**—**
G: Virtual experiment	**23–24**	**35–36**
For use in the *Debriefing lesson*:		
H: Interpretation and evaluation	**25–26**	**—**
I: Using connectives	**27**	**—**
J: Sentence starters	**28**	**—**

Worksheet A: Field line patterns

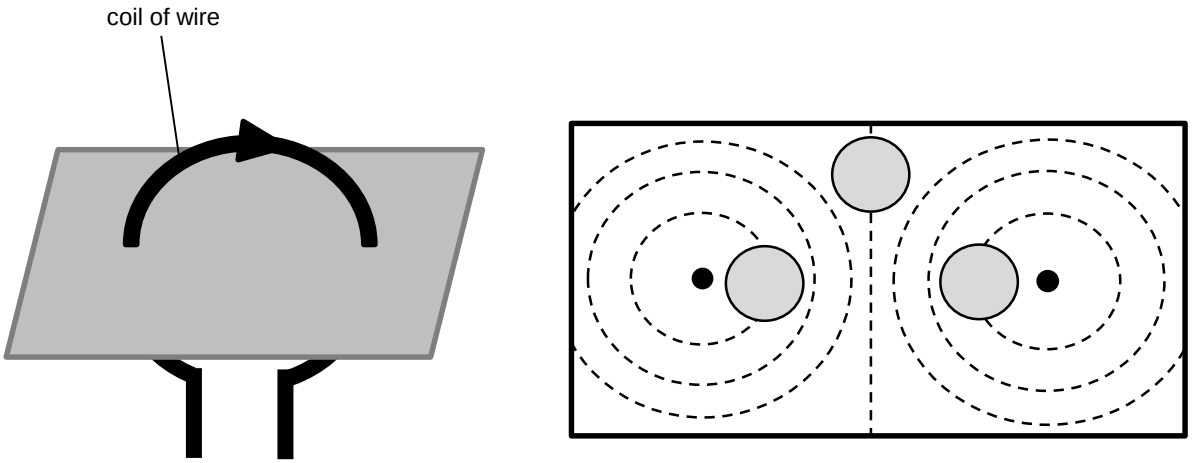
The diagrams below show two straight wires with current passing through them in opposite directions.



The diagrams below show the same wires, but viewed from above. Fill in the empty plotting compasses to show the direction of the induced magnetic fields.

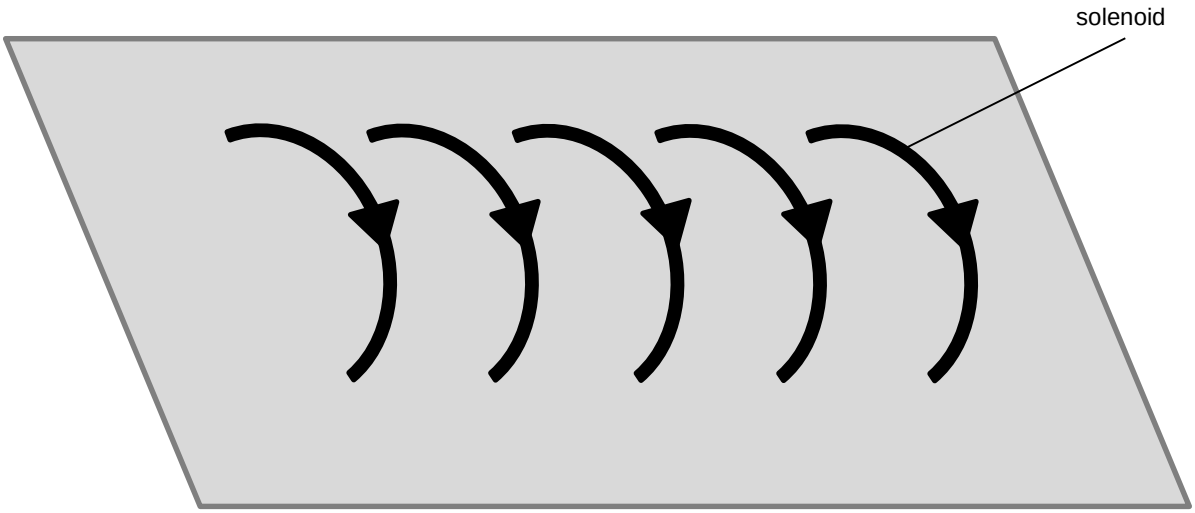


Now do the same for a flat circular coil.

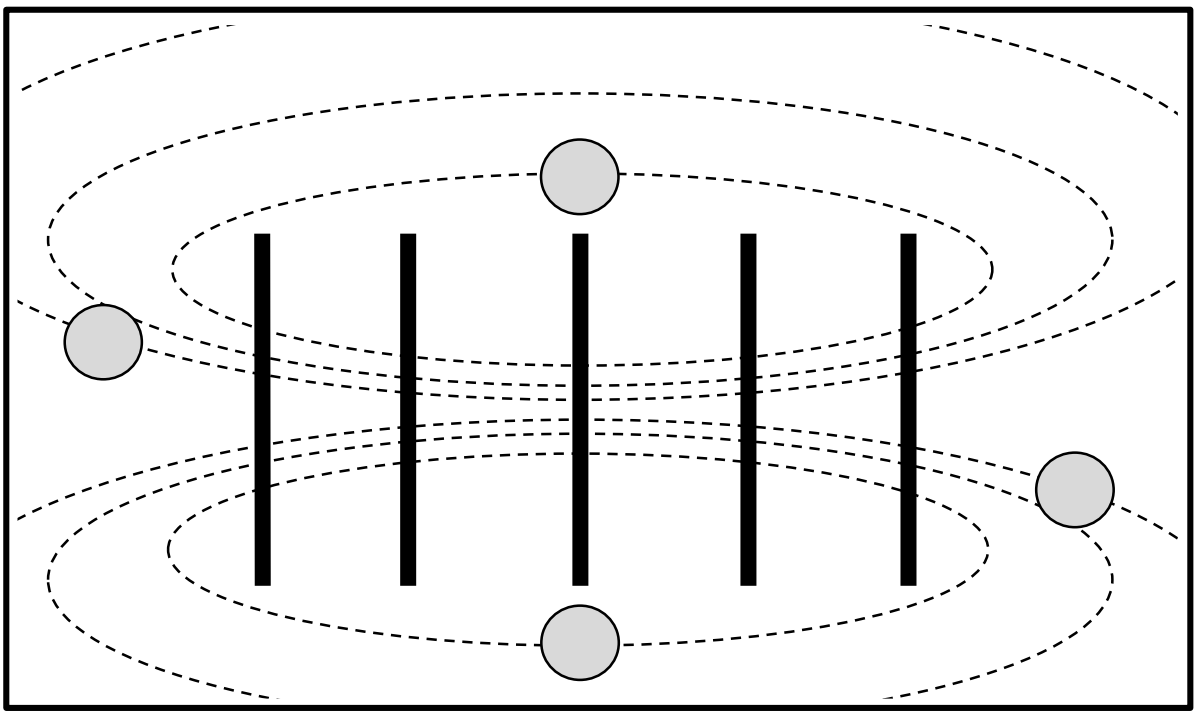


Worksheet A: Field line patterns

The diagram below shows a spiral of wire with a current flowing through it. This arrangement is called a solenoid.



