Version 1.0

General Certificate of Education (A-level)
June 2011

Physics A PHYA5/2A

(Specification 2450)

Unit 5/2A: Astrophysics

Report on the Examination

Further copies of this Report on the Examination are available from: aqa.org.uk

Copyright © 2011 AQA and its licensors. All rights reserved.

Copyright
AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales (company number 3644723) and a registered charity (registered charity number 1073334).
Registered address: AQA, Devas Street, Manchester M15 6EX.

GCE Physics, Specification A, PHYA5/2A, Section A, Nuclear and Thermal Physics

General Comments

The paper was generally well received by candidates and there were plenty of opportunities for students to show their knowledge. All the marking points were used and some candidates gained full marks. There was also no indication that candidates lacked time to complete the examination.

Question 1

The more able candidates successfully negotiated the majority of this question but the less able found many pit-falls.

In part (a) most obtained the first mark but then did not obtain the anti-neutrino.

For part (b) some candidates did not identify the position of P. Position Q was easier for students to identify.

A majority of candidates could balance the number of neutrons in part (c)(i) to obtain the correct answer x = 4. Those that guessed the answer almost always gave the answer x = 3.

Part (c)(ii) was very discriminating. Less able candidates did not know how to balance the energies and only scored marks on the conversion from u to MeV. Some did not go directly from u to MeV and gave many lines of calculation. If correctly performed, they still got the mark for the conversion, but they had many opportunities to show errors and so tended to be less successful and missed the mark.

Question 2

Part (a) was very straightforward for most candidates but less than half could tackle part (b) effectively. Problems were seen at every stage. Some had no idea what was happening at all; some used the wrong charge on the aluminium nucleus and used $27 \times 1.6 \times 10^{-19}$ C; and some even changed the equation given in the question to the Coulomb law of force equation by introducing a squared term for the separation.

Question 3

Part (a) gave a much greater spread of marks than expected. About one third of candidates did not attempt to place a unit on the y-scale and less able candidates also could not recall the correct shape of the graph. At the top end, candidates allowed the graph to fall too steeply as the nucleon number increased and/or they had the peak in the wrong position. Only the more able candidates knew the height of the peak.

In part (b) only the more able candidates could use the idea of 'binding energy' in a coherent manner. Less able candidates did not really make any significant points that were worthy of marks. On a marking point, although the question starts with 'use the graph…', it was possible to score full marks without reference to the graph, as we allowed a reference to high and low nucleon numbers as being equivalent to being either side of the peak.

Question 4

Most candidates performed well in part (a).

In part (b) the less able candidates tended to score only one mark because they could not form the energy balance equation when both changes of temperature and changes of state were taking place.

Part (c) caught a majority of candidates out. Even grade A students were tempted to roll out the usual answer, 'the temperature would be less because heat is lost to the surroundings'. This statement scored no marks.

Question 5

The graph in part (a) was done well by most, but the less able candidates were not careful in reading the temperature scale and did not place the x-axis intercept at absolute zero. In some cases they had drawn a curve that had no intercept on the x-axis.

Parts (c) (d) and (e) were tacked well by more able candidates. The less able could only manage to do part (b) but then started either to substitute the wrong data, eg temperature in °C, or quote incorrect equations in the parts that followed. It was appreciated that not enough space was given to answer.

Part (e) allowed almost all candidates to score some marks, but the scores tended to be grouped in the following way. Less able candidates scored a couple of marks by discussing movement of molecules but did not go any further because of their poor use of physics in using phrases such as, ’the molecules have more energy and so hit each other harder giving more pressure’.

Some candidates started to use Newton’s second law more effectively and referred to pressure in a more scientific manner.

The more able candidates could explain how increasing the volume allowed the pressure to remain constant as the temperature increased in terms of molecular motion.

GCE Physics, Specification A, PHYA5/2A, Section B, Astrophysics

General Comments

All the questions in this paper were accessible and the paper produced marks across the whole mark range. There was a balance of descriptive questions, numerical questions, and questions requiring diagrams. As usual, the questions requiring calculations tended to be answered quite well, whereas those requiring extended writing were generally answered poorly. Many candidates lost marks in the diagram questions due to carelessness and a lack of detail.

It is recommended that all teachers of this option use the support booklet on Astrophysics. It can be downloaded here.

Question 1

To get both marks in part (a) candidates were required to draw the curvature of both mirrors correctly and to show the path of two rays. Although it was answered correctly by many candidates, it was common to see a plane or concave mirror for the secondary, and rays leaving the secondary parallel. Some of the better answers showed the two rays crossing at the gap in the primary mirror. In some answers, the curvature of the secondary mirror was unclear. It would be helpful if centres encouraged the correct convection when drawing mirrors – ie that the non-reflecting surface of the mirror should be hashed.

There was only one mark for (b)(i), and to be awarded this mark, candidates had to not only show that the focal points were different for parallel rays at different distances from the axis, but also get the foci the correct way round, ie the further out rays being focused closer to the mirror. Rather than simply showing the reflection in a concave mirror, some candidates repeated their ray diagram from part (a) and tried to show what happened to two pairs of rays. This unclear diagram rarely gained credit.

