Answers: P7.6 – Electric motors

Connection

1 F=B x I x L
2 The tesla (T)
3 B= F/ (I x L) = 5N/ (2A x 1m) = 2.5T

Demonstration

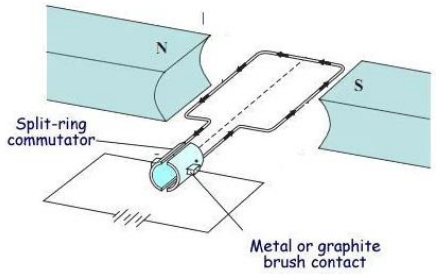
1 e.g. washing machine, fan, vacuum cleaner
2 The magnetic field produced by the electric current interacts with the magnetic field produced by the magnets. This creates forces on the coil which push one side up and the other side down. These forces turn the coil.
3 The split-commutator connects the coil to the power supply. However, the connections swap to the other side of the coil every time the coil makes half a turn. This ensures that the direction of the current is correct for the forces to continue to spin the coil in the same direction.
4 When a current is parallel to the magnetic field from the magnets then no force acts.
5 There would be no effect if the current was reversed as this is an ac current so it keeps changing direction anyway. However, if the magnetic field is reversed then the coil rotates in the opposite direction. So the overall effect is that the coil rotates in the opposite direction.
6 Reduce the current / Reduce the strength of the magnetic field / Reduce the number of turns on the coil.
7 As the coil rotates, the wires would become all tangled up.
8 The iron will magnetise with the same shape as the magnetic field that is present. This makes the magnetic field much stronger and therefore the motor will turn faster

Lesson 8: P7.7 – Loudspeaker (Higher)

Connection

Q1. What is the difference between A.C and D.C?

Q2. Will this motor spin clockwise or anticlockwise?



Activation

LI: describe how a moving-coil loudspeaker works

https://www.youtube.com/watch?v=Awef78YtWmc

1. Make a note of the title and the LI
2. Read pages 256-257
3. Define “frequency” and “amplitude” using the glossary
4. Draw and label figure 7.23 and 7.24
5. Use this simulation and the text from section 2 The moving-coil loudspeaker to describe how a speaker works? https://javalab.org/en/speaker_en/

Demonstration

Attempt questions 1-6.
In 15 mins answer as many questions as you can.
Self-mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self-assess the relevant past paper question for this topic - From the P7 DIP file

Extension

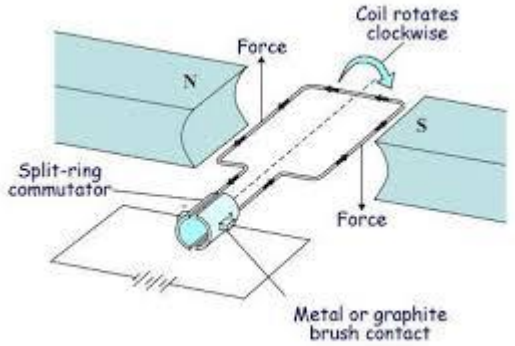
Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: P7.7 – Loudspeaker

Connection

1 In D.C, the current flows only one direction, in A.C the current is constantly changing direction backwards and forwards.

2. The motor will spin clockwise



Demonstration

1 Sound waves are produced by vibrating objects, which in turn make the air vibrate.
2 The alternating current keeps changing direction. This produces a force on the loudspeaker cone which keeps changing direction – so the loudspeaker cone vibrates.
3 The louder speaker could have more turns in its coil and/or it could be using a stronger magnet. Also the coil might be made of lighter wire so it can move more easily.
4 This is an accurate statement. The headphones are just very small loudspeakers.
5 The sound needs to be much louder from loudspeakers as they are much further away from your ear. This means they need to transfer energy more quickly and need a source of power which is greater than a mobile phone can provide.
6 At the top of the coil, the current would be flowing in a direction up, out of the page. The magnetic field above the coil is in the upwards direction. Apply Fleming's left hand rule, the direction of the force on the top of the coil would be to the left. So the cone would move to the left. (You can check this below the coil too: here, the current would be going into the page and the magnetic field would be downwards – the direction of the force is also to the left.

