Questions matter

GCSE

Combined Science: Trilogy

8464/P/1H Combined Science: Trilogy Physics Paper 1H

Report on the exam

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Contents

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Overview

This paper is one of the six examined components for Combined Science: Trilogy. All of these papers follow a similar structure and test the same assessment objectives.

This paper has 70 marks available to students and is made up of six questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 40% of marks target Standard demand, 40% of marks target Standard/high demand and 20% of marks target High demand.

Questions 1 and 2 on this paper and questions 6 and 7 on the Foundation Tier paper are common. These questions are identical and are targeted at standard demand.

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/high demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade is based on their attainment across all six papers.

Summary of overall performance

Overall, students found this paper to be accessible, with the vast majority attempting to answer all questions.

Students were provided with a Physics Equations Sheet that included all equations needed. This considerably eased the demand of many calculation questions. For example, question 06.3 was a 6-mark calculation question in which a high proportion of students were able to score very highly. However, questions such as 06.1, which required more of an understanding of physics, and did not require the use of the equations given, proved to be a lot more challenging.

A small, but noticeable, minority of students had a tendency to make spurious conversions for some quantities. This was seen most often in question such as 04.2, 04.3 and 06.3, where quantities had units that included kilograms (eg mass, density), with some students attempting to convert values into grams.

Particularly towards the end of the paper, where the level of demand of the questions is greater, many responses to 'describe' or 'explain' questions lacked the clarity and precision of language needed to answer the question effectively. For example, in question 06.2, describing particles as 'moving more' is not the same as particles moving faster, and describing 'more collisions' happening is not the same as describing more frequent collisions.

Several questions brought to light misconceptions in a range of topics that seemed to be relatively common across the entire cohort. These included errors in the understanding of the plum pudding model of the atom, the understanding of potential difference in circuits, and aspects of radioactivity and half-lives.

Question 1 (standard demand)

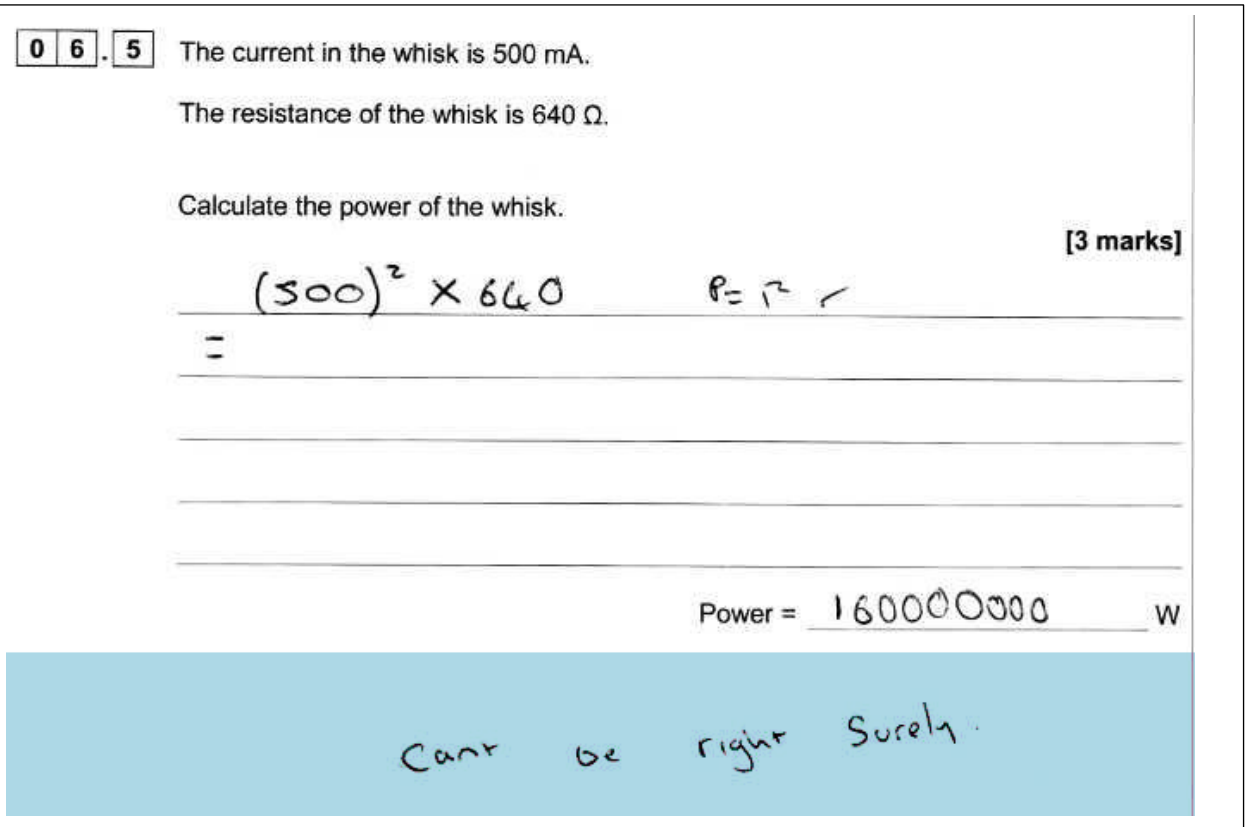
01.1 Almost all students scored at least 1 mark on this question, with nearly two-thirds scoring both marks. The most common incorrect answers were an increase in electrical energy and an increase in chemical energy.

