A-LEVEL
PHYSICS

7408/2 Paper 2
Report on the Examination

7408
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General Comments

Students scored a mean mark of just over 46% for this paper. Questions involving calculations yielded higher marks than those demanding written answers. A good performance was seen from some students on nearly all of the questions.

Section A

Question 1

1.1 This question was found to be very accessible, with more than half of the students scoring full marks. The main problems were the choice of correct heat energy value in the $Q = mc\Delta\theta$ equation and errors with units.

1.2 This was a more difficult calculation, with just over half of the cohort scoring at least 2 out of 4. More successful students typically managed to determine the volumes of the gaseous and liquid forms of nitrogen. The top 30% scored full marks and were able to reference and manipulate the appropriate equation. A significant minority did not understand the nature of the required comparison.

Question 2

2.1 At least one of the two marks was scored by 75% of the students. A lack of detail in the answer generally meant the student failed to gain the second mark. References to total energy or particles/atoms were sometimes missing.

2.2 Most answers were correct but sometimes only one interpretation was given. A significant number of scripts referred incorrectly to the vibration of the gas molecules. This affected the score when the student suggested that at absolute zero the molecules stopped vibrating; examiners did not take this to mean ‘stationary’. Some students simply gave a value of absolute zero in degrees Celsius or they simply described it as the lowest possible temperature. Overall, half the students scored full marks.

2.3 This question discriminated well. About a fifth of the students did not know a correct version of an equation involving c_{rms} that could be used to solve the problem. However, one third of the students scored full marks. Between these two extremes, scripts would show a correct working equation but data were not substituted into it correctly. Often there was a confusion between molecular and molar masses.

2.4 Only a minority of students thought the mean kinetic energies were the same. Most were swayed by the idea that a higher mass automatically means a higher kinetic energy. Many scripts dropped the reference to the mean when referring to kinetic energy. The use of complete technical descriptions is essential at this level of examination.

2.5 Students found this question difficult because they did not follow the wording of the question; it required a response in terms of kinetic theory of gases. Many quoted a gas law or its equation and thought this was a sufficient explanation. Very few gave the sequence of ideas that are followed in proving the pressure equation. More able students failed to gain marks by the way they quoted Newton’s second law: force was often related to a change in momentum rather than a *rate of change* of momentum. Less able students additionally often interchanged or used technical words at random. Vague sentences such as '*the kinetic energy pushes on the piston and this work gives rise to the pressure'* were not uncommon. Only 60% of students scored one or more marks.

2.6 Most students knew two changes that would reduce the pressure. It was only the less able students that ignored the question and suggested a change that altered the gas in some way. The discrimination of the question was a reflection of the quality of the explanations. Less effective answers just made a reference to a gas law, saying '*P is inversely proportional to V*'. This did not gain credit.

Question 3

3.1 Here, it was lack of care that prevented students from gaining marks rather than lack of understanding. Around half the students obtained the mark. Those who failed to do so often did not refer to a unit mass. A very few made other errors such as choosing the wrong direction to move the mass.

3.2 More than half the students gave a quick answer and said why the field was not uniform. Many of the others did not really know what to say and answers were often very confused. Some who gave a clear statement thought incorrectly that in a uniform field the potential should not change at all.

3.3 This was a very discriminating question with around 30% of students achieving no marks but around 40% gaining full marks. A large number of students could conjure up the escape-velocity equation in some form. When used, this gained a mark. The main difficulty for the students was to find an appropriate mass to substitute into the equation and this is where most errors occurred. Either students used a correct potential equation but with the wrong data, or they tried to use a force equation which would not give the correct mass.

Question 4

4.1 Many students found this to be a relatively straightforward calculation and 60% gained full marks. For others, the main difficulty was in choosing the correct radius to substitute into the equation. Some who performed the calculation in a single step made a slip and squared the radius.

4.2 On this relatively simple question only a quarter of the students scored both marks. Even more able students did not seem to know that the foot of an arrow represents the position where the force is applied. The weight arrow, for example, was more frequently seen starting at the base of the sphere B rather than starting at the centre of mass. Also, many students did not try to represent all three forces.

