A Level OCR Physics

Chapter 13 Refraction, diffraction and interference

Question	Answers	Extra information	Mark	AO	Spec reference
1(a)	one with a constant/fixed phase relationship/difference		1	1	4.4.3
(b)	one with a single wavelength/frequency		1	1	4.4.3
(c)	do not look directly at laser / do not point laser at anyone / do not look at reflection of laser light / wear safety goggles	allow any sensible suggestion	1	1	4.4.3g
(d)	$x = \frac{8 \times 10^{-3}\ \text{m}}{4} = 2 \times 10^{-3}$ m $x = \frac{\lambda D}{a}$ $\lambda = \frac{ax}{D} = \frac{2 \times 10^{-3} \times 0.4 \times 10^{-3}}{1.5}$ $\lambda = 5.3 \times 10^{-7}$ m		1 1 1	2	4.4.3g
(e)	% uncertainty in $D = \frac{0.001}{1.5} \times 100\% = 0.07\%$ % uncertainty in $a = \frac{0.01}{0.40} \times 100\% = 2.5\%$ % uncertainty in $x = \frac{0.1}{8.0} \times 100\% = 1.3\%$ % uncertainty in λ = 0.07 + 2.5 + 1.3 = 3.9%		1 1 1	2	2.2.1c
(f)	a and D remain constant so $\lambda \propto x$ longer λ means the maxima would be further apart	can be expressed in words but must state s and D constant for this mark	1 1	2	4.4.3g
2(a)	$n \sin \theta$ = constant		1	2	4.4.2d

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	$n_1 \sin \theta_1 = n_2 \sin \theta_2$ remember $n_1 = 1$ $\sin \theta_2 = \frac{\sin \theta_1}{n_1} = \frac{\sin 60}{1.5}$ $\theta_2 = 35°$		1		
(b)	$\sin C = \frac{1}{1.5}$ $C = 42$ (41.8°)		1	2	4.4.2d
(c)	angle of incidence side KL = 55° since this is > than critical angle ray is totally internally reflected.	could be shown on sketch on the diagram	1 1	3	4.4.2.d
(d)	$1.5 \sin C = 1.4 \sin 90$ $\sin C = \frac{1.4}{1.5}$ $C = 69°$		1 1	3	4.4.2.d
3(a)	2.8 cm		1	2	4.4.1b
(b)	$\lambda = 2.8$ cm $c = 8.4$ cm s^{-1} $c = f\lambda$ $f = \frac{c}{\lambda} = \frac{8.4}{2.8} = 3$ Hz	allow ECF for λ answer from part (a)	1 1	2	4.4.1d
(c)	$\frac{\pi}{2}$ rad or 90 °		1	2	4.4.1b
(d)	displacement will be **negative (downwards)** to max in $\frac{T}{4}$ s		1 1	2	4.4.1b

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	decreases through to zero displacement at $\frac{T}{2}$ s				
4(a)	place the diffraction grating at a distance of 4 m (must be > 1 m) from a screen measure with a metre ruler or tape measure. shine laser directly onto grating. (Identify the central maxima) and measure the distance the first-order maxima either side with a ruler and find the mean (or measure distance between 1st order and divide by 2)		max 3	1	4.4.3g
(b)	$\frac{1\times10^{-3}\,\text{m}}{330} = 3.0\times10^{-6}\ \text{m}^{-1}$		1	2	5.5.3g
(c)	$n\lambda = d\sin\theta$ $\lambda = 3.0\times10^{-6}\sin 12.5 = 6.5\times10^{-7}$ m $\lambda = 650$ nm (649 nm)	ECF	1 1	2	5.5.3g
(d)	central white maxima each of the orders is now a spectrum violet closest to the centre/red furthest from centre $\lambda \propto \theta$ so as λ increases so does θ at higher orders colours mix so ROYGBIV spectrum not seen		3 max	3	5.5.3g
5(a)	In unpolarised light the oscillations are in many planes in plane polarised light the oscillations are in one plane only.		1 1	1	4.4.1f 4.4.2c
(b)	Reflected light is polarised so intensity of light reflected on water will be reduced by polarising filter.		1 1	2	4.4.1f 4.4.2c
(c)	rotate the polarising filter through 180°/360° variation in intensity between max and min (or light and dark) one maxima and min in180°		1 1	2	4.4.1f 4.4.2c

