 Module 4: Electricity and magnetism

Year 11 Physics

Duration: 3-4 hours

This document references the [Physics Stage 6 Syllabus](https://syllabus.nesa.nsw.edu.au/physics-stage6/) © 2017 [NSW Education Standards Authority (NESA)](http://syllabus.nesa.nsw.edu.au/copyright/) for and on behalf of the Crown in right of the State of New South Wales.

Description of unit

This unit of work addresses inquiry question 3, magnetism in Module 4. Atomic theory and the laws of conservation of energy and electric charge are unifying concepts in understanding the electrical and magnetic properties and behaviour of matter. Interactions resulting from these properties and behaviour can be understood and analysed in terms of electric fields represented by lines. Students use these representations and mathematical models to make predictions about the behaviour of objects, and explore the limitations of the models.

Students also examine how the analysis of electrical circuits’ behaviour and the transfer and conversion of energy in electrical circuits has led to a variety of technological applications.

Magnetism

Inquiry question: How do magnetised and magnetic objects interact?

Working scientifically skills

* PH11-1 develops and evaluates questions and hypotheses for scientific investigation
* PH11-2 Designs and evaluates investigations in order to obtain primary and secondary data and information
* PH11-3 Conducts investigations to collect valid and reliable primary and secondary data and information
* PH11-4 Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* PH11-6 Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes
* PH11-7 communicates scientific understanding using suitable language and terminology for a specific audience or purpose

While all Working Scientifically outcomes have been presented in this sample unit of work, teacher judgement should be used about which skill descriptors students will be working towards and engaging with.

In the sample unit of work, Working Scientifically outcomes are placed after content descriptors.

Outcomes

* PH11-11 explains and quantitatively analyses electric fields, circuitry and magnetism

Assessment

This unit allow teachers to collect information for formative assessment of student progress. This may include:

* planning and conducting practical investigations using reports and logs
* student reflections (can be oral, video or face to face or written)
* quizzes and feedback
* representations of patterns and data using diagrams, tables and graphs
* problem solving and application of knowledge to new situations.

Resources

* [Magnetic fields and forces](http://ww2.odu.edu/~jdudek/Phys112N_materials/4-magnets.pdf)

| Outcomes/content | Teaching and learning | Evidence of learning |
| --- | --- | --- |
| * investigate and describe qualitatively the force produced between magnetised and magnetic materials in the context of ferromagnetic materials (ACSPH079)

Working scientifically - PH11-3, PH11-7 | [Mind blowing magic magnets](https://www.youtube.com/watch?v=IANBoybVApQ) https://www.youtube.com/watch?v=IANBoybVApQ[How magnet works](https://www.youtube.com/watch?v=BY1LS10GMkg) https://www.youtube.com/watch?v=BY1LS10GMkgEngageStudent survey outlining what they know and what they would like to achieve, provide various magnetic stimuli (floating globe, ferrofluid)[Monster magnets meets magnetic fluid](https://www.youtube.com/watch?v=L8cCvAITGWM) https://www.youtube.com/watch?v=L8cCvAITGWMInvestigate - Are all metals magnetic?Explore * allow students to conduct first-hand investigations using permanent magnets and magnetic materials

Resources* [Poles of a magnet](http://www.bbc.co.uk/education/guides/zxxbkqt/revision/1) http://www.bbc.co.uk/education/guides/zxxbkqt/revision/1
* [Are all metals attracted to magnets? ApexMagnets](https://www.youtube.com/watch?v=Xgy5laDEkBU) https://www.youtube.com/watch?v=Xgy5laDEkBU
* [Exotic Elements vs. Magnet | Part 1/5 | Uranium and 40 other metals - Brainiac75](https://www.youtube.com/watch?v=62dez4tD5Ok) https://www.youtube.com/watch?v=62dez4tD5Ok
* Magnet, magnetic and non-magnetic materials, Play go fish
 | Students * identify the poles of a permanent magnet
* state law of magnetic poles
* Perform FHI to identify some magnetic materials
* list magnetic materials
* identify magnetic effect of current through a conductor
 |
| * use magnetic field lines to model qualitatively the direction and strength of magnetic fields produced by magnets, current-carrying wires and relate these fields to their effect on magnetic materials that are placed within them (ACSPH083)

**Working scientifically** - PH11-3, PH11-6, PH11-7* apply models to represent qualitatively and describe quantitatively the features of magnetic fields

**Working scientifically** - PH11-4, PH11-5, PH11-6 | Explain * magnetic field using field lines
* identify magnetic field lines as vectors
* define magnetic field strength

Explore* field lines around a straight current carrying conductor using a compass/iron filings

