# Scheme of work

## Combined Science: Trilogy

## Physics - Magnetism and electromagnetism

This resource provides guidance for teaching the Magnetism and electromagnetism topic from our new GCSE in Combined Science: Trilogy/Physics (8464). It has been updated from the draft version to reflect the changes made in the accredited specification. There are a few changes to the learning outcomes and opportunities to develop skills columns.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 6.7 Magnetism and electromagnetism

### 6.7.1 Permanent and induced magnetism, magnetic, forces and fields

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most candidates should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
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| 6.7.1.1 | The forces magnets exert on each other. | The poles of a magnet are the places where the magnetic forces are strongest. When two magnets are brought close together they exert a force on each other. Two like poles repel each other. Two unlike poles attract each other. Attraction and repulsion between two magnetic poles are examples of non-contact force. | 0.5 | What is the shape of the Earth’s magnetic field?  Identify magnetism as a non-contact force. | Describe two experiments that can be used to identify the magnetic field pattern of a permanent magnet.  Describe what would happen if two North seeking Magnetic Poles were placed near each other, two South seeking Poles or one of each.  Which part of a permanent magnet is the strongest?  Investigate and draw the shape of the magnetic field pattern around a permanent magnet.  Investigate the effect that two magnets have on each other in different orientations. | Video clip:  [BBC Bitesize – Laws of magnetism](http://www.bbc.co.uk/education/clips/z77qxnb)  [BBC Bitesize – Magnets](http://www.bbc.co.uk/education/guides/zxxbkqt/revision)  [Cyberphysics – Magnetism](http://www.cyberphysics.co.uk/topics/magnetsm/Magntism.htm)  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX) |
| 6.7.1.1 | The differences between permanent and induced magnets. | A permanent magnet produces its own magnetic field. An induced magnet is a material that becomes a magnet when it is placed in a magnetic field. Induced magnetism always causes a force of attraction. When removed from the magnetic field, an induced magnet loses most/all of its magnetism quickly. | 0.5 | Describe how an induced magnet is produced.  Explain what is meant by a permanent magnet and give examples of materials that can become magnetised.  What are the advantages of using an electromagnet rather than a permanent magnet? | How can we make an electromagnet?  Investigate how to make an induced magnet by stroking an iron nail with a permanent magnet.  Investigate electromagnets and why they are referred to as temporary magnets. Find out why soft iron is used as the core in an electromagnet rather than steel. Investigate what affects the strength of a temporary magnet. | [BBC Bitesize – Magnets](http://www.bbc.co.uk/education/guides/zxxbkqt/revision)  [BBC Bitesize – Electromagnets and motors](http://www.bbc.co.uk/education/guides/zmm39j6/revision)  [Cyberphysics – Electromagnetism experiment](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Electromagnetism%20experiment.htm) |
| 6.7.1.2 | Magnets exert forces on magnetic materials due to their magnetic fields. | The region around a magnet where a force acts on another magnet or on a magnetic material (iron, steel, cobalt, and nickel) is called the magnetic field. | 0.25 | Name three magnetic materials.  Describe why steel is magnetic.  Explain what is meant by the magnetic field of a magnet. | What is the shape of the magnetic field of a bar magnet? How is the field pattern found?  Investigate the magnetic field of a permanent magnet using plotting compasses or iron filings if this wasn’t done in the earlier section.  Floating paper clip challenge. Can pupils make a paper clip float in mid-air? | [S-cool, the revision website – Magnetism](http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/revise-it/magnetism)  [Cyberphysics – Magnetism](http://www.cyberphysics.co.uk/topics/magnetsm/Magntism.htm) |
| 6.7.1.2 | The difference between magnets and magnetic materials. | The force between a magnet and a magnetic material is always one of attraction. | 0.25 | Describe how to distinguish between a magnetic material and a magnet by experiment. | Investigate the difference between magnetic materials and permanent magnets. | [BBC Bitesize – Magnets](http://www.bbc.co.uk/education/guides/zxxbkqt/revision/1) |
| 6.7.1.2 | The strength of a magnetic field depends on the distance from the magnet. | The strength of the magnetic field depends on the distance from the magnet. The field is strongest at the poles of the magnet. | 0.5 | Describe where the strongest point of a magnet is and how this is shown by the magnetic field pattern.  Describe how the strength of the magnet varies with distance from the magnet. | Investigate the strength of a permanent magnet at various points along its length to show that the magnet is strongest at the poles. This can be demonstrated with the iron filings investigation.  Plan and carry out an experiment to find out how the strength of a magnet changes with the distance from the magnet. | [BBC Bitesize – Magnets](http://www.bbc.co.uk/education/guides/zxxbkqt/revision/2)  [Cyberphysics – Magnetism](http://www.cyberphysics.co.uk/topics/magnetsm/Magntism.htm) |
| 6.7.1.2 | Magnetic compasses point to the Earth’s poles due to the Earth’s magnetic field. | The direction of the magnetic field at any point is given by the direction of the force that would act on another North Pole placed at that point. The direction of a magnetic field line is from the North (seeking) Pole of a magnet to the South (seeking) Pole of the magnet.  A magnetic compass contains a small bar magnet. The Earth has a magnetic field.  The compass needle points in the direction of the Earth’s magnetic field. | 0.5 | Draw the magnetic field pattern of a bar magnet and describe how to plot the magnetic field pattern using a compass.  Describe how a compass can be made using a needle floating on a leaf once it has been magnetised by a permanent magnet.  Explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic.  Investigate the magnetic field pattern of the Earth. | How does a compass work?  Why would a compass sometimes point in the wrong direction (eg not to the North Pole in the UK)?  Try making a compass using a needle and a permanent magnet.  Suspend a permanent magnet so it is free to rotate. Check the direction it points with an actual compass. | [BBC – Earth – Earth’s magnetic field now flips more often than ever](http://www.bbc.com/earth/story/20141110-earths-magnetic-field-flips-more)  [BBC Bitesize – Magnetic fields](http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway_pre_2011/living_future/5_magnetic_field1.shtml)  [Cyberphysics – The Earth's Magnetic Field](http://www.cyberphysics.co.uk/topics/magnetsm/Earth.htm) |

