# Programme of Study – Year 11 Physics 2023-24 (Cambridge)

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| | Theme | Overview of key learning to take place | How learning will be assessed |
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| Term 1 | Unit 3: waves | **3.3: Electromagnetic spectrum**<br>• I can identify the main regions of the electromagnetic spectrum in order of frequency and in order of wavelength<br>• I can identify that all electromagnetic waves travel at the same high speed in a vacuum<br>• I can describe typical uses of the different regions of the electromagnetic spectrum including:<br>(a) radio waves; radio and television transmissions, astronomy, radio frequency identification (RFID)<br>(b) microwaves; satellite television, mobile phones (cell phones), microwave ovens<br>(c) infrared; electric grills, short range communications such as remote controllers for televisions, intruder alarms, thermal imaging, optical fibres<br>(d) visible light; vision, photography, illumination<br>(e) ultraviolet; security marking, detecting fake bank notes, sterilising water<br>(f) X-rays; medical scanning, security scanners<br>(g) gamma rays; sterilising food and medical equipment, detection of cancer and its treatment<br>• I can describe the harmful effects on people of excessive exposure to electromagnetic radiation, including:<br>(a) microwaves; internal heating of body cells<br>(b) infrared; skin burns<br>(c) ultraviolet; damage to surface cells and eyes, leading | **Examples of Formative Assessment to be used this term:**<br>In class peer and self-assessment of extended answer questions<br>Homework questions<br><br>**Summative assessment:**<br>Baseline assessment<br>Mid-term assessment (Unit 3 and 4)<br>End of term assessment (Until 1-4) |

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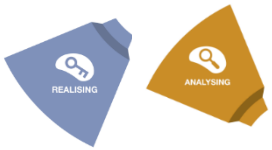
| | | to skin cancer and eye conditions<br>(d) X-rays and gamma rays; mutation or damage to cells in the body<br>• I can identify that the speed of electromagnetic waves in a vacuum is 3.0 × 108m/s and is approximately the same in air<br>• I can identify that communication with artificial satellites is mainly by microwaves:<br>(a) some satellite phones use low orbit artificial satellites<br>(b) some satellite phones and direct broadcast satellite television use geostationary satellites<br>• I can identify that many important systems of communications rely on electromagnetic radiation including:<br>(a) mobile phones (cell phones) and wireless internet use microwaves because microwaves can penetrate some walls and only require a short aerial for transmission and reception<br>(b) Bluetooth uses radio waves because radio waves pass through walls but the signal is weakened on doing so<br>(c) optical fibres (visible light or infrared) are used for cable television and high-speed broadband because glass is transparent to visible light and some infrared; visible light and short wavelength infrared can carry high rates of data<br>• I can identify the difference between a digital and analogue signal<br>• I can identify that a sound can be transmitted as a digital or analogue signal<br>• In can explain the benefits of digital signaling including increased rate of transmission of data and increased range due to accurate signal regeneration | |
| Term 1 | Unit 4- Electricity and magnetism | **4.2.1: Electric charge**<br><br><br>• I can state that there are positive and negative charges | |

- I can state that positive charges repel other positive charges, negative charges repel other negative charges, but positive charges attract negative charges
- I can describe simple experiments to show the production of electrostatic charges by friction and to show the detection of electrostatic charges
- I can explain that charging of solids by friction involves only a transfer of negative charge (electrons)
- I can describe an experiment to distinguish between electrical conductors and insulators
- I can recall and use a simple electron model to explain the difference between electrical conductors and insulators and give typical examples
- I can state that charge is measured in coulombs
- I can describe an electric field as a region in which an electric charge experiences a force
- I can state that the direction of an electric field at a point is the direction of the force on a positive charge at that point
- I can describe simple electric field patterns, including the direction of the field:
  (a) around a point charge
  (b) around a charged conducting sphere
  (c) between two oppositely charged parallel conducting plates (end effects will not be examined)

### 4.2.2: Electric Current

- I can identify that electric current is related to the flow of charge
- I can describe the use of ammeters (analogue and digital) with different ranges
- I can describe electrical conduction in metals in terms of the movement of free electrons
- I can identify the difference between direct current (d.c.) and alternating current (a.c.)
- I can define electric current as the charge passing a point per unit time; recall and use the equation $I = Q t$