Lesson 9: P7.8 – The generator effect (Higher)

Connection

Q1. Name three objects with a loudspeaker in them

Q2. Does a loud speaker use A.C or D.C?

Q3. Using your knowledge of a loudspeaker, how would a microphone work?

Activation

LI: describe how a potential difference is induced across the ends of in a wire when it moves in a magnetic field

https://www.youtube.com/watch?v=pkzY7QfTowM

1. Make a note of the title and the LI
2. Read pages 258-259
3. Draw and label figure 7.26
4. Name three ways that the induced potential difference can be increased
5. Draw and label figure 7.28
6. Use the simulation to show how a changing magnetic field can generate a changing current https://phet.colorado.edu/sims/cheerpj/faraday/latest/faraday.html?simulation=generator

Consolidation

Complete and self-assess the relevant past paper question for this topic - From the P7 DIP file

Demonstration

Attempt questions 1-5.
In 15 mins answer as many questions as you can.
Self-mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: P7.8 – The generator effect

Connection

1 Phone, TV, Computer etc.

2. A loudspeaker uses A.C with a varying frequency

3. Sound waves cause a coil of wire to move around a permanent magnet. This induces a potential difference in the wire.

Demonstration

1 By changing the magnetic field – either by varying the strength of the magnets or by moving the wire relative to the magnets.
2 0 V – since the magnetic field doesn't change.
3 You can move the magnet more slowly, use a weaker magnet or use a solenoid with fewer turns.

4a The induced current is flowing through the solenoid. This current produces the second magnetic field.

4b On the left hand diagram the left hand end of the coil is a north pole and the right hand end is a south pole. On the right hand coil, the left hand end is a south pole and the right hand end is a north pole. You can work this out by knowing that the coil opposes the motion of the magnet (so it must repel the magnet in the left diagram and attract the magnet in the right diagram).

4c The magnetic field produced by the current in the coil attracts and repels the magnet, making it harder for the magnet to move. Therefore, you need to apply a force to balance out this magnetic effect.

4d For example on the diagram on the left – this time the coil would attract the magnet. The magnet would speed up and therefore there would be more energy in its kinetic energy store. This energy would have come from nowhere and so energy has not been conserved. Therefore it is impossible for the induced p.d. to be in this direction.

5 There would not be a complete circuit so no current flows. Therefore, the meter would always be pointing to 0 A.

Lesson 10: P7.9 – Key concept: The link between electricity and magnetism (Higher)

Connection

Q1. Name three ways that the induced potential difference can be increased

Q2. How is the coil of wire spun in a power plant?

Activation

LI: explore how electricity and magnetism are connected.

https://www.youtube.com/watch?v=zPqEEZa2Gis

1. Make a note of the title and the LI
2. Read pages 260-261
3. Briefly describe how an electric motor works
4. Briefly describe how an electric generator works
5. Read the DART
6. Answer the questions on the DART

Consolidation

Complete and self-assess the relevant past paper question for this topic - From the P7 DIP file

Demonstration

Attempt questions 1-6.
In 15 mins answer as many questions as you can.
Self-mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: : P7.9 – Key concept: The link between electricity and magnetism

Connection

1 moving the wire or magnet faster, using a stronger magnet.
replacing the wire with a coil

2. In a powerplant, water is heated until it turns into steam. This steam is pushed through a turbine, which then spins.

Demonstration

1. e.g. an electromagnet, a bell, a relay, a motor, a loudspeaker
2. e.g. a motor, a loudspeaker
3 e.g.a dc or ac generator, a microphone, an electric guitar pickup
4 A motor consists of a coil of wire which carries a current and the coil is inside a magnetic field. The current in the coil produces its own magnetic field which interacts with the magnetic field from the magnet. This interaction produces forces on the coil. The forces act upwards on one side of the coil and downwards on the other side which makes it turn. The coil is connected to a power supply using a split ring commutator. The commutator ensures that the current goes through the coil in the correct direction to make the coil keep turning the same way. It does this by reversing the direction of the current every half turn.
5 You can use Fleming's Left Hand Rule. Place your thumb, first fingerand second finger of your left hand at right angles to each other. The first finger needs to point in the direction of the magnetic field produced by the magnets (north pole to south pole) and the second finger needs to point in the direction of the current. Your thumb will point in the direction of the magnetic force. In Figure 7.31 you can see that the force would push the wire down towards the bottom of the magnet.
6 Motors and generators both consist of a rotating coil inside a magnetic field. However, motors require a power supply and an electric current is used to produce motion. Generators, however, do not require a power supply but they do require something to rotate the coil. They use the rotation of the coil to generate an electric current.