### 6.7.2 The motor effect

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| 6.7.2.1 | A wire carrying an electric current has its own magnetic field. | When a current flows through a conducting wire a magnetic field is produced around the wire. The shape of the magnetic field can be seen as a series of concentric circles in a plane, perpendicular to the wire. The direction of these field lines depends on the direction of the current. The strength of the magnetic field depends on the current through the wire and the distance from the wire. | 0.5 | Describe how the magnetic effect of a current can be demonstrated.  Use the ‘right hand thumb rule’ to draw the magnetic field pattern of a wire carrying an electric current. | Demonstrate what happens when a foil strip with a current flowing through it is placed in a strong magnetic field. What happens if the direction of the current is reversed?  Try to demonstrate the shape of the magnetic field by placing a wire through a piece of card with iron filings sprinkled near it. Apply a current through the wire. | [YouTube: The Motor Effect](https://www.youtube.com/watch?v=hrzL3EWT0No)  [BBC Bitesize – Electromagnets and motors](http://www.bbc.co.uk/education/guides/zmm39j6/revision/3)  [Cyberphysics – Electromagnetism](http://www.cyberphysics.co.uk/topics/magnetsm/Electromagntism.htm) |
| 6.7.2.1 | A coil of wire carrying an electric current has its own magnetic field. | Shaping a wire to form a solenoid increases the strength of the magnetic field created by a current through the wire. The magnetic field inside a solenoid is strong and uniform.  The magnetic field around a solenoid has a similar shape to that of a bar magnet.  Adding an iron core increases the magnetic field strength of a solenoid. An electromagnet is a solenoid with an iron core. | 0.5 | Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid.  Describe the effect on the magnetic field of changing the direction of the electric current.  Describe ways of increasing the magnetic field strength of a solenoid.  Explain how an electromagnet can be made from a solenoid.  Research uses of solenoids in medicine and in security doors. | Plan an experiment to see if a coil of wire has a stronger magnetic field than a straight wire when both carry the same electric current. What are the control variables in this experiment?  Find the magnetic field pattern of a solenoid using iron filings or a plotting compass. How can the shape of the magnetic field inside the solenoid be determined? | [S-cool, the revision website – Electromagnetism](http://www.s-cool.co.uk/gcse/physics/magnetism-and-electromagnetism/revise-it/electromagnetism)  [Cyberphysics – Electromagnetism](http://www.cyberphysics.co.uk/topics/magnetsm/Electromagntism.htm) |
| 6.7.2.2 | Motors rotate due to the interaction of magnetic fields. HT only. | When a conductor carrying a current is placed in a magnetic field the magnet producing the field and the conductor exert a force on each other. This is called the motor effect. | 0.75 | Explain what is meant by the motor effect.  Explain why a motor spins with respect to the magnetic field produced by a wire carrying an electric current and the magnetic field of the permanent magnets in the motor interacting. | Make an electric motor (available from Winchester Kits) and investigate how the speed and direction of rotation can be changed. | [BBC Bitesize – Electric motors](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/electric_circuits/electricmotorsrev2.shtml)  [Cyberphysics – The Motor Effect](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm)  [Pass My Exams – Electric Motors and Generators](http://www.passmyexams.co.uk/GCSE/physics/electric-motors.html) |
