Revision summary

Use the following summary of syllabus dot points and key knowledge within Module 6 to ensure that you have thoroughly reviewed the content. Provide a brief definition or comment for each item to demonstrate your understanding or code them using the traffic light system – green (all good); amber (needs some review); red (priority area to review). Alternatively, write a follow-up strategy.

Charged particles, conductors, and electric and magnetic fields	
Define 'charge' and 'electric field'.	
Identify that charge is a fundamental property of matter.	
Describe how electric fields are created.	
Describe how electric field lines are used to represent electric fields, including direction and density.	
Describe how two parallel plates can be used to make a uniform electric field.	
Define 'potential difference', 'electric potential' and 'electrical potential energy'.	
Identify that the electric field between two oppositely charged parallel plates is $E = \frac{V}{d}$.	
Use $E = \frac{V}{d}$ to solve problems involving electric fields between parallel plates.	
Explain why and how a charged particle can be accelerated in a uniform electric field.	
Identify that the force on a charged particle is given by $F = qE$ and $F = ma$, and use these equations to solve problems involving acceleration and force on charged particles in uniform electric fields.	

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Show that the work done on a charged particle in a uniform field is given by $W = qEd$, and thus derive $W = qV$.	
Use conservation of energy to describe the energy conversions occurring for an accelerating charged particle: $\Delta U + \Delta K = 0$ and thus $\Delta U = -\Delta K$.	
Use $W = qEd$, $W = qV$ and $K = \frac{mv^2}{2}$ to solve problems involving accelerating charged particles in a uniform electric field.	
Describe the force acting on both positively and negatively charged particles in a uniform electric field.	
Compare the acceleration of a charged particle moving perpendicular/parallel to an electric field.	
Identify that the initial velocity of a charged particle entering a field can be broken into components $u_{\parallel} = u\cos\theta$ (parallel) and $u_{\perp} = u\sin\theta$ (perpendicular).	
Compare the velocity and acceleration of a charged particle parallel/perpendicular to the uniform electric field to the velocity and acceleration of a mass parallel/perpendicular to a uniform gravitational field.	
Identify and explain why a charged particle moving in a uniform electric field will undergo projectile motion.	
Use the equations of projectile motion and equations involving charged particles in uniform electric fields to solve mathematical problems.	
Identify that magnetic fields are created by moving charged particles and can be described by magnetic field lines, and that a uniform magnetic field can be created by a current-carrying coil of wire.	
Compare the forces acting on stationary and moving charged particles in electric and magnetic fields.	
Identify the factors that affect the force on a moving charged particle in a magnetic field: charge, speed, field strength, and direction of motion relative to a magnetic field.	

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Use the formula $F = qv_{\perp}B = qvB\sin\theta$ to solve problems involving charged particles in magnetic fields.	
Describe and use the right-hand rule to find the direction of force on a moving charged particle in a magnetic field.	
Describe and calculate the acceleration on a moving charged particle in a uniform magnetic field using $a = \frac{F}{m} = \frac{qvB\sin\theta}{m}$.	
Identify that for a charged particle entering the field at 90°, the force is perpendicular to velocity and, hence, the path of the charged particle is circular and equations for uniform circular motion apply.	
Derive and use the formula for radius of the circular path of a charged particle in a uniform magnetic field: $r = \frac{mv}{qB}$.	
Derive and use the formula for the period of a charged particle in a uniform magnetic field: $T = \frac{2\pi m}{qB}$.	
Describe and explain other types of forces that can cause uniform circular motion: • gravitational • electrostatic • tension.	
Compare the causes and effects of uniform circular motion for a range of situations (car turning a corner, electron orbiting its nucleus, rock on a string) with a charged particle in a uniform magnetic field.	
Perform calculations involving uniform circular motion.	
Explain why no work is done on a charged particle that moves in uniform circular motion.	
Compare features of the motion of charged particles in electric and magnetic fields: • path shape • velocity • acceleration • force.	

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››	The motor effect	
	Describe the motor effect as the force on a current-carrying conductor in a magnetic field.	
	Describe why a current-carrying conductor experiences a force in a magnetic field.	
	Show that $F = lI_{\perp}B = lIB\sin\theta$ by using $I = \frac{q}{t}$ and $F = qvB\sin\theta$.	
	Identify and describe factors that affect the force on a current-carrying conductor in a magnetic field: field strength, current, length of conductor, angle of conductor to field.	
	Describe how the force on a current-carrying conductor changes as the angle to the field changes, identifying when maximum and zero force is produced.	
	Use $F = lI_{\perp}B = lIB\sin\theta$ to solve mathematical problems involving force on current-carrying conductors.	
	Describe and use the right-hand rule to determine the direction of force on a current-carrying conductor in a magnetic field.	
	Describe magnetic field as the force per unit current, per unit length, on a current-carrying wire in a magnetic field: $B = \frac{F}{lI\sin\theta}$.	
	Explain why a force is generated between two current-carrying wires because of their magnetic fields.	
	Identify factors that affect the size of the force between two current-carrying wires: current, length of wire, distance of separation of wires.	
	Identify that the force between two current-carrying wires is attractive when current is in the same direction and repulsive when current is in opposite directions.	
	Explain why the force between two current-carrying wires is an example of Newton's third law.	

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Use $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$ to solve problems involving forces between two parallel current-carrying wires.	
Define 'ampere'.	
Explain how the definition of the ampere gives the value of the constant μ_0, the permeability of free space.	
Explain how Newton's third law is related to the definition of the ampere.	
Electromagnetic induction	
Define 'electromagnetic induction' and 'magnetic flux'.	
Identify the factors that affect magnetic flux: size of magnetic field, area of field, angle between field vector and area.	
Use $\Phi = B_{\parallel}A = BA\cos\theta$ to solve problems involving magnetic flux.	
Describe how magnetic flux varies as the area vector goes from 0° to the field, through to 90° to the field.	
Identify that emf will be induced in a coil of wire that rotates in a magnetic field and explain the process by which this occurs.	
Define 'electromotive force (emf)' and 'induced emf'.	
Describe how an induced emf is produced.	
State Faraday's law.	

