Questions matter

A-level
Physics

7408/3BA Paper 3 Section B Astrophysics

Report on the Examination

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General Comments

This paper was similar to those of previous years in terms of specification coverage and demand. Students had opportunities to demonstrate their knowledge, skills and understanding across a range of topics. The usual variety of question styles including short answers, single and multi-step calculations, extended writing and multiple-choice were used.

The balance of assessment objectives and the mathematical demand was similar to those of previous series.

Question 1

This question tested students' knowledge and understanding of the astronomical telescope in the context of observations of Jupiter.

The mark scheme in question 01.1 was designed to give partial credit to students who could do one step in the calculation but not complete it. Over half of the students were awarded both marks. Common errors included mixing up the two lenses, getting the magnification the wrong way round, or not including the focal length of the eyepiece.

Question 01.2 was much more demanding. There was evidence of much careless work, failing to take the magnification into account or using the radius rather than the diameter of Jupiter in the calculation. Many students appeared to have no idea of how to approach the question, invoking any equation available to evaluate distance in astronomy, including the magnitudes equation and Hubble's law.

Question 01.3 also proved to be challenging for most students. There was much confusion between diffraction and refraction, for example. Many students also thought that the cap would behave as a filter blocking out some wavelengths and not others. The best answers demonstrated an understanding of the nature of chromatic aberration, and why it affects light entering the edge of the lens the most.

Question 01.4 asked about the effect on the image of Jupiter. Most students identified that the image would become dimmer but did not explain their answer in sufficient detail. Some students mentioned reduced resolution without explaining how it was caused or the effect it would have on the image. Some students identified a reduced amount of spherical aberration, which gained credit provided they gave a clear account of what was happening. Some students attempted to say that the image would be both clearer and less clear, referring to resolution and spherical aberration, without realising the contradiction in their answer.

Question 2

This question tested the students' knowledge of the parsec and the magnitudes equation in the context of the proper motion of stars.

Question 02.1 tested students' ability to deal with the different units for distance used in astronomy. The best answers correctly converted the distances involved into the same units before working out the correct angle. Partial credit was given to answers that made some progress with this method.

Question 02.2 was more open-ended. The most successful answers made a clear comparison of the distance given by parallax and the distance from the magnitudes. They then went on to compare these,

making a comment about the significance of the difference. This was often done by calculating a ratio between the two but an appreciation that the difference was very large was sufficient.

Question 3

This question tested Wien's law and Stefan's law in the context of an intensity–wavelength curve.

In 03.1 most students simply calculated the temperature of the star using Wien's law. Some students used an incorrect peak wavelength, either misreading the scale or using the cut-off rather than the peak. The question also required them to show that the graph was consistent with the value given, and therefore some comparison was expected. Other successful routes included calculating a value for Wien's constant using the data in the question, or a value for the peak wavelength. In both these cases a comparison with the given value was required for full credit.

Question 03.2 required the use of Stefan's law and was answered correctly by almost 60% of students. Common errors included using the volume or area of a circle for the surface area of a sphere and missing out the power of four for the temperature. Partial credit was given for some of these errors.

Question 03.3 required students to realise that the radius in 03.2 made the star a dwarf, and that the only option with a compatible spectral class for the temperature was the first one.

To obtain both marks in 03.4, students had to identify the effect the absorption would have on the wavelength of the peak, and then conclude the effect this would have on the observed temperature. Some students attempted to argue in terms of Stefan's law, suggesting that the overall power output would apparently be reduced. This would not affect the estimate unless the absolute magnitude of the star was known, however.

Question 4

This question tested knowledge and understanding of black holes and Hubble's law in the context of merging the Milky Way and Andromeda galaxies.

In question 04.1, most students identified Hubble's law or the Hubble constant as the method of finding the age of the Universe. Far fewer students identified that this was invalid in this situation as the galaxies are approaching and not receding.

The calculation in question 04.2 was completed successfully by more than half of the students. Common errors included missing out the factor of 2, incorrectly calculating the mass of the black hole and failing to square the speed of light. The unit mark was linked to the final answer, and any appropriate unit was accepted provided the value was correct.

Question 04.3 allowed students to explain what they knew and understood about quasars and their formation. As is typical on this paper, this six-mark question was the most discriminating on the paper, allowing E grade students to gain at least one mark and A* students to get five or six marks. The mark scheme was quite generous. Many students had some idea of the power output and distance to quasars and many managed to link these to their brightness relative to their host galaxies and the redshift, respectively. Fewer students managed to successfully describe the likely process of quasar formation with much confusion with type 1a supernovae being evident, for example.

Mark Ranges and Award of Grades

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