## Assessment

**Assessed with a 1 hour 45 minute, 100 mark paper where all questions are answered.**

## Useful Data

| | |
|---|---|
| Speed of light in a vacuum, *c* | $3.00 \times 10^{8}$ m $s^{-1}$ |
| Elementary charge, *e* | $1.60 \times 10^{-19}$ C |
| Planck constant, *h* | $6.63 \times 10^{-34}$ J s |

## Module 1: Electric current

| You should be able to... | Unaware of this section | I am aware of this, but need to do more work | I understand this area well |
|---|---|---|---|
| **2.1.1 Charge and current** | | | |
| ...explain that electric current is a net flow of charged particles | | | |
| ...explain that electric current in a metal is due to the movement of electrons, whereas in an electrolyte the current is due to the movement of ions. | | | |
| ...explain what is meant by conventional current and electron flow. | | | |
| ...select and use the equation $\Delta Q = I\Delta t$ | | | |
| ...define the *coulomb.* | | | |
| ...describe how an ammeter may be used to measure the current in a circuit. | | | |
| ...recall and use the elementary charge $e = 1.6 \times 10^{-19}$ C | | | |
| ...describe Kirchhoff's first law and appreciate that this is a consequence of conservation of charge. | | | |
| ...state what is meant by the term *mean drift velocity* of charge carriers. | | | |
| ...select and use the equation $I = Anev$ | | | |
| ...describe the difference between conductors, semiconductors and insulators in terms of the number density *n*. | | | |

Module 2: Resistance

| You should be able to... | Unaware of this section | I am aware of this, but need to do more work | I understand this area well |
|---|---|---|---|
| **2.2.1 Circuit symbols** | | | |
| ...recall and use appropriate circuit symbols as set out in SI Units, Signs, Symbols and Abbreviations (ASE, 1981) and Signs, Symbols and Systematics (ASE, 1995) | | | |
| ...interpret and draw circuit diagrams using these symbols. | | | |
| **2.2.2 E.m.f. and p.d.** | | | |
| ...define *potential difference* (p.d.). | | | |
| ...select and use the equation $W = VQ$ | | | |
| ...define the *volt*. | | | |
| ...describe how a voltmeter may be used to determine the p.d. across a component | | | |
| ...define *electromotive force* (e.m.f.) of a source such as a cell or a power supply. | | | |
| ...describe the difference between e.m.f. and p.d. in terms of energy transfer. | | | |
| **2.2.3 Resistance** | | | |
| ...define *resistance*. | | | |
| ...select and use the equation for resistance V = I R | | | |
| ...define the *ohm*. | | | |
| ...state and use Ohm's law. | | | |
| ...describe the *I*–*V* characteristics of a resistor at constant temperature, filament lamp and light-emitting diode (LED). | | | |
| ...describe an experiment to obtain the *I*–*V* characteristics of a resistor at constant temperature, filament lamp and light-emitting diode (LED). | | | |
| ...describe the uses and benefits of using light-emitting diodes (LEDs). | | | |
| **2.2.4 Resistivity** | | | |
| ...define *resistivity* of a material. | | | |
| ...select and use the equation: $\rho = R A / L$ | | | |
| ...describe how the resistivities of metals and semiconductors are affected by temperature. | | | |
| ...describe how the resistance of a pure metal wire and of a negative temperature coefficient (NTC) thermistor is affected by temperature. | | | |
| **2.2.5 Power** | | | |
| ...describe power as the rate of energy transfer. | | | |
| ...select and use power equations: $P = VI = I^2R = V^2/R$ | | | |
| ...explain how a fuse works as a safety device. | | | |
| ...determine the correct fuse for an electrical device. | | | |
| ...select and use the equation: $W = IVt$ | | | |
| ...define the kilowatt-hour (kW h) as a unit of energy. | | | |
| ...calculate energy in kW h and the cost of this energy when solving problems. | | | |

## Module 3: DC Circuits

| You should be able to... | Unaware of this section | I am aware of this, but need to do more work | I understand this area well |
|---|---|---|---|
| **2.3.1 Series and parallel circuits** | | | |
| ... state Kirchhoff's second law and appreciate that this is a consequence of conservation of energy. | | | |
| ...apply Kirchhoff's first and second laws to circuits. | | | |
| ...select and use the equation for the total resistance of two or more resistors in series. | | | |
| ...select and use the equation for the total resistance of two or more resistors in parallel. | | | |
| ...solve circuit problems involving series and parallel circuits with one or more sources of e.m.f. | | | |
| ... explain that all sources of e.m.f. have an internal resistance. | | | |
| ...explain the meaning of the term *terminal p.d.* | | | |
| ...select and use the equations:<br>e.m.f. = $I(R + r)$<br>e.m.f. = $V + Ir$ | | | |
| **2.3.2 Practical circuits** | | | |
| ...draw a simple potential divider circuit. | | | |
| ...explain how a potential divider circuit can be used to produce a variable p.d. | | | |
| ...select and use the potential divider equation:<br>$V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in}$ | | | |
| ...describe how the resistance of a light dependent resistor (LDR) depends on the intensity of light. | | | |
| ...describe and explain the use of thermistors and light-dependent resistors in potential divider circuits. | | | |
| ...describe the advantages of using dataloggers to monitor physical changes. | | | |