Fill in the empty plotting compasses in the view below to show the directions in the induced magnetic field.



Worksheet B: Planning an investigation

Background information

Answer the questions below to build up some background information about electromagnets.

1. When an electric current flows in a wire, it creates a magnetic field. What three things can you do to make the magnetic field stronger?

   ……

   ……

   ……

2. What name do we give to a spiral of wire that produces a magnetic field?

   ……

   ……

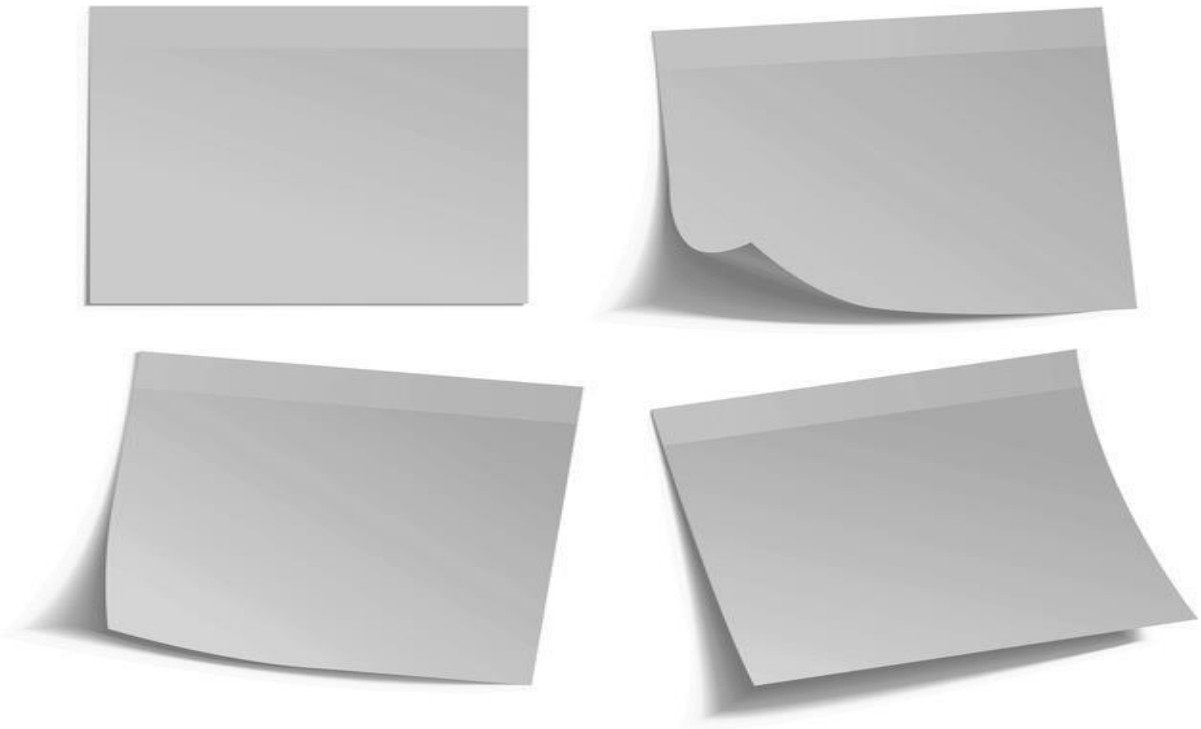
3. The magnetic field around an electromagnet is the same as the magnetic field around a permanent magnet. Give two ways an electromagnet is different from a permanent magnet.

   ……

   ……

Variables

Use the blank sticky notes below to record the variables you could change in order to investigate the strength of an electromagnet.



Worksheet B: Planning an investigation

Measuring variables

In the table below, record how you would measure the results of changing the variables.

Variable	Instrument to use

Final plan

Use the space below to record an example of the variables you would change in the experiment. You need to explain how you would do this and in what intervals.

I will change (independent variable)

- .....
- .....
- .....

I will measure and observe (dependent variable)

- .....
- .....
- .....

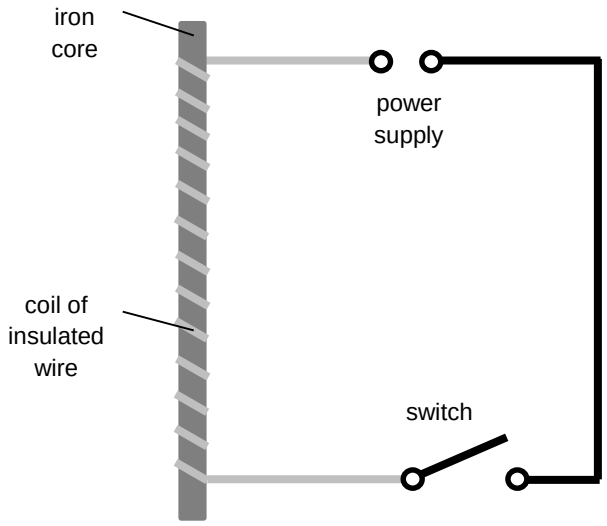
I will keep the same (control variable)

- .....
- .....
- .....

Worksheet C: Method

Set up your equipment as shown in the diagram below

You may want to start with 50 turns of wire around the iron core.



Set the power supply to 0.5A.

Switch on the power and test your electromagnet to see if it picks up any paper clips.

If the magnet does not work, add 10 more turns of wire.

Make sure you turn off the power supply before making any changes to your electromagnet.

Test your magnet again. If it does not work, add 10 more turns of wire at a time until it does.

Make sure you keep count of the number of turns of wire.

Once the magnet works, perform a series of tests where you increase the current at fixed intervals and count the number of paper clips the electromagnet collects each time.

Make sure you turn off the solenoid while you are counting and recording the number of paper clips collected.

Do not exceed the current limit set by your teacher.

Return the power supply to its original setting.

Now carry out a series of tests where you increase the number of turns of wire at fixed intervals and count the number of paper clips the electromagnet collects each time.

Make sure you turn off the solenoid while you are counting and recording the number of paper clips collected.

