Q5 The key lists statements about stellar evolution. Which *two* of these statements are *false*? Pencil across *two* cells in row 5.

KEY for Q5

A In a contracting cloud of interstellar material, gravitational energy is converted into thermal kinetic energy.

B A star joins the main sequence when energy from nuclear fusion in its core halts contraction.

C The main sequence on the Hertzsprung–Russell diagram represents stable configurations of different mass stars with similar chemical compositions.

D The more massive a star the greater its main sequence lifetime.

E Only a small proportion of the mass of a main sequence star is ejected into the interstellar medium by stellar winds.

F The main sequence lifetime ends when there is no more hydrogen fuel in the core.

G Nucleosynthesis in red giants proceeds beyond oxygen in all cases.

Q6 Select from the key the primary factor in determining whether the pp or CNO cycles are the main source of energy in a particular star. Pencil across *one* cell in row 6.

KEY for Q6

A The age of the star

B The radius of the star

C The core temperature of the star

D The core density of the star

E The abundance of carbon, oxygen and nitrogen in the core

Q7 The luminosity of a supernova from day 100 after outburst is controlled by the radioactive decay of $^{56}_{27}$Co. The half-life of the cobalt is 77 days and the luminosity of the supernova halves every 77 days. If the luminosity is 10^{34} W at day 100, what is it at day 870? Select from the key the value closest to yours, and pencil across *one* cell in row 7.

KEY for Q7

A 2×10^{33} W

B 10^{32} W

C 2×10^{31} W

D 10^{31} W

E 5×10^{30} W

F 4×10^{30} W

Q8 If 4×10^{58} neutrinos spread uniformly out into space from a supernova, how many pass through an area of 1 m^2, 170 000 light years away? (This is roughly the distance to SN 1987A.) The area is perpendicular to the direction of travel of the neutrinos. Select from the key the value closest to yours, and pencil across *one* cell in row 8. (*Hint*: The area of a sphere, radius r, is $4\pi r^2$.)

KEY for Q8

A 5×10^{-37}

B 8×10^{-16}

C 10^{-5}

D 1

E 10^{15}

F 2×10^{36}

PART B

This part relates to Block 1, Chapter 5, and carries 40% of the marks for this assignment.

Q9 In the interstellar medium, calculate the minimum temperature for appreciable collisional excitation of hydrogen atoms, in which the atom is raised from its lowest electronic energy level to the electronic level above the lowest. Select from the key the value closest to yours, and pencil across *one* cell in row 9.

KEY for Q9

A 0.05 K

B 300 K

C 3 000 K

D 15 000 K

E 50 000 K

F 80 000 K

Q10 Assume that the dense cloud fragment from which the Solar System formed had a mass of about $2M_\odot$. Assume also that the fragment at some point in its contraction was roughly spherical, with a number density at the upper end of the range observed for dense clouds. Calculate the fragment's radius at this stage. Select from the key the value closest to yours, and pencil across *one* cell in row 10. (*Hint*: Obtain the volume, V. This is related to radius r via $V = \frac{4}{3}\pi r^3$.)

KEY for Q10

A 2 600 AU

B 1 500 AU

C 900 AU

D 150 AU

E 30 AU

F 13 AU

Q11 The key lists pairs of different types of region in the interstellar medium. For which two pairs is the second type *not* predominantly the direct result of the evolution of the first type? Pencil across *two* cells in row 11.

KEY for Q11

A Dense cloud; planetary nebula

B Planetary nebula; interstellar cirrus

C Dense cloud; HII region

D Warm intercloud medium; GMC complex

E Interstellar clouds; warm intercloud medium

F Supernova remnant; hot intercloud medium

G Hot intercloud medium; warm intercloud medium

Q12 Which event in the key does *not* normally lead to an increase in the density of a region in the interstellar medium? Pencil across *one* cell in row 12.

KEY for Q12

A The impact of shock fronts from supernovae

B The impact of shock fronts from OB associations

C Ultraviolet radiation from young stars

D Violent collisions between denser regions in a GMC complex

E The onset of a gravitational instability