Revision summary

Use the following summary of syllabus dot points and key knowledge within Module 7 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.

Electromagnetic spectrum	
Identify that Maxwell derived four equations that form the theory of electromagnetism.	
Describe Maxwell's predictions of electromagnetism. • Accelerating charged particles produced electromagnetic radiation. • Electromagnetic waves comprised perpendicular oscillating electric and magnetic fields. • Speed of propagation of electromagnetic waves could be theoretically predicted using permittivity and permeability constants. • A large range of frequencies should have been possible for electromagnetic waves, beyond the visible spectrum.	
Describe that the electric field at a point in space varies as a charge moves past it.	
Describe how self-propagating electric and magnetic fields form electromagnetic waves that propagate away from a source at the speed of light.	
Describe electromagnetic wave properties: perpendicular fields, constantly oscillating.	
Outline historical experiments performed by the following scientists to determine the speed of light. • Galileo Galilei • Ole Roemer • James Bradley • Armand Fizeau • Leon Foucault • Albert Michelson	
Outline the modern method of measuring the metre. Include the technical definition of the metre.	

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Outline how interferometry is used to measure the speed of light.	
Define ‘electromagnetic spectrum’.	
Define ‘spectroscopy’ and ‘incandescent light source’.	
Describe how an emission spectrum is produced.	
Describe how an absorption spectrum is produced.	
Describe how a spectrum for an element is constant for all atoms of that element, but unique to that element.	
Light: wave model	
Identify that reflection, refraction, diffraction and interference are characteristic properties of light.	
Draw diagrams to show the circular nature of the diffraction of light through a single slit.	
Identify that maximum diffraction occurs when the slit width is approximately equal to the wavelength of the wave.	
Outline how Young’s double-slit experiment is performed, including a diagram of the set-up and light path.	
Explain the pattern formed, both qualitatively and quantitatively, in Young’s double-slit experiment.	
Identify that bright fringes form when $d \sin\theta = m\lambda$ and m is an integer, and solve problems involving double-slit diffraction.	

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Describe the structure of a diffraction grating.	
Describe and explain the interference pattern formed by light through a diffraction grating.	
Identify and use $d\sin\theta = m\lambda$ to solve problems involving diffraction gratings.	
Compare qualitatively and quantitatively the patterns formed by double slits and diffraction gratings.	
Describe the competing models of light in the 17th century: Newton's corpuscular (particle) model vs Huygens' wave model.	
Outline the evidence that supported Newton's and Huygens' respective models of light including the following properties: rectilinear propagation (travels in straight lines), reflection, diffraction, refraction, interference and polarisation.	
Identify that Young's work with the double-slit experiment provided conclusive evidence for light as a wave.	
Define 'plane polarisation of light'.	
Describe the structure of unpolarised light and polarised light in terms of the electric and magnetic fields.	
Identify that the polarisation of light can be detected by an analyser that only allows components of light of a particular plane of polarisation to pass through.	
Use Malus' law to explain when intensity of light is at a maximum and at a minimum.	
Describe how an understanding of the polarisation of light confirms the wave model of light.	

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›› **Light: quantum model**

Describe radiation of electromagnetic waves due to oscillating particles in objects.	
Describe how the emitted electromagnetic spectrum of an object varies with temperature.	
Explain why certain objects (e.g. metals, lava, coals) emit visible light when heated.	
Define 'continuous spectrum' and 'black body'.	
Sketch graphs of intensity vs wavelength for a black body object at different temperatures and describe the key features (peak wavelength decreases as temperature increases, overall intensity increases as temperature increases).	
Describe Wien's law and use it to solve problems involving peak wavelength of emitted light.	
Describe the fundamental problem posed by experimental black body radiation curves: there was no theory to explain the intensity–wavelength curve, comparison of classical model against measured data – UV catastrophe.	
Describe Planck's proposal of quantised energy to explain the observed intensity–wavelength graph.	
Identify that Planck's model was mathematical and theoretical in nature and was not confirmed experimentally by him.	
Use Planck's equation $E = hf$ to solve problems involving quanta of light/energy.	
Describe the photoelectric effect as the experiment that provided evidence for the quantisation of energy proposed by Planck.	
Draw and annotate the set-up for a photoelectric apparatus.	