Worksheet D: Data collection

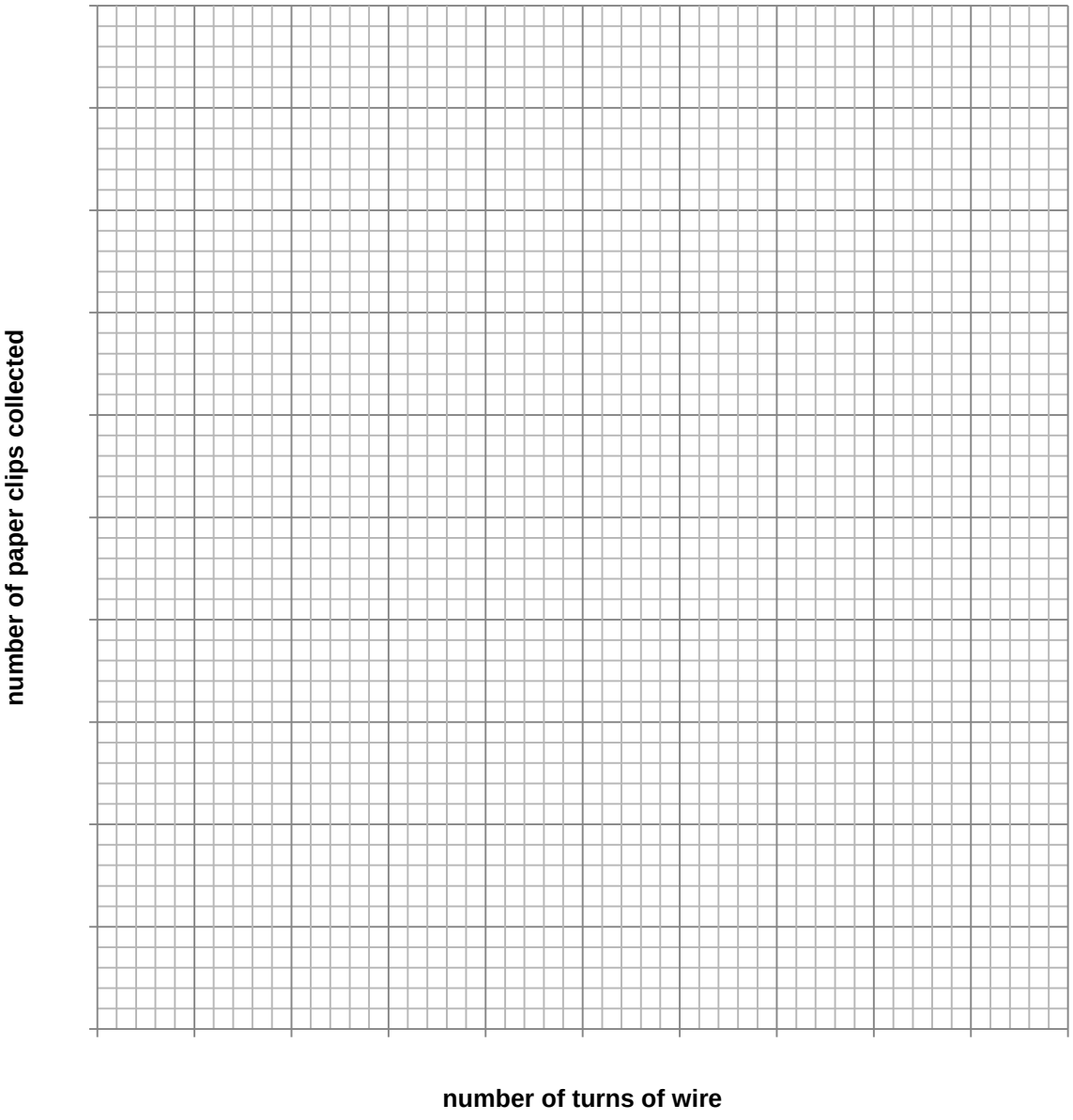
Use this table to collect the data from your experiments.

Current (A)	Number of turns of wire	Number of paper clips collected

Worksheet E: Graphs

Use the outline below to draw a graph of your data

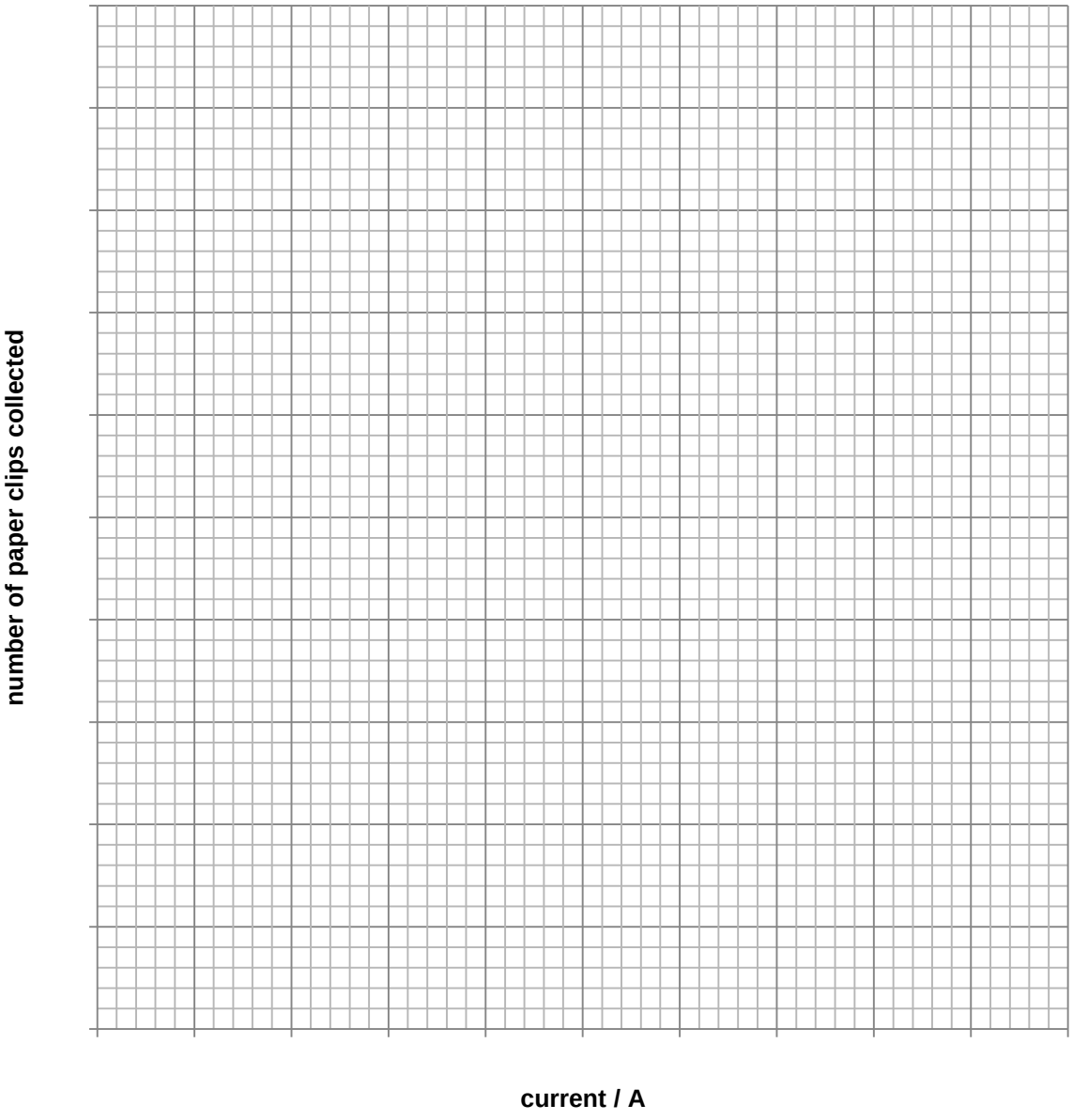
.....



