Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Mark Schemes

Q1.

(a) Speed = $3.0 \times 10^8/1.47$
$= 2.0(4) \times 10^8$ m s^{-1} ✔
Do not accept 1 sf answer

1

(b) Critical angle calculation ✔
sin $C = n_{clad}/n_{core} = 1.41/1.47 = 0.96$
critical angle = 73.6°
Angle of refraction calculation✔
$r = 90 - C = 16.4°$
Do not give MP2 if calculated answer is given as A
Angle of incidence calculation ✔ sin (i) = 1.47 sin (r)
$i = 24.5°$
Allow 2 sf answer; allow 24.6°

3

(c) Correct path of light drawn showing partial reflection and transmission of ray when it encounters the boundary ✔

Angle of incidence on core–cladding boundary decreases✔
And will now be less than critical angle ✔
(Some light will escape/be refracted into cladding
Some light will continue)
If the diagram is not annotated and no other mark is given, 1 mark can be given for correct description of partial reflection.

3

[7]

Q2.

(a) reads off $\lambda_{p\ 1}$✔
for $_1$✔ condone POT;
expect $\lambda_p = 635 \pm 2$ (nm) /
$635 \pm 0.02 \times 10^{-9}$ / $6.35 \pm 0.02 \times 10^{-7}$ (m)
*allow evidence of working on **Figure 1***

1

use of $n \times$ their $\lambda_p = d \sin\theta_{\ 2}$✔
for $_2$✔ accept subject n with no / incomplete substitution, eg

$$N = \frac{\sin\theta}{n \times \lambda_p}$$

OR

subject d *and* <u>*full*</u> *substitution, eg*

$d = \frac{5 \times \text{their } \lambda_p}{\sin 76.3}$ / $5.15 \times$ their λ_p *5.15 × their* λ_p

OR

correct result $d = 3.27$ *(×* 10^{-6} *(m));*

allow ECF in λ_p *including POT;*

allow recognisable d */ 2 sf intermediate result*

3

$$N = \left(= \frac{1}{d} = \frac{1}{3.27 \times 10^{-6}} \right) = 3.06 \times 10^5$$ ₃✔

for ₃✔ *accept ≥ 3 sf in range 3.05 to 3.07 × 10*^{5} *OR*

$N = \frac{0.194}{their\ \lambda p}$ *(allow ECF for* λ_p *out of range but not if due to POT)*

1

(b) identifies an appropriate physical characteristic that makes the measurement of the (5th) maximum more difficult ✔

take 'it' to be the 5th *maximum / peak*

(centre difficult to locate because)

(5th*) 'maximum is wider' / 'peak less pronounced' / 'less defined' or wtte;*

allow 'maximum more spread out' / 'less pronounced'

OR

maximum 'is fainter' / 'less bright' / 'intensity reduced';

reject 'not as clear'

OR

(cannot use edges to determine location of centre because)

'whole maximum (may be) not visible' / 'can't see edges'

OR

*(**L**$_R$ produces a range of wavelengths so)*

4th *and 5*th */ adjacent fringes may overlap*

1

(c) extrapolation of linear region of the $\mathbf{L_R}$ characteristic ₁✔

for ₁✔ *reads off where a ruled extrapolation to the linear region of the* ***L***$_R$ *characteristic reaches the horizontal axis*

the line must be free from discontinuities; condone a ruled dashed line

condone tangent meeting curve at I *≥ 10 mA*

V_A for $\mathbf{L_R}$ in range 1.91 to 1.93 (V) ₂✔

for ₂✔ *> 3 sf acceptable if rounding to 3 sf*

2

(d) any fully correct calculation of the Planck constant ₁✔

for ₁✔ *allow 2 sf*

use of $c = 3(.00) \times 10^{8}$ AND $e = 1.6(0) \times 10^{-19}$

AND EITHER

V_A from (c) AND λ_p in range 620 to 650 nm / ECF their λ_p from (a)

OR

$V_A = 2.00$ AND λ_p in range 550 to 580 nm;

calculates mean of two valid calculations of the Planck constant;

result in range 6.10 to 6.50 × 10^{-34} (J s) $_2$✔

for $_2$✔ Planck constant result rounding to correct 3 sf

(check very carefully working leading to data booklet value 6.63 × 10^{-34})

1

(e) V_F corresponding to I_F = 21 mA read from $\mathbf{L_R}$ graph in **Figure 3**;

use of $V_F = 2.01$ (V) leading to $R = 195$ (Ω) earns both marks

calculates R from $\frac{6.1 - \text{their } V_F}{21(.0 \times 10^{-3})}$ $_1$✓

*for $_1$✔ accept evidence of working on **Figure 3** condone 2 sf eg V_F = 2.0 (V)*

allow POT error for I_F

1

R = 195 (Ω) from $\frac{6.10 - 2.01}{21(.0) \times 10^{-3}} = 195$ $_2$✓ 195 $_2$✔

for $_2$✔ evidence to show use of $V_F = 2.01 \pm 0.01$ (V) must be seen, ie allow

$\frac{6.10 - 2.00}{21(.0) \times 10^{-3}} = 195$ OR $\frac{6.10 - 2.02}{21(.0) \times 10^{-3}} = 194$

1

[10]