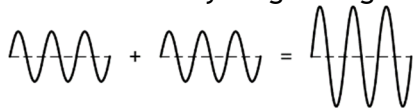
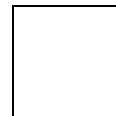
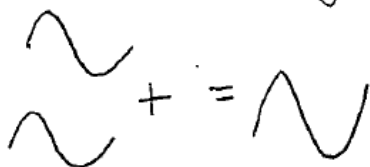


Question			Answer	Max mark	Additional guidance
8.	(a)	(i)	Waves <u>meet</u> in phase. OR Crest <u>meets</u> crest. OR Trough <u>meets</u> trough. OR Path difference = $m\lambda$	1	Accept: peak for crest. Can be shown by diagram eg  Diagram must imply addition of two waves in phase. Do not accept: 'join' or 'merge' alone.
		(ii)	$m\lambda = d \sin \theta$ (1) $3 \times 630 \times 10^{-9} = \frac{1}{250\,000} \sin \theta$ (1) $\theta = 28^\circ$ (1)	3	Accept: 30° , 28.2° , 28.20° Note: $d = 4 \times 10^{-6} \text{ m}$ Alternative substitution: $m\lambda = d \sin \theta$ (1) $3 \times 630 \times 10^{-9} = \frac{1 \times 10^{-3}}{250} \sin \theta$ (1) $\theta = 28^\circ$ (1)
		(iii)	Spots will be further apart. OR Angle θ is greater. (1) Slit separation d of new grating is smaller than the previous grating. (1)	2	Look for correct statement of effect first - if incorrect or missing then 0 marks. Accept: fewer/less spots on the screen. Justification can be done by calculation. If calculation is carried out using $m = 3$, candidate will obtain an invalid answer. This implies fewer/less spots (five) on the screen.
		(iv)	(The waves from the laser have a) constant phase relationship (and have the same frequency, wavelength, and velocity).	1	"In phase" is not sufficient.
	(b)		(Polymer) note has vertical and horizontal or crossed lines/grid/grating.	1	Accept: crosshatch, mesh Accept: diagram to aid description There are vertical and horizontal spots so there are vertical and horizontal lines or a grid of lines.

Question			Answer	Max mark	Additional guidance
9.	(a)		$n = \frac{\sin \theta_1}{\sin \theta_2} \quad (1)$ $n = \frac{\sin 45 \cdot 0}{\sin 22 \cdot 0} \quad (1)$ $n = 1.89$	2	“SHOW” question Accept: $\frac{n_2}{n_1} = \frac{\sin \theta_1}{\sin \theta_2} \quad (1)$ $\frac{n_2}{1} = \frac{\sin 45 \cdot 0}{\sin 22 \cdot 0} \quad (1)$ $n = 1.89$
	(b)	(i)	The angle of incidence such that the angle of refraction is 90° .	1	Accept a description of the incident ray as an alternative to the word ‘incidence’. Do not accept: The minimum angle of incidence that causes total internal reflection.
		(ii)	$\sin \theta_c = \frac{1}{n} \quad (1)$ $\sin \theta_c = \frac{1}{1.89} \quad (1)$ $\theta_c = 31.9^\circ \quad (1)$	3	Accept: 32° , 31.94° , 31.945°

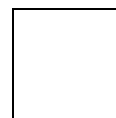
Q8(a)(i) Maximum Mark: 1
RESPONSE 1

maximas are formed.



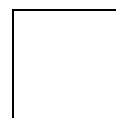
RESPONSE 2

These are points in which the waves meet exactly in phase creating maxima and minima



RESPONSE 3

Maxima (bright spots) are produced where two waves meet in phase and combine constructively - where two wave crests combine.

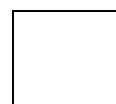


Q8(a)(iii) Maximum Mark: 2
RESPONSE 1

The bright spots will appear further apart as more diffraction will take place due to the slits being closer together.

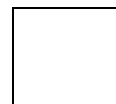
$$d \sin \theta = m \lambda$$

↑ ↑ ↑ ↑
 increases fixed increase constant



RESPONSE 2

The distance between maximums are increased due to $d \sin \theta = m \lambda$ where m and λ stay constant



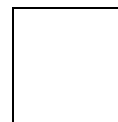
RESPONSE 3

The maxima will be more spread out as
 the gaps are closer to its wavelength
 meaning ^{the light} it will diffract more.



RESPONSE 4

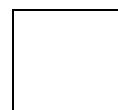
Smaller d (distance between lines)
 and since $\sin \theta = \frac{n\lambda}{d}$ if λ & n
 remain the same the θ will increase.
 Therefore the bright spots will be
 more spread out.



Q8(a)(iv) Maximum Mark: 1

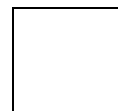
RESPONSE 1

~~Light~~ travels in one direction
 only.



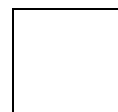
RESPONSE 2

Coherent means that the
 waves are in phase i.e.
 crest to crest, trough to trough



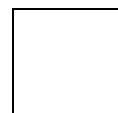
RESPONSE 3

Same phase relationship.



RESPONSE 4

Coherence is when two waves
 oscillate with a constant phase
 relationship. i.e. same frequency
 and speed.



Q8(b)

Maximum Mark: 1

RESPONSE 1

In grating, the waves pass through while in
5 note only some light goes through

RESPONSE 2

the grating used by the student has the
vertical lines. the grating in the note has
horizontal and vertical lines.

RESPONSE 3

The grating had lines running vertically, the 5 note
may have lines running vertically, horizontally and
diagonally.

Question /Response	Mark	Commentary
Q8(a)(i)	1	
Response 1	1	The candidate has explained the production of bright spots using a diagram. This is acceptable, as described in <i>Physics: general marking principles</i> , issue 19. The diagram is clear without requiring labels.
Response 2	0	The candidate's response explains the production of an interference pattern, but is not specific to <i>bright spots</i> , and so the mark is not awarded.
Response 3	1	The candidate's explanation is acceptable.
Q8(a)(iii)	2	
Response 1	1	The candidate has given a correct statement, but their justification is incorrect.
Response 2	1	The candidate has given a correct statement, but their justification does not link the increased density of lines to a decrease in line spacing, and so is not sufficient for the second mark to be awarded.
Response 3	1	Again, the candidate has given a correct statement, but their justification does not state that slit separation decreases, and so is not sufficient for the second mark to be awarded.
Response 4	2	The candidate has given a correct statement, and an acceptable justification.
Q8(a)(iv)	1	
Response 1	0	The candidate's statement is incorrect.
Response 2	0	The candidate's statement is incorrect.
Response 3	0	The candidate's statement is incorrect. The word ' <i>same</i> ' is not an acceptable alternative to ' <i>constant</i> ' in this context.
Response 4	1	The candidate's statement is correct.
Q8(b)	1	
Response 1	0	The candidate's suggestion is not acceptable.
Response 2	1	The candidate's suggestion is acceptable.
Response 3	1	The candidate has given an acceptable suggestion (lines running vertically, horizontally). The addition of 'and diagonally' is not an incorrect suggestion.