A-LEVEL
PHYSICS

7408/2
Report on the Examination

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General Comments

The maximum mark for this paper was 85; scores ranged from 0 to 80, with an average mark of 39.6 (46.6% of the maximum mark). As usual, students scored more highly on questions involving calculations than those involving definitions and longer written answers.

Section A

Question 1

01.1 Most students seemed to be completely aware of what was being asked but their answers commonly fell short because of missing details. Less than half referred to the absence of a change in temperature and many also missed stating which change of state was occurring and that a unit mass was involved.

01.2 A majority performed this calculation well and with a good degree of clarity (64.5% of students scored all three marks). One error made by normally competent students was to give the final temperature rather than the rise in temperature. The other and more common fault was to quote an answer to only one significant figure. Only the very weak students made faults in re-arranging the equations.

01.3 It was a common misconception that the time it took for the water to pass the heater had an effect on the average rise in temperature. This could have been a possibility if the question had not said that heat was not lost to the surroundings. The other error seen was for students to relate kinetic energy of the whole body of water to the temperature. It is the mean kinetic energy of the random motion of molecules that is related to temperature. In addition, very few students picked up on the idea that work done, as well as heating, can raise the temperature. Nearly three-quarters of students failed to score.

Question 2

02.1 As was the case in 2017, many students had not learnt definitions thoroughly. So, the actual unit of charge was absent from many scripts as was a reference to a positive charge. Weaker students mixed the definition of electric field strength with electric potential. 44.4% of students did not gain any credit here.

02.2 This was a very discriminating question and just over half of the students performed well and gained at least two marks. The hurdle to overcome was to use an inverse-square force equation rather than an inverse equation that relates to potential. Once the correct equation had been established, most found no difficulty in the re-arrangements involved. It is worth pointing out that students who explained their work with a couple of words were much more likely to obtain marks even if their calculations were wrong.

02.3 Most students showed a weakness in their understanding in this topic. The fact that the resultant electric field was zero at P, and they rightly concluded that the field was zero at infinity, made it too tempting to conclude the line between P and infinity must be an equipotential, which was obviously wrong. Only about a third of the students thought about the work that must be done in moving a proton to a region close to two positive charges. Also very few referred to the potential being zero at infinity. 60.7% of students scored zero.

02.4 This was another question done badly, with 61.1% failing to score. The common answers fell into two groups. The first just regarded the ball being released as if it were thrown and therefore following a parabolic path. The second group ignored gravity all together and wrote about the ball travelling away horizontally. Very few students analysed the situation by considering the forces and then the resulting accelerations in the horizontal and vertical directions. In fact, many students did not mention force or acceleration but kept to generalities such as “it moves away from the wall and falls”.

Question 3

03.1 A majority of students knew that capacitance relates to charge and pd. Marks were missed simply because of missed detail such as using appropriate units. Also, some scripts lacked a sense of explanation. ‘Charge per volt’, leaves off the essential fact that the charge is stored. 79% of students scored at least one mark here.

03.2 This was an easy question for most students; nearly 90% wrote the correct answer.

03.3 This question discriminated well, with a majority of students knowing what the growth graph should look like. Some showed a lack of care in reading the vertical scale and placed the X above 9V. Others drew the curve with a flattened top or showing a slight peak. Some of the weaker students elected to draw an exponential decay type graph.

03.4 This was another straightforward calculation which a majority of students (55.4%) could do well. However, a significant minority did not know the simple equation for the half-life.

03.5 This was quite a difficult exponential calculation so it was encouraging to see well over half of the students scoring at least one mark. Most students can clearly deal with this type of exponential equation and cope with the re-arrangements and calculation. The common error made by others was to try to use an exponential decay equation rather than an exponential charging equation. These students were able to score marks by evaluating the maximum charge. Overall, it was more common for students to use the charge equation rather than the voltage equation. Nearly 8% of students made no attempt at this question.

