Level 2 Physics
ELECTRICITY AND MAGNETISM

Physics 2.6 Demonstrate understanding of electricity and electromagnetism

Electric fields

Students should be able to

- ❒ Understand the simple model of the atom
- ❒ Understand concepts of charge and neutrality
- ❒ Understand the concept of charge-carrier (free electrons, ions, electron holes) in metals and electrolytes
- ❒ Know that if there is a difference in charge between two points an electric field exists.
- ❒ Know that an electric field has both magnitude and direction.
- ❒ Know that the magnitude of the electric field is found by $E = V/d$
- ❒ Know that the unit is V/m or Vm^{-1}
- ❒ Use the equation $E = F/q$ to demonstrate that a charge will move in an electric field.
- ❒ Understand that a charged object can have potential energy by virtue of its position in an electric field.
- ❒ Use the equation $E_p = Eqd$
- ❒ Understand that the concept of electric potential energy per unit charge is called electric potential.
- ❒ Use the equation $V = E_p/q$
- ❒ Know the unit for electric potential.
- ❒ Know that electric potential is often called voltage.
- ❒ Know that 1 volt = 1 joule /1 coulomb

EMF, current, potential difference

Students should be able to:

- ❒ Know some devices that provide EMF
- ❒ Define EMF (and the Volt) in terms of work done on charge
- ❒ Understand and describe a model for current in terms of charge carrier density and drift speed.
- ❒ Use the equation $Q = I\,t$
- ❒ Know the nature and importance of insulators.
- ❒ Understand a “volt-drop” as a loss of potential and in terms of work being done by a charge
- ❒ Know that both EMF and volt-drop are “voltages” if voltage is a voltmeter reading

- ❒ Understand that EM.F. is the cause of current flow and p.d is the result

Resistance

Students should be able to:

- ❒ Define resistance in terms of volt-drop (voltage) and current.
- ❒ Define the ohm
- ❒ Understand the ***basic*** concept of resistivity of a material by using a range of metals from silver to iron.
- ❒ Know the reason for electric current flow.(change in energy)
- ❒ Understand a simple electric circuit in terms of source and load. (reason for each.)
- ❒ State Ohm's law and interpret graphically
- ❒ Understand the limitations of Ohm's law
- ❒ Understand that there are non-ohmic conductors such as lamps, thermistors, LEDs, LDRs and diodes
- ❒ Interpret non-linear graphs of V and I

Circuits and meters

Students should be able to:

- ❒ Understand the basic circuit as a close loop with equality of current in all parts
- ❒ Understand the simple one-loop circuit in terms of the EMF, voltage drop and current.
- ❒ Understand the characteristics of voltmeters and ammeters
- ❒ How to use a multimeter as an ammeter and a voltmeter and how to connect them in a circuit
- ❒ How to use a multimeter as a simple Ohmmeter and how to measure resistances (that are otherwise "unpowered")

Loops and loads

Students should be able to:

- ❒ Understand the behaviour of current and voltage drops(p.d) in multi-element series circuits.
- ❒ Understand the behaviour of current and voltage drop (p.d) in multi-element parallel circuits
- ❒ Use series and parallel combinational formulas in practical systems
- ❒ Analyse and predict voltages and current in "complex" circuits with ohmic components (and test practically)
- ❒ Use ohmmeter to measure R of a complex network
- ❒ Understand the use of variable resistors as rheostats and potentiometers.

- ❒ Understand the use and design of voltage dividers as variable voltage supplies (+limitations)

Electrical work and power

Students should be able to:

- ❒ Understand that work is done when charge moves across a potential difference (energy is changed)
- ❒ Understand that current and the potential difference determines the power in the section or component
- ❒ Use W = Q V = V I t and P = V I in practical systems
- ❒ Illustrate electric work with resistive heating
- ❒ Distinguish the power of devices/systems from the electric work/energy that is used and paid for

Magnetic Flux and field

Students should be able to:

- ❒ Understand the link between current and flux
- ❒ Understand the purpose of a small compass in determination of flux direction
- ❒ Sketch the field of a bar magnet and a U-shaped magnet
- ❒ Use “a rule” to find the direction of the magnetic field around a current carrying conductor and the magnetic polarity of a current carrying coil.
- ❒ Sketch the field round a long straight wire with current; round two long straight parallel wires with a current; round and through a solenoid with current
- ❒ Know that field is uniform within the solenoid
- ❒ Know that field strength decreases inversely with distance from a long straight current (wire)
- ❒ Understand the terms: flux, field, forces, poles in the magnetic context
- ❒ Know the units for flux and magnetic field strength.

Magnetic forces

Students should be able to:

- ❒ Understand the relation between current in a length of wire, uniform magnetic field, and the force acting on both current and magnet
- ❒ Use a “rule” to link directions of the 3 vectors
- ❒ Use F= BIL in practical systems
- ❒ Describe the operation of a simple DC motor with one coil situated in a uniform magnetic field.
- ❒ Know why a commutator is necessary in a DC motor
- ❒ Use F = B Q v in solution of particle beam systems (constant speed across field)

- ❒ Understand how a force is exerted on a electron moving through a magnetic field.
- ❒ Understand why a commutator is necessary in a DC generator.

Electromagnetic induction

Students should be able to:

- ❒ Understand the circumstances and quantities that control the production, direction and size of the induced EMF and induced current
- ❒ Understand the relationship between a conductor being moved through a magnetic field, the direction of the field and the polarity of the induced EMF in the conductor.
- ❒ Use “a rule” to link the 3 vectors.
- ❒ Use the equation E = B v l in solution of practical problems
- ❒ Understand that there are other methods (besides magnet or coil motion) for producing induced current
- ❒ Describe the operation of a simple generator with one coil turning at constant rate in a uniform magnetic field
- ❒ Know that the output EMF (and current into a resistive load) is a “sine-wave” form (AC)