01.2 A very low proportion of students answered this incorrectly.

01.3 Nearly 90% of students arrived at the correct final answer for this calculation, gaining 3 marks.

01.4 Most students selected the correct equation, with about 1% of students not gaining this mark.

01.5 For this calculation, many students did not correctly convert the current into amps. Some students forgot to show that the current should be squared in their substitution. Others showed a valid substitution but forgot to square the current when they entered it in their calculator. About 40% scored all 3 marks, but about 50% gained 2 marks, and over 95% scored at least 1 mark.



This student did not realise that the current was given in milliamps, so only scored marking points 2 and 3. However, the comment 'Can't be right, surely' indicates that they realise that the power of an electric whisk ought to be a lot lower. Students who think about how realistic their answer is may give themselves a much better chance of spotting their mistakes and doing something to rectify them.

01.6 Slightly more than one in two students could recall the potential difference between the live and neutral wires.

01.7 Over 80% of students identified that an increase in current would be caused by a decrease in resistance.

Question 2 (standard demand)

02.1 Most students were unable to accurately recall the structure of an alpha particle, with about 40% giving a full description.

02.2 The number of neutrons was correctly determined by nearly 85% of students.

02.3 Most students were able to make a good attempt at this question. The majority recalled a reasonable level of detail of at least one of the two atomic models, and many students gave some account of how the evidence led to the replacement of the plum pudding model with the nuclear model.

Some students used diagrams of the two models as part of their answers. Clearly labelled diagrams could help students to gain credit, but many diagrams were not labelled at all. However, many answers which included unlabelled diagrams had then gone on to describe features of each model, and the diagrams may have helped these students to recall the relevant details and to structure their answers.

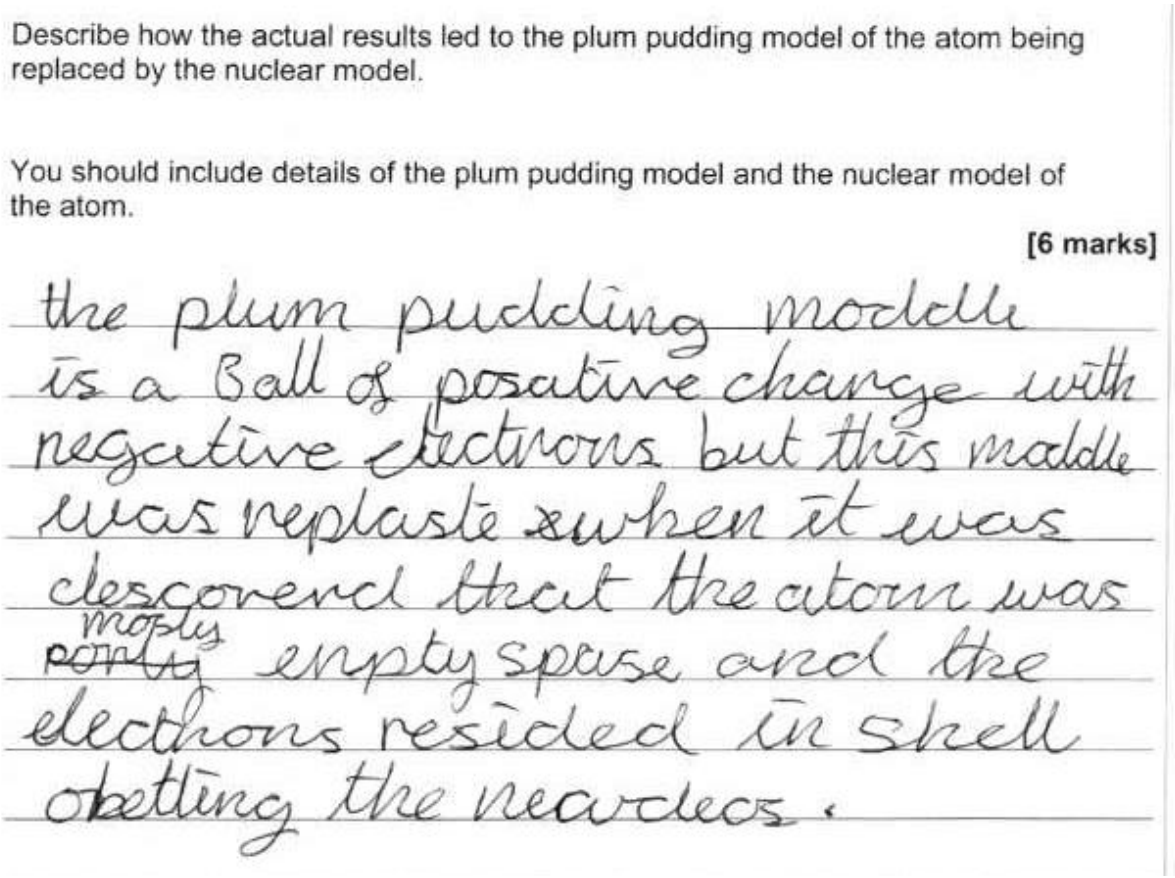
A number of students described the ionising and penetrating properties of alpha particles, which did not prevent credit from being awarded, but was not relevant to answering the question.