Question 4

04.1 Although a few students quoted Faraday’s law of electromagnetic induction or some other rule, a majority gave the impression that they knew about Lenz’s law. However, many failed to gain marks due to missing necessary details. The most common was to confuse the word ‘opposite’ with ‘oppose’. A huge number of students wrote that the direction of the emf was opposite to the force, motion or flux change. Also, many students left out a reference to the emf and went straight for “the induced magnetic field opposes the change in flux”. It was evident that very weak students did not think about the situation given, but instead tried to remember some law by heart. The sentences written by these students often did not make any sense. Only 21.4% of students gained a mark.

04.2 A majority of students (53.9%) gave clear correct answers. Students failed to gain a mark mainly by not being clear about what happens when the magnet stops. To be awarded a mark, it needed to be explicitly stated that the reading falls to zero. Stating that “the dial stops” does not make it clear whether the reading retains its value or falls to zero.

04.3 Less than a third of students were aware that it was a repulsion between magnetic fields that provided the opposition to movement. These students generally scored both marks and gave a good explanation. Many other students made statements like “the current is pointing in a direction opposite to the magnets movement, so this shows Lenz’s law”. They gave an answer in this form to match up with their previously wrong quote of Lenz’s law. It appeared as if a majority of students did not appreciate that the opposition to the flux change manifests itself in a physical force that needs to be worked against.

04.4 This question was tackled well by two-thirds of students, with the majority choosing to equate the rate of change of flux linkage to the emf. A simple, but common, error was to calculate the area wrongly. The side length was often seen doubled rather than squared.

04.5 Students found this more difficult than the previous question (42.8% completely correct). A minority did know the emf equation to use but they could not obtain a maximum value. They failed to replace the trigonometric factor with 1.

Question 5

05.1 About half of the students knew that gamma radiation was to be used. However, only 19.6% actually gained a mark because they did not know *why* gamma radiation was to be used. They either left out the reason or simply wrote something they knew about gamma radiation, whether it was relevant or not. “It is least ionising” or “it kills germs” are examples of statements that did not gain marks.

05.2 It was clear that over 90% of students were not aware of how materials can become radioactive. There were extremely few references to nuclei. Students mainly wrote that the induced radioactivity was “too small to be of harm” or “has a short half-life” or “is only ionised a bit, so can be ignored”.

05.3 More than half of the students (56.1%) gained full marks and they established that the constant of proportionality was not constant when an inverse square of distance relationship was used. Other students put the square on the count rate rather than the distance and did not gain any marks. Others only compared two rows of data rather than three, but these could score one of the marks.

05.4 A great number of weak answers simply stated that the measurements were taken wrongly in some way because of human error. Examples included “the readings were copied wrongly” and “the GM tube was old and faulty”. The most common answer was to state that the background reading was changing or not accurate. It was also obvious that some students did not know how the inverse square law comes about, since they wrote “the detector captures fewer radiations as it moves away from the source”. Approximately one third of students could give one acceptable answer; 59.5% failed to score.

Question 6

06.1 Nearly half of the students (44.6%) could produce the answer without too much trouble because they spotted that the half-life was 19 s. Other students either made a small error in reading off the graph and got close to the correct answer, or they did not spot the half-life approach and made a difficult question for themselves by trying to fit the exponential decay equation to the graph. Most of these students made mistakes.

06.2 62.4% of students found this to be an accessible question and gained the mark. The 'near-miss' answer put forward by many others was to write about increasing the volume of the cylindrical tube. The problem here is that it was not made clear that the height and not the diameter occupied by the water needs to be altered.

06.3 Most students did realise that the water should take longer to empty if the decay constant represented was smaller. Some of these students suggested changing the geometry of one of the tubes but they did not make it clear which one they were referencing. The students who focussed on the tap scored the mark more often than not. A final error point seen frequently was to treat 'density' as having the same meaning as 'viscosity'. 34.7% of students wrote a sufficiently detailed answer to gain the mark.

