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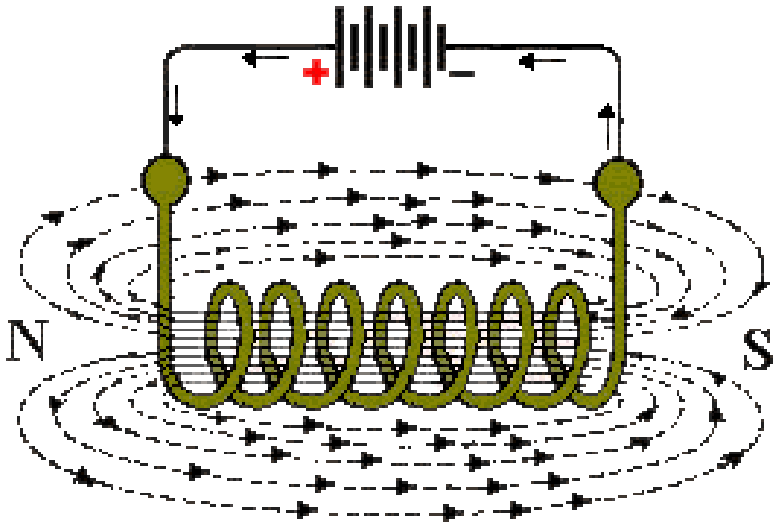
IGCSE Physics



Unit 7 – Magnetism

Name: .....

Class: ..... **Date:**.....

Summary

Topic	Objectives : Students will be assessed on their ability to
Magnets and Magnetic Fields	• understand that magnets repel and attract other magnets, and attract magnetic substances • describe the properties of magnetically hard and soft materials and understand that magnetism is induced in some materials when they are placed in a magnetic field • understand the term 'magnetic field line' • describe experiments to investigate the magnetic field pattern for a permanent bar magnet and that between two bar magnets • describe how to use two permanent magnets to produce a uniform magnetic field pattern
Electromagnetism	• understand that an electric current in a conductor produces a magnetic field around it • describe the construction of electromagnets • sketch and recognise magnetic field patterns for a straight wire, a flat circular coil and a solenoid when each is carrying a current
The Motor Effect	• understand that there is a force on a charged particle when it moves in a magnetic field as long as its motion is not parallel to the field • understand that a force is exerted on a current-carrying wire in a magnetic field, and, how this effect is applied in loudspeakers. • use the left hand rule to predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field
Applications of the Motor Effect	• understand that a force is exerted on a current-carrying wire in a magnetic field, and, how this effect is applied in simple d.c. electric motors and loudspeakers • understand that the force on a current-carrying conductor in a magnetic field increases with the strength of the field and with the current.
Electromagnetic Induction	• recall that a voltage is induced in a conductor or a coil when it moves through a magnetic field or when a magnetic field changes through it. • Recall the factors which may affect the size of the induced voltage
Applications of Induction	• Describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coild of wire within a magnetic field. • Describe the factors which may affect the size of the induced voltage
Transformers	• describe the structure of a transformer, and understand that a transformer changes the size of an alternating voltage by having different numbers of turns on the input and output sides. • know and use the relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer: $V_2/V_1 = N_2/N_1$
Electricity Transmission Lines	• know and be able to use the relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer: $V_2 / V_1 = N_2 / N_1$ • explain the use of step-up and step-down transformers in the large-scale generation and transmission of electrical energy. • know use the relationship input power = output power, for 100% efficiency: $V_1 \times I_1 = V_2 \times I_2$

1 – Magnets and Magnetic Fields

Objectives:

- understand that magnets repel and attract other magnets, and attract magnetic substances
- describe the properties of magnetically hard and soft materials and understand that magnetism is induced in some materials when they are placed in a magnetic field
- understand the term 'magnetic field line'
- describe experiments to investigate the magnetic field pattern for a permanent bar magnet and that between two bar magnets
- describe how to use two permanent magnets to produce a uniform magnetic field pattern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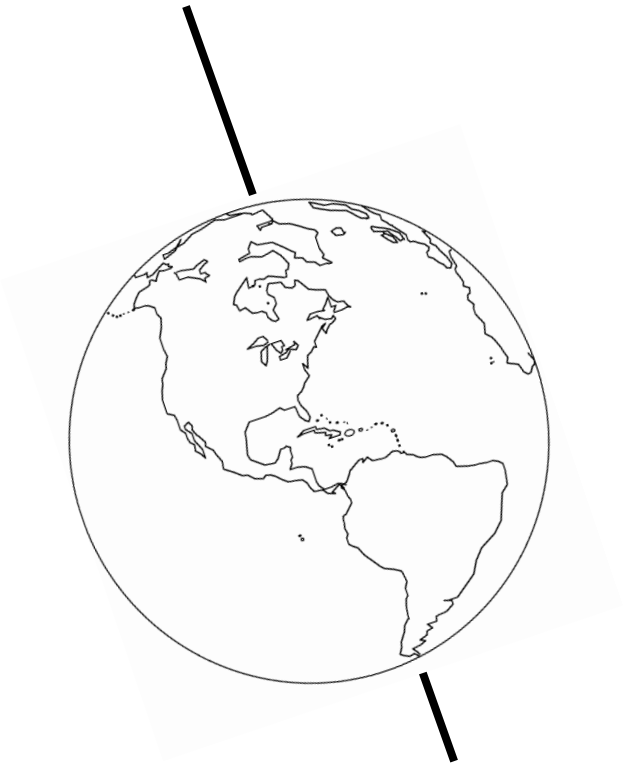
CW 7.1 - The Earth's Magnetic Field (Geomagnetism)

1) Draw and label a picture of the Earth's magnetic field. (2)



2) Based on your picture explain how a compass works and why it is useful. (2)

3) Which end of a compass needle would point toward the N pole of a bar magnet? (1)

