Sample Teaching Plan
Unit G635: Working waves

Suggested teaching time	Plan is based on 12 weeks at 5 hours per week (4 hours contact time + 1 hour directed study).

The learning activities are suggestions only. Teachers may wish to develop alternative strategies. The plan should be read alongside the G635 Specification and, in particular, the Assessment Evidence Grid (attached for your reference).

Week number	Specification Unit Reference and Assessment Objectives	Suggested Learning Activities	Resources
		Teacher - led input may be supported by the following:	
1 – 2	3.16.1 All waves: displacement, speed. Repeating waves: speed, wavelength, frequency, periodic time, phase, amplitude.	• demonstration using student participants with "Slinky" spirals • discussion of hospital heart monitor traces (as seen on TV hospital programmes) as non-repeating waves • demonstration using student participants with "Slinky" spirals • students measure wave speed, wavelength, and frequency using ripple tank and hence calculate periodic time • students draw displacement–time and displacement–distance graphs of same wave • OHP/electronic whiteboard demonstration of phase shifts in multiples of 90° / ¼ cycle • demonstration using student participants. with "Slinky" spirals.	"Slinky" spirals. Wave demonstration software e.g. www.immersiveeducation.eu/ Ripple tank.

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	Features of some waves: transverse or longitudinal displacement. Polarisation of light, microwaves and radio waves. Sine and square wave shapes. Standing waves in pipes and strings, musical notes.	• observation of unpolarised and polarised (reflected) light through single and crossed polaroids • demonstration of effect on microwaves of polarisation grille at a range of angles to polarised microwaves • observation or orientation of TV aerials in locality of school/college and elsewhere. Discussion of reasons for vertical and horizontal alignments • observation of CRO traces of sine and square waves signals • students create transverse and longitudinal standing waves in Slinky spirals. Note that resonance only occurs at certain frequencies. Produce both fundamentals and overtones.	Polaroid samples. Microwave kit (e.g. Philip Harris Product Code: B8R01266) with polarisation grill (e.g. included in accessory kit Philip Harris Product Code: B8R01267 CRO. Signal Generator.

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	Experiments on standing waves in strings and wires – patterns of nodes and antinodes in open and closed pipes; similar calculations for wires. Electromagnetic waves; Changing electric field and associated magnetic field, travel through a vacuum, effects of media production. $v = f\lambda$, Regions of the electromagnetic spectrum. Similarities and differences of speed in vacuum, air and other media: • wavelength • frequency • production • detection • uses • properties.	• experiment with standing waves in stretched wire using a magnet (poles either side of wire) and signal generator. Observe nodes and antinodes. Measure frequency and wavelength at several harmonics and hence find speed of wave in wire. If time permits extend to different tensions in wire • demonstrate sound in pipes by blowing • calculations to find wavelength for open and closed pipes and for wires.	Long (2 – 4 m) wire. Pulley wheel. Masses to tension wire. Large magnet. Signal Generator. Wind instrument or pipe.

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3	3.16.2 'Hot-body' spectrum of radiation, perfect black body. The total radiation given off by a surface. How thermal imaging cameras produce images corresponding to surface temperatures. Applications of thermal imaging. Advantages of thermal detecting /imaging systems. Spatial resolution and thermal resolution.	• measure radiation emitted from each side of a Leslie Cube • research examples of applications of thermal imaging.	Leslie Cube. Thermopile. Milliammeter. Internet access.
4	3.16.3 Refraction. Total internal reflection and critical angle. Measure the refractive index of glass.	• observe effects of bending of light beams, e.g. ruler in water, ray passing through glass block • observe total internal reflection in prism using ray box. Note that reflected ray is present even when i < C but becomes much brighter when prism is rotated so that emerging ray disappears and TIR occurs • measure i and r for rays from ray box passing through the long sides of a rectangular glass or Perspex block. Repeat for various values of i. Either calculate refractive index for each ray and average, or plot a graph of sin i against sin r and find refractive index from the gradient.	Beaker of water. Ruler. Ray box. Glass block. Prism. Ray box. Rectangular glass or Perspex block. Large sheet of paper. Protractor. Ruler.