06.4 This calculation was performed well by nearly 90% of the students. Most knew the relevant physics and errors only occurred in arithmetic items such as getting the wrong power of 10.

06.5 This was another reasonably difficult question that about half of the students could do very well (45.3% scored all three marks). The most common approach was to use the exponential decay in the mass, but others successfully used the exponential decay in the number of molecules. A very small proportion of students calculated the number of half-lives that must have occurred and deduced the mass in this way. Most of these, unfortunately, did not retain three significant figures and so failed to gain one of the marks available. As expected in this type of question, a significant number of students made powers of ten errors and a similar number did not give their answer to three significant figures. 25% of students failed to score.

06.6 This calculation caused far more problems for students than the previous calculation. Many attempted to work the activity out in counts per year, which was not accepted. So, the calculation was marked in essentially three independent parts: the number of molecules involved, the calculation giving an answer in becquerel, and finally the unit. Of the 68% of students who scored at least one mark, about one third, but not always the same one third, scored each mark.

Question 7

07.1 Nearly one third of the students drew the sequence on the grid totally correctly and scored two marks. Many students started on the final isotope and drew the sequence of decays; these could score one mark only. The other group scoring one mark usually got the two alpha decay arrows following the correct lines but, because they started in the wrong position, just drew two beta arrows to finish in the correct position. About two thirds of the students scored at least one mark.

07.2 This question discriminated very well; there was a very good spread from zero to four marks. It was only the very weak students who did not understand that the question was about describing the contributions made by the strong nuclear force and the electromagnetic force. These students introduced the weak nuclear force and gravity as having some influence on the situation. Most students scored marks by knowing that the electromagnetic force is repulsive for protons in the nucleus and that the SNF is attractive between nucleons at short range. The variation in the marks came from students giving different amounts of detail, which could be about the specific ranges involved and the fact that the SNF is repulsive at very short range. Only the best students appreciated how the main forces lead to the requirement for more neutrons.

07.3 Just over half of the students made some mistake in writing down the equation. The most common error was to write the wrong proton number for thallium, followed closely by students thinking an antineutrino was emitted.

07.4 A good number of students, approaching half, either gave the source of radiation as coming from orbiting electrons or coming from an excited nucleus. Only a few (9.4%) gave two sources. A large number of answers were not specific enough to award marks. "The electrons give off radiation" and "the thallium atom gives off radiation" are examples. It was evident that some students did not fully understand the question and simply quoted situations when radiation is emitted.

07.5 Many students had problems in avoiding absolute statements that disqualified them from a potential mark. Some examples are "It does not ionise, so causes no harm to the body" and "It has a short half-life so is not dangerous at all". Many students did know that this source gave off gamma rays, but not that these were alone. Also, there were just as many references to the half-life being long as there were to it being short. These references only gained marks if the benefit was explained, for example 'long enough to complete the investigation'.

Section B

The 25 questions in Section B are summarised in the table below. For each question, the key (correct answer) is provided, along with the percentage of students answering correctly. There was a good range of 'facility' across this section; the most accessible question was 13 (answered correctly by 81.4% of students), the least accessible were 12 and 23 (answered correctly by only 15% and 13.3% of students respectively). The overall mean mark achieved by the students for Section B was 15.4 out of 25 (61.6%).

Question	Key	% correct	Question	Key	% correct	Question	Key	% correct
08	A	43.8	17	D	36.6	26	C	34.8
09	C	61.7	18	C	30.8	27	C	41.9
10	C	77.6	19	A	58.5	28	A	57.5
11	B	73.6	20	C	49.2	29	A	63.1
12	B	15.0	21	D	63.3	30	C	53.2
13	A	81.4	22	D	57.5	31	C	54.6
14	D	80.5	23	B	13.3	32	D	70.1
15	C	27.1	24	C	52.4			
16	B	47.6	25	C	54.0			

Mark Ranges and Award of Grades

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