Personal Learning Checklist Physics – C1 Working with waves

This checklist covers the first section of the Physics content in Paper 1. Use this to help you reflect upon what you know and to help direct your revision.

Understand the features common to all waves and use the following terms as applied to waves:				
periodic time	• know that a period of a wave or oscillation is the time required to complete a full cycle, e.g. the time taken to produce a complete wave or complete one full oscillation			
	• know that the symbol T is used to represent periodic time/time period and the unit for T is the second (s)			
	• know that time period, T and frequency (f) are linked by the equation T = 1/f			
	• be able to substitute a value for either T or f into this equation and calculate a value of the other term			
	• be able to use the term period T, the unit (s), for this quantity and the equation T= 1/f			
speed	• know that the speed of a wave is also referred to as wave speed or wave velocity			
	• know that wave speed is the distance in metres (m) travelled by the wave in one second (s)			
	• be able to use information about the distance travelled by a wave in a given amount of time to calculate wave speed/velocity in ms^{-1}			
wavelength	• know that the wavelength of a wave is the distance between two points on a wave that have the same amplitude and are moving in the same direction, e.g. between two consecutive crests or troughs			
	• determine the wavelength of a wave from a graphical representation of the wave			
	• know that wavelength is given the symbol λ (lambda) and has the unit metre (m)			
frequency	• know that the frequency of a wave is the number of waves produced in one second (s) or the number of waves that pass a point each second			
	• be able to use the unit hertz (Hz) or s-1 for frequency			
	• be able to use information about the number of waves produced in a given amount of time to calculate frequency in hertz (Hz)			
amplitude	• know that the amplitude of a wave is its maximum displacement from its undisturbed position			
	• determine the amplitude of a wave from a graphical representation of the wave			
oscillation	• know that an oscillation is a regular repetitive motion, e.g. a weight on a spring bouncing up and down, a pendulum swinging backwards and forwards or a string on a guitar vibrating to and fro			

	• understand that one complete oscillation is a vibration of a particle or wave or source through one complete cycle, e.g. for a pendulum to swing from its maximum displacement on the left to its maximum displacement on the right AND back to the maximum displacement on the left			
graphs of wave features	• be able to identify and/or determine displacement, amplitude, wavelength, period and frequency of waves or oscillations from information supplied on graphs and diagrams			
Be able to use the wave equation: *v = f λ*	• know that v is the velocity (or speed) of the wave in ms-1			
	• know that f is the frequency of the wave in Hz (s-1)			
	• know that λ is the wavelength of the wave in m			
	• be able to substitute values for any two of velocity, v or frequency, f or wavelength, λ into this equation and calculate a value for the other term			
	• be able to re-arrange/transform the equation, i.e. change the subject of the equation			

Understand how waves can interfere with each other				
Distinguish between the two main types of wave:	• describe the differences between transverse and longitudinal waves in terms of the motion of their particles			
	• understand the production of transverse and longitudinal waves using a slinky			
	• identify examples of transverse and longitudinal waves			
transverse	• know examples of transverse waves including all electromagnetic waves, seismic S-waves and surface water waves			
	• be able to describe the motion of the particles in a transverse wave			
longitudinal	• know examples of longitudinal waves including sound, ultrasound and P-waves			
	• be able to describe the motion of the particles in a longitudinal wave			
	• know the term and use the terms compression and rarefaction to describe longitudinal waves			
	• understand the applications of longitudinal waves, to include ultra sound in diagnostic medicine and echo-location			
Understand concepts of displacement, coherence, path difference, phase difference, superposition as applied to diffraction gratings	• understand the principle of superposition of waves, i.e. the total displacement of the medium at any point in space or time, is simply the sum of the individual wave displacements			
	• understand that phase difference is the amount by which one wave leads or lags (falls behind) another wave			
	• phase difference can also be measured in degrees i.e. $1/4\lambda = \frac{1}{4} \times 360 = 90$			
	• understand constructive and destructive superposition (interference)			
	• understand that constructive interference occurs when waves are in phase (e.g. a peak meets a peak and they add to give a peak with twice the amplitude) and waves destructively interfere (i.e. cancel each other out) when they are 180° out of phase. (e.g. a peak meeting a trough with the same amplitude gives zero wave displacement)			

