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^o θ in range 15-65^o*	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 *(only in linearized coordinates)* (axis labeled and scaled, experimental points plotted, linear fit line shown);	 0.3 0.3 0.9= *0.3x3*		
A4	Sample parameters calculation *(scored only if A2 score* ≥ 0.4*):* Numeric parameters of the linear fit written All points approximation *Two points only* 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	$\lambda = 659 nm$ selected	0.1		
B2	$I(\theta)$ measurements: Scored only if minimum is found in range *20-45^o* ***<u>and its transmittance value is lower that 0.5</u>*** - number of points 10 and more (*from 5 to 9, less than 5*) ; - angles range *(not less than* $25°$ *near minimum)*	 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^o* $\Delta\theta$ value in range *10-20^o*	0.1 0.1		
B5	Formula for λ_X Numerical value for λ_X in range $\pm$ **15 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^o*	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 $\pm$**30 nm from the real value for the sample** λ_2^{sp} in range $\pm$**30 nm from the real value for the sample** λ_3^{sp} in range $\pm$**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^o* ***<u>and its transmittance value is lower that 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^o* ***<u>and its transmittance value is lower that 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 that 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 $\pm$**15 nm from the real value for the sample** $\lambda_2^{(n)}$ value in range $\pm$**15 nm from the real value for the sample** $\lambda_3^{(n)}$ value in range $\pm$**15 nm from the real value for the sample** $\lambda_4^{(n)}$ value in range $\pm$**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 ± 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 $\pm$**15 nm from the real value for the sample** $\lambda_3^{(n)}$ value in range $\pm$**15 nm from the real value for the sample** $\lambda_4^{(n)}$ value in range $\pm$**15 nm from the real value for the sample** $\lambda_5^{(n)}$ value in range $\pm$**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	m deriving method: $1/\lambda^{(n)}$ values analysis Searching for missing minima (using graph or $\Delta\left(1/\lambda^{(n)}\right)$ calculation or equivalent) m numerical values 0.2 for each correct value (no more than 1.2 in total) *Error* ± 1 *for* m *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 $\pm$ **15 nm from the real value for the sample**	0.1x2 0.4x2		
	Part D total	**4.5**		
E1	Scored only if t values in task C8 obtained Correct sample structure name selected (n-6) t 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**		