Q5 and Q6 These questions are based on the labelled Hertzsprung–Russell diagram in Figure 1. The labels A–G constitute the key for Q5 and Q6.

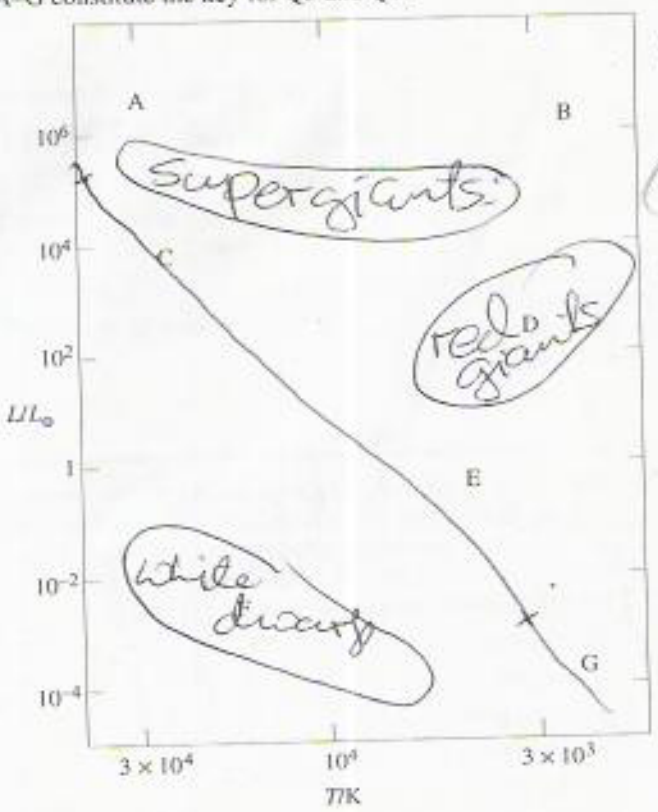

Figure 1 A labelled H–R diagram.

Q5 Which of A–G labels the area where hot, faint stars are found? Pencil across *one* cell in row 5.

Q6 Which of A–G labels the region of the main sequence where there are no old stars? Pencil across *one* cell in row 6.

Q7 In red giants of mass $5M_\odot$, which *two* of the following nuclei are *not* created (in any significant quantity) by nuclear reactions in their interiors?

KEY for Q7

A $^{4}_{2}$He
B $^{12}_{6}$C
C $^{16}_{8}$O
D $^{20}_{10}$Ne
E $^{21}_{10}$Ne
F $^{24}_{12}$Mg
G $^{59}_{26}$Fe
H $^{197}_{69}$Au

Pencil across *two* cells in row 7.

PART B

This part relates to Block 1, mainly Chapters 4 and 5, and carries 50% of the marks for this assignment.

Q8 The key lists statements about a supergiant *before* it has reached the stage when it will become a supernova. Which *one* of the statements is *false*?

KEY for Q8

A As each nuclear fuel in the core is exhausted, the core contracts and its temperature increases until the core can undergo further fusion.

B The contraction of a supergiant is halted when nuclear energy is released in the core sufficiently rapidly to sustain a pressure gradient large enough for stability.

C As long as it has an iron core of mass less than $1.4M_\odot$ then the star can continue to be stable through fusion that increases the mass of the iron core.

D In the core of a young supergiant the electrons are non-degenerate.

E In the outer layers of the supergiant, r-process reactions are creating elements more massive than iron.

F For most fusion reactions involving elements less massive than iron, the fusion of more massive elements releases less energy per kilogram of reactants than the fusion of less massive elements.

Pencil across *one* cell in row 8.

Q9 The remnant core of a supergiant after a Type II supernova at some instant has a radius of 1 000 km and a rotation period of 500 s. It continues to contract, without loss of mass, to form a neutron star with a radius of 10 km. Given that the moment of inertia of the contracting core is proportional to the square of its radius, calculate the rotation period of the neutron star. Select from the key the value closest to yours.

KEY for Q9

A 2×10^{-2} s
B 5×10^{-2} s
C 0.2 s
D 0.5 s
E 2 s
F 5 s
G 20 s
H 50 s

Pencil across *one* cell in row 9.

Q10 Consider the following set of objects:

(i) a supergiant
(ii) a white dwarf
(iii) a neutron star
(iv) a black hole

Which of these four objects has an *actual* radius less than (or equal to) its Schwarzschild radius? Select *one* set of objects from the key.

KEY for Q10

A Only (i)
B Only (ii)
C Only (iii)
D Only (iv)
E Only (ii) and (iii)
F Only (iii) and (iv)
G All except (i)
H All of (i)–(iv)

Pencil across *one* cell in row 10.