# Sample Unit: Physics - Year 12

***Sample for implementation for Year 12 from Term 4, 2018***

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| **Unit title** | Module 6 – Electromagnetism | **Duration** |  30 hours including 4 hours for Depth Study |
| **Unit description** | Discoveries about the interactions that take place between charged particles and electric and magnetic fields not only produced significant advances in physics, but also led to important technological developments. These developments include the generation and distribution of electricity, and the invention of numerous devices that convert electrical energy into other forms of energy.Understanding the similarities and differences in the interactions of single charges in electric and magnetic fields provides students with a conceptual foundation for this module. Phenomena that include the force produced on a current-carrying wire in a magnetic field, the force between current-carrying wires, Faraday’s Law of Electromagnetic Induction, the principles of transformers and the workings of motors and generators can all be understood as instances of forces acting on moving charged particles in magnetic fields.The law of conservation of energy underpins all these interactions. The conversion of energy into forms other than the intended form is a problem that constantly drives engineers to improve designs of electromagnetic devices. |
| **Outcomes**A student:* develops and evaluates questions and hypotheses for scientific investigation PH11/12-1
* designs and evaluates investigations in order to obtain primary and secondary data and information PH11/12-2
* conducts investigations to collect valid and reliable primary and secondary data and information PH11/12-3
* selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media PH11/12-4
* analyses and evaluates primary and secondary data and information PH11/12-5
* explains and analyses the electric and magnetic interactions due to charged particles and currents and evaluates their effect both qualitatively and quantitatively PH12-13
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| **Practical Investigation**Risk assessments are to performed for all practical investigations | **Formal assessment: Depth Study – 4 hours**Modelling TaskStudents will be required to:* exhibit a model, explain the principles employed and make an evaluation during a 5 – minute interview
* submit a comprehensive logbook, and
* submit a properly referenced bibliography of their sources.
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| **Charged Particles, Conductors and Electric and Magnetic Fields** |
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| **Inquiry question:** What happens to stationary and moving charged particles when they interact with an electric or magnetic field? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** investigate and quantitatively derive and analyse the interaction between charged particles and uniform electric fields, including: (ACSPH083)
* electric field between parallel charged plates $(\left|E\right|=-\frac{V}{d})$
* acceleration of charged particles by the electric field $(F=ma, F=qE)$
* work done on the charge$ $

$$W=qV, W=qEd, KE=\frac{1}{2}mv^{2}$$ | * Students revise how to draw magnetic and electric fields and determine their direction
* Students develop understanding of how single point charges have an electric field around them and how they interact together when the charges are placed near each other using “[Electric Field](http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/Forces_and_fields_creative_commons/7304/7304_00.htm)” web resource
* Students demonstrate the electric field between parallel plates using grass seeds in oil and measure the potential at various points in the uniform electric field.
* Students investigate the motion of electrons in an “[Electron Deflection Tube](http://practicalphysics.org/electron-deflection-tube-using-electric-field.html)” using the web resource computer simulation.
* Students research and report on the relationship between work and voltage.
 | Electric Field<http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/Forces_and_fields_creative_commons/7304/7304_00.htm>Electron Deflection Tube<http://practicalphysics.org/electron-deflection-tube-using-electric-field.html> |
| **Students:*** model qualitatively and quantitatively the trajectories of charged particles in electric fields and compare them with the trajectories of projectiles in a gravitational field
 | * Students compare equations for gravitational fields with equations for electric fields
* Students perform calculations to determine range, time of flight, maximum height, initial and final velocities in a range of situations where charged particles travel through uniform electric fields.
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| **Students:*** analyse the interaction between charged particles and uniform magnetic fields, including: (ACSPH083)
* acceleration, perpendicular to the field, of charged particles
* the force on the charge $(F=qvBsinθ)$
 | * Students observe the deflection of cathode rays by magnetic fields and contrast with deflection by electric fields.
* Students use $F=qvBsinθ $to calculate force on a charge in various situations.
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| **Students:*** compare the interaction of charged particles moving in magnetic fields to:
* the interaction of charged particles with electric fields
* other examples of uniform circular motion (ACSPH108)
 | * Students compare the motion of charged particles in magnetic fields to satellites in orbit and charged particles in uniform electric fields.
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| **The Motor Effect** |
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| **Inquiry question:** Under what circumstances is a force produced on a current-carrying conductor in a magnetic field? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** investigate qualitatively and quantitatively the interaction between a current-carrying conductor and a uniform magnetic field $(F=BIlsinθ)$ to establish: (ACSPH080, ACSPH081)
* conditions under which the maximum force is produced
* the relationship between the directions of the force, magnetic field strength and current
* conditions under which no force is produced on the conductor
 | * Students investigate the motor effect of Faraday’s motor using the “[computer simulation](http://practicalphysics.org/faradays-motor.html)” web resource.
* Students conduct a series of investigations examining magnetic forces on a current-carrying wire using a current balance:
* Force vs current
* Force vs length of wire
* Force vs magnetic field strength
* Force vs angle of wire with field.
 | Computer Simulation<http://practicalphysics.org/faradays-motor.html> |
| **Students:*** conduct a quantitative investigation to demonstrate the interaction between two parallel current-carrying wires
 | * Students demonstrate or use online resources to make measurements of the force between two current-carrying wires.
 | https://www.youtube.com/watch?v=43AeuDvWc0k |
| **Students:*** analyse the interaction between two parallel current-carrying wires $(\frac{F}{l}=\frac{μ\_{0}}{2π}×\frac{l\_{1}l\_{2}}{r})$ and determine the relationship between the International System of Units (SI) definition of an ampere and Newton’s Third Law of Motion (ACSPH081, ACSPH106)
 | * Students solve problems for a range of scenarios using $(\frac{F}{l}=\frac{μ\_{0}}{2π}×\frac{l\_{1}l\_{2}}{r})$
* Students research the definition of the Ampere and present findings.
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| **Electromagnetic Induction** |
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| **Inquiry question:** How are electric and magnetic fields related? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** describe how magnetic flux can change, with reference to the relationship $Φ = BA $ (ACSPH083, ACSPH107, ACSPH109)
* analyse qualitatively and quantitatively, with reference to energy transfers and transformations, examples of Faraday’s Law and Lenz’s Law $(ε=-N\frac{ΔΦ}{Δt}) $