- I can state that conventional current is from positive to negative and that the flow of free electrons is from negative to positive

### 4.2.3: Electromotive force and Potential difference

- I can define electromotive force (e.m.f.) as the electrical work done by a source in moving a unit charge around a complete circuit
- I can identify that e.m.f. is measured in volts (V)
- I can define potential difference (p.d.) as the work done by a unit charge passing through a component
- I can know that the p.d. between two points is measured in volts (V)
- I can describe the use of voltmeters (analogue and digital) with different ranges
- I can recall and use the equation for e.m.f. $E = W/Q$
- I can recall and use the equation for p.d. $V = W/Q$
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### 4.2.4: Resistance

- I can recall and use the equation for resistance $R = V/I$
- I can describe an experiment to determine resistance using a voltmeter and an ammeter and do the appropriate calculations
- I can state, qualitatively, the relationship of the resistance of a metallic wire to its length and to its cross-sectional area
- I can sketch and explain the current–voltage graphs for a resistor of constant resistance, a filament lamp and a diode

- I can recall and use the following relationship for a metallic electrical conductor:

(a) resistance is directly proportional to length
(b) resistance is inversely proportional to cross-sectional area

### 4.2.5: Electrical energy and electrical power

- I can understand that electric circuits transfer energy from a source of electrical energy,such as an electrical cell.
- I can recall and use the equation for electrical power P=IV
- I can recall and use the equation for electrical energy E = IVt
- I can define the kilowatt-hour (kW h) and calculate the cost of using electrical appliances where the energy unit is the kW h
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### 4.3 Electric Circuit
### 4.3.1 Circuit diagrams and circuit componets

- I can draw and interpret circuit diagrams containing cells, batteries, power supplies, generators, potential dividers, switches, resistors (fixed and variable), heaters, thermistors (NTC only), light-dependent resistors (LDRs), lamps, motors, ammeters, voltmeters, magnetising coils, transformers, fuses and relays, and know how these components behave in the circuit

- I can draw and interpret circuit diagrams containing diodes and light-emitting diodes (LEDs), and know how these components behave in the circuit

### 4.3.2 Series and parallel circuits

- I can know that the current at every point in a series circuit is the same
- I can know how to construct and use series and parallel circuits
- I can calculate the combined e.m.f. of several sources in series
- I can calculate the combined resistance of two or more resistors in series
- I can state that, for a parallel circuit, the current from the source is larger than the current in each branch
- I can state that the combined resistance of two resistors in parallel is less than that of either
- resistor by itself
  I can state the advantages of connecting lamps in parallel in a lighting circuit
- I can describe that electric circuits transfer energy from the battery or power source to the circuit components then into the surroundings and use the equation P=IV and E= IVT.
- I can identify the hazards of:
  — damaged insulation
  — overheating of cables
  — damp conditions
- I can explain the use of fuses, earthing metal cases and circuit breakers and choose appropriate fuse ratings and circuit breaker settings.
- I can Recall and use in calculations, the fact that:
  (a) the sum of the currents entering a junction
  in a parallel circuit is equal to the sum of the

currents that leave the junction
(b) the total p.d. across the components in a series circuit is equal to the sum of the individual p.d.s across each component
(c) the p.d. across an arrangement of parallel resistances is the same as the p.d. across one branch in the arrangement of the parallel resistances

- I can explain that the sum of the currents into a junction is the same as the sum of the currents out of the junction
- I can calculate the combined resistance of two resistors in parallel

### 4.3.3 Action and use of circuit components

- I can know that the p.d. across an electrical conductor increases as its resistance increases for a constant current
- I can describe the action of a variable potential divider

Recall and use the equation for two resistors used as a potential divider R1/R2 = V1/V2

### 4.4 Electrical safety

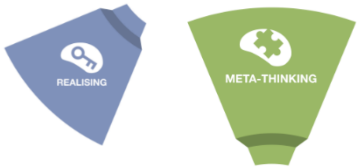


- I can state the hazards of:
  (a) damaged insulation (b) overheating cables
  (c) damp conditions (d) excess current from overloading of plugs, extension leads, single and multiple sockets when using a mains supply
- I can know that a mains circuit consists of a live wire (line wire), a neutral wire and an earth wire and explain why a switch must be connected to the live wire for the circuit to be switched off safely