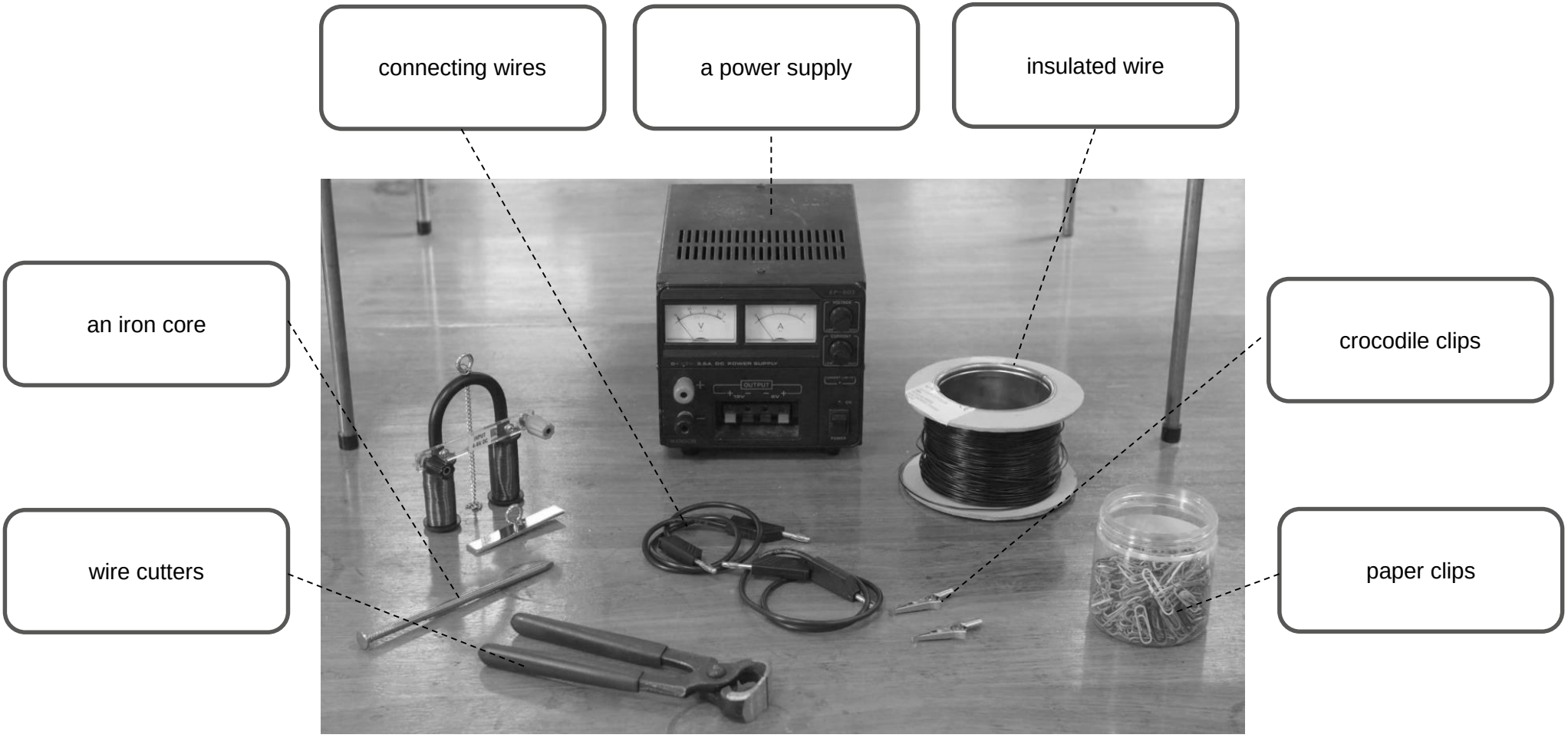
Worksheet E: Graphs

Use the outline below to draw a graph of your data

.....



Worksheet F: Available equipment



Worksheet G: Virtual experiment

Answer the questions.

1. What was the aim of this investigation?

……

2. Which statement best explains why the paper clips fall off when the current is removed?

    a) The power supply cannot establish a flow of magnetism to the coils anymore.
    b) The magnetic field is only observed around the coils if there is current passing through them.

3. What is the main function of the iron core inside the coil of wire?

……

……

……

……

4. How is the strength of the electromagnet measured in this investigation?

……

……

……

……

……

Worksheet G: Virtual experiment

5. Use the tables below to record the results of this experiment.

Current (A)	Number of turns of wire	Number of paper clips collected
	50	
	50	
	50	

Current (A)	Number of turns of wire	Number of paper clips collected
0.6		
0.6		
0.6		
0.6		

6. What is the link between the current and the strength of the electromagnet?

…….....

…….....

7. What is the link between the number of turns of wire around the iron core and the strength of the electromagnet?

…….....

…….....

8. Give two applications of electromagnets.

…….....

Worksheet H: Interpretation and evaluation

Use this worksheet to help you to write up your interpretation and evaluation of the experiment.

Interpretation

Use this section to explain each of the measurements you made. Make sure you support this with the data collected. You should refer to:

- the variables that were changed
- the control measures
- the effects of changing the different variables on the strength of the electromagnet.

Evaluation

Use this section to describe the strengths of the experiment and what you could do to make it better. You should refer to:

- what went well and the reasons for this
- what problems you experienced and why
- how you could solve the problems if you did the experiment again.

Writing check

1. Have you explained each of your deductions, supported by data collected?

2. Have you identified what worked well and where improvements were needed?

3. Have you used a range of linking words (e.g. *next, because*) to extend your writing?

Check it

Read your partner's work and look back at the success criteria.

Record **three** things they have done well and **one** thing they need to improve.

Cut along the broken line and give this feedback to your partner.

The three things you have done well are:

1. ……

……

2. ……

……

3. ……

……

To improve, you need to:

……

……

Worksheet H: Interpretation and evaluation

This worksheet shows some ideas and techniques you might want to use when writing up experiments.