## Module 4: Waves

| You should be able to... | Unaware of this section | I am aware of this, but need to do more work | I understand this area well |
|---|---|---|---|
| **2.4.1 Wave motion** | | | |
| ...describe and distinguish between progressive longitudinal and transverse waves. | | | |
| ...define and use the terms *displacement*, *amplitude*, *wavelength*, *period*, *phase difference*, *frequency* and *speed of a wave.* | | | |
| ...derive from the definitions of speed, frequency and wavelength, the wave equation: $v = f\lambda$ | | | |
| ...select and use the wave equation. | | | |
| ...explain what is meant by reflection, refraction and diffraction of waves such as sound and light. | | | |
| **2.4.2 Electromagnetic waves** | | | |
| ...state typical values for the wavelengths of the different regions of the electromagnetic spectrum from radio waves to X-rays. | | | |
| ...state that all electromagnetic waves travel at the same speed in a vacuum. | | | |
| ...describe differences and similarities between different regions of the electromagnetic spectrum. | | | |
| ...describe some of the practical uses of electromagnetic waves. | | | |
| ...describe the characteristics and dangers of UV-A, UV-B and UV-C radiations and explain the role of sunscreen. | | | |
| ...explain what is meant by plane polarised waves and understand the polarisation of electromagnetic waves. | | | |
| ...explain that polarisation is a phenomenon associated with transverse waves only. | | | |
| ...state that light is partially polarised on reflection. | | | |
| ...recall and apply Malus's law for transmitted intensity of light from a polarising filter. | | | |
| **2.4.3 Interference** | | | |
| ...state and use the principle of superposition of waves. | | | |
| ...apply graphical methods to illustrate the principle of superposition. | | | |
| ...explain the terms *interference*, *coherence*, *path difference* and *phase difference*. | | | |
| ..state what is meant by constructive interference and destructive interference. | | | |
| ...describe experiments that demonstrate two source interference using sound, light and microwaves. | | | |
| ...describe constructive interference and destructive interference in terms of path difference and phase difference. | | | |
| ...use the relationships: intensity = power/cross-sectional area; intensity $\alpha$ amplitude$^2$ | | | |
| ...describe the Young double-slit experiment and explain how it is a classical confirmation of the wave-nature of light. | | | |

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|---|---|---|---|
| | | | |
| ...select and use the equation:<br>$\lambda = ax/D$<br>for electromagnetic waves. | | | |
| ...describe an experiment to determine the wavelength of monochromatic light using a laser and a double slit. | | | |
| ...describe the use of a diffraction grating to determine the wavelength of light (the structure and use of a spectrometer are not required). | | | |
| ...select and use the equation:<br>$d\sin\theta = n\lambda$ | | | |
| ...explain the advantages of using multiple slits in an experiment to find the wavelength of light. | | | |
| **2.4.4 Stationary waves** | | | |
| ...explain the formation of stationary (standing) waves using graphical methods. | | | |
| ...describe the similarities and differences between progressive and stationary waves. | | | |
| ...define the terms *nodes* and *antinodes.* | | | |
| ...describe experiments to demonstrate stationary waves using microwaves, stretched strings and air columns. | | | |
| ...determine the standing wave patterns for stretched string and air columns in closed and open pipes. | | | |
| ...use the equation:<br>separation between adjacent nodes (or antinodes) = $\lambda/2$ | | | |
| ...define and use the terms *fundamental mode of vibration* and *harmonics.* | | | |
| ...determine the speed of sound in air from measurements on stationary waves in a pipe closed at one end. | | | |

## Module 5: Quantum Physics

| You should be able to... | Unaware of this section | I am aware of this, but need to do more work | I understand this area well |
|---|---|---|---|
| **2.5.1 Energy of a photon** | | | |
| ...describe the particulate nature (photon model) of electromagnetic radiation. | | | |
| ...state that a photon is a quantum of energy of electromagnetic radiation. | | | |
| ...select and use the equations for the energy of a photon: $E = hf$ and $E = hc / \lambda$ | | | |
| ...define and use the electronvolt (eV) as a unit of energy. | | | |
| ...use the transfer equation $eV = \frac{1}{2} mv^2$ for electrons and other charged particles. | | | |
| ...describe an experiment using LEDs to estimate the Planck constant $h$ using the equation $eV = hc / \lambda$ | | | |
| **2.5.2 The photoelectric effect** | | | |
| ...describe and explain the phenomenon of the photoelectric effect. | | | |
| ...explain that the photoelectric effect provides evidence for a particulate nature of electromagnetic radiation while phenomena such as interference and diffraction provide evidence for a wave nature. | | | |
| ...define and use the terms *work function* and *threshold frequency.* | | | |
| ...state that energy is conserved when a photon interacts with an electron. | | | |
| ...select, explain and use Einstein's photoelectric equation: $hf = \Phi + KE_{max}$ | | | |
| ...explain why the maximum kinetic energy of the electrons is independent of intensity and why the photoelectric current in a photocell circuit is proportional to intensity of the incident radiation. | | | |
| **2.5.3 Wave–particle duality** | | | |
| ...explain electron diffraction as evidence for the wave nature of particles like electrons. | | | |
| ...explain that electrons travelling through polycrystalline graphite will be diffracted by the atoms and the spacing between the atoms. | | | |
| ...select and apply the de Broglie equation $\lambda = h / mv$ | | | |
| ...explain that the diffraction of electrons by matter can be used to determine the arrangement of atoms and the size of nuclei. | | | |
| **2.5.4 Energy levels in atoms** | | | |
| ...explain how spectral lines are evidence for the existence of discrete energy levels in isolated atoms, ie in a gas discharge lamp | | | |
| ...describe the origin of emission and absorption line spectra. | | | |
| ...use the relationships: $hf = E_1 - E_2$ and $hc/\lambda = E_1 - E_2$ | | | |