A-LEVEL
PHYSICS

7408/2
Report on the Examination

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Section A

Question 01.1

This question was answered well by most students but many made a significant error because they correctly evaluated the temperature difference in °C but then converted the value to K by adding 273. These students did not appreciate that temperature changes are the same in both °C and K. Other errors seen included an incorrect re-arrangement when combining the two equations, and power of ten errors in the evaluation.

Question 01.2

Nearly half of the students scored full marks on this question by having a clear initial approach to the problem. All the routes given in the mark scheme were used successfully by students. Students who did not plan their approach made a variety of errors. Some only considered the process of converting the water to steam and forgot about raising its temperature to 100 °C. Others tried to equate the energy to raise the temperature with the energy to turn the water to steam. There were others who used data referencing the metal instead of water or who thought that the water temperature rose by 125 °C.

Question 02.1

For most this was a straightforward recall question. However, there was a significant number who did not know what to write. These made statements such as '*the temperature or pressure is constant*' or '*particles move at the same speed*'. Students who typically lost one mark tended not to complete the answer fully. They stated that the time taken by collisions is small but did not complete the answer by saying what this time was compared with.

Question 02.2

Students at all levels of ability had some problems in answering this question. Newton's laws are a familiar topic introduced before A-level, so examiners expect that students should raise the standard of their answers above this first introduction; just quoting a Newton's law was not sufficient – it had to be related to a particular event or situation. Weaker students ignored the Newton's law reference and were content to write about the kinetic energy of the molecule giving it a force as it hits the wall. More able students tried to use Newton I but only wrote about molecules hitting the wall and failed to state that the velocity or momentum changes. In terms of Newton II, many students did not refer to rate of change when discussing the momentum. A more subtle error was to regard the wall as being given the force even though it was the molecule that had the rate of change of momentum. The forces are obviously related but the order of events was not made clear. The main failure was to quote the law in isolation and not refer to the wall and molecule.

Question 02.3

Students who realised that two equations were necessary to solve this problem generally obtained the correct answer. Others went down this route but confused the number of molecules N with the number of moles n. Many others tried to obtain an answer using only the energy equation or just the ideal gas equation and got nowhere.

Question 02.4

Most students scored at least one mark by drawing the correct basic shape that passed correctly through one data point. It was very common for students to miss the second mark through lack of care and by failing to use other useful data points for their graph. Students who failed to score usually drew the correct general shape but did not locate the graph correctly, with some even drawing the graph below the printed given line.

Question 03.1

This question was not answered very well. A common wrong answer was that electrons go into orbit around the atoms in the sphere. Another was that the electrons jump out into the surrounding volume. Many students who knew that the electrons would collect on the surface were not very careful with their wording. Electrons were said to '*surround*' the sphere; it is not clear whether this means in or out of the surface. Few referred to electrons mutually repelling and simply stated the electrons are repelled from the negative charge. Again, a reference to electrons being equally spaced in the surface was rarely stated and less than 10% scored full marks.

Question 03.2

Almost half the students failed at the first stage by not using a tangent, but taking single values of V and r at r = 0.3 m. Those using a tangent approach began by drawing a tangent but then often failed to gain marks for a number of reasons. First, the triangle from which they calculated the gradient was too small. Also, at this stage powers of ten errors crept in because the potential scale was not recognised. This error was condoned in working out the gradient but was penalised in the final answer. Some students failed to give the final answer to better than one significant figure. Students who only scored one mark tended to get the final unit mark correct. Only a handful of students who went back to fundamental base units in this final part were successful.

Question 03.3

Nearly half of the students confirmed the value of the capacitance successfully. Most combined the potential with distance from a point-charge equation with that of $C = \frac{Q}{V}$ to obtain an equation for capacitance that could be evaluated. Some performed this in stages by obtaining the charge, and others obtained the capacitance in one combined stage. More errors were made by students who used information gained in question 03.2 concerning the electric field strength in order to find the charge. A serious conceptual mistake made by students was to think of the situation being the same as a parallel-plate capacitor with the plate area being the surface area of the sphere. This approach failed to score even though it, unfortunately, arrived numerically at the right answer.

Question 03.4

It was common for students to score only a single mark in this question. This is because most students could find the energy stored equation from the Data and Formulae booklet and make at least one calculation. A number of mistakes were made in finding the difference in stored energy. Some simply stopped after finding a single energy; others tried to show the difference in algebraic terms and made basic mathematical errors. The calculation involved the difference between two squares of voltage which was interpreted by many as the difference in voltage squared. This problem was not encountered by students who simply subtracted the calculated energies stored at the different voltages.

Question 04.1

Only a minority of students did not realise that G had the greater mass. Where students failed to gain marks, it was because they explained their answer in a vague way. '*G has straighter lines*' and '*G has lines that push lines from H*' are statements seen that do not explain the situation. Many did refer to a greater density of lines around G compared to H to score one mark. Often they failed to gain the second mark because they did not explicitly connect the density of field lines with mass. Students who chose to explain the situation in terms of the null point often scored both marks. Their main downfall was to refer to the equilibrium of null point as a point of zero potential.

Question 04.2

Weak students placed the arrows in totally the wrong direction, sometimes placing them at right angles to the field lines and sometimes having them point away from the masses. Even many stronger students also failed to score on this question – this was because their lines were not drawn in the direction of the tangent to the field line. This was most obvious at Y where the arrow often was curved in the direction of the field line or directed straight to H.