4) We don't know where the Earth's Magnetic Field comes from. Its magnetic field is similar to that of a bar magnet,but the Earth is not a magnetized chunk of iron like a bar magnet. Why can't the magnetic field be explained using the concept of magnetic domains? (2)

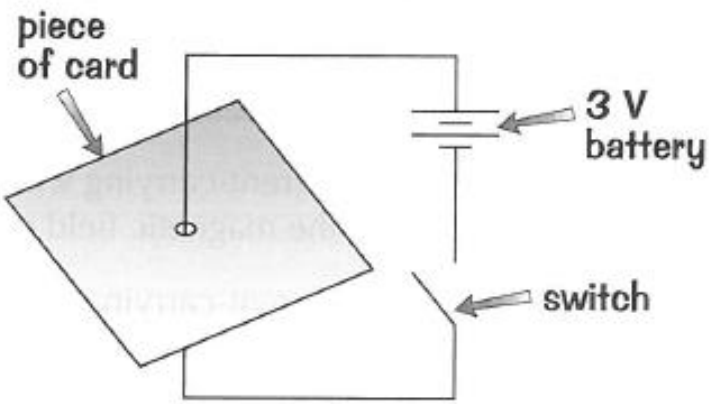
5) Describe some possible causes of the Earth's magnetic field. (2)

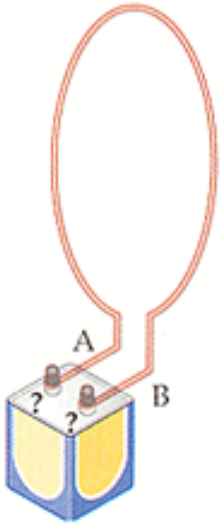
6) The Earth's magnetic field is not stable. Give some evidence of this. (2)

2 – Electromagnetism

Objectives:

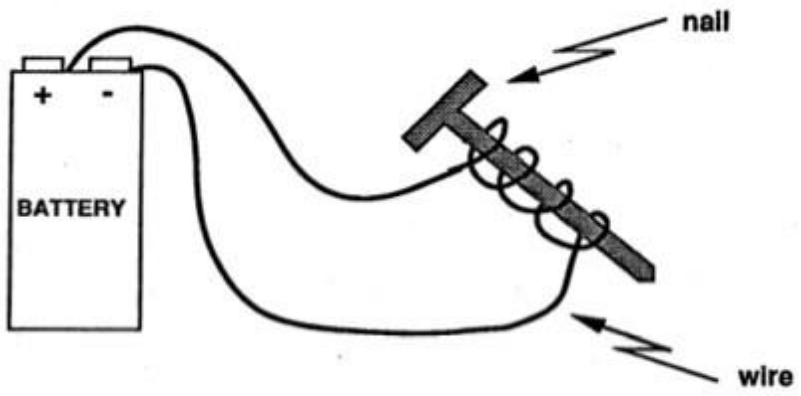
- understand that an electric current in a conductor produces a magnetic field around it
- describe the construction of electromagnets
- sketch and recognise magnetic field patterns for a straight wire, a flat circular coil and a solenoid when each is carrying a current




A
B
?
?

LAB 7.1 - Making an Electromagnet (LAPTOP)

Aim: To investigate what factors affect the strength of an electromagnet.



Prediction: State the **TWO** variables that you intend to investigate and explain what you think is likely to happen and why. (4)

Method: Write a detail set of instructions for your investigations. Make sure that you include how you kept the test fair and improved the reliability of the results. (4)

Data: Record the results in a suitable table and present using appropriate charts and graphs. (12)

Conclusion: What did you learn from this investigation? (4)

Evaluation: Could the investigation be improved upon? (4)

CW 7.2 – Magnets and Electromagnets

1. What is meant by the N-pole of a magnet? (1)

2. What is the difference between magnetized and magnetic materials (1)

3. Magnetic materials are described as being HARD or SOFT. What does this mean? (1)

4. Describe two methods of making a magnet. (2)

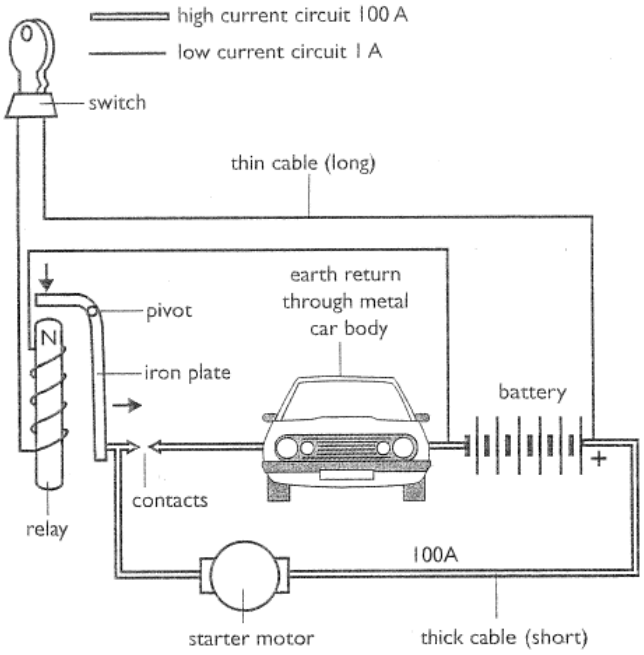
5. Describe two methods of destroying a magnet. (2)

6. How could you map a magnetic field? (use a diagram if required) (2)

7. How can you decide which end of an electromagnet is the N-pole? (1)

8. Electromagnets can work with both ac and dc electricity. Describe one of the differences between the two electromagnets. (1)

9. A relay is a switch that uses an electromagnet inside. They are useful as a small current can be used to operate a switch for a high current. Annotate the diagram to show how it works. (2)

