

M1.(a) (i)  $\lambda_{\max} T = 0.0029$

$$\lambda_{\max} = 180 \times 10^{-9} \text{ m } \checkmark$$

$$T = 0.0029 / 180 \times 10^{-9}$$

$$= 1.6 \times 10^4 \text{ K } \checkmark$$

*Allow range for wavelength.*

*170nm to 190nm correct.*

*150nm to 200nm incorrect but treat as a.e.*

*Anything else treat as PE –first two marks not awarded.*

*Allow kelvin for unit. But not degrees kelvin.*

3

(ii)  $P = \sigma AT^4$

$$A = P / \sigma T^4 = 4.2 \times 10^{24} / (5.67 \times 10^{-8} \times (1.6 \times 10^4)^4) \checkmark$$

$$= 1.1 \times 10^{15} \text{ m}^2$$

$$r = \sqrt{(A / 4\pi)} = 9.5 \times 10^6 \text{ m } \checkmark$$

*Allow c.e. for T from ai.*

*If formula wrong treat as PE – no marks awarded. Note: this is true if the incorrect equation for A is used within the power equation.*

2

(b) (i) dwarf ticked

1

(ii) it has a high temperature  $\checkmark$

*Allow low power output for small.*

*Allow high power output for large.*

but is relatively small, so it will have a low absolute magnitude  $\checkmark$

*Marks can be awarded for ruling out other two.*

(this puts it into the bottom left region of the HR diagram)

*If white dwarf not ticked in bi :-*

*Giant stars – cool and big.*

*Main sequence – either cool and small or hot and big for 2*

marks.

Or 'middling temperature and size' for 1 mark.

2

[8]

**M2.(a)** Apparent magnitude at a distance of 10pc

*Allow "brightness".*

*Do not allow luminosity or magnitude.*

1

(b) Absolute magnitude from 15 to -10  
Temperature from 50 000K to 2500K

*Allow 15 to -15.*

*Allow 50 000 to 3500 K.*

2

(c) (i) S at 5700 K and abs mag 5

*The position of S should be consistent with the scales on the axes. Allow ce on scale.*

*Allow 6000 for T.*

*If labels not present, or if only correct extreme values on scale, S should be to the right of and below the centre.*

1

(ii) W at same abs mag as S, but further to left

*Judgements on ii – iv should be based on the position of S. If S is not labelled, it should be based on where S should be.*

1

(iii) X at same temperature as S but greater absolute magnitude

1

(iv) Y at same abs mag or above S, on the right hand side of the diagram

1

(d) Similar power output ✓  
but is hotter ✓

Ref to  $P = \sigma AT^4$  hence W must have smaller diameter than the Sun ✓

Allow luminosity for Power.

Answer must be supported to get the mark.

3

[10]

**M3.** (a) brightness (or apparent magnitude) of star from a distance of 10 pc (1)

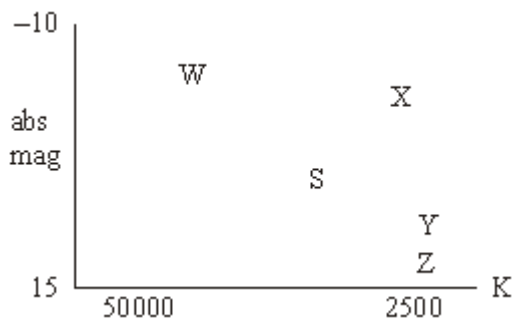
1

(b) (i) temperature from 50000 K to 2500 K (1)  
absolute magnitude from +15 to -10 (1)

(ii) S at 6000 K, and abs mag 5 (1)

(iii) W above and to left of S (1)  
X above and to right of S (1)  
Y below and to right of S (1)  
Z below and to right of S (1)

7



[8]

**M4.** (a) (i) main sequence correct (1)  
Giants and Dwarfs correct (1)  
OBAFGKM (1)

(ii) X at G, 5 (1)  
line up to Red Giant, down to White Dwarf (1)

max 4

(b) (i) temperature and colour [or reference to correct spectral line] **(1)**

(ii)  $\frac{330}{3.26} = 100 \text{ (pc)}$  **(1)**

(iii)  $m - M = 5 \log \frac{d}{10}$  gives  $m - M = 5$  **(1)**

$M = -2.1$  **(1)**

(allow C.E. for value of  $d$  from (ii))

(iv) Matar is brighter (but at same temperature) **(1)**

(since  $P = \sigma AT^4$ ), Matar must have larger  $A$ , therefore larger **(1)**

6

[10]