There were a few misconceptions, which were demonstrated by a number of students. Descriptions of the plum pudding model as a proton with embedded electrons was common. A small proportion of answers alluded to positive electrons and negative electrons being present in atoms. A similar proportion referred to atoms being neutral because they contain neutrons.

Describe how the actual results led to the plum pudding model of the atom being replaced by the nuclear model.

You should include details of the plum pudding model and the nuclear model of the atom.

[6 marks]



This Foundation tier response is at the top of Level 1, gaining 3 marks. There is a description of the plum pudding model, but the description of the nuclear model lacks any detail about the massive and charged nature of the nucleus. Had the answer also included some detail about the nucleus, or referred to how the actual results led to the rejection of the plum pudding model, the answer would have been in Level 2.

Describe how the actual results led to the plum pudding model of the atom being replaced by the nuclear model.

You should include details of the plum pudding model and the nuclear model of the atom.

[6 marks]

- The ~~plum~~ plum pudding model was a solid sphere of positive charge, with negatively charged electrons throughout.
- Some alpha particles passed straight through, showing it is mainly empty space, not a solid ball.
- Some were slightly deflected showing there are the electrons circling the positive charge in the middle.
- Some completely ~~deflected~~ deflected back as they were repelled by the positive charge at the centre of the atom.
- The nuclear model was made to show these findings. It had a positive nucleus in the centre, a cloud of electrons orbitting it and the rest is mainly empty space.

In order to achieve the top mark on 'extended response' type questions, answers do not have to be completely correct, and neither do they need to address every single point in the indicative content on the mark scheme.

This response (from a Higher tier paper) gives a complete description of the plum pudding model. It describes how the evidence led to an understanding both that the atom is mostly empty space and that the nucleus is positively charged. However the statement that some alpha particles were deflected by electrons is incorrect, and there is no mention of the nucleus being massive.

However, taken as a whole, there is a reasonably detailed description of the plum pudding model, relevant points made about how the evidence led to the nuclear model, and a reasonably detailed description of the nuclear model, which was enough to allow this student to gain the maximum mark of 6 on this question.

02.4 About 55% of students correctly identified the scientist who provided evidence for the existence of neutrons.

Question 3 (standard & standard/high demand)

03.1 Approximately half the students gained both marks, with roughly a quarter scoring 1 mark. The vast majority of students were able to draw the correct symbols for a voltmeter and ammeter, but positioning the voltmeter correctly caused a problem for many students.

03.2 While most students attempted to describe a way to vary the magnitude of the potential difference across the LED, the majority of students did not address how to change the potential difference to obtain negative values.