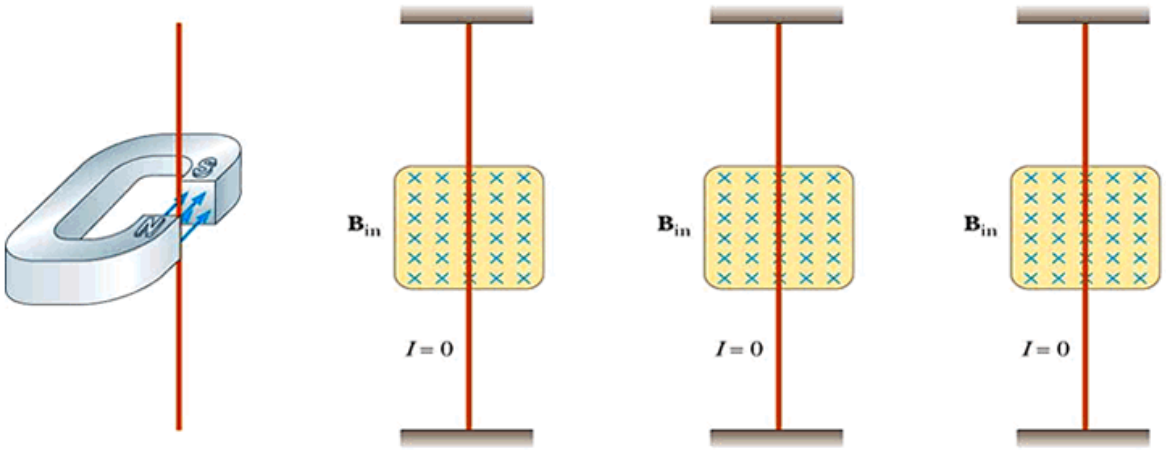


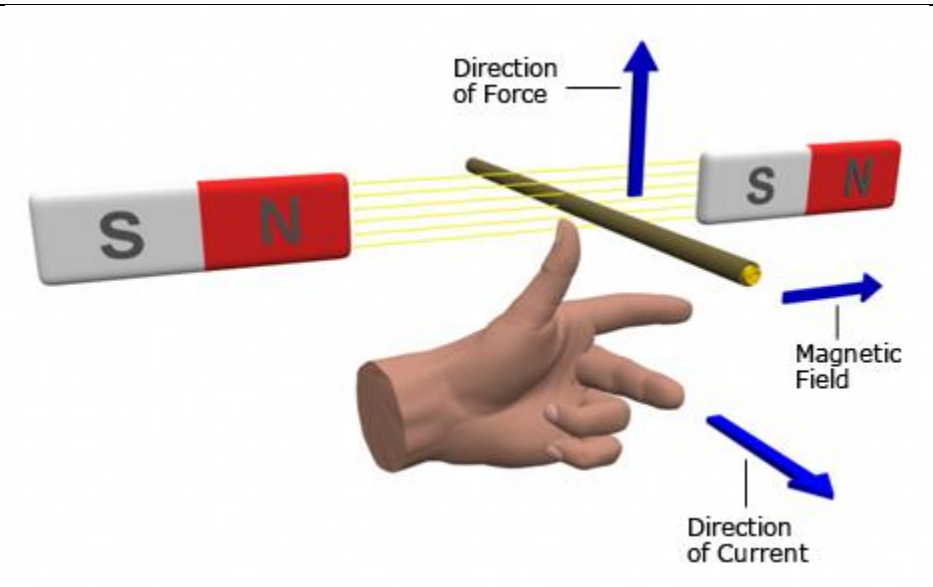
3 – The Motor Effect

Objectives:

- understand that there is a force on a charged particle when it moves in a magnetic field as long as its motion is not parallel to the field
- understand that a force is exerted on a current-carrying wire in a magnetic field, and, how this effect is applied in loudspeakers.
- use the left hand rule to predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field

Notes:





LEARN:

a) How to make this effect stronger!

b) how to determine the direction of the force.

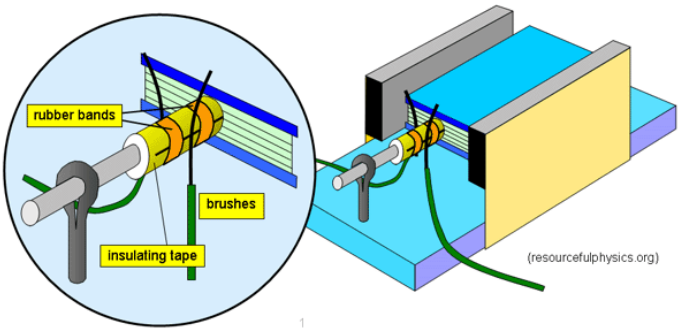
4 – Applications of the Motor Effect

Objectives:

- understand that a force is exerted on a current-carrying wire in a magnetic field, and, how this effect is applied in simple d.c. electric motors and loudspeakers
- understand that the force on a current-carrying conductor in a magnetic field increases with the strength of the field and with the current.

LAB 7.2 - Making a Motor

Aim: To make a simple dc motor



Note: the exposed wires at the end of the coil which connect with the brushes are the hardest part of this experiment. It is worth taking your time with this. Officially the bits of exposed wires are called the "commutator".

