Marking Scheme

#1

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		[Particle] oscillations accept displacement (1) Along/parallel to direction of wave travel (1)	2			2		
	(b)		0.6 [mV]	1			1		
	(c)	(i)	Rearrangement of $c = f\lambda$ to give = 3.95×10^8 [Hz]		1		1	1	
		(ii)	Using $T = \frac{1}{f}$ (1) Frequency = 4×10^6 [Hz] (1) Yes must be clarified – close to 3.95×10^6 Hz or values similar (1) **ecf** **Alternative:** Calculation of period 0.25×10^{-6} [s] (1) Period = $\frac{1}{3.95 \times 10^6}$ (1) Yes must be clarified – values similar (1) **ecf**			3	3	2	
			Question total	**3**	**1**	**3**	**7**	**3**	**0**

#2

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)		Transverse – oscillations / vibrations 90° or perpendicular to energy transfer/wave direction [1] Longitudinal – oscillations / vibrations parallel/same direction to energy transfer / wave direction [1] Penalise missing oscillations / wave direction only once	2			2		
	(b)	(i)	4 [cm]	1			1	1	
		(ii)	0.8 [m]	1			1	1	
		(iii)	Period = 0.3 [s] [1] $f = \frac{1}{T}$ and $v = f\lambda$ used or $v = \frac{\lambda}{T}$ [1] ecf on T Answer = 2.67 [m/s] [1] don't accept 2.6 [m/s]	1	1 1		3	1	
	(c)	(i)	Arrow radially outward (accept inward) based on point S	1			1		
		(ii)	S and T only	1			1		
			Question 1 total	**7**	**2**	**0**	**9**	**3**	**0**

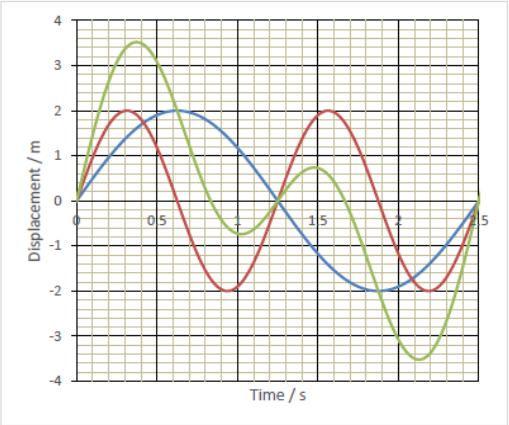
#3

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
2	*(a)*		**Polarisation** Polarised – vibrations in one plane only Use polarising filters Rotate filter If polarised; intensity will change Intensity will change at intervals of 90° Wave is transverse only. **Interference** Laser light is a coherent source Use of double slits to observe pattern Description of interference pattern Constructive interference occurs when path difference = $n\lambda$ Destructive interference when path difference = (n + ½) λ Young's double slit formula quoted $y = \frac{\lambda D}{a}$ Symbols explained Wavelength can be determined AO1 – show understanding of what polarisation and interference are AO3 – evaluate what properties can be determined using polarisation and interference **5-6 marks** Comprehensive description including both polarisation and interference. *There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.* **3-4 marks** Comprehensive description of either polarisation or interference OR limited description including both polarisation and interference. *There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.* **1-2 marks** Limited description of either polarisation or interference. *There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.* **0 marks** No attempt made or no response worthy of credit.	2		4	6		6
	(b)		Advantage – Efficiency; improvements to society (1) Issue – Disposal of materials (1) Benefit of research and development given - impact on environment should always be considered before developing new materials (1)			3	3		
			Question 2 total	**2**	**0**	**7**	**9**	**0**	**6**

#4

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*		Each end has zero displacement (1) Only integers of half wavelengths can fit on string (1) As $c = f\lambda$ and speed is constant - this only occurs at particular frequencies (1) OR Waves are reflected from the fixed end (1) At particular frequencies only - arrive in phase with the next wave leaving / complete half wavelengths / nodes created (1) By principle of superposition *or* interference occurs to create nodes / antinodes (1)	3			3		
	(b)	(i)	Node to node distance = $\frac{\lambda}{2}$ (1) Wavelength = 0.24 [m] (1) Speed ($v = f\lambda$) = 108 [m s^{-1}](1)	1	1 1		3	2	
		(ii)	At 450 Hz: Length of string = $n \times 0.12$ (n = no. of loops) (1) At higher f: $(n + 2) \times 0.1$ = length of sting (1) Therefore $0.12n = 0.1\ (n + 2)$ (1) n = 10 (1)		4		4	4	
			Question 1 total	**4**	**6**	**0**	**10**	**6**	**0**

