OCR A A Level Astrophysics 1 worksheet

35-40 minutes independent practice + 15-20 minutes review | 35 marks

Specification points covered

- 5.5.1(a) Define and distinguish planets, planetary satellites, comets, solar systems, galaxies and the universe.
- 5.5.1(b) Describe the formation of a star from interstellar dust and gas by gravitational collapse and fusion of hydrogen into helium.
- 5.5.1(c) Describe the evolution of a low-mass star like the Sun into a red giant and then a white dwarf via planetary nebula.
- 5.5.1(d) Describe the characteristics of a white dwarf and the Chandrasekhar limit arising from electron degeneracy pressure.
- 5.5.1(e) Describe the evolution of a massive star into a red supergiant and then either a neutron star or a black hole after supernova.
- 5.5.1(f) Describe the characteristics of a neutron star and a black hole.
- 5.5.1(g) Interpret a Hertzsprung-Russell diagram as a luminosity-temperature plot showing main sequence, giants and white dwarfs.

Nereid Cluster survey

The Arclight Observatory is preparing an evidence dossier about the fictional Nereid Cluster: a group of stars at different stages of evolution.
Its observations include a solar-mass star, a high-mass star, a pulsar and three objects plotted on a Hertzsprung-Russell diagram.
Use the cluster evidence carefully. In particular, distinguish what the diagram shows directly from what requires information about stellar mass.

1. Scale and star formation

1. State one difference between a solar system and a galaxy. A natural body that orbits a planet is also listed in the Nereid registry. Give the correct term for this body. [2 marks]

2. The registry describes Nereid-4, a rocky body orbiting its star, and Nereid-4a, a smaller natural body orbiting Nereid-4. State the correct term for Nereid-4 and for Nereid-4a. [2 marks]

3. Cold interstellar dust and gas in the Nereid Cluster are drawn together. Explain how a main-sequence star forms from this material. [3 marks]

2. Stellar fates

4. Star N-17 has an initial mass similar to the Sun and has exhausted hydrogen in its core. Describe its subsequent evolution to a stable remnant. [3 marks]

5. Star N-38 began with a much greater mass than the Sun. Describe its likely evolution from leaving the main sequence to a compact remnant. [3 marks]

6. The team estimates that a degenerate stellar core has a mass of 1.32 times the mass of the Sun. Explain how it can be a stable white dwarf. State what happens if a comparable core exceeds the Chandrasekhar limit of about 1.4 solar masses. [3 marks]

7. A radio source in the cluster brightens once every 0.68 s. Identify the likely object and explain why this repeating signal is detected. [3 marks]

3. Hertzsprung-Russell diagram evidence

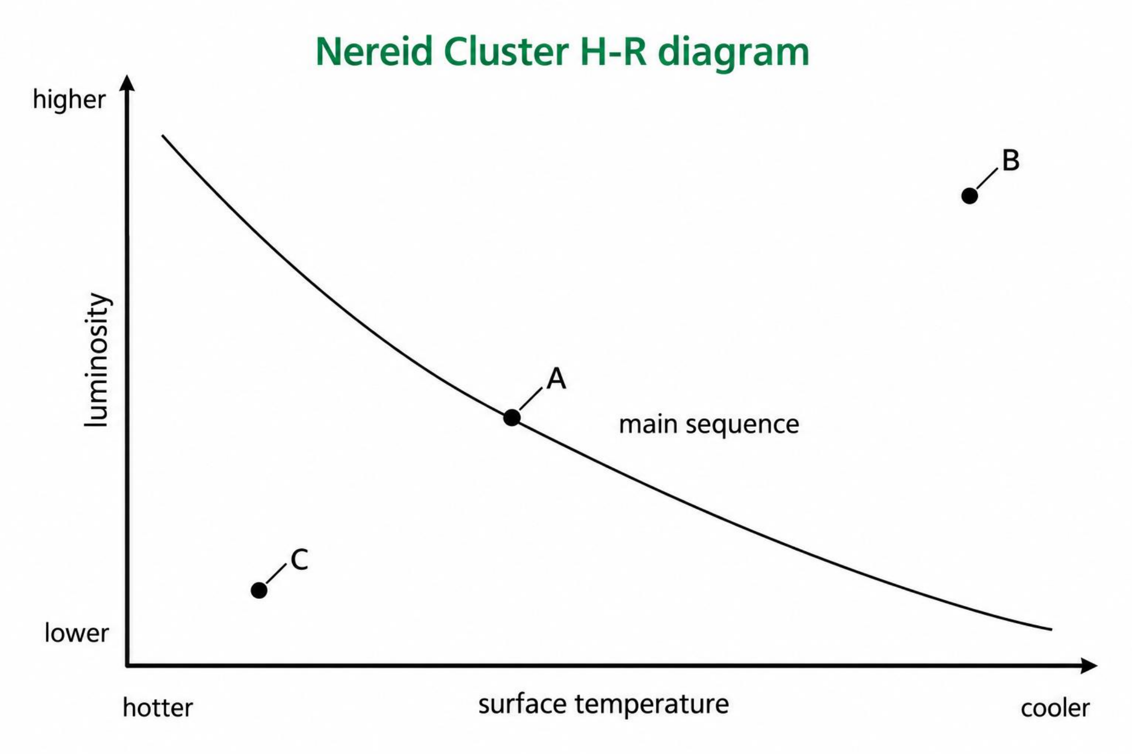

Figure 1: Hertzsprung-Russell diagram for the fictional Nereid Cluster

8. Figure 1 shows three objects in the Nereid Cluster. Identify the type of star at B and at C. State whether A has a higher or lower surface temperature than B. [3 marks]

9. Star C is hotter than B but has a much lower luminosity. Explain why these observations are consistent with C being a white dwarf and B being a red giant. [3 marks]

3. Hertzsprung-Russell diagram evidence continued

10. Star A has a mass similar to that of the Sun. Using Figure 1, describe how its position changes during the rest of its evolution. [3 marks]

11. A visitor says: "Every star expands to a red giant and then becomes a black hole." Correct this statement using the role of stellar mass. [3 marks]

12. A trainee concludes that B will definitely become a black hole because it is luminous, and that C has always been a low-mass main-sequence star because it is faint. Evaluate the conclusion using Figure 1 and the stellar-evolution model. [4 marks]