SPECIMEN ANSWERS

These specimen answers to the SEP questions are *one* set of answers that would have earned *very high marks*. We do not claim that they are perfect, nor that they include every point that would have earned marks. Better, or different answers are no doubt possible, and *you can be sure that in marking your scripts we shall be glad to give marks for any valid point that is made.*

Our comments on the answers are in square brackets [ ]. We have also used square brackets to show where material relevant to the answer can be found in S281.

PART I

This is the computer-marked section of the paper, so the details of argument/working are given here so that you can see the basis of the correct responses. Even though when you sit the actual paper you would have some rough working and notes, these must *not* be submitted with the CME form.

Q1 The correct response is A.

The equation given on page 2 of the specimen paper only requires V subscripts to be added (for V band), to give

$$\begin{aligned} d &= [L_V/(4\pi F_V)]^{1/2} \\ &= [5.0 \times 10^{30}\,\mathrm{W}/(4\pi \times 2.7 \times 10^{-10}\,\mathrm{W\,m^{-2}})]^{1/2} \\ &= 3.8 \times 10^{19}\,\mathrm{m} \\ &= 4\,100 \text{ light years} \end{aligned}$$

using the given conversion.

Q2 The correct response is C.

Subsection 3.3.3 of Book 1 states that hydrogen burning is the energy-releasing process in the cores of all main sequence stars. Subsection 3.4.1 states that the end of hydrogen burning in the core marks the end of the main sequence lifetime. Full marks, however, would also be given for option A. This is because in S281 we do not give the overall effect of the CNO nuclear reactions that predominate in the cases of upper main sequence stars in the form of a detailed net reaction: we say only that the net effect is the produciton of of a He nucleus from four protons. (In fact the overall effect has 3γ in place of 2γ.)

Q3 The correct response is C.

Neutron stars are the subject of Book 1 Subsection 4.4.1, and escape speed is revised in Book 1 Subsection 4.4.4, and in Section 1.4 of Book 2. Using the given equation for escape speed, and the given values,

$$\begin{aligned} v_{esc} &= (2GM/R)^{1/2} \\ &= (2 \times (6.7 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}})(1.0 \times 2.0 \times 10^{30}\,\mathrm{kg})/(1.0 \times 10^{4}\,\mathrm{m}))^{1/2} \\ &= 1.6 \times 10^{8}\,\mathrm{m\,s^{-1}} \end{aligned}$$

Q4 The correct response is F.

All non-solar objects in the Solar System, except for the giant planets, are extremely depleted in hydrogen and helium because of their high volatility. The giant planets are exceptions because they developed kernels massive enough to capture gas from the solar nebula before it dissipated. Uranus is thought to have captured the order of an Earth mass of hydrogen and helium – 10% or so of the mass of Uranus (Book 2 Subsection 2.5.3).

Q5 The correct (FALSE) responses are D and G.

D FALSE – Ices condense at *lower* temperatures than hydrated minerals. See Book 2 Subsection 2.3.1 and Table 2.1.