#5

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
	(a)		Matter also transferred / no vibrations involved (1) So wrong (1) Accept de Broglie wavelength argument for 1 mark			2	2		
	(b)	(i)	Holes far smaller than wavelength of micro (1) So nothing passes (1) Light wavelength far smaller than 2 mm (so little or no diffraction) (1)	1 1	1		3		
		(ii)	1.6-3.3 eV or 2.56-5.28 × 10^{-19}J (or calculation leading to said numbers)	1			1		
		(iii)	Smaller because f smaller or lambda longer		1		1		
	(c)		Evidence of application of superposition e.g. 0 s (1) 0.4 and 2.1 s correct i.e. 3.4/3.6 and -3.4/-3.6 (1) 1 s and 1.5 s i.e. -0.7 and +0.7 (1) Smoothish curve through points (1)  		4		4	2	
			Question total	**3**	**6**	**2**	**11**	**2**	**0**

#6

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*		A pattern of disturbances travelling through a medium and carrying energy with it (1) involving the particles of the medium oscillating about their equilibrium positions (1) [Accept answers appropriate to e-m waves: A travelling pattern of oscillating electric and magnetic fields (1) carrying energy with it (1)]	2			2		
	(b)	(i)	Phase difference between A and B = 90° or $\frac{\pi}{2}$ accept fractions of cycle i.e. ¼ (1) Phase difference between B and C = 0 or n 2π or n 360°(1)		2		2	1	
		(ii)	Determining $f = \frac{1}{T} = \frac{1}{0.4}$ = 2.5 Hz (1) Wavelength = 1.5 km (1) Using $v = f\lambda$ (1) 3.75 × 10^3 m s^{-1} accept 3.75 km s^{-1} (1)	1	1 1 1		4	4	
	(c)		Substituting values in Young modulus = $= \frac{\text{stress}}{\text{strain}}$ (1) Rearranging strain = $\frac{900\text{ MPa}}{70\text{ GPa}}$ (1) Strain = 0.013 (1) (ecf power of 10)	1	1 1		3	3	
	(d)		Data can be used to determine locations/frequency of Earthquakes (hotspots) (1) Informs planning and sites for new builds or increases knowledge of structure of the Earth (1)			2	2		
			Question 1 total	**4**	**7**	**2**	**13**	**8**	**0**

#7

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	*(a)*		Energy - progressive carries [stationary not] or converse (1) Phase – stationary: constant in loop or successive loops in antiphase; progressive: varies with distance [or can have any value] along (1) Amplitude - antinodes & nodes or varies in stationary, constant amplitude in progressive(1)	3			3		
	(b)		$n \times \frac{\lambda}{2} = L$ (1) Multiply by the frequency or substitution: $\lambda = \frac{v}{f}$ (1) Neatly laid out algebra (1) NB.Stating $\lambda = \frac{2L}{n} \rightarrow$ no credit for 2nd mark.		3		3	2	3
	(c)		'Good agreement' on its own → 0 Straight line [with positive gradient] & good agreement (1) Lines / line of best fit [allow: mean line] pass(es) through all error bars (1) Lines straddle the origin [accept: line of best fit passes through the origin] (1)			3	3		3
	(d)		Velocity decreases (1) Gradient decreases [implied if factor < 1] (1) By factor $\sqrt{1.5}$ (1) [changes by factor $\frac{1}{\sqrt{1.5}}$ or ×0.82 - not: 25%]		3		3	1	3
	(e)		**Any sensible 2 ×(1) from:** e.g. higher concentrations (might) cause bad effects (precautionary principle) Some pedestrians suffer health effects die - respiratory problems Respiratory problems caused by other chemicals Acid rain produced by NO_2 Some pedestrians claim NO_2 bad - psychosomatic Reliable data difficult to obtain - Worse for asthma sufferers Data may be more conclusive in future Accept cheating NO_2 figures is fraud Sensible conclusion (1)			3	3		
			Question 5 total	**3**	**6**	**6**	**15**	**3**	**9**