A-LEVEL
PHYSICS

7408/3BA Astrophysics
Report on the Examination

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General Comments

This paper consisted of questions designed to assess knowledge and understanding across a range of topics. The style of questions was similar to those of previous series. In keeping with the balance of assessment objectives required on this paper, students were given opportunities to demonstrate a range of skills including recall, an ability to perform straightforward tasks, mathematical skills in several contexts, the application of knowledge and understanding and the ability to reason and reach a judgement. It is in this latter assessment area in particular that many students continue to have difficulties.

Question 1

There was a range of demand to the parts of question 1 and it produced a good spread of marks.

01.1
The diagram of a parsec required students to include a lot of detail for one mark. This proved to be quite demanding. Many students labelled the wrong angle as the arc second, or failed to label the AU. A fairly common error was drawing 1 AU between the surfaces of an enlarged Sun and Earth. This was not given credit.

01.2
Identifying the spectral class of Rigel was also surprisingly difficult, with only 65% of students getting the mark. Note that a lower case ‘b’ was not credited.

01.3
Almost 70% of students obtained both marks. Students who got the wrong answer could access one mark for either using m-M correctly or using base-10 antilogs, provided they set out their answers sufficiently clearly so that examiners could spot what they were doing.

01.4
Many students who did not get the mark started their answer at the position where the Sun is now, having failed to read the question. Many answers were also seen that went into the supergiant region, or did not go through the area around G5. This meant that fewer than 30% of students were awarded the mark.

01.5
Although it is not fully understood, the important aspects of the GRB are that the star must be a supergiant that is collapsing into a neutron star or black hole. Many answers were confused with type 1a supernovae or were in other ways vague or incomplete.

Question 2

Overall question 2 proved to be quite challenging for many students.

02.1
Although other answers were accepted, some of the best answers showed an understanding that the final image formed by the telescope is at infinity and therefore the eye is behaving in the same way as it is when viewing the object unaided. Answers that referred to the length of the telescope as the sum of the focal lengths or referred to F_o and F_e without definition did not get the mark. Many answers that also were given no credit used the angular-magnification equation given in the data booklet.

02.2
Nearly two-thirds of students got this right. Many other students preferred the third response, showing that they were unfamiliar with the types of lens used in the telescope.

02.3
This discriminated well. Students who did not get the correct answer could access one mark if they realised that they had to add the value of 6 to their magnitude.

02.4
Many students approached the question from a resolution perspective rather than from collecting power. One mark was available for this error when the answer was otherwise correct. Many of those who used the collecting power did not compare their answer with the value of 40 from the stem of the question and were therefore also restricted to one mark.

02.5
Answers contained many misconceptions about the CCD. Many of the best answers explained the difference in quantum efficiency of the CCD and the eye in some detail. Some answers that did not get the mark mentioned the idea that the CCD allows an image to be stored without any idea of why that would allow dimmer objects to be seen. Others discussed resolution, again failing to take into account the context of the question.

Question 3

The questions on the effects of the black hole in M87 proved to be more accessible. They produced a range of marks across the ability range.

03.1
The defining feature of a black hole is stated in the specification. Many answers appeared to confuse black holes with black bodies, made references to singularities or density or simply said ‘light cannot escape’. Other answers also failed to gain the mark for a lack of clarity, for example referring to ‘beyond’, ‘past’ or ‘before’ the event horizon without specifying direction. Other answers defined the event horizon rather than a black hole.

03.2
This was one of two questions that provided the best discrimination on the paper. The best answers worked out the resolution of each telescope, and showed an understanding of angular resolution in their discussion. They also included calculations of the angle between the stars and the black hole to show that the EHT would be able to resolve them but that the Hubble would not. Problems with powers of ten and other arithmetic errors were quite common.

03.3
The mark scheme allowed students to receive partial credit for some idea of how to approach this question, which meant nearly 80% obtained at least one mark. Many answers did not take the factor of two into account and therefore obtained the wrong value for z. This question also discriminated well.

Question 4

This question was marked using a levels of response mark scheme. Along with 03.2 it was the best discriminating question on the paper.

Most students demonstrated an understanding of how the spectral class was related to colour. There was some confusion about apparent magnitude and absolute magnitude, with students unsure whether they were writing about what can be seen from Earth or not. Some students attempted to calculate an absolute magnitude assuming a distance. Calculations were often well done, but a missing factor of 4 for the area of the star in Stefan's Law was very common. The best answers included the calculation of the difference in brightness as seen from Earth and the difference in power output to show that M40A must be closer than M40B.

Question 5

The two parts of this question produced a good range of marks and discriminated well.

05.1
Students were required to draw a line of best fit through the origin on **Figure 2**. Many students either failed to do this step or drew a line that did not pass through the origin. A mark was still available, provided the gradient of the line was determined. The third mark was for a correct answer in range. Students who simply used the data booklet value for H were not given credit.

05.2
Many of the answers demonstrated much confusion about the expanding Universe. Some referred to the Universe itself accelerating, or simply stated Hubble's Law. The best answers made a clear statement that the expansion of the Universe is accelerating and that the idea of dark energy was introduced to explain it. Any reference to dark matter meant that the second mark point could not be awarded.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.