- I can explain the use and operation of trip switches and fuses and choose appropriate fuse ratings and trip switch settings
- I can explain why the outer casing of an electrical appliance must be either non-conducting (double-insulated) or earthed
- I can state that a fuse without an earth wire protects the circuit and the cabling for a double-insulated Appliance

## 4.5 Electromagnetic effects

### 4.5.1 Electromagnetic induction




- I can know that a conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an e.m.f. in the conductor
- I can describe an experiment to demonstrate electromagnetic induction
- I can state the factors affecting the magnitude of an induced e.m.f.
- I can know that the direction of an induced e.m.f. opposes the change causing it
- I can state and use the relative directions of force, field and induced current

### 4.5.2 The a.c. generator


- I can describe a simple form of a.c. generator (rotating coil or rotating magnet) and the use of slip rings and brushes where needed
- I can sketch and interpret graphs of e.m.f. against time

for simple a.c. generators and relate the position of the generator coil to the peaks, troughs and zeros of the e.m.f.

### 4.5.3 Magnetic effect of a current

META-THINKING

- I can describe the pattern and direction of the magnetic field due to currents in straight wires and in solenoids
- I can describe an experiment to identify the pattern of the magnetic field (including direction) due to currents in straight wires and in solenoids
- I can describe how the magnetic effect of a current is used in relays and loudspeakers and give examples of their application
- I can state the qualitative variation of the strength of the magnetic field around straight wires and solenoids
- I can describe the effect on the magnetic field around straight wires and solenoids of changing the magnitude and direction of the current

### 4.5.4 Force on a current-carrying conductor

META-THINKING

- I can describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing:
  (a) the current
  (b) the direction of the field
- I can recall and use the relative directions of force, magnetic field and current
- I can determine the direction of the force on beams of charged particles in a magnetic field

### 4.5.5 The d.c. motor

- I can know that a current-carrying coil in a magnetic field may experience a turning effect and that the turning effect is increased by increasing:
  (a) the number of turns on the coil
  (b) the current
  (c) the strength of the magnetic field
- I can describe the operation of an electric motor, including the action of a split-ring commutator and brushes

### 4.5.6 The transformer

- I can describe the construction of a simple transformer with a soft iron core, as used for voltage transformations
- I can use the terms primary, secondary, step-up and step-down
- I can recall and use the equation Vp/Vs = Np/Ns where p and s refer to primary and secondary
- I can describe the use of transformers in high-voltage

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| | | transmission of electricity<br>• I can state the advantages of high-voltage transmission<br>• I can explain the principle of operation of a simple iron-cored transformer<br>• I can recall and use the equation for 100% efficiency in a transformer IpVp = IsVs<br>where p and s refer to primary and secondary<br>• I can recall and use the equation P = I2R to explain why power losses in cables are smaller when the voltage is greater | |

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| **Term 2** | Unit 5<br>Nuclear physics | **5.1 The nuclear model of the atom**<br>**5.1.1 The atom**<br>• I can describe the structure of an atom in terms of a positively charged nucleus and negatively charged electrons in orbit around the nucleus<br>• I can know how atoms may form positive ions by losing electrons or form negative ions by gaining Electrons<br>• I can describe how the scattering of alpha (α) particles by a sheet of thin metal supports the nuclear model of the atom, by providing evidence for:<br>(a) a very small nucleus surrounded by mostly empty space<br>(b) a nucleus containing most of the mass of the atom<br>(c) a nucleus that is positively charged | **Examples of Formative Assessment to be used this term:**<br>In class peer and self-assessment of extended answer questions<br>Homework questions |

### 5.1.2 The nucleus

- I can describe the composition of the nucleus in terms of protons and neutrons
- I can state the relative charges of protons, neutrons and electrons as +1, 0 and –1 respectively
- I can define the terms proton number (atomic number) Z and nucleon number (mass number) A and be able to calculate the number of neutrons in a nucleus
- I can use the nuclide notation
- I can explain what is meant by an isotope and state that an element may have more than one isotope
- I can describe the processes of nuclear fission and nuclear fusion as the splitting or joining of nuclei, to include the nuclide equation and qualitative description of mass and energy changes without values
- I can know the relationship between the proton number and the relative charge on a nucleus
- I can know the relationship between the nucleon number and the relative mass of a nucleus

