A-level

PHYSICS

7408/2 Paper 2

Report on the Examination

June 2017

Version: 1.0

General comments

A good proportion of students made successful attempts at most questions with, on average, only 3.5% not being attempted. The maximum mark was 85 and scores ranging from 0 to 83 were seen with an average of 46. This spread gave the paper good discrimination.

Scripts from this exam showed problems that also occurred in the legacy examinations. The steps in solving mathematical problems were often not shown sequentially, and calculations sometimes ‘moved randomly’ around the page. As a consequence, they could be difficult to follow by examiners.

There was also a tendency for the less able students to be too brief, and their answers did not always score because of some missing detail. This is an area that needs to be addressed by students in future examinations.

Question 1

01.1 Some less able students did not adhere to the limitations of the question, which only required information about the size of molecules. Many simply stated an assumption used in kinetic theory. Apart from this, the question gave good discrimination. The main misconception was that all molecules have to be the same size and the ‘near miss answer’ was to state that molecules must be small without giving any relative measure.

01.2 It was only the less able students who failed to get full marks in this calculation. The main errors were to use the temperature in Celsius when Kelvin should have been used, or to have arithmetic errors. Also some scripts showed an obvious confusion between n moles and N molecules.

01.3 Here, again, the majority of students found the question straightforward and either used the proportionality between volume and pressure, or used the ideal gas equation to calculate the new temperature. Other students seemed to make up their own equations or, again, had trouble over which temperature units to use.

01.4 This turned out to be a discriminating question. What distinguished the more able student was not only to have the knowledge to calculate the new temperature, but the ability to deduce what must remain constant if the temperature was constant. They then could interpret their calculations in a clear fashion. They could provide a statement as simple as, ‘if the temperature were constant then PV would be constant, which is not the case’. Less able students tended to give an array of numbers with very little calculation. They also showed errors in substituting the wrong data.

01.5 Students found this question very difficult, with only about one third scoring any marks. A majority did not have the knowledge even to perform the first task that involved $W = P\Delta V$. Many launched into ‘internal energy of a gas’ equations. As a result, some of these thought that negative work was done on the gas, because the temperature falls between A and B. Not many students were aware of the connection between work done on the gas and the area under a $P – V$ graph. Even the students who did know, calculated the area from B to C incorrectly by only considering the increase in area.

Question 2

02.1 Many students failed to use the concept of Newton III and incorrectly chose the fourth alternative.

02.2 More students got this incorrect than got it correct. So again it appeared that errors came in the practical use of Newton's third law. Some students wrote some side notes referring to Fleming's left hand rule and they still made errors.

02.3 This was the lowest scoring question on the paper. Most students interpreted the question as, 'What is a tesla equal to?' Most answers seen were based on formulae that happen to contain B, the magnetic field strength. So an answer such as, 'The tesla is the force per unit current per unit length', was one of the better attempts, but even here the tesla is being described in the wrong units. The least able students did not even get this far and simply gave vague answers such as, "it's used for magnetic fields".

02.4 A majority of students tackled this question with little trouble. The most common error was in failing to convert the mass from g to kg.

Question 3

03.1 Most students did not pick-up on the idea that the force is perpendicular to the motion. These students often searched for something to explain the situation, by writing something like, "the magnetic field is static or uniform so it can't affect the speed". A few students did know the answer had to do with directions, but only said the magnetic field was perpendicular to the motion, which misses the point.

03.2 More than half the students could present the starting equation relating the force due to the magnetic field, to the centripetal force. Many continued to successfully find an expression for the period of motion. However, only some of these referred back to the question to give the time to travel round one semi-circle. Many of the other students got into difficulties if their initial expression for the centripetal force did not involve velocity. From this point on, they often took numerous false trails and the work presented looked very disorganised. Another route taken by some was to reduce their first equation to $R = mv / BQ$ and simply say that this radius does not involve time and is constant. This not only re-writes the question, but misses the point that v is different on each transit.

03.3 This calculation was done well by the majority of students. There were also very few errors shown in the numerical calculations. The weaker scripts either showed students producing the wrong equation, or not rearranging the equation correctly.

Question 4

04.1 A significant number of students were too brief in their answers to score a mark. To state "it slows" was not a sufficient answer. It was necessary to add the idea of a collision occurring. The least able students referred to absorption and in some cases fission.

04.2 This was a very straightforward question done well by all but the least able students.

04.3 Good students had knowledge of the physical process of fission and could express their ideas coherently. The middle to low ability students often did not express their ideas in a concise manner. The main failing was in not appreciating that the incident neutron was absorbed. Many thought it simply jogged the uranium nucleus in fission. The process of the nucleus splitting was often confused with other radioactive decays, and the ejected neutrons were not always mentioned. This group of students also wasted time trying to explain a chain reaction.