| 6.7.2.2 | The direction of rotation of a motor can be changed. HT only. | The direction of the force on the conductor is reversed if either the direction of the current or the direction of the magnetic field is reversed. | 0.5 | Explain why changing the direction of the electric current in an electric motor changes the direction of rotation.  Explain why changing the polarity of the permanent magnets in the electric motor will change the direction of rotation. | Investigate the effect of changing the direction of the current or changing the direction of the magnetic field on the rotation of a motor. | [Cyberphysics – The Motor Effect](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm)  [Pass My Exams – Electric Motors and Generators](http://www.passmyexams.co.uk/GCSE/physics/electric-motors.html) |
| 6.7.2.2 | Using Fleming’s left-hand rule to find out the direction of rotation of a motor. HT only. | The direction of the force on the conductor can be identified using Fleming’s left-hand rule. | 0.5 | Recall and use Fleming’s left-hand rule. | Predict the direction of rotation of an electric motor when given the direction of the magnetic field and the direction of the current in the coil. Use animations from Boardworks or models students have built themselves. | [BBC Bitesize – Electromagnets and motors](http://www.bbc.co.uk/education/guides/zmm39j6/revision/5)  [Cyberphysics – The Motor Effect](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm)  [Pass My Exams – Electric Motors and Generators](http://www.passmyexams.co.uk/GCSE/physics/electric-motors.html) |
| 6.7.2.2 | Factors that affect the size of the force on a conductor. HT only. | The size of the force on the conductor depends on:   * the magnetic flux density * the current in the conductor * the length of conductor in the magnetic field. | 0.25 | Describe how the size and direction of the force on a conductor in a magnetic field can be changed. | Investigate both the size and direction of the force on a conductor in a magnetic field. This can be done when making simple motors by wrapping more wire around, increasing the p.d. or using stronger magnets. | [Cyberphysics – The Motor Effect](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm)  [Pass My Exams – Electric Motors and Generators](http://www.passmyexams.co.uk/GCSE/physics/electric-motors.html) |
| 6.7.2.2 | Calculating the force on a conductor in a magnetic field. HT only. | For a conductor at right angles to a magnetic field and carrying a current:  force, *F*, in newtons, N  magnetic flux density, *B*, in tesla, T  current*, I,* in amperes, A  length, *l*, in metres, m | 0.5 | Use and apply the equation:  to calculate any missing value when given other values.  State the units of force, magnetic flux density, current and length.  Convert units into SI units as required and use standard form as required.  What is magnetic flux density?  What determines magnetic flux density? |  | [Schoolphysics – Force on a current in a magnetic field](http://www.schoolphysics.co.uk/age16-19/Electricity%20and%20magnetism/Electromagnetism/text/Force_on_a_current_in_a_magnetic_field/index.html) |
| 6.7.2.3 | Magnetic fields cause motors to rotate. HT only. | A coil of wire carrying a current in a magnetic field tends to rotate. This is the basis of an electric motor.  The force on a conductor in a magnetic field causes the rotation of the coil in an electric motor. | 0.25 | Explain how rotation is caused in an electric motor. | Investigate the movement of a single straight wire carrying an electric current at right angles to the magnetic field lines. Use this to explain why a coil of wire with a current flowing through it turns in a magnetic field. | [BBC Bitesize – The electric motor](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/electric_circuits/electricmotorsrev2.shtml)  [Cyberphysics – The Motor Effect](http://www.cyberphysics.co.uk/topics/magnetsm/electro/Motor%20Effect.htm)  [Pass My Exams – Electric Motors and Generators](http://www.passmyexams.co.uk/GCSE/physics/electric-motors.html) |