

Marking scheme
(minimal score 0.1pt)

Marker _____

Student _____

TOTAL _____

Task	Criteria	Max. points	Marker	Consensus
A1	Diffraction grating equation	0.1		
A2	$\theta(\varphi)$ measurements: - 0.2 for each point (not greater than 1.0) φ in range $35-45^\circ$ θ in range $15-65^\circ$	1.0		
A3	Linearization: - $\sin^2 \theta$ from $\sin^2 \varphi$ dependence; Calculation of the $\sin^2 \theta$ and $\sin^2 \varphi$ values; Graph plotting (<i>only in linearized coordinates</i>) (axis labeled and scaled, experimental points plotted, linear fit line shown);	0.3 0.3 0.9= 0.3x3		
A4	Sample parameters calculation (<i>scored only if A2 score ≥ 0.4</i>): Numeric parameters of the linear fit written All points approximation <i>Two points only</i> Formulae for D_x , n_x calculation using linear fit parameters n_x value in range 1.4-1.6 D_x value in range 210-250 nm	0.2 (0.1) 0.2 0.2 0.3		
Part A total		3.5		
B1	$\lambda = 659\text{nm}$ selected	0.1		
B2	$I(\theta)$ measurements: Scored only if minimum is found in range $20-45^\circ$ <u>and its transmittance value is lower than 0.5</u> - number of points 10 and more (<i>from 5 to 9, less than 5</i>) ; - angles range (<i>not less than 25° near minimum</i>)	0.6 (0.3; 0) 0.4		
B3	Graph plotted: (axis labeled and scaled, experimental points plotted, approximating curve shown);	0.2 0.6 0.2		
B4	θ_1 value in range $20-45^\circ$ $\Delta\theta$ value in range $10-20^\circ$	0.1 0.1		
B5	Formula for λ_x Numerical value for λ_x in range $\pm 15\text{ nm}$ from the real value for the sample	0.1 0.1		



B6	$\Delta\lambda$ calculation: Transition from θ to λ ; Low $\Delta\theta$ value approximation Numerical value for Δn in range 0,09 – 0,15	0.2 0.1 0.4		
B7	Numerical value for θ_2 in range 30-60°	0.3		
B8	Formulae for p and n_{AAO} calculation Numerical value for p in range 0,15 – 0,35 Numerical value for n_{AAO} in range 1,55 – 1,75	0.2+0.2 0.3 0.3		
B9	Formula for p_i versus n_i n_1, n_2 values selection Numerical values for: p_1 in range 0,05 – 0,25 p_2 in range 0,2 – 0,45	0.1 0.1 0.2 0.2		
Part B total		5.0		
C1	Values λ_1^{sp} in range ± 30 nm from the real value for the sample λ_2^{sp} in range ± 30 nm from the real value for the sample λ_3^{sp} in range ± 30 nm from the real value for the sample	0.2 0.2 0.2		
C2	$I(\theta)$ measurements for red laser: Scored only if minimum is found in range 10-30° <u>and its transmittance value is lower than 0.9</u> - number of points is 10 and more (from 5 to 9, less than 5) ; - angle range (from 10° to 50°)	 0.3 (0.2, 0) 0.2		
C3	$I(\theta)$ measurements for green laser: Scored only if minimum is found in range 20-45° <u>and its transmittance value is lower than 0.5</u> - number of points is 10 and more (from 5 to 9, less than 5) ; - angle range (from 10° to 50°)	 0.3 (0.2, 0) 0.2		
C4	$I(\theta)$ measurements for blue laser: Scored only if at least 1 minimum is found in range 10° - 65° <u>and its transmittance value is lower than 0.9.</u> - number of points is 10 and more (from 5 to 9, less than 5) ; - angle range (from 10° to 65°)	 0.3 (0.2, 0) 0.2		



C5	Normal wavelengths calculation (in the wavelength descending order) $\lambda_1^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_2^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_3^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_4^{(n)}$ value in range ± 15 nm from the real value for the sample	0.1 0.1 0.1 0.1 0.2		
C6	Appropriate method Correct value for m corresponding to $\lambda_i^{(n)}$ (in case of error in $m \pm 1$)	0.2 4x0.2 (0.1)		
C7	D_Y value in range 1000 – 1160 nm	0.2		
C8	I_1, I_2 values obtained for 3-4 minima (for 1-2 minima) t numerical values: $t_1 > 0.45$ $t_2 < 0.35$ $t_3 < 0.35$ $t_4 > 0.45$	0.2 (0.1) 0.1 0.1 0.1 0.1		
Part C total		4.5		
D1	Experimental setup for wavelength measurement sketch; Formula for $\lambda^{(n)}$ calculation; Wavelengths values (in the descending order) $\lambda_1^{(n)}$ value in range 790 -840 nm $\lambda_2^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_3^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_4^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_5^{(n)}$ value in range ± 15 nm from the real value for the sample $\lambda_6^{(n)}$ value in range 400-420 nm 0.2 pt for each (no more than 1.0)	0.1 0.1 0.2x5		



D2	<i>m</i> deriving method: $1/\lambda^{(n)}$ values analysis Searching for missing minima (using graph or $\Delta(1/\lambda^{(n)})$ calculation or equivalent) <i>m</i> numerical values 0.2 for each correct value (no more than 1.2 in total) <i>Error</i> ± 1 for <i>m</i> value	0.4 0.4 0.2x6 0.1x6		
D3	D_z value in range 1680 – 1920 nm	0.3		
D4	m' values obtained from D2 Values for missing $\lambda_m^{(n)}$ obtained in range ± 15 nm from the real value for the sample	0.1x2 0.4x2		
Part D total		4.5		
E1	Scored only if <i>t</i> values in task C8 obtained Correct sample structure name selected (n-6) <i>t</i> values are in agreement with the table in Appendix (central minima are deep, peripheral minima are shallow)	0.2 1.0		
E2	Idea: structure selection using missing minima numbers Points below are given only if the missing minima in task D4 are correct! Correct sample structure name selected (hi5-5) Missing minima numbers are in agreement with the table in Appendix	0.3 0.2 0.8		
Part E total		2.5		
Total points		20		