

1	B is the correct answer (A path difference of λ would cause constructive interference) A is not the correct answer as this path difference would cause destructive interference C is not the correct answer as this phase difference would cause neither constructive nor destructive interference D is not the correct answer as this phase difference would cause destructive interference	(1)
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9	The only correct answer is C time between consecutive pulses is too short The next pulse would be transmitted before the previous pulse is received <i>A is not correct because it is not significant</i> <i>B is not correct because it is not significant</i> <i>D is not correct because it is not significant</i>	1
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2	D is the correct answer A is not correct because the electrons need to move to lower energy levels and emit photons. B is not correct because the electrons need to move to lower energy levels. C is not correct because the electrons need to emit photons.	1
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4	A is the correct answer (de Broglie wavelength = 2.43×10^{-9} m) B is not the correct answer as the de Broglie wavelength = 1.82×10^{-9} m C is not the correct answer as the de Broglie wavelength = 1.13×10^{-12} m D is not the correct answer as the de Broglie wavelength = 9.93×10^{-13} m	(1)
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5	A is the correct answer as a large change in density causes most of the ultrasound to reflect, so the ultrasound does not penetrate deeper into the body. B is not the correct answer as this does not affect whether ultrasound can enter the lungs C is not the correct answer as this does not affect whether ultrasound can enter the lungs D is not the correct answer as ultrasound is not considered to cause damage to the body.	(1)
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8	D is the correct answer as only transverse waves can be polarised A is not the correct answer as only transverse waves can be polarised B is not the correct answer as only transverse waves can be polarised C is not the correct answer as only transverse waves can be polarised	(1)
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3	A is the correct answer B is not correct because this would give the momentum of the electron C is not correct because this gives $\frac{1}{\text{velocity}}$ D is not correct because this would give $\frac{1}{\text{momentum}}$ for the electron	
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A is the correct answer (Evidence for the wave nature of electrons came from experiments involving diffraction)

B is not the correct answer

C is not the correct answer

D is not the correct answer

(1)

Question Number	Answer	Mark																																								
*16a	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. <table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr><tr><td>6</td><td>4</td><td>2</td><td>6</td></tr><tr><td>5</td><td>3</td><td>2</td><td>5</td></tr><tr><td>4</td><td>3</td><td>1</td><td>4</td></tr><tr><td>3</td><td>2</td><td>1</td><td>3</td></tr><tr><td>2</td><td>2</td><td>0</td><td>2</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td></tr></table> The following table shows how the marks should be awarded for structure and lines of reasoning. <table><tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr><tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr><tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr><tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr></table> Indicative content • Atoms/electrons absorb energy/photons • Electrons move to higher energy levels • Then drop down energy levels, releasing <u>photons</u> • Energy levels are discrete • For hydrogen atoms, there are only a small number of possible energy level differences (that can occur to produce visible light) • Since $E = hf$ and $v = f\lambda$, only certain wavelengths are emitted (For IC1, do not allow 'gain energy') (For IC2 and IC3, allow electrons excited and de-excited) (IC4, allow 'atoms only have certain/specific energy levels')	IC points	IC mark	Max linkage mark	Max final mark	6	4	2	6	5	3	2	5	4	3	1	4	3	2	1	3	2	2	0	2	1	1	0	1	0	0	0	0		Number of marks awarded for structure of answer and sustained line of reasoning	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2	Answer is partially structured with some linkages and lines of reasoning	1	Answer has no linkages between points and is unstructured	0	6
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16b	Air contains different gases/molecules/elements/atoms (1) Each (different) gas has its own energy levels (so light with a large number of wavelengths/frequencies are released) (1) (MP1 – do not accept 'air is a mixture of different particles')	2																																								
Total for question 16		8																																								

14(a)	Oscillations / vibrations are perpendicular to the <u>direction</u> of energy transfer Or Oscillations / vibrations are perpendicular to the <u>direction</u> of wave travel (allow propagation for wave travel) (1)	1
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14(b)(i)	Uses appropriate trigonometry to determine θ	(1)	4
	Use of $n\lambda = d \sin \theta$ to calculate d	(1)	
	Calculate $\frac{1}{d}$	(1)	
	Number of lines per mm = 260	(1)	
	<u>Example calculation</u> $\theta = \tan^{-1} \left(\frac{0.22 \text{ m}}{1.30 \text{ m}} \right) = 9.61^\circ$ $1 \times 650 \times 10^{-9} \text{ m} = d \sin(9.61^\circ)$ $d = \frac{650 \times 10^{-9} \text{ m}}{\sin(9.61)} = 3.89 \times 10^{-6} \text{ m}$ No. of lines per mm = $\frac{10^{-3}}{3.89 \times 10^{-6} \text{ m}} = 257$		

14(b)(ii)	The path difference (for light from different slits travelling to the screen) is one wavelength	(1)	3
	(So) the waves are in phase at the screen	(1)	
	(So) constructive interference occurs (causing a maximum)	(1)	
Total for question 14			8

13(a)	Oscillations / vibrations are perpendicular to the <u>direction</u> of energy transfer of the wave Or Oscillations / vibrations are perpendicular to the <u>direction</u> of wave travel / propagation	(1)	1
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13(b)	The paths are different lengths / distances	(1)	3
	Or There is a path difference		
	If the path difference is a whole number of wavelengths	(1)	
	Or path difference = $n\lambda$ where n is an integer		
	Waves are in phase (so constructive interference occurs)	(1)	
	Or there is a phase difference of 0 (so constructive interference occurs)		
	Or there is a phase difference of $2\pi n$ where n is an integer		
Total for question 13			4