Section	What to include
Plan	This section should explain the processes involved in your experiment. You might also need to explain a theory or concept linked to your experiment. • Begin with general statements to introduce the background, e.g. 'Solenoids are created by wrapping wire into a spiral and passing a current through it.' • Your vocabulary should be precise and you should use relevant technical words. • Your language should be impersonal. Do not use words like 'I' or 'we'.
Instructions or method	This section should have a sequence of steps that show how a task should be carried out. • State what you want to achieve, e.g. 'How to test the strength of an electromagnet'. • Make sure you explain (or draw) the equipment and materials needed. • Explain clearly what steps should be taken to achieve the goal, e.g. 'Wrap 50 turns of insulated wire tightly around the iron core'. • You should use imperatives like 'Turn on the power and use the electromagnet to pick up the paper clips'. Your instructions should be like a series of commands. • Use numbers or temporal connectives to show the stages involved. • Your language should be clear so that someone could repeat the experiment without mistakes.
Observations	This section should be made up of what you have been able to measure or observe. • Only record what can be seen or measured – do not make guesses about what the products of an experiment are without testing them. For example, if you see bubbles, that is all you can say (unless you have tested the gas produced). • Your observations need to be as accurate as possible. Make sure you record them using the correct units. You may need to repeat observations.
Interpretation	This is where you need to make sense of the observations you have collected and explain them using your scientific knowledge. • Support points made with evidence from your observations or measurements, e.g. 'The strength of the electromagnet increased as the current did. At 0.6 A the electromagnet only picked up one paper clip, but at 2 A it could pick up two.'
Evaluation	The evaluation is an opportunity to discuss both the strengths and weaknesses of an experiment. • Identify both the strengths and weaknesses of the experiment. • Avoid meaningless comments like 'It did not work very well'. Be specific and explain why the experiment did not work well and how you could improve it. • Use connectives to balance the strengths and weaknesses, e.g. 'although' or 'however', or to give evidence, e.g. 'This is because …' or 'This shows that'.

Worksheet I: Using connectives

Connectives help to develop your extended writing by allowing you to link ideas. This means that you can show how parts of the experiment link or how your observations might be supported by evidence.

In the table below, there are examples of connectives you could use in your writing.

Useful connectives and where you might use them	
These connectives help you to show how time progresses. They are very useful in the planning and instruction sections.	• next • after • first, second, third etc. • 20 minutes later • meanwhile
These connectives help you to show cause and effect. They are very useful in the interpretation and evaluation sections.	• because • so • since • therefore • as a result
These connectives help you to show links and connections. They are very useful in the interpretation and evaluation sections.	• therefore • this shows • because • in fact • for example • furthermore • in conclusion
These help you to make comparisons, or to show differences. They are very useful in the interpretation and evaluation sections.	• although • while • similarly • equally • unless • whereas
These connectives help you to include evidence in your writing. They are very useful in the interpretation section.	• this shows that • as can be seen • as suggested by

Worksheet J: Sentence starters

Below are sentence starters for each of the points that should be addressed when writing the interpretation and evaluation sections of experiment write-ups.

Interpretation

This section should include:

- the variables that were changed
- the control measures that were used
- the effects of changing the different variables on the strength of the electromagnet.

In this experiment the variables that were changed to investigate the strength of the electromagnet were …

It was found that as the current was increased the number of paper clips collected …

It was found that as the number of turns of wire was increased the number of paper clips collected …

The strength of the electromagnet changed because …

Evaluation

This section should include:

- what went well and the reasons for this
- what problems you experienced and why
- how you could solve the problems if you did the experiment again.

