A-LEVEL
PHYSICS

7408/2 Paper 2
Report on the Examination

7408/2
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Section A

Question 1

01.1
Most students did not pick up the point that the gas is ideal. Potential energy was often added to the kinetic energy in answers. Only very few students went on to state that, in this case, potential energy is zero. Those who appreciated that kinetic energy alone was the expected answer sometimes spoiled the point by referring to a mean kinetic energy.

01.2
Most students did not explain the sign convention by, for example, stating that the initial momentum was mc. Simply giving an answer – mc – mc = –2mc did not explain the situation. Some did add that the collision was elastic and that the speed remains the same but this was not a complete explanation. The statement that “momentum is conserved” was ignored.

01.3
A number of students brought in terms such as wavelength or factors of 2π which lost credit immediately. Others failed to gain marks due to being too brief and not showing the necessary two stages in the calculation, these being finding an expression for the time and then relating time to frequency.

01.4
This question was tackled in a straightforward way by fewer than half of the students; the remainder did not know how to start their answer even though it covers a small stage in a standard proof. It was common to see an absence of any reference to a Newton law.

Question 2

02.1
Most students failed to get to the end of this determination; they tripped up at various points. The weakest answers used the wrong equation to find the volume of the gas, then some used the temperature in Celsius when calculating the number of moles. Only the better students found the number of moles present in the tyre at both pressures. Most who got to this stage used a single molar value to calculate a molar mass.

02.2
Many students made the link between temperature and pressure to gain the first mark. Many then failed to obtain the second mark because they suggested that the tyre might explode. Only a minority of students understood that the tyre could produce the appropriate pressure with less gas at an elevated temperature.

Question 3

03.1
Most of the answers seen lacked detail. For example, instead of referring to the inverse-square relationship of gravitational field with distance, students often wrote that the field strength decreases with distance. The “field lines spread out” was written instead of referring to the centre of mass being the location at which field lines point or the directional gravitational force acts. Finally, equipotential lines were described as being “curved” rather than being concentric about the centre of mass.

03.2
Most gave the generic answer to what is represented by the area under a force-distance graph. So, references to potential energy or work done were commonly seen but these lacked sufficient details to gain credit. Only a minority considered the extent of the shaded area in **Figure 3**. When the height was given in the answer, there were still a few who lost the mark by not referring to the space probe; instead they mentioned a unit mass.

03.3
It was most common for students to determine g_S and g_E individually rather than going straight to the ratio (as in the alternative on the mark scheme). The major problems for most students were the choice of correct distances to substitute into their working equations or failing to square the chosen distance in their calculations. Adding the Sun's radius to the distance or just using the Sun's radius in the calculation of g_S was a common error.

03.4
Most students did not produce an answer of the standard that is expected at A-level. Many stated the Sun has a larger effect because its is "bigger" or "more massive" than the Earth. They ignored the fact that distance has a bearing on the gravitational force on the probe. Very few took the trouble to state anything about the probe–Earth distance and probe–Sun distance being comparable.

03.5
Most students simply looked for an equation that involved mass, speed and distance, then simply 'played' with numbers. Inappropriate force and circular-motion equations were commonly seen. The third marking point was also lost by many who missed any reference to the changes in kinetic and potential energies. The most frequently gained mark was the calculation of change in kinetic energy. However, there were many who failed to gain this mark by using the square of the difference in speed in their calculation. The determination of change in potential energy had a common error too; this was the substitution of the difference in distance for separation into the potential-energy equation.

Question 4

04.1
The most common answer by far was to show that the electric field strength declined with distance, with some even showing a constant gradient. It appeared that most students did not consider **Figure 5** in detail, because very few sketches had a horizontal initial section.

04.2
Many students knew that the energy provided both to the electron and the argon ion was the same. Using this information to calculate the ratio of speeds then contained errors and so marks were missed by many. A significant minority (more than 10% of students) made no attempt at answering this question.

04.3
A majority thought that the argon ion would slow down more but then gave an inadequate reason. Many suggested that "it is because it's bigger". Only a few mentioned collisions in their answers. Several who were on route to gaining the mark spoiled their answer by stating the ratio is smaller.
04.4
Most students knew how to analyse the graph to see whether it followed an inverse-square relationship. It was not common, however, to see this work presented in a clear or logical order. Only a minority showed a method to determine whether the graph followed an exponential

relationship; those who did used a variety of acceptable methods. Looking for a variation in the half-distance was the most common. An unexpected number thought that an exponential relationship was the same as a reciprocal relationship and used a wrong test. For the last mark, many thought they had to suggest one of A or B as being correct which was not implied by the question.

