Paper B3

146 Candidates; paper mean 55.2*147/146; S.D. 16.2. The first two questions, on stellar structure, attracted fewer candidates than the cosmology questions ($\sim$ 80 versus 115) but stellar structure questions yielded significantly higher means ($\sim$ 67% versus 46%). The question on Earth observation was much less popular than that on climate change.

Question 1: 80 attempts; mean 13.3; s.d. 4.3

This problem involved the derivation of the mass-radius relation for sub-stellar objects from the equation of hydrostatic equilibrium, similar to what the students had seen before in the lectures and the problem set. The problem was done reasonably well by the majority of students, producing a very wide distribution of marks with quite a few (near-) perfect answers. Very few students were able to write the answer in the suggested, non-dimensional form. The problem probably missed a challenging part for the best students.

Question 2: 83 attempts; mean 14.6; s.d. 2.8

In this problem the students were asked to analyze the equilibrium abundances for the PPI reaction chain. The problem was very similar to, but a bit easier than a problem on the CNO cycle they did in the problem set. Apparently quite a few students did not see the similarities and avoided the problem altogether. However, those students who did the problem generally did it very well, producing a very high average mark and very few sub-standard answers. Despite the high mark, there were a few subtle points only the best students were able to answer, giving them some extra distinction.

Question 3: 115 attempts; mean 8.8; s.d. 4.0

This question expected basic understanding of the Robertson- Walker metric and Friedmann's equation. Almost no candidates were able to explain correctly what is meant by a "flat universe", and very few were able to understand that "show that da/dt will increase" required them to consider the second-derivative of a. Overall, there seems to have been a mismatch between the examiners' expectations and the candidates' level of understanding which needs to be addressed in future years. The large number of attempts perhaps indicates that a number of candidates attempted this question in favour of others on the paper, despite perhaps being not very well prepared on this topic.

Question 4: 95 attempts; mean 9.7; s.d. 4.3

The second cosmology question on the microwave background was slightly better answered than question 3, with a few very good scripts, although again the mean mark was low with a fair number of very low scores. Those responses which received low marks tended to be poor not only in the algebraic part of the question but also in the description of the origin of the microwave background. Although many candidates understood that matter and radiation were once in equilibrium, the majority of candidates did not appreciate that the deduction of the redshift of last scattering arises from this consideration, and very few were able to explain the value of the temperature at last scattering.

Question 5: 126 attempts; mean 10.9; s.d. 4.5

A straightforward question on inviscid flow around a cylinder, which was generally quite well answered. Some candidates forgot to verify that the given potential implies zero normal velocity on the cylinder; others failed to evaluate the tangential velocity there, as asked, and then got bogged down in the calculation of the pressure. Quite a few forgot to take the x- and y-components of the normal pressure force on each surface element of the cylinder, before integrating to find the net force.

Question 6: 71 attempts; mean 8.4; s.d. 5.4

Some candidates did very well on this question, but a larger number performed poorly. Many failed to realise that the requested physical argument involves conservation of angular momentum and hence requires consideration of the torques (not forces) acting on concentric cylinders of fluid. (This was despite a similar argument being used in a question on the problem sheet.) In the last part quite a large number of candidates confused the torque with the stress and therefore went badly astray.

Question 7: 40 attempts; mean 10.8; s.d. 4.8

This was a fairly straightforward question about infrared measurements of the Earth's surface from space, including a signal-to-noise calculation. It attracted relatively few attempts, and most of those were not very good, although there were a small number of good answers.

Question 8: 111 attempts; mean 13.7; s.d. 4.0

This involved calculating the parameters of a 2-box model of the Earth's climate system. Following reviews of the question, several generous hints were provided. Candidates were asked to comment on the relevance of the model solution for the real Earth. There were many good answers and only a few poor ones.