1. Which direction does the current flow around the coil when it is a) horizontal, b) vertical and c) flipped the other way around half-way through a complete revolution? Why is this important? (4)

2. What would happen if the coil was connected directly to the power supply and the brushes and commutator were removed? (2)

3. Explain with the aid of diagrams, why the coil rotates. (4)

4. Give some examples of objects that use motors in some way or another. (2)

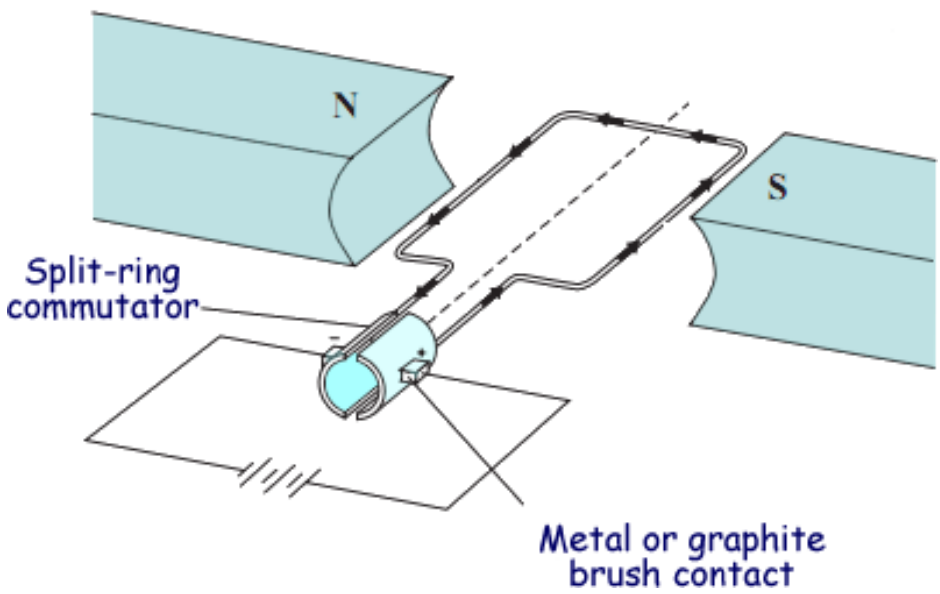
CW 7.3 - Motor Effect

1. Which of the following will make an electric motor spin faster? (Circle the relevant letters) (1)

A	More turns on the coil of wire
B	Stronger magnetic field
C	Using a soft iron core
D	Increasing the current
E	Using a commutator

2. Describe the purpose of a commutator. (1)

3. The diagram shows a simple electric motor.



a) Draw arrows to show the B-field. (1)

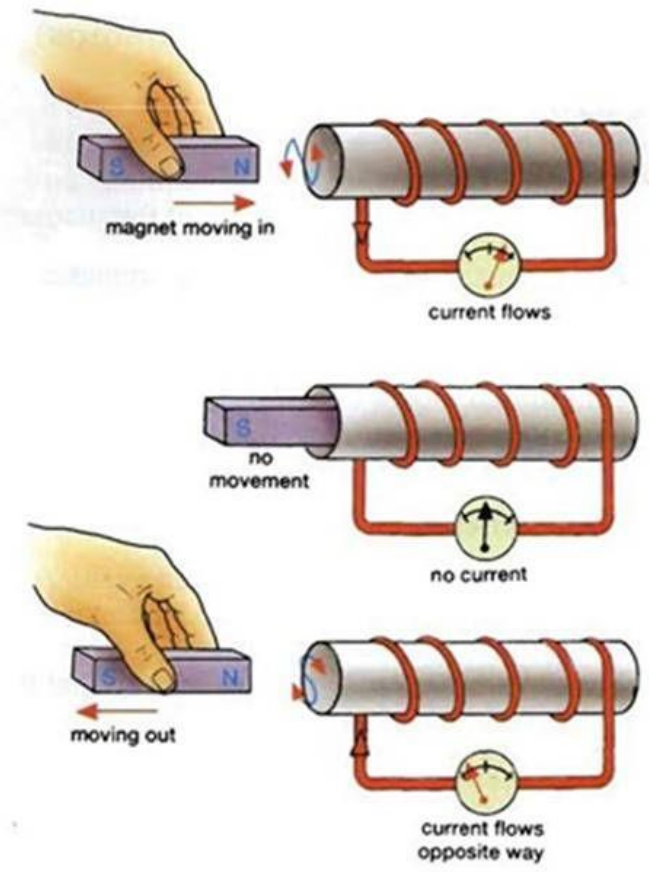
b) Draw labelled arrows to show the forces on the coil of wire. (1)

c) Draw a labelled arrow to show the direction of rotation. (1)

5 – Electromagnetic Induction

Objectives:

- recall that a voltage is induced in a conductor or a coil when it moves through a magnetic field or when a magnetic field changes through it.
- Recall the factors which may affect the size of the induced voltage



LAB 7.3 - PhET Faraday Simulation

http://phet.colorado.edu/en/simulation/faraday

Part 1 – Bar Magnet

1) Open the Faraday's Electromagnetic PhET simulation. Begin on the "Bar Magnet" tab. What variables can you change in the simulation? (1)

2) What happens to the compass as you move it around the magnet? (1)

3) Draw a picture of what you see below (1)

4) What do you notice about the arrows the further they are from the magnet? What do you think this means? (2)

Part 2 – Pickup Coil

5) Find two ways to make the light bulb light up. Describe them in the table below. (4)

Method	Picture	Description
1		
2		

6) Select one of your methods and now try to increase the brightness of the bulb by changing the properties of the pickup coil. (2)

Item	How it influences the brightness of the bulb

7) Why do you think it is called a pickup coil? (1)