Lesson 11: P7.10 – Using the generator effect (Higher)

Connection

Q1. What is a superconductor?

Q2. What is “Maglev” short for?

Q3. Briefly describe Flemings left hand rule

Activation

LI: explain how moving-coil microphones use the generator effect, explain how a dynamo generates direct current and an alternator generates alternating current

https://www.youtube.com/watch?v=k1IivkRjd1U&t=199s

1. Make a note of the title and the LI
2. Read pages 262-263
3. Draw and label figure 7.32
4. Draw and label figure 7.33
5. Draw and label figure 7.34
6. State 3 ways that the size of the induced current can be increased

Demonstration

Attempt questions 1-10.
In 15 mins answer as many questions as you can.
Self-mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self-assess the relevant past paper question for this topic - From the P7 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: : P7.10 – Using the generator effect

Connection

1 A superconductor is a material that has no resistance.

2. Maglev is short for magnetic levitation

3. The thumb shows the direction of the force or motion, the first finger is the direction of the magnetic field, the second finger is the direction of the current

Demonstration

1 A microphone has the same components as a loudspeaker –a diaphragm / cone, a magnet and a coil.
2 The pressure variations in the sound waves make the diaphragm vibrate which makes the coil vibrate. The moving coil in the magnetic field induces a current in a coil due to the generator effect. So the pressure variations produce variations in the current flowing through the coil.
3 This makes the microphone more sensitive to vibrations. The large number of turns means that a large current is produced when there is a small movement and the thin wire means that the coil is light enough to move easily when the sound waves hit the diaphragm.
4 You can use a higher current, a stronger magnet or more turns in the coil.
5 In a d.c. dynamo you use a split ring commutator where each side of the coil switches its connection to the output terminals every half turn. This means that one terminal will always be positive and the other terminal will always be negative as you turn the dynamo. In an a.c. generator each side of the coil is connected to its own slip ring. This means that the polarity of the output terminals swaps every half turn of the coil.
6 The coil moves through a magnetic field which induces the potential difference from the generator effect. The potential difference is alternating because one side of the coil is alternately moving upwards then downwards through the magnetic field as the coil turns.
7 The induced p.d. will be larger and the output will vary quicker. This means that the graph will have higher peaks and lower troughs and the horizontal distance between the peaks and troughs will be smaller.
8 When the p.d. is zero, the sides of the coil are moving parallel to the magnetic field.
9 Rotate the coil faster, use stronger magnets, use more turns, decrease the resistance of the circuit.
10 There is no longer a complete circuit so a current doesn't flow in the coil. This means that there is no longer a magnetic field produced by the current in the coil, which opposes the motion of the coil. (Alternatively this can be argued in terms of energy: When the light bulb is shining then you have to do work while rotating the coil in order to transfer the energy. When the light bulb blows then no work needs to be done so you don't need to apply a force to turn the coil in order to do the required work.

Lesson 12: P7.11 – Transformers (Higher)

Connection

Q1. What is the electrical frequency and potential difference of the UK mains electricity?

Q2. Briefly sketch a diagram of the national grid.

Q3. Why is the potential difference so high in the national grid?

