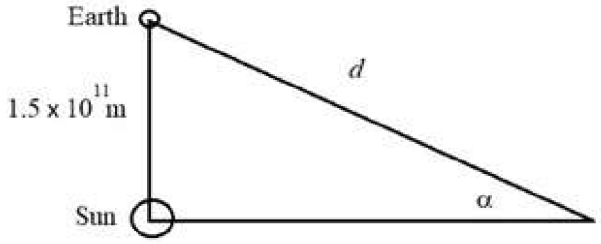
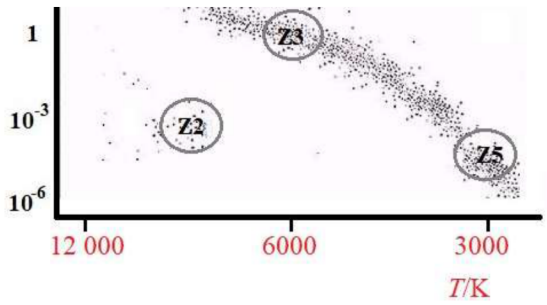
| Question Number | Answer | | Mark |
|---|---|---|---|
| **19(a)** | Use of trigonometry to calculate the parallax angle<br>**Or** Use of trigonometry to calculate distance | (1) | |
| | (Smallest) parallax angle = $3.3 \times 10^{-7}$ (rad )<br>**Or** max distance = $6.25 \times 10^{17}$ (m) | (1) | |
| | Comparison of calculated value with corresponding value in question with valid conclusion | (1) | **3** |
| | <u>Example of calculation</u><br>$\sin\alpha = \dfrac{1.5 \times 10^{11}\ \text{m}}{d}$<br>$\alpha = \sin^{-1}\left(\dfrac{1.5 \times 10^{11}\ \text{m}}{4.6 \times 10^{17}\ \text{m}}\right) = 3.26 \times 10^{-7}\ \text{rad}$<br>**Or** $\alpha = \left(\dfrac{1.5\times10^{11}\ \text{m}}{4.6\times10^{17}\ \text{m}}\right) = 3.26 \times 10^{-7}\ \text{rad}$ (small angle approximation)<br>  <br> | | |
| **19(b)** | The intensity (of radiation from the candle) is measured | (1) | |
| | The luminosity of the standard candle is known | (1) | |
| | The inverse square law is used to determine the distance<br>[Accept reference to $I=L/4\pi d^2$ with symbols defined] | (1) | **3** |
| **19(c)(i)** | Axis labelled with $T$ / K | (1) | |
| | Reverse logarithmic scale | (1) | |
| | 6000 K in correct position on scale | (1) | **3** |
| | <u>Example of graph labelling</u><br>  <br> | | |

**19(c)(ii)**

| Description | Zone | |
|---|---|---|
| High mass hot stars | Z1 | (1) |
| Low mass cool stars | Z5 | (1) |
| Low mass hot stars | Z2 | (1) |

**3**

**19(c)(iii)**

This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.

Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for structure and lines of reasoning.

| | Number of marks awarded for structure of answer and sustained line of reasoning |
|---|---|
| Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout | 2 |
| Answer is partially structured with some linkages and lines of reasoning | 1 |
| Answer has no linkages between points and is unstructured | 0 |

Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning

| IC points | IC mark | Max linkage mark | Max final mark |
|---|---|---|---|
| 6 | 4 | 2 | 6 |
| 5 | 3 | 2 | 5 |
| 4 | 3 | 1 | 4 |
| 3 | 2 | 1 | 3 |
| 2 | 2 | 0 | 2 |
| 1 | 1 | 0 | 1 |
| 0 | 0 | 0 | 0 |

Indicative content

IC1 The star is fusing hydrogen in its core

IC2 When fusion ceases (the core of the star cools and) the core collapses/contracts (under gravitational forces)

IC3 The star (moves to Z4 as it expands and) becomes a red giant star

IC4 Temperature (in the core) is high enough for helium fusion to begin

IC5 Helium begins to run out and then fusion ceases

IC6 The star becomes a white dwarf (in Z2)

**6**

**Total for question 18** **18**