Part 3 – Generator

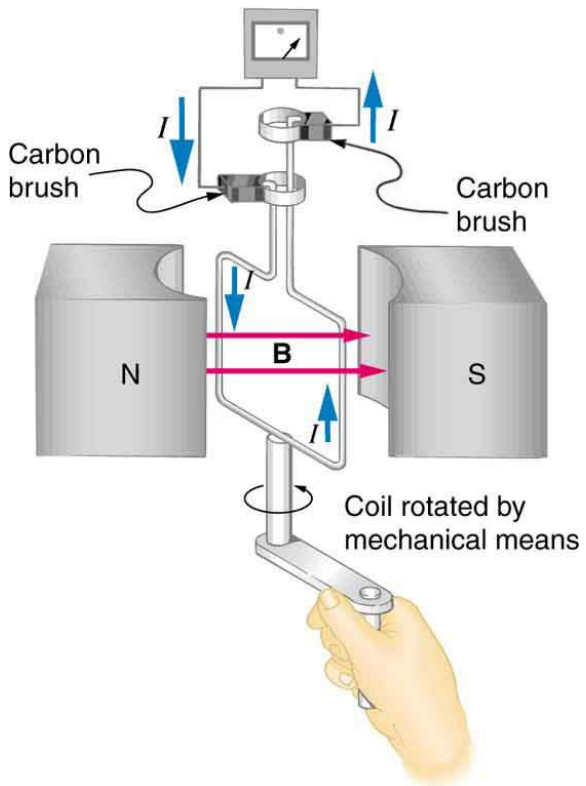
7) Using what you have learned with the pickup coil, you will now design the best generator ever (that the sim will allow!). Make a list of the characteristics you think it should have below. (2)

8) Test your ideas out using the simulation. How does the simulation accomplish what you wanted it to? Does it include anything additional? (1)

6 – Applications of EM Induction

Objectives:

- Describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coil of wire within a magnetic field.
- Describe the factors which may affect the size of the induced voltage



CW 7.4 - EM Induction

1. A voltage is induced when a magnet is moved into a coil of wire. Describe 3 ways to increase the voltage produced. (3)

2. What happens to the voltage when the magnet stops moving? (1)

3. What happens to the voltage when the magnet is pulled out of the coil? (1)

4. AC electricity is made by rotating a magnet inside a coil of wire. Describe one method of converting the ac to dc. (1)

5. A scientist wants to make a perpetual motion machine. So he hooks up a dynamo to an electric motor. Assuming that there is a battery to start the motor, will this work? Explain. (2)

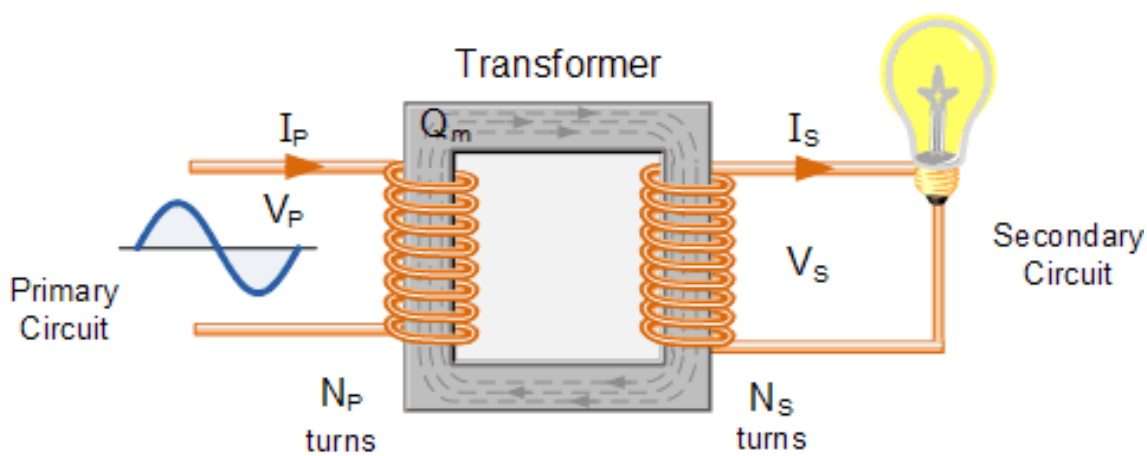
6. Why does BELCO have to put more fuel into its generators as the current demand increases? (2)

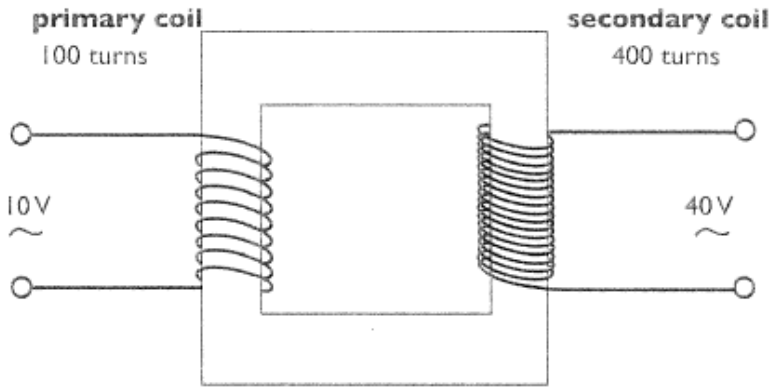
8 – Transformers

Objectives:

- describe the structure of a transformer, and understand that a transformer changes the size of an alternating voltage by having different numbers of turns on the input and output sides.
- know and use the relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer:

$$V_2/V_1 = N_2/N_1$$





step-up (ratio 1:4)

CW 7.5 - Transformers

1. What does a transformer do? (1)

2. What is the difference between a 'step-up' and a 'step-down' transformer? (1)

3. Why won't a transformer work on dc electricity? (1)

4. Why does the current decrease if the voltage increases across a transformer? (1)

5. Why do transformers have laminated iron cores? (2)

6. A student is investigating a transformer. She uses it to power a spotlight and measures the voltage and current on both the input and output sides. Here is her data:

Voltage in (V)	Current in (A)	Voltage out (V)	Current out (A)
240	0.25	12	5.0

a) Is her transformer a 'step-up' or a 'step-down' transformer? (1)

b) Calculate the power on the input (primary) side of the transformer. (1)

c) Calculate the power on the output (secondary) side of the transformer. (1)

d) What is the efficiency of the transformer? (1)

