Name of the Student:_____
Max. Marks : 21 Marks **Time : 21 Minutes**

Mark Schemes

Q1.

(a) reads off $\lambda_{p\ 1}$✔

for $_1$✔ condone POT;
expect λ_p = 635 ± 2 (nm) /
635 ± 0.02 × 10^{-9} / 6.35 ± 0.02 × 10^{-7} (m)
*allow evidence of working on **Figure 1***

1

use of n × 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 (5^{th}) maximum more difficult ✔

take 'it' to be the 5^{th} maximum / peak
(centre difficult to locate because)
(5^{th}) 'maximum is wider' / 'peak less pronounced' / 'less defined' or wtte;

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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 5th / adjacent fringes may overlap

1

(c) extrapolation of linear region of the **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 $I \geq 10$ mA

V_A for **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 **L_R** graph in **Figure 3**;

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

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

*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 $\dfrac{6.10 - 2.01}{21(.0) \times 10^{-3}} = 195$ $_2$✓ 195 $_2$✔

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

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allow

$$\frac{6.10-2.00}{21(.0)\times10^{-3}}=195 \text{ OR } \frac{6.10-2.02}{21(.0)\times10^{-3}}=194$$

1

[10]

Q2.

(a) W – protostar/gas cloud ✔1

Candidates may add to the diagram – this should be credited

Accept formation stage for W

X – main sequence star ✔2

Y – (Red) giant AND Z – (white) dwarf ✔3

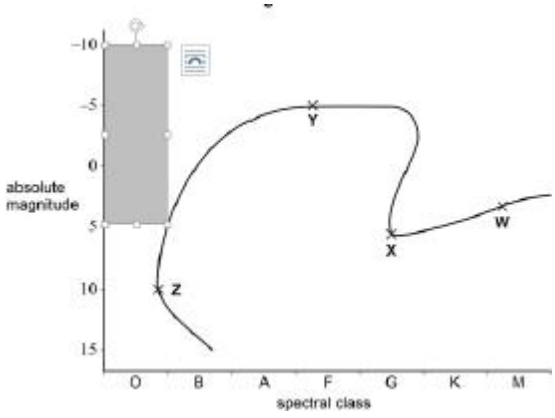
Condone Supergiant for Y

3

(b) Positioned magnitude less than 5

…and class O ✔

Grey box shows accepted region



1

(c) Transit method measures how much light is blocked by planet.✔1

MP1 Candidate demonstrates they know what the transit method is. Any suggestion that method involves seeing a dot moving across the face of the star award 0 marks.

1

Planet is small (and star is very big) so little light blocked out.✔2

MP2 Links this to Earth-sized planet.

1

(d) Use of σAT^4 ✔1

Condone incorrect A formula but must include other quantities.

3

= 8.0 (7.97) × 10^{30}(W) ✔2

Attempt to use inverse square law for Earth or find ratio of powers (allow ecf) ✔3

Equates intensities for Earth and planet orbiting TC✔4

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√their ratio × 1.5 × 10^{11} or √their power for TC✓

(= 2.2 (2.17) × 10^{13} m)

For example

Power output of Theta Carinae = σAT^4=

$5.67 \times 10^{-8} \times 4\pi R^2 \times 31000^4$ ✓1

$= 8.0\ (7.97) \times 10^{30}$ W ✓2

Ratio of power outputs = $\frac{7.97 \times 10^{30}}{3.8 \times 10^{26}}$

2.10×10^4 ✔3

So planet must be $\sqrt{2.10 \times 10^4}$ *1.45×10^2 times further away* ✔4

$1.45 \times 10^2 \times 1.5 \times 10^{11}$ 2.2×10^{13} m ✔5

2

[11]

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