The method that worked particularly well was …

It worked well because …

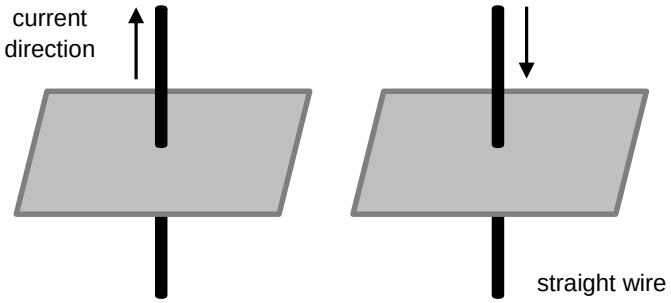
There was a problem with …

This problem affected the results by …

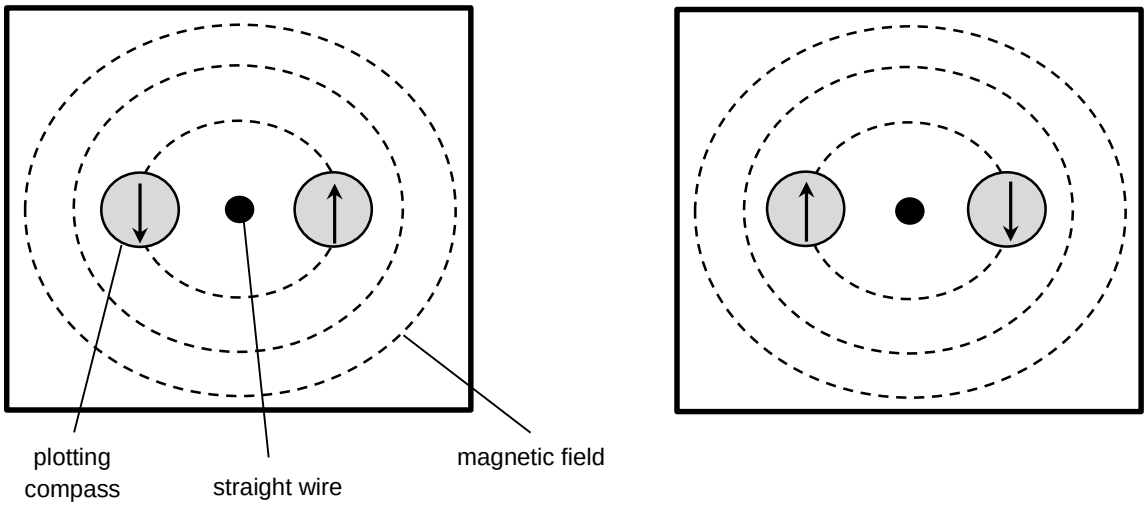
To improve the experiment …

Worksheet A: Answers

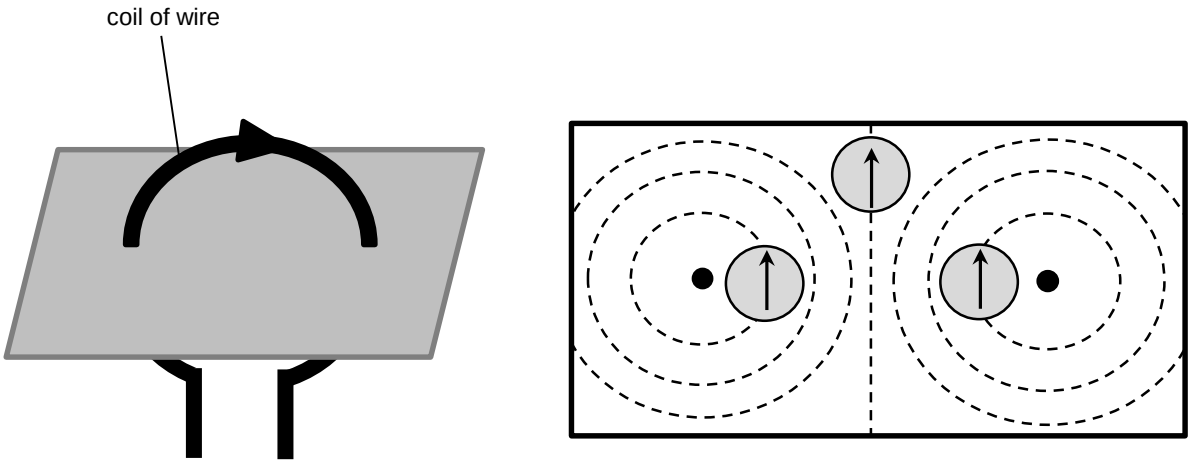
The diagrams below show two straight wires with current passing through them in opposite directions.



The diagrams below show the same wires, but viewed from above. Fill in the empty plotting compasses to show the direction of the induced magnetic fields.

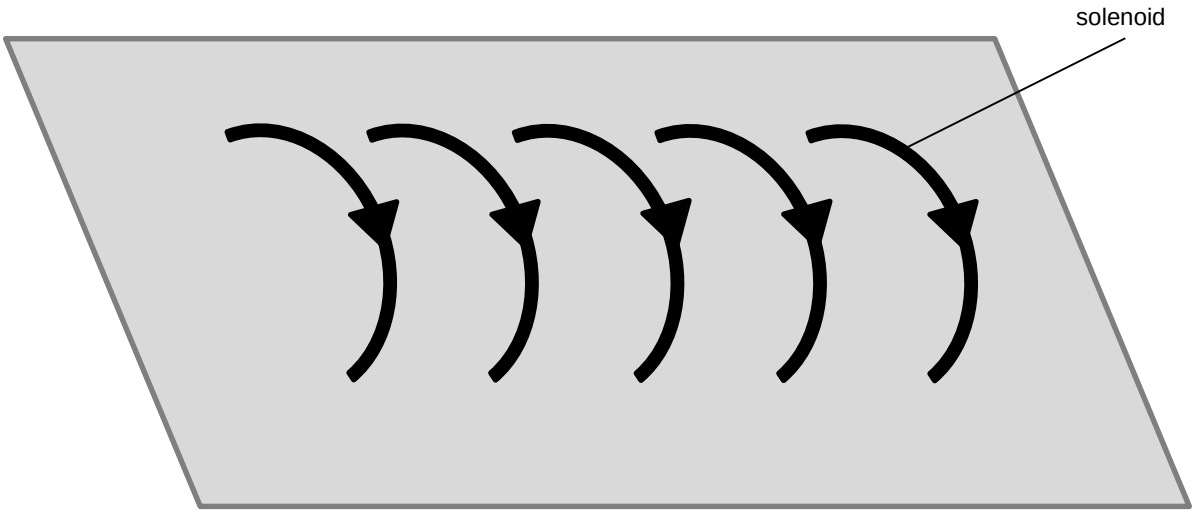


Now do the same for a flat circular coil.

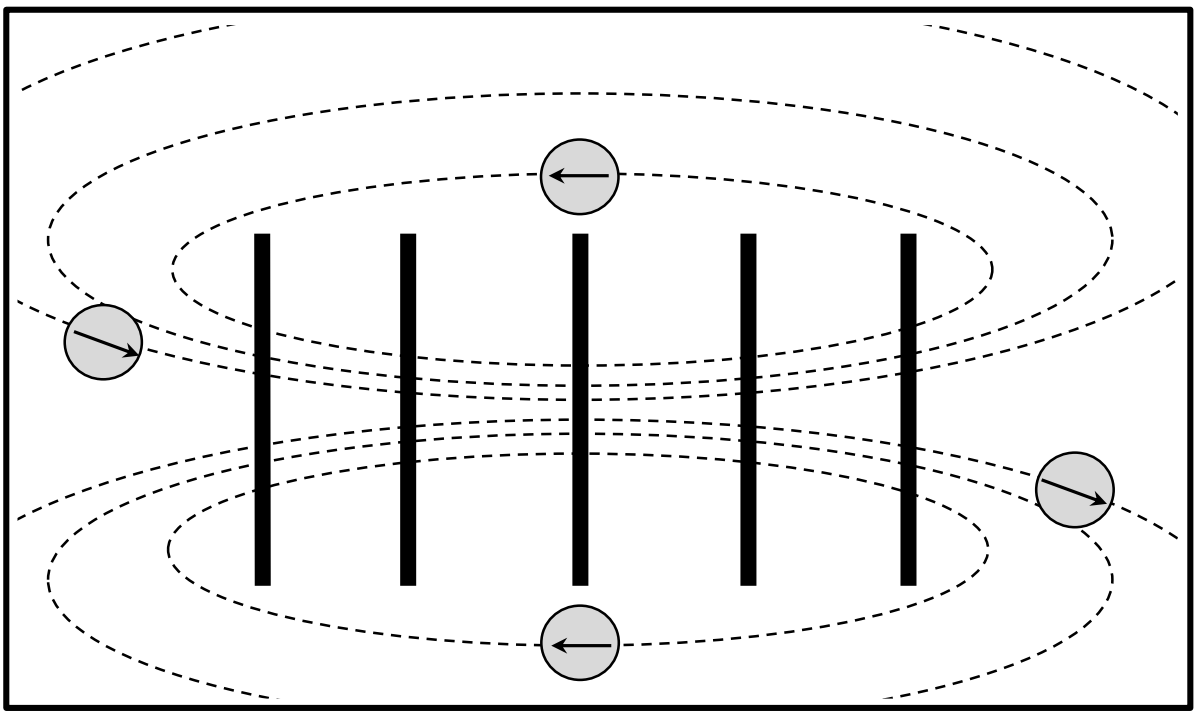


Worksheet A: Answers

The diagram below shows a spiral of wire with a current flowing through it. This arrangement is called a solenoid.



Fill in the empty plotting compasses in the view below to show the directions in the induced magnetic field.



Worksheet B: Answers

Background information

Answer the questions below to build up some background information about electromagnets.

1. When an electric current flows in a wire, it creates a magnetic field. What three things can you do to make the magnetic field stronger?

