<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>20(a)</td><td>Star on main sequence with a relative luminosity of 1 (1)</td><td>(1)</td></tr>
<tr><td>*20(a)(ii)</td><td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.<br><br>
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.<br><br>
The following table shows how the marks should be awarded for structure and lines of reasoning.<br><br>
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained line of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
<br>
Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning<br><br>
<table>
<tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr>
<tr><td>6</td><td>4</td><td>2</td><td>6</td></tr>
<tr><td>5</td><td>3</td><td>2</td><td>5</td></tr>
<tr><td>4</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
<br>
Indicative content<br><br>
IC1 When hydrogen fusion ends main sequence stars evolve into red giant stars<br><br>
IC2 This happens first for stars near the top of the main sequence<br>
Or this happens first for the (most) massive main sequence stars<br><br>
IC3 Red giant stars are located above the main sequence<br><br>
IC4 When helium fusion ends red giant stars evolve into white dwarf stars<br><br>
IC5 White dwarf stars are located below the main sequence<br><br>
IC6 Red giant stars are larger (in surface area) and have a lower (surface) temperature<br>
Or White dwarf stars are smaller (in surface area) and have a higher (surface) temperature
</td><td>(6)</td></tr>
</table>

| | | |
|---|---|---|
| **20(b)(i)** | λ value read from graph (1)<br><br>Use of $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ for either spectral line (1)<br><br>$v = (-)3.05 \times 10^5$ m s$^{-1}$ (1)<br><br>Andromeda is moving towards the Earth (1)<br><br><u>Example of calculation</u><br><br>$\frac{393.0\text{ nm} - 393.4\text{ nm}}{393.4\text{ nm}} = \frac{v}{3.00 \times 10^8\text{ m s}^{-1}}$<br>$\therefore v = 3.00 \times 10^8\text{m s}^{-1} \times \left(\frac{-0.4\text{ nm}}{393.4\text{ nm}}\right) = -3.05 \times 10^5\text{ m s}^{-1}$ | **(4)** |
| **20(b)(ii)** | A layer of dust around the candle would reduce the intensity (1)<br><br>Intensity obeys an inverse square law<br>**Or** $I = \frac{L}{4\pi d^2}$ (symbol *I* **or** *L* defined) (1)<br><br>A smaller value of intensity would lead to larger (calculated) distance, so claim is valid (1) | **(3)** |
| | **Total for question 20** | **14** |