### 5.2 Radioactivity
### 5.2.1 Detection of radioactivity

- I can know what is meant by background radiation
- I can know the sources that make a significant contribution to background radiation including:
  (a) radon gas (in the air)
  (b) rocks and buildings
  (c) food and drink

**Summative assessment:**
Mock exams -
Unit 1 to 6:
Paper 2
Paper 4 and
Paper 6

Unit 5
Nuclear physics

(d) cosmic rays

- I can know that ionising nuclear radiation can be measured using a detector connected to a counter
- I can use count rate measured in counts / s or counts / minute
- I can use measurements of background radiation to determine a corrected count rate

### 5.2.2 The three types of nuclear emission

Unit 5
Nuclear physics

- I can describe the emission of radiation from a nucleus as spontaneous and random in direction
- I can identify alpha (α), beta (β) and gamma (γ) emissions from the nucleus by recalling:
  (a) their nature
  (b) their relative ionising effects
  (c) their relative penetrating abilities (β+ are not included, β-particles will be taken to refer to β–)
- I can describe the deflection of α-particles, β-particles and γ-radiation in electric fields and magnetic fields
- I can explain their relative ionising effects with reference to:
  (a) kinetic energy

(b) electric charge

### 5.2.3 Radioactive decay

- I can know that radioactive decay is a change in an unstable nucleus that can result in the emission of α-particles or β-particles and/or γ-radiation and know that these changes are spontaneous and random
- I can state that during α-decay or β-decay, the nucleus changes to that of a different element
- I can know that isotopes of an element may be radioactive due to an excess of neutrons in the nucleus and/or the nucleus being too heavy
- I can describe the effect of α-decay, β-decay and γ-emissions on the nucleus, including an increase in stability and a reduction in the number of excess neutrons; the following change in the nucleus occurs during β-emission
  neutron → proton + electron
- I can use decay equations, using nuclide notation, to show the emission of α-particles, β-particles and γ-radiation

### 5.2.4 Half-life

Unit 5
Nuclear physics

- I can define the half-life of a particular isotope as the time taken for half the nuclei of that isotope in any sample to decay; recall and use this definition in simple calculations, which might involve information in tables or decay curves (calculations will not include background radiation)

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| | | • I can calculate half-life from data or decay curves from which background radiation has not been subtracted<br>• I can explain how the type of radiation emitted and the half-life of an isotope determine which isotope is used for applications including:<br>(a) household fire (smoke) alarms<br>(b) irradiating food to kill bacteria<br>(c) sterilisation of equipment using gamma rays<br>(d) measuring and controlling thicknesses of materials with the choice of radiations used linked to penetration and absorption<br>(e) diagnosis and treatment of cancer using gamma rays<br><br>**5.2.5 Safety precautions**<br><br>• I can state the effects of ionising nuclear radiations on living things, including cell death, mutations and cancer<br>• I can describe how radioactive materials are moved, used and stored in a safe way<br>• I can explain safety precautions for all ionising radiation in terms of reducing exposure time, increasing distance between source and living tissue and using shielding to absorb radiation | |
| **Term 2** | Unit 6<br>Space Physics | **6.1 Earth and the Solar System**<br>**6.1.1 The Earth**<br><br>• I can know that the Earth is a planet that rotates on its axis, which is tilted, once in approximately 24 hours, and use this to explain observations | **Examples of Formative Assessment to be used this term:**<br>In class peer and self-assessment of extended answer questions<br>Homework questions<br><br>**Summative assessment:**<br>Mock exams -<br>Unit 1 to 6: |

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| | Unit 6<br>Space Physics | of the apparent daily motion of the Sun and the periodic cycle of day and night<br>• I can know that the Earth orbits the Sun once in approximately 365 days and use this to explain the periodic nature of the seasons<br>• I can know that it takes approximately one month for the Moon to orbit the Earth and use this to explain the periodic nature of the Moon's cycle of Phases<br>• I can define average orbital speed from the equation $v = 2\pi r / T$ where r is the average radius of the orbit and T is the orbital period; recall and use this equation<br><br>**6.1.2 The Solar System**<br><br>• I can describe the Solar System as containing:<br>(a) one star, the Sun<br>(b) the eight named planets and know their order from the Sun<br>• (c) minor planets that orbit the Sun, including dwarf planets such as Pluto and asteroids in the asteroid belt<br>(d) moons, that orbit the planets<br>(e) smaller Solar System bodies, including comets and natural satellites<br>• I can know that, in comparison to each other, the four planets nearest the Sun are rocky and small and the four planets furthest from the Sun are gaseous and large, and explain this difference by referring to an accretion model for Solar System formation, to include:<br>(a) the model's dependence on gravity<br>(b) the presence of many elements in interstellar clouds of gas and dust<br>(c) the rotation of material in the cloud and the formation of an accretion disc | Paper 2<br>Paper 4 and<br>Paper 6 |

