Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Mark Schemes

Q1.

(a) High power/powerful radio emitter. ✔

Some indication of high power needed.

1

(b) Use of $m - M = 5 \times \log\frac{d}{10}$ ✔

1

$M = m - 5 \times \log\frac{d}{10}$ ✔

$M = 12.8 - 5 \times \log\frac{760 \times 10^6}{10} = -26.6$ ✔

1

(c) Quasar is brighter because more negative abs magnitude. ✔

Difference in absolute magnitudes 26.6 − 22.8 = 3.8 ✔

Brighter by $2.51^{3.8} = 33$ times ✔

Use of -27 (giving 48 times brighter) scores mp2 and mp3
Allow any value of absolute magnitude which rounds to -27.
Use of apparent magnitudes scores no marks.

3

(d) $R_s = \frac{2GM}{c^2} = \frac{2\times6.67\times10^{-11}\times7.1\times10^{11}\times1.99\times10^{30}}{3.00\times10^{8^2}} = \checkmark (2.1 \times 10^{15}\ \text{m})$

$\text{volume} = \frac{4}{3}\pi R_s^{\ 3} = \frac{4}{3}\pi 2.1 \times 10^{15^3} = \checkmark (3.7 \times 10^{46}\ \text{m}^3)$

If the mass of the Sun is not included mp1 is not awarded – ecf for mp2 and mp3.
2.094×10^{15} m
3.85×10^{46} m^3

1

$\rho = \frac{\text{mass}}{\text{volume}} = \frac{7.0\times10^{11}\times1.99\times10^{30}}{3.7\times10^{46}\text{m}^3}$ = 3.7 (3.67)× 10^{-5} $kg\ m^{-3}$ ✔

2

[9]

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Q2.

(a) The minima are caused when one star passes in front of the other. ✔

For mp2 it must be clear that dip size is related to temperature.

1

Deeper minima are caused by the cooler star passing in front of the hotter star. ✔

NB this is NOT related to the diameter of the star.

1

(b) The system is moving towards us AND mention of Doppler/red shift/effect ✔

OR

The system is moving so the light is blue shifted ✔

Condone 'star is, or stars are moving towards us'

1

(c) $\Delta\lambda = \frac{486.498 - 485.672}{2} = 0.413 \text{ nm}$ ✔

$z = \frac{\Delta\lambda}{\lambda} = \frac{0.413}{486.085\checkmark} = 8.50 \times 10^{-4}$

Alternative for mp1 use of average and one of the other values.

For mp2 must see evidence of correct use of average value (NB use of other wavelengths likely to give same answer to 3 sf).

2

$v = zc = 8.50 \times 10^{-4} \times 3.00 \times 10^{8} = 2.55 \times 10^{5} \text{ m s}^{-1} = 255 \text{ km s}^{-1}$ ✔

Average value (486.085)

Final answer must be seen to more than 2sf

For mp3 Allow ecf from mp1 and mp2 if answer is in range 250-260

1

(d) Identifies period (T) is 2.5 days ✔

$$v = \frac{2\pi R}{(their\ value\ of)\ T}$$

$R = \frac{v \times T}{2\pi} = \frac{2.55 \times 10^{5} \times 2.5 \times 24 \times 3600}{2\pi} = 8.76 \times 10^{9} \text{ m}$ ✔

Allow ecf from ***(c)***

1

Use of 250 km s^{-1} gives 8.59 × 10^{9} m ✔✔

1

(e) hydrogen and helium ✔

1

(f) Observable property of Neutron Star or White Dwarf ✔

Observable properties

Property of the other object

AND

coincident in space OR idea of how a property varies

WD – O or B class/ H-He absorption lines/ high temp AND not very bright abs mag.

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NS – radio emissions/Pulsars

Variations include radio emissions from neutron star blocked by white dwarf ✔

Spectroscopic variation in white dwarf seen ✔

2

[11]

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