04.4 It was clear that the vast majority of students did not have knowledge about nuclear waste management. Many just expanded on their reasonably sensible thoughts of ‘keep clear from it, and get rid of it’. For weaker students, this simply meant wearing protective clothing and sending the waste into space. The middle-ability students gave a better solution by suggesting handling the waste remotely, encasing the waste in a named and effective radiation shield, and placing it in a deep mine or trench away from people. It was only about 20% of students who seemed to write with knowledgeable authority. These students knew it was the spent fuel rods that posed the main problem, unlike others who could answer with any item that had to do with the reactor. It was also only these students that knew about waste producing heat or about vitrification. It was rare for any student to refer to reprocessing. In terms of the quality of the writing, it was clear that most students do not give themselves even a brief plan. Often the ideas presented did not follow a logical sequence.

Question 5

05.1 Almost half the students tackled the calculation in a straightforward way as in the mark scheme. Other students’ responses ranged from this fully correct method down to simply trying to convert the nuclear mass of Co-59 to MeV units. The students using approaches in between these two obtained a difference in mass between the nucleons and the complete nucleus, but used a variety of units and data which sometimes did not yield the precision required; for example, using the mass of any nucleon as 1.67×10^{-27} kg. A clue about the precision required should have been understood from the number of significant figures used for the nuclear mass given in the question. Some students did pick up a mark for converting the units throughout their calculation, to correctly end up with an answer in MeV.

05.2 A majority of students understood the situation and performed the calculation without error. A significant number of others missed seeing the longest energy gap between iron and cobalt. Many of these gave a variety of calculations using energy gaps that did not correspond to beta energies.

05.3 Only 50% of students got the correct answer of 6 and the answer 3 featured regularly.

05.4 Only the bottom 10% of students could make no headway in this question. A majority could obtain the equation relating wavelength to energy, and could perform the numerical calculation. It was choosing the incorrect energy gap that let many students down.

Question 6

06.1 A majority of answers simply reinterpreted the words of the question and made no reference to force or mass. So there was a proliferation of answers such as, “They show the direction of the field acts in”. Only a minority of students gave a complete answer. A common misunderstanding that was frequently stated was the idea that a mass will follow the field line when free to move. This may be true for an initial movement, but subsequently, because of the build-up of momentum, it is not generally true.

06.2 Many students appreciated that the gravitational field was stronger at K but then did not give a good reason for it. They often referred to the earth not being flat, or stated that K is up a mountain or down a hole. Other students did state that there was a mass at K or it was an area where the Earth's density is greater, but they did not refer to the field being stronger. Also a few students referred to gravitational force when they were really referring to gravitational field.

06.3 Only a small number of students deduced that the field had a component horizontally near K. Therefore very few scored 2 marks. A majority did appreciate that the ball would accelerate, even if their reasoning was sometimes false. Several students misinterpreted the question and thought that the ball was falling, but this would not have excluded the student from scoring both marks. If no direction was stated, the motion was treated as horizontal by examiners. If the students thought the ball was falling, and separated the horizontal and vertical motion, both marks are obtainable. The vertical was ignored and both points in the mark scheme are still true for the horizontal motion.

06.4 The idea behind the question was well understood by the vast majority of students. It was only the least able who missed out on the mark.

06.5 Most students, 70%, could do this easily.

06.6 A majority of students seemed to be unaware how equipotential lines relate to field lines. Very few scored full marks. Common shapes drawn were a line joining L to M, a straight vertical line, and a tight circle around M.

Question 7

07.1 Most scripts showed a clear connection between the centripetal force and the force of gravity on the satellite, to arrive at the correct proportional relationship between T^2 and r^3. Less able students failed to get the two starting equations and only toyed with the centripetal equation unsuccessfully. The most common algebraic mistake was to miss that the π term was squared when $(2\pi)^2$ was expanded.

07.2 Marks for this calculation were quite low because students could not cope with the quite complicated proportional relationship. Some students avoided the proportional calculation by using the Kepler's equation derived earlier. Quite a number of these students then got into difficulty because the distances were given in km and not m.

07.3 This question was tackled well by most students. Equating the Universal gravitational force to mg was a well understood task. Only the least able students failed to rearrange the equation or made calculation errors. A significant number that were correct failed to answer using 3 significant figures, but by the same token some making calculation errors did give an answer to 3 significant figures, and thereby gained a mark.

07.4 The students who took the very straightforward approach and calculated the escape velocity were very successful in this question. However, a majority of students made errors. Many did not know the escape velocity equation or could not get to it from the conservation of energy. Other students referred to the top of the graph, Figure 8, at a potential of $-1.4 \times 105\ \mathrm{J\ kg^{-1}}$ as being the point at which the ice escapes, which is a physics error.

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.