Activation

LI: explain how a transformer both uses and produces alternating current, explain the relationship between the number of turns in the primary coil and the number in the secondary coil

https://www.youtube.com/watch?v=7RtBUEZbKmI

1. Make a note of the title and the LI
2. Read pages 264-265
3. Define “transformer” using the glossary
4. Draw and label figure 7.38
5. Copy the equation for the turns ratio of a transformer
6. Copy the equation for the power input and power output of a transformer
7. Briefly describe in bullet points how a transformer works

Consolidation

Complete and self-assess the relevant past paper question for this topic - From the P7 DIP file

Demonstration

Attempt questions 1-8.
In 15 mins answer as many questions as you can.
Self-mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Extension

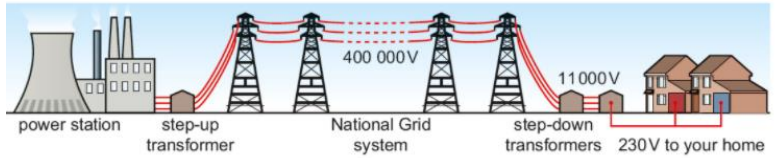
Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: :P7.11 – Transformers

Connection

1 Frequency: 50Hz
Potential difference: 230V

2.



3. The potential difference is high in the national grid because with a fixed resistance, the current is low. This means there will be less energy lost as heat.

Demonstration

1a Step up
1b Step down
2 Transformers need an alternating potential difference to work. A battery is d.c.
3 The magnetic field in the iron core is changing. So the secondary coil is in a changing magnetic field which means there is a p.d. induced in the secondary coil due to the generator effect.
4 Vp / Vs = np / ns 240 / 12 = 720 / ns 20 = 720 / nsns = 720 / 20 = 36
5 Vp / Vs = np / ns 240 / 20 = np / 100 12 = np / 100 np = 12 × 100 = 1200
6 Vp / Vs = np / ns 240 / Vs = 100 / 10Vs= 240 / 10 = 24 V.
7 Power output = IV= 3.4 × 19 = 64.6 W Assume the transformer is 100% efficient. Power in = 64.6 W So 240 × I= 64.6I= 64.6 / 240 = 0.27 A (to 2 significant figures).
8a. Vs× Is= Vp× Ip60 000 × Is= 3000 × 20Is= 60 000 / 60 000 = 1 A
8b Vp/ Vs= np/ ns 3000 / 60 000 = 500 / ns0.05 = 500 / nsns= 500 / 0.05 = 10 000 turns

P7 Revision

Connection

Q1. What does a step down transformer do?

Q2. What is the significance of the turns ratio equation? $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

Q3. If a transformer is 100% efficient what can you say about the power?

Activation

LI: Create a topic summary sheet

1. Fold an A3 sheet so it is divided into 8 sections
2. Look back over you lesson and group them into 8 main headings
3. Summarise the key points into each section, use keywords and diagrams and symbols rather than sentences

Demonstration

Design a climate awareness fact sheet this must include:

- Climate Change
- Pollution
- Names of Gases contributing to Climate change
- Activities that can reduce Climate Change

Consolidation

Look though the relevant past paper questions for this topic - From the C9 DIP file – see if you can complete any additional questions

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: P7 Revision

Connection

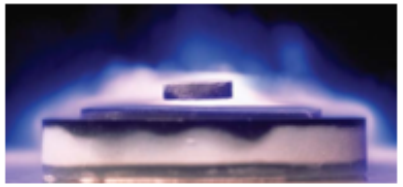
1 reduces the potential difference
2 it tells you that the ratio of the primary to secondary voltage is equal to the ratio of the number of turns on the primary to secondary coils. Can be used to calculate 1 of the 4 parameters
3 Power in is equal to power out. Can use the equation:

$$V_P \times I_P = V_S \times I_S$$

DART P7: Maglev Train

A Maglev train uses magnets and superconductors to allow it to levitate and travel at very high speeds.

You can now get a train at Shanghai in China that will take you 30 km in just over 7 minutes, reaching a top speed of 431 km/h and an average speed of 250 km/h. As well as travelling so fast, the train is levitating, so it hovers a few centimetres above the track. It is supported by very strong magnets, which reduces friction. This means that it can travel much faster than a conventional train.

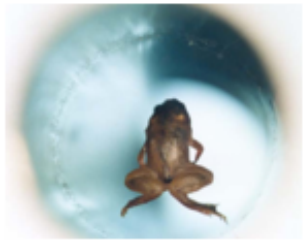


Superconductors can be levitated with magnetic forces. This principle is used in Maglev trains. The development of scientific ideas and discoveries has enabled us to advance new technologies, although these do not always seem obvious at first. At the start of the twentieth century scientists were trying to find things that conducted electricity very efficiently. This led to the discovery of superconductors.