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5	3.16.3 How total internal reflection prevents light from leaking through the sides of the fibres. Measure the critical angle of a sample of glass and relate this to the refractive index.	• demonstration using straight and curved Perspex cylinders • rays from ray box enter at right angles to curved side of a semicircular glass or Perspex block. Rotate block about centre of circle until emerging ray just disappears. Trace rays on paper underneath the block and measure critical angle C.	Straight and curved Perspex cylinders. Ray box. Semicircular glass or Perspex block. Large sheet of paper. Protractor. Ruler.
6	3.16.3 Applications of coherent and incoherent optical fibre bundles. Construction of step-index, graded index and monomode optical fibres. Advantages and disadvantages of step-index, graded index and monomode optical fibres for local and long distance data transmission. Signal degradation in multimode fibres: How this can be overcome with graded index or monomode. Advantages of fibre-optics. Send a light signal down an optical fibre and detect it with a photodiode.	• use of fibre optic kit to gain hands-on experience of fibre optics communications.	Fibre optics kit, e.g. Feedback Instrument Limited Optical Fibre Trainer OFT.

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7	3.16.4 Analogue and digital systems. Binary coding. AM, FM and digital radio transmissions. Pulse Code Modulation, analogue-to-digital conversion and digital-to-analogue conversion. How broadband transmission over conventional telephone lines increases the speed of data connection to the Internet. How optical fibres can further increase Internet connection speeds.		
8	3.16.4 Multiple access and cellular technologies. How the splitting of a geographic area into many small cells increases the number of users a mobile telephone network can carry and the range over which an individual user can communicate. Factors affecting the distribution of base stations; factors affecting mobile phone signal strength. Up-link and down-link. Full-duplex system and half-duplex.	• students record signal strength on their mobile phones at various distances from masts and around obstructions. Discussion of students experience when unable to use phones because of excessive demand, e.g. at large events.	http://electronics.howstuffworks.com/cell-phone.htm

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9	3.16.5 Differential absorption of X-rays, contrast media, the appearance of X-rays on film. Techniques for improving quality of X-ray images: grid, narrow beam, filtration. How X- and γ-radiations damage cells through ionisation. Evaluate the consequent health hazards. The use of image-intensifying screens to reduce dose rate. Digital X-ray cameras convert the energy into visible light, which is converted in turn to electrical signals that can be displayed as diagnostic images on a flat panel screen. CAT scanners can produce much more detailed information than conventional X-rays.		

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10	3.16.5 Radiological protection measures taken in X- and γ-ray imaging and radiotherapy treatment areas. The half-thickness value of lead. Staff dose reduced by: reducing the size of source, increasing distance, reducing exposure time, inserting materials between the source and person. X-ray patient's dose reduced as follows: more sensitive X-ray emulsions, image intensifying screens. Radiotherapy patient's dose reduced by: careful planning, balance between risk and benefit.	• visit to radiology department of local hospital • demonstration of effect of various thicknesses of lead on Geiger counter count rate from gamma source • discussion of the balance of risk and benefit in this and other contexts.	Co -60 source. Geiger counter. Lead sheets of various widths up to 5 cm in total.
11	3.16.5 Structure and principles of the γ-camera used to image radioactive tracers administered to the body; identify the advantages of technetium-99m as a radioactive tracer.	• visit to radiology department of local hospital.	

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	Physical and biological half-life as applied to technetium-99m tracer. Calculation of overall half life from biological and physical half life data. Describe how γ-radiation is used therapeutically.	• half life exercise using dice. Start with 100 dice and remove those coming up ‘6’ in each throw. Plot a graph of number remaining against throw number, Note that time for number of dice to be halved is approximately constant. Variation due to random nature of “radioactive” decay • discuss what graph would look like for 12 sided dice • discuss biological half life in context of patients excreting sources ingested for medical reasons • exercises using equation: $\frac{1}{t_{1/2}} = \frac{1}{t_{b1/2}} + \frac{1}{t_{p1/2}}$ • visit to radiology department of local hospital.	100 dice.
12	Revision		Past question papers.