   Wrap the coil around an iron core

   Add more turns to the coil

   Increase the current flowing through the coil

2. What name do we give to a spiral of wire that produces a magnetic field?

   A solenoid

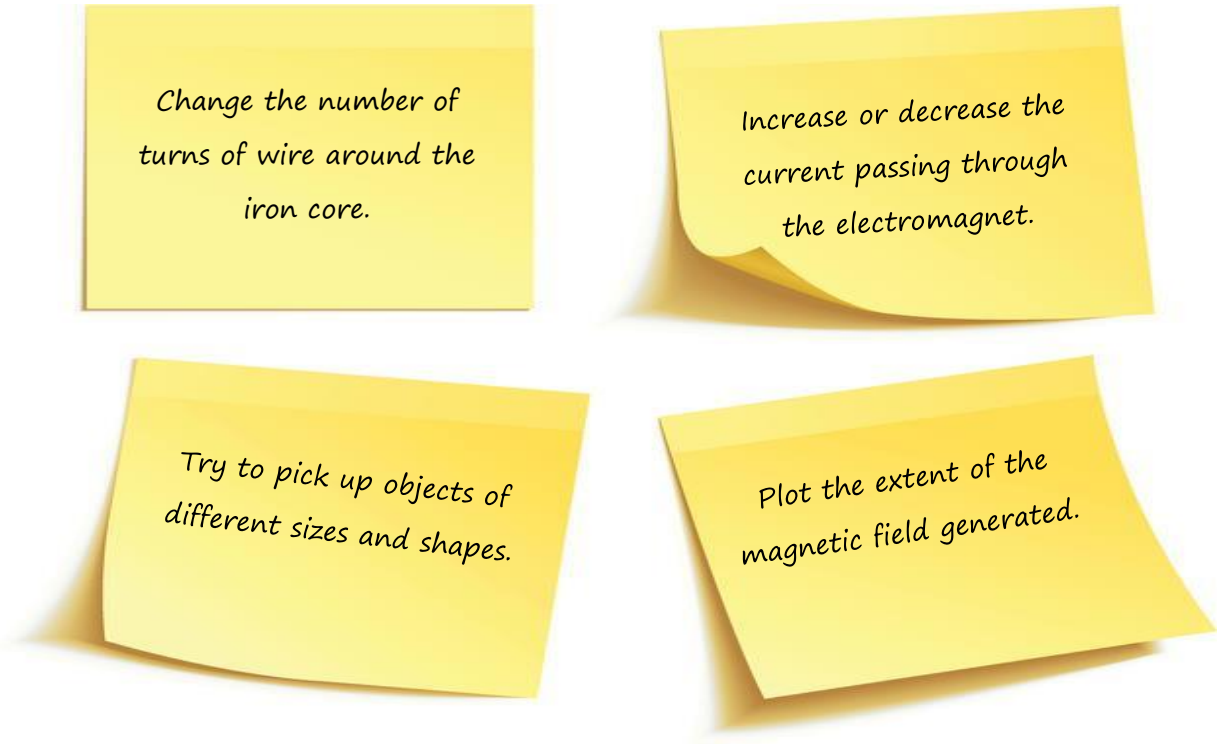
3. The magnetic field around an electromagnet is the same as the magnetic field around a permanent magnet. Give two ways an electromagnet is different from a permanent magnet.

   The magnetism from an electromagnet can be turned off by removing the current.

   The field around an electromagnet can be reversed by switching the polatiry of the power supply.

Variables

Use the blank sticky notes below to record the variables you could change in order to investigate the strength of an electromagnet. The answers below are suuggestions.



Worksheet B: Answers

Measuring variables

In the table below, record how you would measure the results of changing the variables.

Variable	Instrument to use
number of turns of wire	manual counting of material collected
current passing through the iron core	manual counting of material collected
different sized and shaped objects	observation of success/failure
extent of magnetic field	small plotting compasses

Final plan

Use the space below to record an example of the variables you would change in the experiment. You need to explain how you would do this and in what intervals.

I will change (independent variable)

- The number of turns of wire around the core.
- This will be done by adding 50 turns of wire at a time.
- Extra turns of wire should increase the strength of the induced magnetic field.

I will measure and observe (dependent variable)

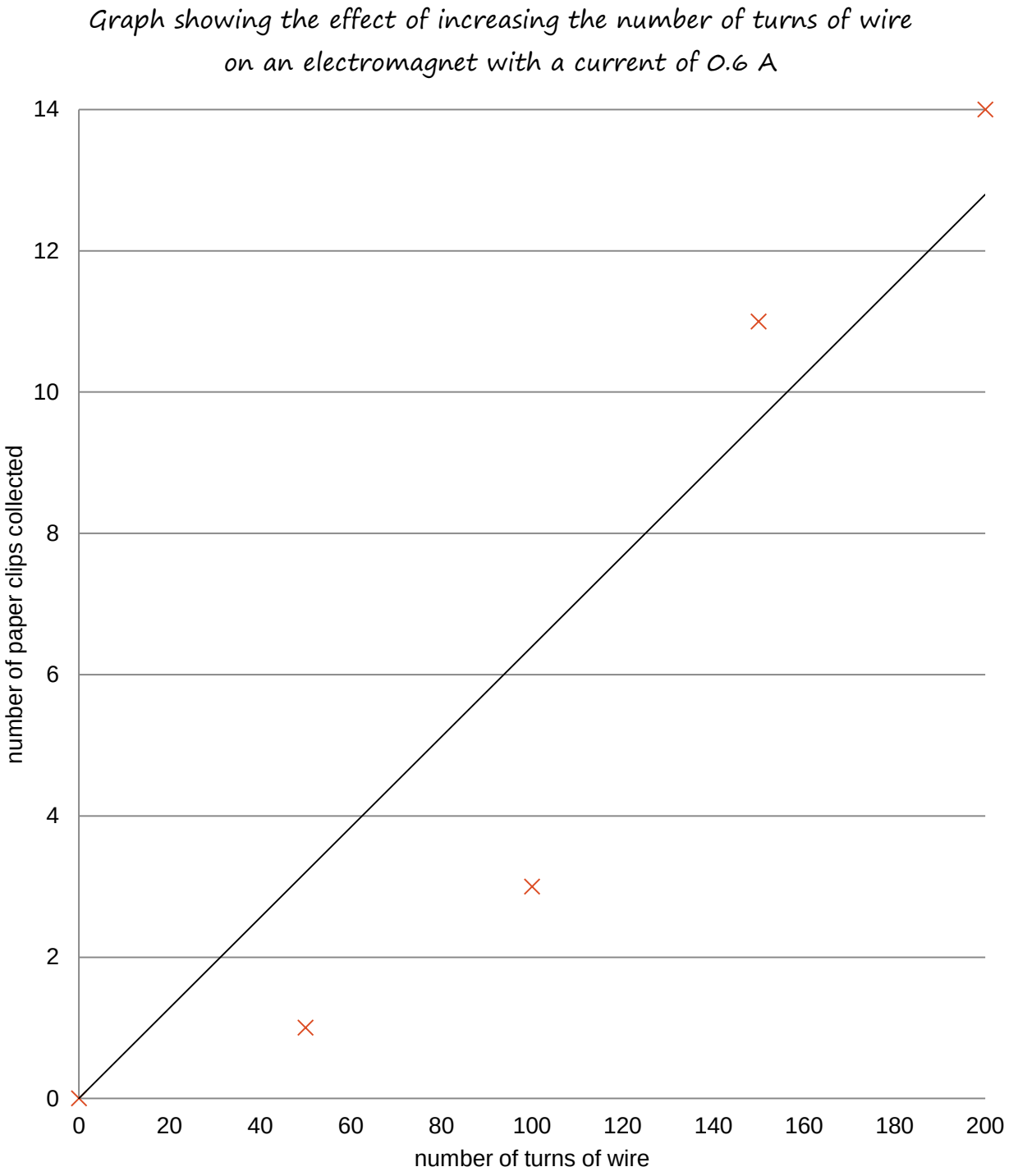
- The number of paper clips collected.
- The magnet will be tested after every extra 50 turns.
- This will provide evidence of the magnet strength changing.