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| | Unit 6<br>Space Physics | • I can know that the strength of the gravitational field (a) at the surface of a planet depends on the mass of the planet (b) around a planet decreases as the distance from the planet increases<br>• I can calculate the time it takes light to travel a significant distance such as between objects in the Solar System<br>• I can know that the Sun contains most of the mass of the Solar System and this explains why the planets orbit the Sun<br>• I can know that the force that keeps an object in orbit around the Sun is the gravitational attraction of the Sun<br>• I can know that planets, minor planets and comets have elliptical orbits, and recall that the Sun is not at the centre of the elliptical orbit, except when the orbit is approximately circular<br>• I can analyse and interpret planetary data about orbital distance, orbital duration, density, surface temperature and uniform gravitational field strength at the planet's surface<br>• I can know that the strength of the Sun's gravitational field decreases and that the orbital speeds of the planets decrease as the distance from the Sun increases<br>• I can know that an object in an elliptical orbit travels faster when closer to the Sun and explain this using the conservation of energy<br><br>**6.2 Stars and the Universe**<br>**6.2.1 The Sun as a star**<br><br>• I can know that the Sun is a star of medium size, consisting mostly of hydrogen and helium, and that it radiates most of its energy in the | |

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| | Unit 6<br>Space Physics | infrared, visible and ultraviolet regions of the electromagnetic spectrum<br>• I can know that stars are powered by nuclear reactions that release energy and that in stable stars the nuclear reactions involve the fusion of hydrogen into helium<br><br>**6.2.2 Stars**<br><br>• I can state that:<br>(a) galaxies are each made up of many billions of stars<br>(b) the Sun is a star in the galaxy known as the Milky Way<br>(c) other stars that make up the Milky Way are much further away from the Earth than the Sun is from the Earth<br>(d) astronomical distances can be measured in light-years, where one light-year is the distance travelled in (the vacuum of) space by light in one year<br>• I can know that one light-year is equal to 9.5 × 1015 m<br>• I can describe the life cycle of a star:<br>(a) a star is formed from interstellar clouds of gas and dust that contain hydrogen<br>(b) a protostar is an interstellar cloud collapsing and increasing in temperature as a result of its internal gravitational attraction<br>(c) a protostar becomes a stable star when the inward force of gravitational attraction is balanced by an outward force due to the high temperature in the centre of the star<br>(d) all stars eventually run out of hydrogen as fuel for the nuclear reaction | |

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| | Unit 6<br>Space Physics | (e) most stars expand to form red giants and more massive stars expand to form red supergiant when most of the hydrogen in the centre of the star has been converted to helium<br>(f) a red giant from a less massive star forms a planetary nebula with a white dwarf star at its centre<br>(g) a red supergiant explodes as a supernova, forming a nebula containing hydrogen and new heavier elements, leaving behind a neutron star or a black hole at its centre<br>(h) the nebula from a supernova may form new stars with orbiting planets<br><br>**6.2.3 The Universe**<br><br>META-THINKING<br><br>• I can know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years<br>• I can describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies<br>• I can know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth<br>• I can know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory<br>• I can know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)<br>• I acn explain that the CMBR was produced shortly | |

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| | | after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded<br>• I can know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy’s starlight due to redshift<br>• I can know that the distance of a far galaxy d can be determined using the brightness of a supernova in that galaxy<br>• I can define the Hubble constant H0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance from the Earth; recall and use the equation<br>• H0 = v/d<br>• I can know that the current estimate for H0 is 2.2 × 10–18 per second<br>• I can know that the equation d/v = 1/H0 represents an estimate for the age of the Universe and that this is evidence for the idea that all the matter in the Universe was present at a single point | |