	• know that displacement is a vector quantity which refers to the distance moved by a wave or particle or medium from its original position			
	• know that sources of waves are coherent if they have the same frequency and are in phase or have a constant phase difference			
	• know that a path difference of one wavelength gives constructive interference (as a peak will always coincide with another peak and a trough will always coincide with another trough) and a path difference of half a wavelength gives destructive interference (as a peak will always coincide with a trough, i.e. the waves have a phase difference of ½λ or 1800)			
Understand the application of waves in diffraction gratings, musical instruments and stationary waves:				
Application of diffraction gratings to emission spectra	• know that an (atomic) emission spectra is the range of frequencies of light emitted by an element			
	• understand that an emission spectrum is produced by an element due to energy level changes of electrons			
	• know that as the electrons lose energy when returning to a lower energy level they emit light of a specific frequency			
Application of diffraction gratings to identifying gases	• know that the emission spectrum of each element is unique and so can be used to identify the element			
	• understand that elements such as mercury, sodium, lithium, potassium and other heavy metals can be vapourised to form gases that can then be energised to emit (atomic) emission spectra			
Understand the concept and applications of stationary waves, resonance	• know that a standing wave arises from a combination of reflection of a wave and interference between the original (incident) and the reflected wave			
	• know that in strings the amplitude of the standing wave is twice that of the incident or reflected wave as constructive interference takes place			
	• know that a point of maximum vibration in a standing wave is called an antinode			
	• know that a point of zero vibration in a standing wave is called a node			
	• be able to identify nodes and antinodes in standing waves			
	• know that the separation of adjacent nodes is half a			

	wavelength, λ/2			
	• know that the separation of adjacent antinodes is half a wavelength, λ/2			
	• be able to identify fundamental frequencies and harmonics from diagrams of standing waves			
	• use information from diagrams of standing waves to determine wavelengths and frequencies of waves			
	• understand resonance, including vibration in strings, air in pipes or tubes and percussion instruments			
	• understand that stationary waves are also referred to as standing waves			
Musical instruments	• understand the principles of stationary waves and resonance when applied to a range of musical instruments			
	• understand the principles of how a standing wave is produced in vibrating strings, vibrating columns of air or percussion instruments			
Be able to use the equation for calculation of speed: $v = \sqrt{\frac{T}{\mu}}$	• know that v is velocity (or speed) of a wave on a string, in m s^{-1}			
	• know that T is the tension in the string , in newton (N)			
	• know that μ is the mass per unit length of a string, in kg m^{-1}			
	• be able to substitute values for any two of velocity, v or tension, T or mass per unit length, μ into this equation and calculate a value for the other term			
	• be able to re-arrange/transform the equation, i.e. change the subject of the equation			

C2 Waves in communication				
• Understand the principles of fibre optics: ○ refractive index $n = \frac{c}{v} = \frac{\sin i}{\sin r}$ ○ total internal reflection ○ calculation of critical angles at a glass–air interface: $\sin c = \frac{1}{n}$	• know that fibre optics depends upon the total internal reflection of light rays travelling through tiny glass fibres • know that a fibre optic cable consists of large numbers of these fibres • know that the cladding around the glass fibre has a lower refractive index than the glass fibre. The material is chosen to maximise total internal reflection in the fibre • be able to use the refractive index equation both from an optically less dense into an optically more dense material, to include air into glass ($_{a}n_{g}$), or from a(n optically) more dense material into a(n optically) less dense material e.g. from glass into air, (1/ $_{a}n_{g}$) • be able use the correct equation to calculate a value from: *n = c/v* or *n = sin i/ sin r* or *c/v = sin i/sin r* • be able to draw diagrams to illustrate the effect of refraction at an interface • know that refraction occurs because of a change in wave speed at the boundary between two mediums with different refractive indices • be able to draw accurate diagrams to show total internal reflection at an interface • understand a range of different applications of total internal reflection and critical angle to include fingerprinting devices e.g. for mobile phones, and rain detectors e.g. for car windscreens • calculate the critical angle given the refractive index of the more dense medium using *sin c = 1/n,* i.e. be able to substitute a value for either the critical angle, *c* or the refractive index of the more dense medium, *n* into this equation and calculate a value of the other term			
• Understand the applications of fibre optics in medicine to include endoscopes	• understand how a light ray passes by total internal reflection through a bundle of optical fibres in an endoscope to illuminate an area of interest • know that light is reflected from this area and enters a second bundle of optical fibres			