Question 5

05.1
Many students did not know how to tackle this question apart from realising that it involved a charging equation. Most attempted to find the time to charge to 2 V using a 4 V supply, probably chosen because these were the voltages quoted in the question. When the correct equation was selected, it could gain a mark provided the supply voltage was clearly the higher voltage in the equation. Only a very limited number of students understood the process to find the required time. Those who did were usually very successful in working through to the correct time.

05.2
Many students had great difficulties with this question especially if they used a method other than finding the area under the graph of **Figure 9**. In the area approach many chose to think of the graph as being a straight line and therefore failed to gain marks through the resulting approximate values obtained. Those choosing to use equations were often confused with **Figure 9** showing a decay but relating to a charging situation. Also, it was common to see that the voltage used to find R_1 was actually the voltage across the capacitor.

05.3
A large number of students either made little progress or failed to choose to work with a voltage-decay equation. Marks were generally low. Many who did use the correct equation failed to see that the decay on show in **Figure 10** lasted 21s. More frequently seen was 32 s. Credit was still awarded for finding R_{Total} using the correct equation. Following this calculation, only a small number realised that they needed to use their value of R_1 in order to obtain R_2.

Question 6

06.1
Many of the answers given contained correct facts that, unfortunately, did not answer the question. Also, some words used by students did not describe the situation that was intended. For example, “accurate” was often used when “precise” or “greater resolution” would have been more appropriate. The most common correct answer was that using alpha particles leads to an over-estimate of the nuclear radius. The reason for this was misunderstood by some students who thought this was because of electromagnetic repulsion.

06.2
A variety of distributions were seen. A general shape with the intensity falling with angle was given by a majority. However, showing the non-zero minimum was rarely seen and few gained both marks for this question.

06.3
A number of students simply tried to justify the constant density with only the equation given in the question. Not all the students started with the simple equation for density. Once this equation was given, the next error made was usually in the mass substitution; often the mass did not contain the nucleon number. In other cases, the mass of a nucleon was not made clear.

06.4
This question gave rise to a wide spread of answers. The common correct answers were: the nucleus is not a perfect sphere; it does not have uniform density; the mass of a proton is not the same as the mass of a neutron. The most common incorrect answer was to focus on the lack of accurate experimental data.

06.5
Although this question covered the same material as in question 06.3, students were much more successful in answering this question, probably because it was more specific. A majority gained the first mark by completing the radius calculation; the next two marks were more difficult to obtain. When substituting into the density equation some were uncertain whether R_0 or the nuclear radius should be used. Others used the total nuclear mass instead of A multiplied by the nucleon mass.

Question 7

07.1
Most students gave a correct answer. Some did not read the question fully and gave an answer of graphite. Others obviously confused moderators and control rods to give cadmium or boron as their answer.

07.2
For a number of different reasons, only less than a third of the students gained marks in this question. Some failed due to missing out details. For example, they just referred to the uranium-235 as fissile material or more simply as “nuclei”. A significant number who attempted two answers gave almost contradictory answers. For example, “It gives a greater chance of causing fission” alongside “there is a reduced chance of a chain reaction” was seen several times.

07.3
A significant minority of students did not relate kinetic energy to the information presented in **Figure 15** and made little progress. Some tried to find the 30% answer by randomly multiplying the 15% loss in speed by 2. Those who did use the information to find kinetic energies generally scored both marks.

07.4
A majority of students could determine the initial and final kinetic energies in similar units and go on to obtain the correct answer. Re-arranging the equation did not pose much of a difficulty. It was most common for students to work with energies in J. Some of these made errors in converting from eV and some did not use the correct expression for the energy of a thermal neutron. There was also a significant number (nearly 9%) who had no idea how to start.

07.5
Many students did not make any reference to **Figure 15** and gave very flimsy answers such as “they will be more stable” and “they are more likely to be hit by a neutron”. Those who did refer to **Figure 15** interpreted it incorrectly and thought that having a large nucleon number would be better and contradicted the wording in the question. The second marking point (needing fewer collisions) was rarely seen and only a small number of students scored well on this question.

Section B

The multiple choice questions covered parts of the specification not covered in Section A. The distractors in these questions were written with common errors and misconceptions in mind. These questions are therefore an extremely useful resource when preparing students.

A number of questions were found to be quite straightforward by students. These included B8, B11, B12, B17, B18, B20, B26 and B28 which were all answered correctly by at least 70% of students.
The questions found to be the most difficult were B14, B15 and B25 – answered correctly by fewer than 35% of students.

Mark Ranges and Award of Grades

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