4.3 Very few students scored both marks. Even the most able students either presented a problem but then did not suggest how it could be overcome, or told the examiner how to measure *d* without stating a problem. Most students did not express clearly how *d* should be measured. There was often a reference to a tool such as a vernier calliper or set square but no indication of how it should be used. A very common statement that does not answer the question was that ‘d *is not measured in the correct place. It should be measured from the centres of the spheres*’.

4.4 Most students scored some marks on this question and over 60% gained full marks. The minority that failed to gain marks either did not square the distance between the centres of charge or did not use the centre-to-centre distance.

4.5 Less than half showed that the figures were self-consistent. Some students attempted to show consistent values but used an incorrect trigonometrical function. Others gave a general answer such as ‘*the angle is small which fits the data*’. Some did not appreciate the problem and dealt only with the lengths of the triangle made with the two spheres and the support.

4.6 The calculation of the gravitational force was done well by most students. Unfortunately, many students then failed to compare this to the electrostatic force. Many simply said the gravitational force was negligible without saying compared to what.

Question 5

5.1 Over 80% of students knew exactly what calculation to perform and scored full marks. A minority of the rest calculated the flux at the angle shown in the diagram rather than for the maximum. Very few could not calculate a magnetic flux of some description.

5.2 This was another problem that a large majority of students solved well.

5.3 The top third of students jumped straight in and calculated the correct value. However, the most common approach was to use Faraday’s emf equation and find the gradient of the first quarter of the cycle. This did not correspond to the peak emf and did not gain any marks. These students could still gain one mark when the frequency or angular frequency was given.

5.4 The graph was drawn well by over 60% of students. Less able students often drew the flux-linkage graph in phase with the graph given in Figure 5. Only a handful of other students did not draw a sinusoidal form of graph or presented a graph with a different period from that of Figure 5.

Question 6

6.1 Answers to this question seemed to fall into three groups of equal size. The first group understood the purpose of slowing down the neutrons and gained the mark. Another group understood the situation but then failed to express their ideas sufficiently well by ignoring the fuel or fission: ‘*a neutron absorbed by a fuel rod may not be absorbed by a U-235*’. Statements such as this did not receive credit. The third group of students thought that fast neutrons cause the reactor to go out of control and generate too much power.

6.2 This was done well on the whole. Half the students gained full marks. Another 35% could perform the necessary calculations but only scored one mark because they interpreted the loss of 63% as being 63% of the kinetic energy remaining.

6.3 A vast majority of students were unaware that more kinetic energy is transferred away from the neutron when the mass with which it collides is low and comparable to the mass of the neutron. Most thought that, when a neutron hits a massive object, then the massive object absorbs most of the kinetic energy. They thought this even though they often stated that the collision is elastic.

6.4 Very few students did not score some marks on this question. The most straightforward way to gain a mark was to include some valid conversion of the energy units. The next most popular mark was a quotation of the opening mass-difference equation. Only a few students did not include the neutrons correctly. Two-thirds of the students gained full marks by performing the calculations efficiently and simply. Some more able students failed to gain marks by confusing numbers. They chose to convert every mass or energy unit separately and in so doing often made a slip in one of the many calculations.

6.5 This was not answered at all well by the students. First, many thought of nuclear power only in terms of the reactor itself and ignored the mining, transport and building work, etc. This led to a number of false statements being made. There were also a number of misconceptions being quoted. These included: '*a nuclear power station produces more energy than a fossil fuel station'; 'there are more reserves of U-235 than coal and oil'; 'the waste does no harm unlike burning coal or oil'; 'nuclear is renewable'*. There were also many answers that were not complete enough to gain a mark. For example '*nuclear produces more energy*' misses the point that it can produce more energy per mass of fuel used when compared to fossil-fuel reactors.

Section B

Questions 7 - 31

The average score was 69% on Section B (multiple choice). Questions that performed significantly better than this average were B15, B18, B24 and B30. Questions that performed significantly worse than this average were B16, B26 and B28.

Mark Ranges and Award of Grades

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