	• know that the image is returned to be viewed through this second bundle of optical fibres by total internal reflection know that each fibre gives a small part of the complete image			
Understand the applications of fibre optics in communication, to include:				
• analogue and digital signals: analogue-to-digital conversion, broadband	• understand and be able to describe and draw analogue and digital signals • understand the advantages and disadvantages of digital signals compared with analogue signals e.g. that digital signals are less affected by noise and have less energy loss (attenuation) than analogue signals and can therefore travel further • know that a continuously varying analogue signal is sampled at fixed intervals of time • know that the sample values are then converted into a digital binary code to be transmitted as a stream of pulses • know that broadband is the system that gives rapid internet access through cables, optical fibres or satellites using electromagnetic waves with a range of frequencies • know that the frequencies are divided into separate bands, each band carries a separate channel of data • know that in a fibre optic cable, light of different frequencies travel down the cable at the same time • know that each frequency carries data, this is multiplexing know that that broadband can be analogue or digital			
C3 Use of electromagnetic waves in communication				
• Understand that all electromagnetic waves travel with the same speed in a vacuum	• understand that the speed of light in a vacuum (approx. 3 x 10^8 ms^{-1}) is the same as the speed for all other electromagnetic waves in a vacuum, e.g. radio-waves, microwaves, ultraviolet and infra-red			
• Be able to use the inverse	• understand that:			

square law in relation to the intensity of a wave: $$I = \frac{k}{r^2}$$	○ *k* is a constant for a particular source of a wave ○ the intensity of a wave will reduce as the square of the distance from the source of the wave increases, e.g. if the distance from a source is doubled, the intensity at the new distance will be 1/ (2^2) or ¼ • be able to substitute values for any two of intensity, I or tension, T or mass per unit length, μ into this equation and calculate a value for the other term be able to re-arrange/transform the equation, i.e. change the subject of the equation • know that the equation can also be written as $I_1/I_2 = D_1/D_2$ where: I_1 = intensity at position 1 I_2 = intensity at position 2 D_1 = distance of position 1 from source D_2 = distance of position 2 from source			
• Understand how the regions of the electromagnetic spectrum are grouped according to the frequency	• know that the properties of the different regions of the electromagnetic spectrum are related to their frequencies or wavelengths • know that each region of the electromagnetic spectrum is not specifically defined • know that there is an overlap in frequency and wavelength between each region of the electromagnetic spectrum • know the order in terms of increasing frequency or wavelength of the different regions of the electromagnetic spectrum			
• Understand how the applications of electromagnetic waves in communications are related to frequency, including:	• know that frequency can be expressed in MHz (megahertz, 10^6Hz), GHz(gigahertz,10^9 Hz) and THz, (terahertz, 10^{12} Hz) • understand the factors that make different regions of the electromagnetic spectrum suitable for specific applications • know that microwaves are used for mobile phone networks, because their high frequency gives greater bandwidth which allows large amounts of data to be transmitted • know that there is little or no interference because microwaves can be divided into separate channels • know that reception/the quality of the signal is affected by wet weather as microwaves are strongly absorbed by water know that terrain also affects reception as the short wavelength/ high frequency reduces the amount of diffraction of the waves.			

• satellite communication	• know that upload and download signals are transmitted at different frequencies • know that the signals are high power, transmitted over long distances and in the radio-wave/ microwave region of the electromagnetic spectrum • know that microwaves can pass through the ionosphere to high orbit satellites • know that radio waves are reflected by the ionosphere and so can be used for terrestrial communication to receivers beyond the horizon • know that radio waves can be used for communication with low orbit satellites			
• mobile phones	• know that mobile phones are used on a system of networks • understand that mobile phone providers are allocated a band of frequencies in the radio/microwave region • understand that base stations transmit and receive signals over a limited distance			
• Bluetooth®	• know that Bluetooth devices are low power devices which work over short distances to link one device to another e.g. from a mobile phone to hands-free headset • know that Bluetooth devices in mobile phones and tablets have a range of up to 10 m • know that Bluetooth uses short wavelength radio signals and so does not need 'line of sight'. • know that Bluetooth devices can connect to more than one device • understand that Bluetooth© uses a system of 'frequency–hopping' to reduce interference with Wi-Fi as this uses similar frequencies • understand that frequency-hopping limits data loss			
• infrared	• know that infrared is used in low power devices such as remote controls • understand that infrared operates over short distances and in 'line of sight' • understand that infrared does not work well in bright sunlight • understand that atmospheric moisture reduces the range of the infrared signal understand that infrared is a high frequency signal and can potentially transmit large amounts of data			
• Wi-Fi	• know that Wi-Fi allows computers, smart phones and			

	other devices to connect to the internet via a router • understand that Wi-Fi uses medium power in the radio/microwave frequency region • understand that Wi-Fi has a range of up to 100 m • understand that Wi-Fi can pass through walls to allow signals to be received in different rooms in a house • understand that Wi-Fi signals can also be transmitted through both optical fibres and electrical wiring			