Question 04.3

A very straightforward question in which most students were successful. A few failed by not realising that the equation, depending on how it was presented, had a square or square-root term. Others made numerical or re-arrangement errors.

Question 04.4

In a similar way to question 02.4, students failed to gain marks by not searching for specific data points to follow. Many just drew the basic shape they expected. A significant number of students did not know what shape to expect so peaks and other shapes were seen.

Question 04.5

There was quite a spread of marks for this basic bookwork question. Students who referred to a change in gravitational potential tended to stop there and not write about it increasing when moving from *R* to 2*R*. Those who preferred to discuss the 'work done' route tended to be more successful in gaining two marks. However, when they did not refer to a unit mass they did not score at all.

Question 04.6

Most students could find the force on P due to H to gain the first mark, but a majority could not add the forces from G and H on P vectorially. Many attempted a plain addition rather than adding them in quadrature. This meant the next two marks were inaccessible for most. An error carried forward was allowed for the last mark (for use of $F = ma$) – this gave the second mark for the majority. A few students calculated the accelerations that P would experience from G and H and then made the vector addition. This was an acceptable approach and many of these students scored full marks.

Question 04.7

Most students failed to gain the mark for this question because they did not start by thinking about what conditions are necessary for circular motion, i.e. the need for a centripetal force. Many discussed the problem in general terms such as '*force from G pulls the path out of circular*'. This is true but it lacks the main explanation of the necessary conditions required for circular motion. In a similar way, some students stated that the force is not at right angles to the motion. Again, this sounds quite reasonable but the motion or path has not been established so this really cannot be used as a reference.

Question 05.1

This is another question that had a good spread in the marks because so many students had a variety of levels of understanding about what happens in a transformer. For the first mark, examiners were looking for an advantage in using a core compared to not using a core. Increasing the flux linkage between primary and secondary was the answer expected. Many students stated all they could about the core being easily magnetised and demagnetised; this was not relevant to the question. There were many more serious errors which show a total misunderstanding of how transformers operate. Many discussed how voltage and/or current flowed through the core to the secondary. In discussing the secondary coil many failed to write about induced emf and several suggested the power level was controlled by the secondary. In general, the standard of explanation was not of an A-level standard. Many could only refer to transformers being step-up or step-down, depending on the number of turns used.

Question 05.2

This is another question in which the marks were low because the students gave very generic answers rather than considering the specific situation. Only the best students appreciated that they had to describe a feature of the design and then explain how this improves the efficiency. Most students knew that the efficiency is reduced by eddy currents but made no reference to how the core in Figure 8 reduced these eddy currents. Those with the correct idea often failed to gain marks due to dealing in absolutes; they stated that eddy currents are '*stopped*' rather than describing them as being '*reduced*'.

Question 05.3

Many students did not go much further than knowing that transmission at high voltage is more efficient. It was not uncommon to see a completely false explanation of this fact. For example, "increasing the voltage reduces the resistance in the cable which reduces power loss". Some even suggested that electricity is '*quicker*' at higher voltage. Fortunately, most students could give a valid reason for having a higher voltage than 33 KV. In this explanation the power loss needed to be explained as heating of the transmission cable. Only a handful went on to give reasons for not choosing a higher transmission voltage close to 400 KV.

Question 05.4

Students needed to appreciate that the efficiency quoted at each stage was in relation to the power. Some students started off thinking that the percentages given related directly to the currents present at each stage. About half the students realised how to tackle the question and arrived at an answer, but often made errors *en route*. Some, for example, thought that dividing by 0.94 is the same as multiplying by 1.06 when dealing with the transmission efficiency. Others (for some reason) only used two of the efficiencies quoted and combined the 98% with the 94% and failed to combine the last 98%. Students who got confused quickly were mostly the ones that attempted to use the full efficiency equation at each stage with separate currents and voltages. Essentially, they complicated the question too much to allow them to tackle it in the time available.

Question 06.1

Nearly half of the students found this question relatively easy and most gained full marks. The students who did not do this well mainly failed to gain marks by not using appropriate language rather than through misunderstanding. For this group of students, the words molecules, atoms, nuclei, neutrons and nucleons became almost interchangeable.

Question 06.2

This type of question should be familiar to all students and nearly half of them performed well. However, there was quite a large group who simply calculated the energy equivalent of the mass of the iron nucleus. Weaker students used the approximation that the masses of the neutron and proton were the same and used 1.67×10^{-27} kg which was not appropriate when dealing with small differences in mass.

Question 06.3

Most students realised that the addition of the nucleon numbers of the fission fragments should add up to 240 or just below, and most indicated acceptable positions for their F1 and F2. The largest error seen was to place one of their F's to the left of the peak on Figure 10.

Question 06.4

Only a minority of students understood why the fission products would be neutron-rich. Even the ones who did sometimes failed to gain this mark by simply stating they had more neutrons than protons. Then there was a lack of knowledge by many about what radiation would result from this fact. Also many thought the initial decay of the two fission products would be different. Finally, only about half the students made any reference to Figure 11 even though this was requested in the question.

Section B

There was a good spread in the performance on the multiple-choice section. Questions 16, 17, 24, 25 and 29 received correct answers from less than 40% of students. For question 24 it was less than 20%.

Mark Ranges and Award of Grades

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