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Describe the operation of a photoelectric apparatus to generate a current in the circuit.	
Explain why electrons are only emitted above a certain frequency of incident light.	
Explain why the size of the current generated in the photoelectric effect depends on the intensity of incident light but does not vary with change of light frequency.	
Justify that electron emission is instantaneous.	
Explain how the maximum kinetic energy of emitted photoelectrons is measured through the stopping voltage and $K_{max} = q_e V_{stop}$.	
Explain why the maximum kinetic energy of emitted photoelectrons is dependent on the frequency of the incident light.	
Define 'work function' of a metal.	
Explain why different metals have different work functions.	
Sketch a graph of K_{max} vs frequency for different metals, annotating and explaining key features: • x-axis intercept = threshold frequency • y-axis intercept = negative work function • slope = Planck's constant.	
Compare experimental observations of the photoelectric effect with predictions from the classical wave model.	
Use the law of conservation of energy to relate: • energy of incoming photon, hf • work function, ϕ • maximum kinetic energy of emitted photoelectron, K_{max} and hence show that $K_{max} = hf - \phi$.	

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Solve problems using $K_{\max} = hf - \phi$.	
Explain why the emitted photoelectrons have a range of kinetic energies from 0 to $K_{\max}$.	
Light and special relativity	
Define ‘inertial frame of reference’ and ‘non-inertial frame of reference’ in terms of Newton’s laws of motion.	
Provide examples of inertial and non-inertial frames of reference.	
Describe how you can determine through practical investigation whether you are in an inertial or a non-inertial frame of reference.	
Explain why, in an inertial frame of reference, you cannot determine whether you are stationary or moving with constant velocity.	
Describe the relative motion of two inertial frames where one is regarded as stationary (Galilean transformations).	
Describe the principle of relativity as proposed by Newton and Galileo: laws of motion are the same in all inertial frames of reference, all inertial frames are equally valid.	
Solve problems involving relative velocities of two objects in inertial frames.	
Explain why the aether was proposed.	
Describe the Michelson–Morley experiment.	
Describe the significance of the findings of the Michelson–Morley experiment.	

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State Einstein's two postulates of special relativity.	
Explain why Einstein's first postulate did not support the idea of the aether.	
Explain why Einstein's second postulate contradicted Galilean/Newtonian (classical) relativity.	
Explain what is meant by a thought experiment.	
Describe Einstein's thought experiment involving two mirrors and light pulses on a train, including: • the experimental set-up • the results as seen by observers inside • the train and outside the train • how the two observers record a different time for the same event to occur.	
Use equations to solve problems involving time dilation, where 'proper time, t_0,' is the time observed inside the inertial frame and t is the time as seen by the observer not in the frame of the event.	
Explain why time dilation is only large enough to be observed when one frame is moving at relativistic speed to the other frame.	
Use $l = l_0\sqrt{\left(1 - \frac{v^2}{c^2}\right)}$ to solve problems involving length contraction.	
Describe characteristic features of muons: origin, lifetime, travel speed.	
Describe, mathematically, why muons should not reach Earth if produced in the upper atmosphere.	
Explain why muons can be detected at Earth's surface and how this provides evidence of relativity.	

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Describe the Hafele–Keating experiment. • Outline the experimental set-up. • Describe the results of the experiment. • Outline the significance of the experimental results.	
Outline quantitative evidence from particle accelerators and cosmological studies that supports theories of time dilation and length contraction.	
Define ‘rest mass, m_0’, and ‘relativistic mass, m’.	
Identify that relativistic mass increases with increased velocity of the object.	
Use $m_{\text{v}} = \frac{m_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ to solve problems involving relativistic mass. Use $p_{\text{v}} = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$ to solve problems involving relativistic momentum.	
Explain mathematically, using Newton’s third law, why the acceleration of an object decreases as relativistic speed increases and, hence, why an object cannot reach the speed of light.	
Describe the consequences of trying to accelerate particles in a particle accelerator as they approach the speed of light.	
Use $E = mc^2$ to solve problems involving converting mass to energy.	
Define ‘antiparticle’, giving specific examples (including electron and positron).	
Solve problems, given data, involving positron–electron annihilation.	
Solve problems, given data, involving energy released during chemical reactions and compare them to nuclear reactions.	