7. Complete the following table. (8)

Primary voltage (V)	**Primary turns**	**Secondary turns**	**Secondary voltage (V)**	**Step-up or step-down?**
10	100	600		
12	600	100		
	200	800	200	
	800	200	100	
15	600		5	
15	600		30	
2	100		20	
25	500		5	

9 – Electrical Transmission Lines

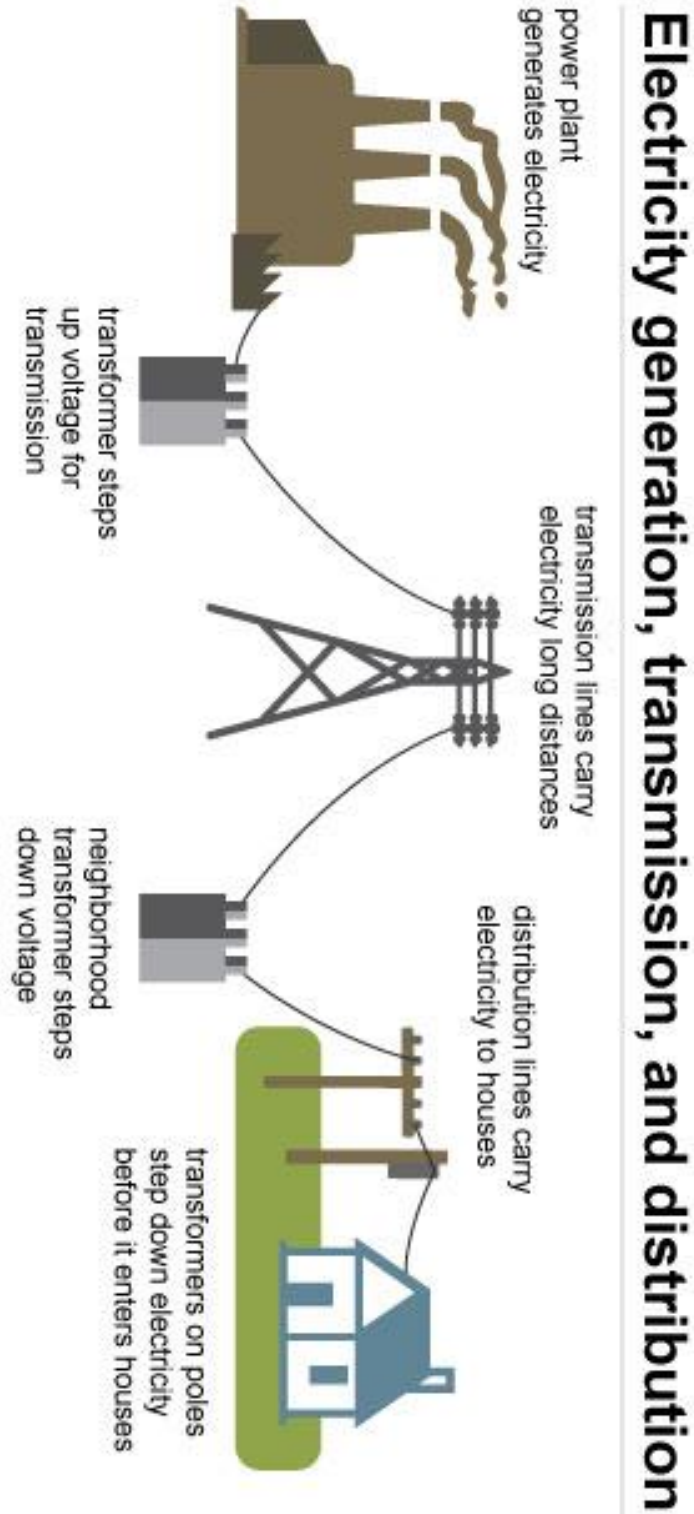
Objectives:

- know and be able to use the relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer:

$$V_2 / V_1 = N_2 / N_1$$

- explain the use of step-up and step-down transformers in the large-scale generation and transmission of electrical energy.
- know use the relationship input power = output power, for 100% efficiency:

$$V_1 \times I_1 = V_2 \times I_2$$


Electricity generation, transmission, and distribution
power plant generates electricity
transmission lines carry electricity long distances
distribution lines carry electricity to houses
transformer steps up voltage for transmission
neighborhood transformer steps down voltage
transformers on poles step down electricity before it enters houses

CW 7.6 - Transmission Lines

1. Why can't BELCO use extension cords and 110 V to transmit electricity around the island? (1)

2. What is the voltage on most overhead lines around the island? (1)

3. Why is this voltage dangerous? (1)

4. In Bermuda, transformers are often mounted on poles. What can sometimes happen during heavy rain and/or hurricanes? (1)

5. Explain why electricity is transmitted at such dangerously high voltages? (2)

6. Underground cables would be safer and more reliable. Why don't we have more of them across the island? (1)

7. In one electricity distribution system, the cable carry a current of 200 A at 132 kV.
   a) Calculate the power transmitted by this circuit. (2)

   b) If a transformer is used to step-down this voltage to 11 kV, what will be the current? (2)

   c) How is energy lost during the transmission of electricity? (1)

   d) If the cables have a resistance of 0.3 Ω , calculate the power lost at:
      i) 132 kV (2)

      ii) 11 kV (2)

8. Explain why it is dangerous to fly kites around power lines. (1)

CW 7.7 - PAST IGCSE QUESTIONS

9 Diagram 1 shows some of the apparatus used to investigate the force on a current-carrying wire, XY, in a magnetic field.