I will keep the same (control variable)

- The current passing through the core.
- This means that any changes to the number of paper clips collected is due to the changing number of turns.

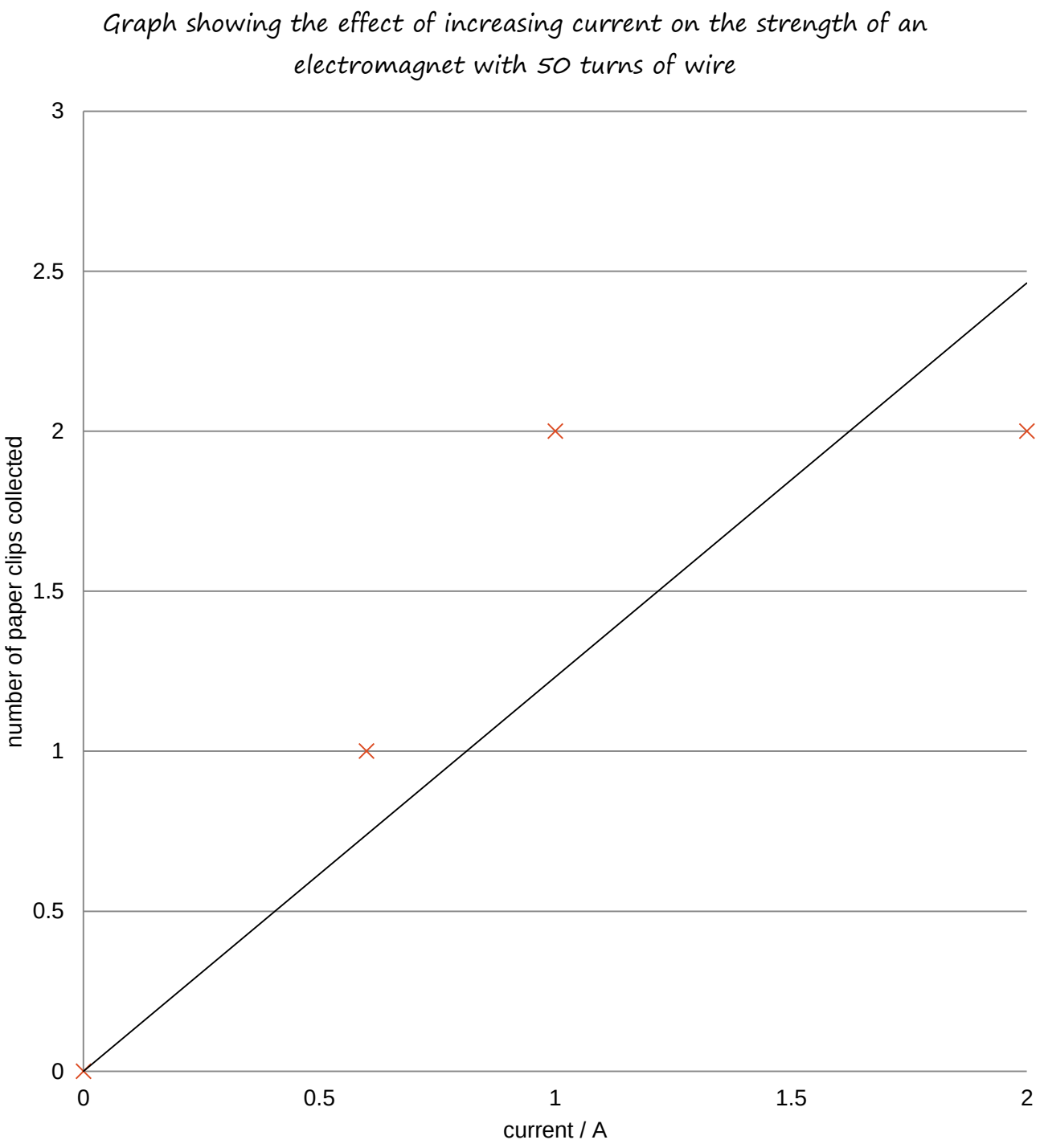
Worksheet E: Answers

Use the outline below to draw a graph of your data



Worksheet E: Answers

Use the outline below to draw a graph of your data



Worksheet G: Answers

Answer the questions.

1. What is the aim of this investigation?

To investigate the factors which alter the strength of an electromagnet

2. Which statement best explains why the paper clips fall off when the current is removed?

    b) The magnetic field is only observed around the coils if there is current passing through them.

3. What is the main function of the iron core inside the coil of wire?

To increase the magnetic force of the solenoid

To increase the strength of the magnetic field around the solenoid

4. How is the strength of the electromagnet measured in this investigation?

The strength of the electromagnet is tested by counting the number of paper clips that the magnet is able to collect each time a variable is altered.

Worksheet G: Answers

5. Use the tables below to record the results of this experiment.

Current (A)	The number of turns of wire	Number of paper clips collected
0.6	50	1
1	50	2
2	50	2

Current (A)	Number of turns of wire	Number of paper clips collected
0.6	50	1
0.6	100	3
0.6	150	11
0.6	200	14

6. What is the link between the current and the strength of the electromagnet?

As the current increases, the number of paper clips that are picked up increases.

7. What is the link between the number of turns of wire around the iron core and the strength of the electromagnet?

As the number of turns of wire increases, the number of paper clips that are picked up increases.

8. Give two applications of electromagnets.

Electric bells, loudspeakers, electromagnetic cranes, relays, electric motors, transformers

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