AQA

A-level
PHYSICS

7408/3BA Astrophysics
Report on the Examination

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General Comments

This year's Astrophysics paper consisted of a range of different questions styles, including single and multi-step calculations, short answers and those requiring more extended writing, ray diagrams, and questions requiring recall, processing and judgement. This is the first Astrophysics paper based on the new A-level specification. Some of the new features of the specification proved to challenge students, including the introduction of exoplanets to the content and the greater emphasis on discussion and making judgements in the assessment objectives. Pleasingly, students demonstrated knowledge and understanding on a range of topics, and marks were achieved across the whole mark range.

Question 1

Much of the work on ray diagrams has been removed from the specification but the two main types of telescope remain. Most students were able to draw this ray diagram without difficulty. However, a large number of refracting telescopes were seen. Other issues included drawing a convex or flat secondary mirror, or drawing the primary as two curves so they look like two mirrors, rather one continuous curve, with or without a gap. Problems with the rays tended to be related to where they cross with several students drawing them so they crossed before the secondary mirror rather than after, or drawing them so that they meet at the eyepiece.

Question 2

This question required students to compare the properties of two different telescopes. There was evidence of confusion between collecting power and resolving power.

02.1 Many students correctly chose the correct answer, but failed to explain why. It should be noted that, in a simple choice like this, any unsupported answer does not gain credit. Other common errors included using the resolving power or calculating the area using the equation for a sphere. A number of students incorrectly maintained that A was the correct answer as the image would be smaller and therefore the light from it would be concentrated into a smaller area. Students had a choice of approaches regarding the calculation, an example of the expectation that students will be able to make a judgement about their approach, rather than be directed to perform a specific calculation.

02.2 This question proved to be significantly more demanding with few students showing anything other than a rudimentary knowledge of the Rayleigh criteria. Specifically, many students simply quoted the equation or talked in general terms about seeing two objects close together. Those that made more progress in terms of the diffraction patterns often failed to gain marks due to lack of clarity, mentioning a maximum (rather than the central maximum) or suggesting that the two central maxima need to be fully separated. For example those that mentioned the Airy disc needed to make it clear that the centre and edge of the discs are significant. Some good answers were seen that made use of a graph of intensity against angle for the two sources.

02.3 A common error that prevented students from getting both marks was to make general statements (bigger diameter means the resolving power is better), rather than more specifically referring to the correct equation or the inverse relationship. It was pleasing to note how many students dealt with the fact that a smaller angle is better without problem.

Question 3

This question required students to compare the nature of four stars based on pertinent information.

03.1 The definition of the parsec is difficult to express, and therefore most successful students preferred to draw a labelled diagram. Three things needed to be included: the angle of 1 arc second, 1 AU and 1 pc. It was relatively common to see one of these missing or mislabelled. Those students who chose to define in words commonly suggested that it was the distant star that subtended the angle of 1 arc second, rather than the Earth – Sun distance.

03.2 The use of Stefan's Law to judge the relative size of a star has been asked in a variety of forms in the previous specification, and many students responded to this question. Many students managed to make some progress by arguing that the absolute magnitude, or power output, of Kornephoros must be greater due it its distance. The use of 'brightness' or 'magnitude' here did not gain credit as students may have been referring to the apparent magnitude. A more common mistake was the failure to make a reference to the temperature, based on the spectral class. A significant number of students made the classic mistake of not reading the question correctly and discussed the relative size of Rasalgethi.

03.3 The vast majority of students had no difficulty determining the temperature based on Wien's Law. Occasionally answers based on power of ten errors were seen, either related to the micro prefix, or the metres in the unit of the constant being interpreted as milli.

03.4 The vast majority of students were also able to use their knowledge of spectral class temperature ranges to identify the correct star.

03.5 It was relatively common to see the calculated absolute magnitudes written next to the name of each star. Undoubtedly many students saved time by spotting that all of the stars have a similar apparent magnitude, and yet one is significantly further away than the others.

03.6 This calculation was performed correctly by the vast majority of students. Common errors included converting the distance into other units, using natural logs rather than base 10 and confusing m and M.

Question 4

This question gave students an opportunity to demonstrate what they had learned about dark energy and the accelerating universe.

04.1 A significant tool in astronomy is related to the use of standard candles, and this specification focuses on type 1a supernovae. Very few students were able to demonstrate sufficient knowledge to gain all three marks. The shape of the graph caused problems, with some confusion with black body radiation curves being apparent. The labelling of the axes also suggested that few students had studied this light curve in sufficient depth.

04.2 Lack of clarity cost many students the mark in this question. As has been pointed out earlier, 'magnitude' can be either 'apparent' or 'absolute' and the correct one needs to be used for credit.

04.3 It is expected that students are away of some of the significant discoveries in recent astronomy, the idea of an accelerating universe being the relevant one here. Very students were able to relate the surprising nature of the supernovae measurements. It was fairly common to see answers discussing the big bang or gamma ray bursts. Marks were also lost by students who confused dark energy and dark matter.

Question 5

This question was related to another aspect of current astronomical research: the search for planets orbiting other stars. Most students were able to recall the transit and radial velocity methods of detection, without making much more progress. More success was made by those that mentioned problems of direct observation. Very few students related any of these methods to the particular situation of an Earth-like planet orbiting a Sun-like star or made any attempt to discuss which method would be most successful in this situation. The most successful students were able to point out that most of the planets discovered so far have been so-called 'hot Jupiters' and that the Earth, being relatively small and far from the Sun, would make little impact on the apparent magnitude of the Sun, or affect its motion significantly.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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