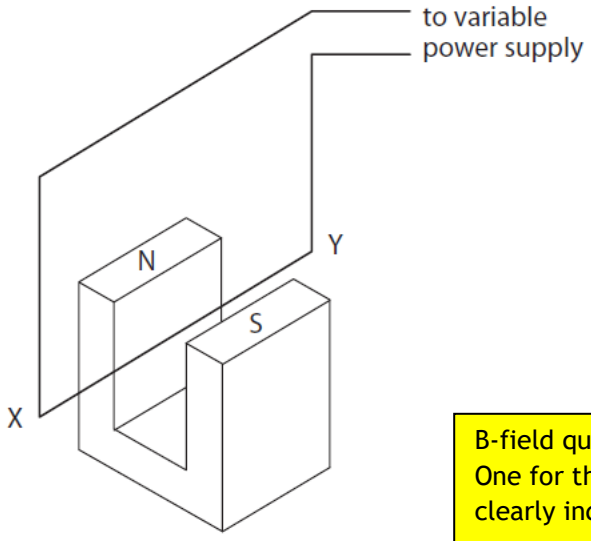


Diagram 1

B-field questions are usually 2 marks. One for the shape and the other for clearly indicating the direction.

(a) Diagram 2 shows the poles of the magnet viewed from above.

Draw the uniform magnetic field between the poles.

(2)

Diagram 2

(b) The current-carrying wire XY is at right angles to the magnetic field.

The current in the wire is 10 A.

(i) Suggest why the wire used in this investigation must be thick.

(1)

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(ii) Explain why the wire XY experiences a force when there is a current in the circuit.

(3)

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(iii) State two ways in which this force can be reduced.

(2)

1 .....

.....

2 .....

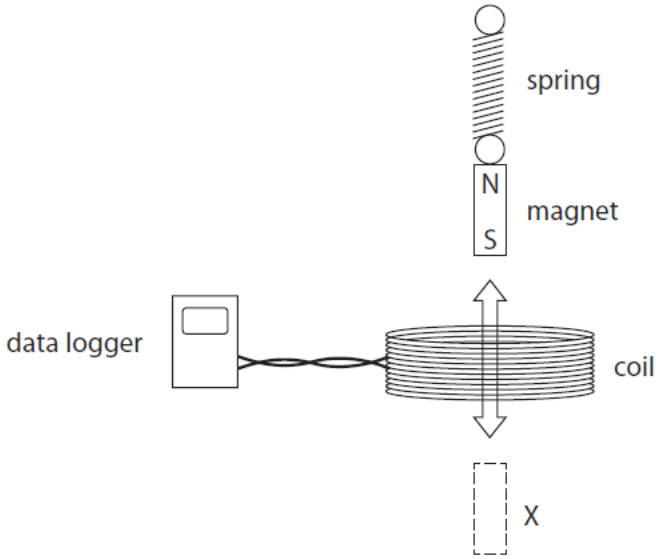
.....

(Total for Question 9 = 8 marks)

Part (ii) is the challenging bit. Go and check your notes. 3 points to make.

14 A student investigates how to produce a voltage.

He hangs a magnet from a spring, above a coil that is connected to a data logger.



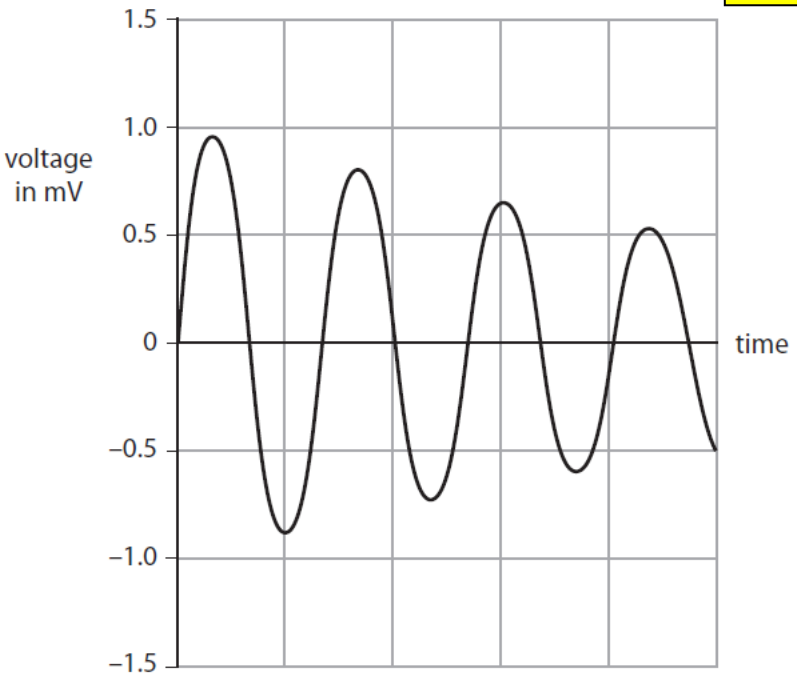
Long question towards the end of the paper. Really take your time reading and understanding what is going on before attempting to answer it.

(a) The student pulls the magnet through the coil to X and then releases it.

The magnet moves up and down through the coil.

The data logger produces this graph of voltage against time.

What do the peaks/troughs mean?
What is happening at the zero points?



(i) Explain why the data logger records a varying voltage.

(2)

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(ii) Which feature of the graph shows that the voltage is alternating?

(1)

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(iii) Suggest why the voltage changes as shown by the graph.

(2)

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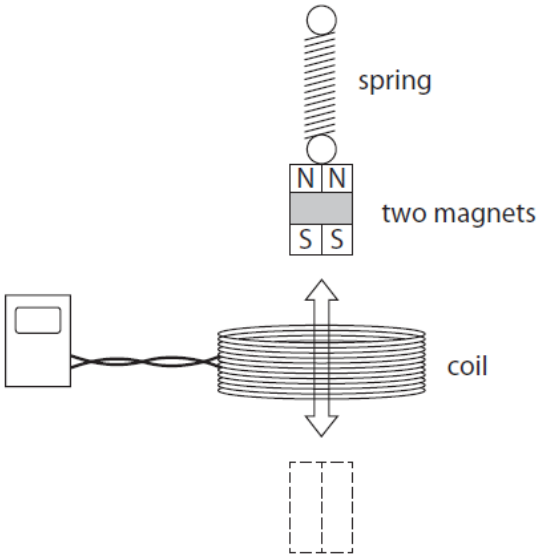
(b) The student repeats the experiment using two magnets taped together.



