A-LEVEL
PHYSICS

7408/3BA Astrophysics
Report on the Examination

7408
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Version: 1.0

General Comments

This year the Astrophysics paper consisted of questions designed to assess the students' knowledge and understanding across a range of topics. The style of questions was similar to those in 2017. In keeping with the balance of assessment objectives required on this paper, students were given many 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 and teachers should be aware of this. Overall the paper discriminated well, with students achieving marks across the whole range.

Question 1

This question required students to demonstrate an understanding of angular magnification and resolving power in a particular context.

01.1 This was answered well by the vast majority of students, with 82.9% gaining both marks. Those who did not gain both marks usually confused D and f, made a power of ten error, or rearranged their equation incorrectly.

01.2 This question proved to be slightly more demanding. Although it can be seen as a two-step calculation, many students chose to combine the equations to provide the answer in one go. Students should always be encouraged to set out their answers clearly as marks can often be awarded for evidence of correct working even if the their final answer is incorrect. 62.4% of students gained all three marks.

01.3 This question required students to make a judgement to demonstrate their understanding of the Rayleigh criterion as a limit. Many answers were seen that compared the angular size of the asteroid with the resolution of the telescope correctly, but then simply stated that the asteroid could be seen without any comment about the level of detail. Students who calculated the separation of objects that could be just resolved at the distance of the asteroid made better progress, but an answer that went on to suggest that this would not allow detail to be seen were rare. Only 3% of students scored all three marks; the proportion failing to gain even a single mark was 43.6%. Surprisingly, 9.4% of students made no attempt at all at this question.

Question 2

This question was concerned with the analysis of the light from stars and some of the information astronomers can obtain from it.

02.1 The mark scheme for this question meant that many students were able to score both marks (63.2%), but some very poor lines were seen. Most students knew that a peak was required, but the curvature of the line either side of the peak was not drawn clearly. The AQA support booklet for this topic, and previous question papers, contain versions of the graph that can be used to make it clear to students what is expected. It should be stressed, for example, that the left hand side of the peak is steeper than the right hand side.

02.2 This question discriminated well, with a range of marks being awarded. Most students mentioned Wien's Law and identified the wavelength required correctly as the peak rather than maximum. A common error was one of simple algebra, with students incorrectly suggesting that this wavelength should be divided by Wien's constant, rather than the other way round. It was satisfying to note that very few students suggested that the 'm' in the unit of the constant represented milli- rather than metre. This has been a common error in the past.

02.3 The 6-mark question has been a feature of this exam for many years and there is evidence to suggest that students are becoming more familiar with what is expected. Many students correctly identified that calculations using Stefan's Law were needed to compare the power output of the two stars, and then related that to the difference in apparent magnitude. There were many examples of students failing to use the correct equation for the area of a sphere or neglecting to use the fourth power of the temperature, however. There was evidence to suggest that many students were familiar with the apparent magnitude scale and correctly calculated a ratio of apparent brightness for the two stars. Students who failed to make much progress simply stated that the values of apparent magnitude, radius and temperature were similar and that, therefore, the two stars were the same distance away. It should be noted that, although the two stars do in fact form a binary system, full credit was given to students who argued that the ratio of the power output and the ratio of the brightness are sufficiently different to suggest that they are too far apart. Pleasingly, just over half of the students were able to gain at least four of the six marks available.

Question 3

This question tested the students' knowledge of Hubble's Law and the inverse-square law in the context of quasars and galaxies.

03.1 Many answers to this question focused on simple properties of the three objects rather than the relationship between them. Some students, who did see what was required, suggested incorrectly that quasars are black holes, or that galaxies orbit a black hole in a similar way to planets orbiting stars, perhaps. Only 18.2% of students gained both marks here.

03.2 This calculation was carried out correctly by the majority of students (54.8%). Those who failed to achieve full marks often tried to work backwards from a 'known' age of the universe, or used the Hubble constant available in the data booklet. Most correctly calculated a value for the speed and distance and either directly determined a time or calculated a value for H and determined 1/H in seconds.

03.3 The use of the inverse-square law proved to be significantly more demanding. There was evidence of students obtaining the square root of 1000 as an answer and then missing a mark by leaving it in this form. Answers of 10, 100 or even 1 000 000 were also relatively common. It was clear that many students knew the inverse-square law but were not sure how to apply it. The important point is that the intensity received at the Earth is the same for the two objects, but that was rarely stated. Only 12.1% of students gained all three marks; the proportion that failed to gain even a single mark was 48.5%.

Question 4

This question focused on two pieces of evidence related to the Big Bang theory.

04.1 Answers to this question demonstrated many of the misconceptions associated with the CMBR. Many answers were seen that suggested that the CMBR itself was created at the time of the Big Bang, rather than relating it to the 'stretching' of gamma rays as the Universe expanded. It was also fairly common to see answers confusing it with the background radiation that comes from rocks, etc. Students rarely stated that the CMBR follows a black-body radiation curve or that the peak in the curve is consistent with a temperature of 2.7K. Only 6.8% of students gained all three marks here.

04.2 A similar lack of detail or clarity was often seen in answers to this question on the relative abundance of hydrogen and helium. It was rare to see answers that explained why virtually no heavier elements were produced after the formation of helium. Many incorrect answers were seen that focused on fusion processes within stars. There was also some confusion between fission and fusion. Only 3.9% of students gained all three marks; the proportion that failed to gain even a single mark was 47.4%.

Mark Ranges and Award of Grades

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