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	OR two maxima (or two minima) in 360° rotation		1		
(d)	sound waves are longitudinal waves since oscillations are **parallel to/same direction** as wave travel they cannot be polarised.		1 1	2	4.4.1a 4.4.2c
6(a)	reflection from metal plate two waves of the same frequency/wavelength travelling in opposite directions (or forward/reflected waves) maxima where waves are in phase or interfere constructively minima where waves are out of phase/antiphase or interfere destructively nodes and antinodes are formed or stationary waves identified	any 3 awarded	max 3	1	4.4.3 and 4.4.4
(b)	distance between minima is $\frac{\lambda}{2}$ $4 \times \frac{\lambda}{2} = 54$ mm $\lambda = 27$ mm		1	2	4.4.4f
(c)	$c = f\lambda$ and $c = 3.0\times10^{8}$ m s^{-1} $f\ \frac{c}{\lambda} = \frac{3.0\times10^{8}}{27\times10^{-3}} = 1.1\times10^{10}$ Hz 11 GHz	allow ECF from part (b)	1 1	2	4.4.1
(d)	P labelled close to the plate in direct line with transmitter		1	2	
(e)	The distance travelled by the transmitted wave and the reflected wave is similar at point P. The amplitude of both waves will be similar. Max destructive interference	max of two marks	max 2	2	4.4.3 4.4.4

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(f)	The microwave transmitter produces plane polarised waves and so the detector has to be in the correct plane.		1	3	4.4.1f 4.4.2c
7(a)	1.35 sin C = 1.30 sin 90 sin $C = \frac{1.30}{1.35}$ C = 74° (74.4°)		1	2	4.4.2d
(b)	• ray is reflected at A or travels from A to B to C • interference or superposition of the two rays • bright fringes constructive interference, dark fringes destructive interference • if the path difference = $n\lambda$ constructive interference occurs (bright fringe) • if path difference = $(n + ½)\lambda$ (ordestructive interference (dark fringe)	Allow wtte	max 3	3	4.4.3
(c)	different colours of white light have different wavelengths constructive/destructive interference will happen for different thicknesses of oil different wavelengths refracted differently		max 2	3	4.4.2
8(a)	80 (ms) $f = \frac{1}{T}$ = 12.5 Hz f^2 = 156 Hz	answer in table row should be completed	1 1	2	4.4.1b 4.4.1c
(b)	$T = mg$ $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$		1 1	2	3.2.1c

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	$= \frac{1}{2l}\sqrt{\frac{mg}{\mu}}$ $f^2 = \frac{1}{4l^2} \times \frac{mg}{\mu}$ since l, g, and μ are constant $f^2 \propto m$		1		
(c)	mark for plotting point ± 0.5 square on graph mark for drawing line of best fit large triangle drawn or evidence shown 1.2 ± 0.1 ($Hz^2\ g^{-1}$)		1 1 1 1	2	1.1.3d
(d)	gradient = $\frac{4l^2\mu}{g}$ $\mu = \frac{9.81 \times 1.2}{4 \times 1^2}$ 3.0 g m^{-1}		1 1	2	1.1.3d
(e)	% uncertainty in length = $\frac{0.001}{1.00} \times 100\% = 0.1\%$ or % uncertainty in mass = $\frac{0.1}{1.7} \times 100\% = 5.9\%$ total % error = 6.0% absolute error = 0.06 × 1.7 = ± 0.1 g m^{-1}	1 mark for calculating either % uncertainty	1 1 1	2	2.2.1d

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(f)	$\% \text{ difference} = \frac{\text{difference}}{\text{actual}} \times 100\%$ $\% \text{ difference} = \frac{1.3}{1.7} \times 100\% = 76\%$	possible ecf from their value for part (d)	1	2	2.2.1c