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Identify that the magnitude of induced emf in a single loop is given by $\varepsilon = \frac{-(\Phi_f - \Phi_i)}{\Delta t} = -\frac{\Delta\Phi}{\Delta t}$.	
By use of $\Phi = BA\cos\theta$ and $\varepsilon = -\frac{\Delta\Phi}{\Delta t}$, identify different ways to induce an emf: change magnetic field, change area, change angle between area and field.	
Describe how an emf can be induced by: • using an alternating current (AC) • spinning a loop of wire in a magnetic field.	
Explain how using multiple loops of wire create a larger induced emf $\varepsilon = -\frac{N\Delta\Phi}{\Delta t}$.	
Solve mathematical problems involving Faraday's law and induced emf.	
State Lenz's law.	
Describe Lenz's law in terms of conservation of energy.	
Use Lenz's law to predict the direction of current in a variety of situations, including magnets, straight conductors, metal plates and solenoids.	
Explain how eddy currents form in metals as a result of a changing magnetic field.	
Use Lenz's law to predict the direction of eddy currents in metals.	
Explain why AC must be used for a transformer rather than DC.	
Sketch graphs to show the sinusoidal nature of AC current.	

›› Define 'flux linkage'.	
Draw diagrams to help describe the structure of a transformer using a ferromagnetic core.	
Use Faraday's law to explain how a transformer uses flux linkage to induce emf in the second coil.	
Use Faraday's law equation to show why $\frac{V_p}{V_s} = \frac{N_p}{N_s}$.	
Describe what is meant by an 'ideal' transformer.	
Show why $V_p I_p = V_s I_s$ in an ideal transformer.	
Use $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ and $V_p I_p = V_s I_s$ to solve transformer problems.	
Describe step-up and step-down transformers in terms of number of coils.	
Describe the effect on current and voltage in both step-up and step-down transformers.	
Perform calculations involving step-up and step-down transformers.	
Analyse uses of step-up transformers, including power station electricity distribution and appliances using more than 240 V.	
Analyse uses of step-down transformers, including electricity distribution substations and appliances using less than 240 V.	››

›› Describe the distribution of electricity from power station to home, including the following steps/devices: • step-up transformers at power station • high-voltage transmission lines • step-down transformers at substations • power pole and household transformers.	
Describe why incomplete flux linkage in transformers occurs.	
Describe the formation of eddy currents in the ferromagnetic core and how it leads to heating of the core and energy loss in a transformer.	
Describe how lamination of the core reduces eddy currents and reduces energy loss in a transformer.	
Describe resistive heating in the primary and secondary coils and how this leads to energy loss in a transformer.	
Applications of the motor effect	
Describe a DC motor as a device to convert electrical potential energy into kinetic energy.	
Describe the forces acting on a coil in a magnetic field due to the current in the coil.	
Explain why a coil in a magnetic field will spin as a result of the generation of a torque.	
Explain why a coil in a magnetic field will oscillate back and forth through 180° when direct current is fed into the coil and hence why the current in the coil must be reversed each half-cycle to ensure constant rotation.	
Explain when torque on a coil in a magnetic field is at a maximum and a minimum.	
Identify factors that affect torque on a coil in a magnetic field: magnetic field strength, current, area of coil, angle of coil to the field and number of coils in the armature.	››

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Use $\tau = nIA_{\perp}B = nBIA\sin\theta$ to solve problems involving torque on a coil.	
Describe components of a DC motor, including drawing labelled diagrams: • stator – motor casing, magnets, brushes • rotor – armature, coils, commutator.	
Explain the purpose and operation of commutators and brushes.	
Explain why the number of coils in an armature, or number of loops in a coil affects the torque produced.	
Explain why the torque on a single coil varies sinusoidally as it rotates.	
Explain why motors use multiple coils.	
Explain why motor magnets have a semicircular shape.	
Define 'supplied emf' and 'back emf'.	
Use Lenz's law to explain how a back emf is induced.	
Explain why the back emf is in the opposite direction to the supplied emf.	
Outline the consequences of back emf in a motor.	
Describe generators as devices that convert kinetic energy into electrical potential energy, creating a current in a coil.	

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Describe and draw the structure of an AC generator, including armature, carbon brushes, magnets, external circuit.	
Explain how a current is generated by the motion of a coil inside a magnetic field.	
Describe how the generated current passes into an external circuit.	
Plot graphs of: • flux against time • emf against time.	
Relate graphs of flux against time and emf against time to the position of the coil in the magnetic field (perpendicular, parallel etc.).	
Explain, using the slope of the flux–time graph, why the emf is the negative of the rate of change of flux.	
Describe the structure of an AC induction motor: • stator coils • squirrel cage rotor • AC-induced changing magnetic field.	
Explain the operation of an AC induction motor.	
Describe uses of AC induction motors.	
Explain why Lenz's law is a statement of the law of conservation of energy.	
Describe how Lenz's law of conservation of energy applies to back emf in DC motors.	
Explain why back emf is small when a DC motor starts and increases as the motor speeds up.	

Explain what happens to the current as a DC motor goes from zero speed to maximum speed.	
Explain why DC motors might have a starting resistance.	
Explain how Lenz's law of conservation of energy applies to the formation of eddy currents in metals.	
Explain how eddy currents can be used to create magnetic braking.	
Describe uses of magnetic braking.	