The calculation in part (b)(ii) was answered well by the majority of candidates. Giving the correct unit proved to be more of a problem, and it was fairly common to see correct numerical answers with the degree as the unit. The use of the phrase ‘minimum angular separation’ rather than ‘resolving power’ possibly made the question more accessible, but despite that, occasionally the watt was given as the unit.

The calculation in (b)(iii) proved to be slightly harder despite the fact that unit errors were ignored. Many candidates correctly noticed that the resolving power of the telescope would not be good enough to resolve the Cassini division with this telescope. Some candidates missed the point of the question and tried to argue that there would be a telescope good enough. Answers correctly arguing that the resolving power would be better with shorter wavelengths were rarely seen. Worryingly, this question was left blank by several candidates.

Question 2

Part (a) produced a range of answers with many candidates obtaining full marks, but others dropping marks through carelessness or lack of detail. It was common to see the absolute magnitude scale upside down, or marked as relative luminosity. Candidates are expected to know that the scale goes from +15 to –10. Similar errors to previous years were seen when drawing the main sequence – some candidates drew it as a line or as a simple straight band. Others had the ends curving the wrong way. None of these got credit. The position of the giant stars was generally correct, but the positioning of the white dwarfs strayed too far to the right in some cases.

The calculation in (b)(i) proved to be relatively straightforward, although some scripts showed confusion with the ‘m’ in the unit of the Wien constant being interpreted as milli rather than metre. There was also some evidence that many candidates ignored the requirement for the answer to be expressed to the correct number of significant figures – two in this case.

There was the opportunity for many careless errors in question (b)(ii). One of the more common was the use of the incorrect formula for the surface area of a sphere, despite this being on the equation sheet. This was not a problem for those candidates who chose to answer using a ratio argument but it was more common to see answers which calculated the power of the Sun and then used this value to calculate the area, and then radius, of Deneb. Other careless answers used the wrong value for the radius of the Sun, or used 7000 rather than 70000 for the ratio of the powers.

Part (c) included the assessment of written communication. Unsurprisingly, perhaps, the content proved to be more accessible than last year's question on dark energy. However, there was still evidence of much confusion. Some candidates suggested that it was the hydrogen itself that was being absorbed, or that hydrogen Balmer was a type of hydrogen. The best answers made it clear that light of all wavelengths passed through the atmosphere of the star, described the absorption process with reference to $E = hf$, and explained why the gaps were present despite the energy being re-emitted.

Question 3

Many answers to part (a)(i) simply restated what was in the question, ie a shift to the red end of the spectrum. This did not gain credit. Although many other candidates made a correct reference to an increase in wavelength, several did not get the mark for suggesting that it was the light itself that was moving away, rather than the source of the light.

The calculation in part (a)(ii) was very straightforward with the majority of candidates getting both marks. Generally, those who failed to gain the mark attempted to change the units of distance or Hubble's constant. Poorer answers were seen where candidates attempted to use the red shift equation substituting random data, and this gained no credit.

Part (b)(i) had three marking points, with a maximum of two marks available. The best answers correctly stated that the maximum absolute magnitude was known to have a value of –19.3, that the maximum apparent magnitude could be measured and that the inverse square law, or $m - M = 5 \log (d/10)$, could be used to calculate the distance. The first mark was not given for answers that did not make it clear that it was the maximum value that was known.

Calculations similar to that asked for in part (b)(ii) have been asked many times before. Although some very good answers were seen, many candidates incorrectly confused m and M, failing to include the minus sign for the absolute magnitude, or using natural logarithms in the calculation. Failure to express their answers in parsec, rather than Mpc, was also a mistake that cost some candidates a mark.

Part (c) assessed candidates understanding of one aspect of *How Science Works*. Many candidates realised that using several methods would improve, or at least test, the reliability of the distance value. Incorrect answers made reference to improvements in accuracy, or the need to have other methods, including parallax as not all distance methods can be applied in all situations. Although in general this is correct, the question was specifically related to galaxies and therefore this answer did not gain credit.

Question 4

Answers to part (a) demonstrated that there continues to be much confusion or careless thinking when it comes to black holes. Answers suggesting that the event horizon is a point or a distance were given no credit. Other incorrect answers suggested that light was somehow unable to escape without any reference to gravity. The best answers stated that that it is a boundary where the escape velocity is equal to the speed of light.

The calculation in part (b)(i) proved to be very straightforward. It is clear that most centres prepare their candidates for calculations of this type. Some careless errors were still evident. Most commonly, candidates forgot to square the velocity of light, missed out the factor of 60 million or used the incorrect value for the mass of the Sun.

The density calculation in part (b)(ii) was also shown to be relatively straightforward, although many candidates used the incorrect equation for the volume of a sphere.

Please visit AQA's Enhanced Results Analysis service. A free, online tool that gives you an instant breakdown of your GCE Physics results.

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

UMS conversion calculator www.aqa.org.uk/umsconversion.