Superconductors are very important because they can be used to make incredibly strong electromagnets. These are more powerful than any other type of magnet because they are so good at conducting electricity.

As better superconductors were developed it was possible to make stronger and stronger electromagnets. This made possible the development of the first magnetically levitating train (shortened to Maglev) in the mid-1980s.

A Maglev train works by having superconducting electromagnets on both the train and the rails it sits above. As the train moves along, the electromagnets on the track are changed constantly by a computer so that the one in front always attracts and the ones behind always repel. This constantly pulls (and pushes) the train along the track.



You may have thought that humans being able to float was just science fiction, but it is not just trains that can be levitated. So far scientists in the Netherlands have managed to levitate a tomato, a strawberry, a frog and a grasshopper (all were unharmed).There is a chance that in your lifetime this technology may be developed to work on human beings.

References:

www.britannica.com/technology/maglev-train

https://science.howstuffworks.com/.../engines-equipment/maglev-train.htm

QUESTIONS

1a. What is the top speed of the Maglev train in Shanghai?

1b. Why is there so little friction between the train and the track?

1c. What is a superconductor?

2a. What is Maglev an abbreviation of?

2b. Describe how superconductors work on the Shanghai superfast train.

2c. State examples of things other than trains have scientists been able to levitate.

3a. Describe what led to the discovery of superconductors.

3b. Explain why the discovery of superconductors was so important

3c. As a scientific journalist write an article describing how the discovery of superconductors has led to the development of Maglev trains. Make sure you explain what superconductors are and how they are used to make Maglev trains work.

Answers

1a. 431 km/h

1b. Levitation – the train hovers above the train track – there is no contact between the wheels and the track reducing friction (contact force)

1c. Superconductors are materials that can conduct electricity very efficiently.

2a. Magnetic levitation

2b. The Shanghai Maglev train works by having superconducting electromagnets on both the train and the rails it sits above. As the train moves along, the electromagnets on the track are changed constantly by a computer so that the one in front always attracts and the ones behind always repel. This constantly pulls (and pushes) the train along the track.

2c. So far scientists in the Netherlands have managed to levitate a tomato, a strawberry, a frog and a grasshopper

3a. in the early 20th century Scientists were trying to find ways of transmitting electricity superfast and efficiently. This led to the discover of superconductors. The development of computer technologies enabled scientists to use the magnets to make objects hover and then speed along by interactions between stores of potential and kinetic energy using magnets and electricity.

3b. Superconductors were used in trains to reduce long rail journeys. It encouraged further scientific research and discovery into combining developing technologies to manufacture superfast and efficient maglev trains.

3c. Students should use the Q/A above to create their own article which can include annotated diagrams.

Must include, scientific principle, scientific terminology (they could highlight key words/phrases first)

The article should include paragraphs, bullets and suggestions regarding the future of this technology.

Attainment Band :	P7 Electromagnetism (AQA) Knowledge and Understanding
Yellow Plus/ Yellow	Explain that an induced magnet is a material that is only magnetic when it is placed in a magnetic field. Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic. Use the magnetic field pattern around a conducting wire and solenoid to explain how the field strength varies. Explain how the direction of the force on the conductor can be identified using Fleming's left-hand rule. Use the equation F = BIl to calculate the force on a conductor.
Blue	Recognise that the poles of a magnet are the places where the magnetic forces are strongest. Recognise that the magnetic field is the region around a magnet where a force acts on another magnet or on a magnetic material. Draw the magnetic field around a conducting wire and a solenoid. Describe the motor effect that applies to a current-carrying conductor in a magnetic field. Explain what the size of a force on a conductor depends on.
Green	Recall that like poles repel, unlike poles attract. Plot the magnetic field around a bar magnet. State how the strength of an electromagnet can be increased. State that a force acts on a current-carrying conductor in a magnetic field. State that magnetic flux density is measured in tesla (T).
White	Some elements of the above have been achieved