where $ε$ is the emf, including but not limited to: (ACSPH081, ACSPH110)* the generation of an electromotive force (emf) and evidence for Lenz’s law produced by the relative movement between a magnet, straight conductors, metal plates and solenoids
* the generation of an emf produced by the relative movement or changes in current in one solenoid in the vicinity of another solenoid
 | * Students are introduced to the concept of magnetic flux with magnets using iron filings.
* Students investigate Faraday’s law with magnets and solenoids.
* Students study animations to analyse qualitatively and quantitatively and report on Faraday’s law: [Faradays law animation](%E2%97%8F%09https%3A/phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_en.html)
* Students demonstrate and analyse Lenz’s law in various situations:
* dropping a magnet down copper/aluminium tubes
* Sliding a magnet down an aluminium sheet
* Slowing a swinging pendulum with a magnet.
* Students demonstrate the production of an emf in a solenoid with a nearby solenoid.
 | [Faradays law animation](%E2%97%8F%09https%3A/phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_en.html)<https://phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_en.html> |
| **Students:*** analyse quantitatively the operation of ideal transformers through the application of: (ACSPH110)

$$\frac{V\_{p}}{V\_{s}}=\frac{N\_{p}}{N\_{s}}$$$$V\_{p}I\_{p} = V\_{s}I\_{s}$$ | * Students perform calculations involving ideal transformers to determine primary and secondary voltages, currents and number of turns in coils.
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| **Students:*** evaluate qualitatively the limitations of the ideal transformer model and the strategies used to improve transformer efficiency, including but not limited to:
* incomplete flux linkage
* resistive heat production and eddy currents
 | * Students conduct an investigation to measure the efficiency of a transformer both with and without a soft iron core.
* Students research strategies to improve transformer efficiency and present findings.
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| **Students:*** analyse applications of step-up and step-down transformers, including but not limited to:
* the distribution of energy using high-voltage transmission lines
 | * Students research secondary sources to analyse the use of step-up and step-down transformers and report on why they are used.
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| **Applications of the Motor Effect** |
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| **Inquiry question:** How has knowledge about the Motor Effect been applied to technological advances? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** investigate the operation of a simple DC motor to analyse:
* the functions of its components
* production of a torque $\left(τ=nBIAcosθ\right)$
* effects of back emf (ACSPH108)
 | * Students construct a simple [homopolar motor](http://www.animations.physics.unsw.edu.au/jw/homopolar.htm) using the web resource.
* Student label diagrams of a DC motor and identify and analyse the function of each component.
* Students explore online animations and information to describe the [production of torque](http://www.animations.physics.unsw.edu.au/jw/electricmotors.html).
* Students analyse problems in a variety of situations with a simple DC motor, to determine torque, magnetic field strength, angles, number of turns and cross-sectional area.
 | Homopolar Motor<http://www.animations.physics.unsw.edu.au/jw/homopolar.htm>Production of Torque<http://www.animations.physics.unsw.edu.au/jw/electricmotors.html> |
| **Students:*** analyse the operation of simple DC and AC generators and AC induction motors (ACSPH110)
 | * Students analyse the operation of simple DC and AC generators and AC induction motors through research
* Students construct a table to compare and analyse the operation of generators and induction motors
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| **Students:*** relate Lenz’s law to the law of conservation of energy and apply the law of conservation of energy to:
* DC motors and
* magnetic braking
 | * Students explain how conservation of energy leads to the negative sign in

$$( ε=-N\frac{ΔΦ}{Δt})$$* Students present research to explain how Lenz’s law is related to the conservation of energy and how it applies to DC motors and magnetic braking.
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|  | **Formal Assessment: Depth Study – 4 hours**Modelling TaskStudents will be required to:* exhibit a model, explain the principles employed and make an evaluation during a 5 -minute interview
* submit a comprehensive logbook, and
* submit a properly referenced bibliography of their sources.
 |  |

**Reflection and Evaluation**

**TEACHER: CLASS:**

**DATE UNIT COMMENCED: DATE UNIT CONCLUDED:**

* **Variations to program:** (List additional resources and outline alternative strategies used)
* **The most effective teaching/learning strategies and resources in this unit were:** (Please nominate 3 at least)
* **Less effective teaching strategies and resources for this unit were:** (Please nominate 2 at least)

**TEACHER’S SIGNATURE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**DATED\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_CHECKED\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**