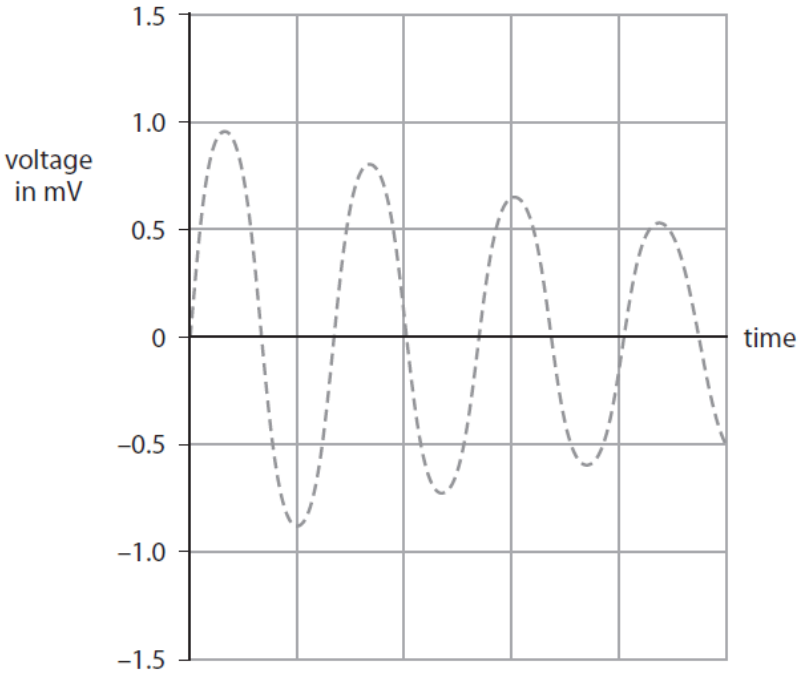
Almost a waves question!
The key is here.

Compared to one magnet, these two magnets take a longer time to move up and down.

The dotted line on the grid shows the original graph for one magnet.

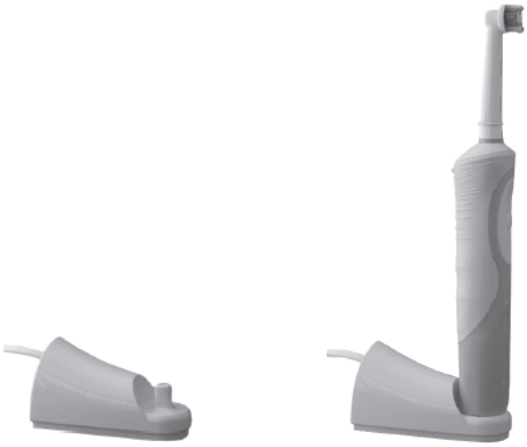
On the same grid, sketch the graph that would be produced using two magnets.

(3)



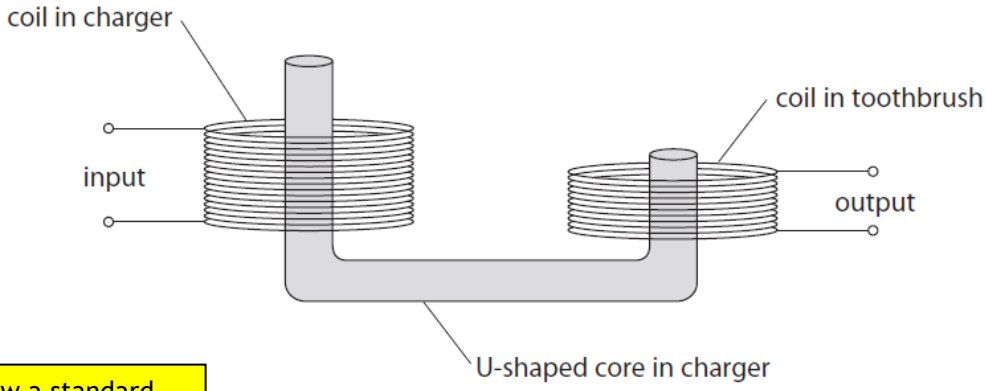
(Total for Question 14 = 8 marks)

8 The photographs show how an electric toothbrush fits on its charger.



The charger and the toothbrush each have a coil of wire inside them.

The diagram shows how the two coils are linked by a U-shaped core.



For practice: draw a standard diagram for this question. (2)

This arrangement of core and coils acts as a transformer that reduces voltage.

(a) (i) Name the type of transformer that reduces voltage.

(1)

.....

(ii) Explain why the core is made of a soft magnetic material, such as iron.

(2)

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(b) (i) State the equation linking the input (primary) and output (secondary) voltages and the turns ratio of a transformer.

(1)

(ii) The transformer has 520 primary turns and 30 secondary turns.

The input voltage to the transformer is 44 V.

Calculate the output voltage.

(2)

output voltage = ... V

(c) (i) The alternating current in the transformer has a frequency of 27 000 Hz.

The toothbrush vibrates at the same frequency when it is being charged.

Explain why these vibrations cannot be heard.

(2)

.....

.....

.....

.....

(ii) A circuit in the toothbrush delivers regular pulses of direct current.

There is a pulse every 1.5 ms.

Calculate the frequency of the pulses.

(2)

frequency = ... Hz

(Total for Question 8 = 10 marks)

A sound waves question has been sneaked in here! This mixing up of topics is often used by examiners.

Be careful with the units!