Resources* [Magnetic field lines](http://www.bbc.co.uk/education/guides/zxxbkqt/revision/2) http://www.bbc.co.uk/education/guides/zxxbkqt/revision/2
* [Bar magnets](http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/elemag.html) http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/elemag.html
* [Mapping Field Lines](https://www.youtube.com/watch?v=fghLhJe1JLY) https://www.youtube.com/watch?v=fghLhJe1JLY
* [Features of field lines](https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields/magnetic-field-current-carrying-wire/a/what-are-magnetic-fields) https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields/magnetic-field-current-carrying-wire/a/what-are-magnetic-fields
* Bar magnet, horseshoe magnet, Iron filings, transparency, Overhead projector, Wax paper.
* Phyphox app [Android](https://play.google.com/store/apps/details?id=de.rwth_aachen.phyphox&utm_source=global_co&utm_medium=prtnr&utm_content=Mar2515&utm_campaign=PartBadge&pcampaignid=MKT-Other-global-all-co-prtnr-py-PartBadge-Mar2515-1) [iOS](https://itunes.apple.com/us/app/phyphox/id1127319693?l=de&ls=1&mt=8): students use the magnetometer to measure field strength of objects around them.
 | Students* define magnetic field
* represent field lines around a bar magnet
* represent field lines between like and unlike poles
* use arrows, dots and crosses to represent field lines
* describe properties of field lines
* describe and apply right hand grip rule
* define magnetic field strength
 |
| * use magnetic field lines to model qualitatively the direction and strength of magnetic fields produced by solenoids and relate these fields to their effect on magnetic materials that are placed within them (ACSPH083)

**Working scientifically -** PH11-1, PH11-2, PH11-3, PH11-6 | Explore* effect of magnetic field around a conductor when a straight line conductor is turned into various 2 dimensional shapes then 3 dimensional shapes

Explain* define a solenoid
* use right hand grip rule to identify the poles of a solenoid (could be explored by students)

Resources* [Magnetic Field in a Solenoid CBSE](https://www.youtube.com/watch?v=ISg_9Wmi5J8) https://www.youtube.com/watch?v=ISg\_9Wmi5J8
* [Solenoid - DeltaStep](https://www.youtube.com/watch?v=Cj6uJcQOmf0) https://www.youtube.com/watch?v=Cj6uJcQOmf0
* [Magnetic field inside a solenoid - Jennifer](https://www.youtube.com/watch?v=qy7bIeBh-0c) Cash https://www.youtube.com/watch?v=qy7bIeBh-0c

Explore* effect of various magnetic materials placed inside a solenoid (use a solenoid, power source, compass)
 | Students* identifying that various shaped current carrying conductors produce magnetic field
* apply the right hand grip rule to identify the direction of the poles of a solenoid
* identify that various magnetic materials placed inside the solenoid enhances the effect of the magnetic field
 |
| * investigate and describe qualitatively the force produced between magnetised and magnetic materials in the context of ferromagnetic materials (ACSPH079)

**Working scientifically** - PH11-2, PH11-3 | Explore* Allow students to design and build electromagnets

Resources* [Make an electromagnet](https://sciencebob.com/make-an-electromagnet/) https://sciencebob.com/make-an-electromagnet/
* [Create an electromagnet](https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1) https://www.teachengineering.org/activities/view/cub\_mag\_lesson2\_activity1
* Iron rod, Iron nails, insulated copper wire, transformer, Paper clips, toilet paper rolls
 | Students* design and build electromagnets
 |
| * conduct investigations into and describe quantitatively the magnetic fields produced by wires and solenoids, including: (ACSPH106, ACSPH107)
* $B=\frac{μ\_{o}I}{2πr}$
* $B=\frac{μ\_{o}NI}{L}$

**Working scientifically** - PH11-3, PH11-4, PH11-5, PH11-6, PH11-7 | ExploreAmpere's law – students identify the relationship between the deflection of a compass needle and the magnitude of current flowing through a straight conductor and a solenoidResources* [Ampere’s law: definition](http://study.com/academy/lesson/amperes-law-definition-examples.html) http://study.com/academy/lesson/amperes-law-definition-examples.html
* [Ampere’s law: applications](http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/amplaw.html#c1) http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/amplaw.html#c1
* [Ampere's Law Example for a Solenoid Doc Schuster](https://www.youtube.com/watch?v=SY4A13uTSmM) - https://www.youtube.com/watch?v=SY4A13uTSmM
	+ Relationship between the deflection of a compass needle and the distance from the straight current carrying conductor
	+ Relationship between the deflection of a compass needle and the number of turns (length) through a solenoid

Explain* + Convert the relationship$ B∝\frac{1}{r} and B∝I$ to $B=\frac{μ\_{o}I}{2πr}$
* (straight current carrying conductor)
	+ apply the relationship $B∝\frac{I}{L}$ to $B=\frac{μ\_{o}NI}{L}$
* (Solenoid)

Resources* [Magnetic field strength equation Christopher Braun](https://www.youtube.com/watch?v=8YWi-kUSOaI) - (duration 7:46)
* Magnetic dip needle
 | Students* Identify the relationship between the deflection of compass needle and magnetic field strength
* Derive the relationship $B∝\frac{1}{r}$ from the results of their investigations
* Derive the relationship $B∝\frac{I}{L}$from the results of their investigations
* Solve problems applying
	+ $B=\frac{μ\_{o}I}{2πr}$
	+ $B=\frac{μ\_{o}NI}{L}$
 |
| Topic test  | Students complete a topic test as formative assessment. This may be done as [Kahoot](https://kahoot.com/)! or using Google Forms or Microsoft Forms. |  |

Reflection and evaluation: