Q6 In red giants the following reaction sequence becomes important at temperatures above 2×10^8 K. What is X? Is the first reaction exothermic or endothermic? Choose *one* answer from cells A–E and *one* from F–H.

$$^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \longrightarrow \mathrm{X} + \gamma$$

$$\mathrm{X} \longrightarrow {}^{18}_{8}\mathrm{O} + e^{+} + \gamma$$

KEY for Q6

A $^{18}_{9}$N
B $^{18}_{8}$F
C $^{18}_{9}$F
D $^{18}_{8}$N
E $^{18}_{9}$O
F Exothermic
G Endothermic
H There is insufficient information to say.

Pencil across *one* of the cells A–E and *one* of the cells F–H.

Q7 Select from the key one *true* statement relating to the formation of stars from dense clouds.

KEY for Q7

A The average number density in a typical dense cloud is too low for contraction to occur.
B If the mass of a dense cloud exceeds the Jeans mass, the cloud will contract to a single star.
C A dense cloud typically has too low a temperature to contract.
D Dense clouds are uniform in density and temperature.
E A dense cloud that begins to contract is likely to break into fragments that contract independently.
F The rise in temperature as a cloud condenses prevents further contraction.

Pencil across *one* cell in row 7.

Q8 Which two statements are *true* about a main sequence star of mass $5M_{\odot}$?

KEY for Q8

A Convection is confined to an outer shell, which contains about 80% of the mass of the star.
B Convection occurs in the core of the star.
C The star will have a main sequence lifetime of greater than 1×10^{10} years.
D The luminosity of the star will be about 3 000 times that of the Sun.
E Helium burning commences in the core following the helium flash.
F About 10^7 years after leaving the main sequence, the star will have a thin shell away from the core where hydrogen burning occurs.

Pencil across *two* cells in row 8.

PART B

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

Q9 A supergiant star has a rotation period of 1 000 years and a radius of $400R_{\odot}$. When it was on the main sequence it had a radius of $4R_{\odot}$. Assuming that there has been no significant mass loss, and that a star's moment of inertia is proportional to its radius squared, calculate the star's rotation period when on the main sequence. Select from the key the value closest to yours, and pencil across *one* cell in row 9.

KEY for Q9

A 100 000 years
B 10 000 years
C 1 000 years
D 100 years
E 10 years
F 1 year
G 0.1 year

Q10 A black hole of mass $5M_{\odot}$ encounters a second black hole of mass $1M_{\odot}$ and swallows it. Which two of the following statements about the resultant black hole are *true*?

KEY for Q10

A It has smaller Schwarzschild radius than the $5M_{\odot}$ black hole.
B The gravitational acceleration at its Schwarzschild radius is smaller than that at the Schwarzschild radius of the $5M_{\odot}$ black hole.
C The escape velocity at the Schwarzschild radius is now smaller than the speed of light, c.
D The escape velocity at the Schwarzschild radius is now larger than the speed of light, c.
E The ratio (mass of black hole)/(volume within its Schwarzschild radius) is smaller than that for the $5M_{\odot}$ black hole.
F The gravitational acceleration at a large distance from the resultant black hole is 1.44 times that at the same distance from a $5M_{\odot}$ black hole, so the Chandrasekhar limit is exceeded.

Pencil across *two* cells in row 10.

Q11 In which of the regions listed in the key for Q11 to Q13 is most carbon created? Pencil across *one* cell in row 11.

KEY for Q11 to Q13

A Dense clouds
B Molecular clouds
C Supernovae
D Stellar interiors
E Circumstellar shells
F Hot intercloud medium
G HII regions
H Carbon-rich white dwarfs