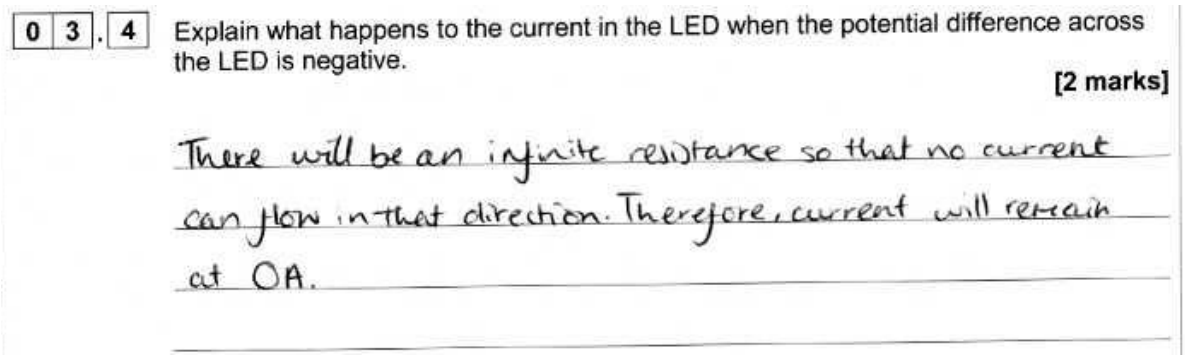
There were some misconceptions demonstrated by a number of students, with suggestions that moving the LED closer to or further from the battery would increase or decrease the potential difference being relatively common. Many students also incorrectly suggested that connecting all the components in parallel rather than in series would vary the potential difference as required.

A very low proportion of students scored both marks, but over 25% gained at least 1 mark.

03.3 A significant minority of students made errors in reading either the *x*-axis scale or the *y*-axis scale when plotting their points. Points plotted at 18 mA, 42 mA and 68 mA were within half a small square, so credit could still be awarded, but students who made errors on the *x*-axis scale tended to be less fortunate. Even if points were not correctly plotted, the line of best fit mark could still be scored. Slightly over half the students gained all 3 marks.

03.4 Fewer than 1 in 10 students scored both marks on this question, with about 20% scoring 1 mark.

It was common for students to incorrectly suggest that the current would reverse, or just to state that the current would decrease. Very few students gave a reason why the current would be zero.



0 3 . 4 Explain what happens to the current in the LED when the potential difference across the LED is negative.

[2 marks]

There will be an infinite resistance so that no current can flow in that direction. Therefore, current will remain at 0A.

This answer gives a valid explanation for the change in current, gaining both marks.

03.5 The difference between repeatability and reproducibility was misunderstood by many students, with nearly 50% choosing the incorrect answer that the results showed repeatability. Just over a third of students gave the correct answer.

03.6 Just under 60% of students recalled that a resistor at constant temperature shows a linear relationship between current and potential difference.

Question 4 (standard/high & high demand)

04.1 Many students just named energy stores and did not describe how the stores changed. A fair proportion of students stated that the kinetic energy of the drone would remain constant, which is not an incorrect statement, but is not a change to a store of energy so did not gain any credit. A small proportion of students referred to the chemical store of energy decreasing.

Approximately two-thirds of students gained at least 1 mark, although only about 10% of students scored both marks.

04.2 There were two routes that students could use to answer this question. Many students who took the first route got as far as the third marking point but then did not subtract their answer from 840 m.

Just under a third of students gained full credit, with slightly over half gaining 3 marks.

04.3 Most students omitted the first step in this calculation and did not add the 3920 J to the initial kinetic energy of the drone. However, marking point 2 could still be scored using any energy value when substituting into the kinetic energy equation. The most common approach was to use 150 J as the maximum kinetic energy.

A noticeable minority of students converted 2.5 kg into grams.

Some students forgot to square the speed when substituting into the equation. Other students struggled to re-arrange the equation. One relatively common mistake was to correctly rearrange the equation for v^2 (eg $v^2 = \frac{4070}{05 \times 2.5}$) but then square this value to determine v (eg $v = \left(\frac{4070}{0.5 \times 2.5}\right)^2$) rather than determining the square root.

A minority of students remembered to convert their final answer into km/s.

Almost 60% of students scored 2 marks, with only the highest-attaining students managing to gain 4 or 5 marks.

0 4 . 3 When the motor was switched off, the kinetic energy of the drone was 150 J.

Calculate the maximum possible speed of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

Give your answer in km/s.

[5 marks]

Kinetic energy = 0.5 × mass × (speed)^2

150 = 0.5 × 2.5 × (speed)^2

2.5 × 100 = 250

150 = 0.5 × 250 × (speed)^2

0.5 × 250 = 125

150 ÷ 125 = 1.2

1.2^2 = 1.44

Maximum possible speed of drone = 1.2 km/s

This student has tried to use the kinetic energy equation but has made several errors along the way and, as a result, does not gain any marks.

The student used an incorrect value for the maximum kinetic energy, so does not score marking point 1.

Although a correct substitution of 150 J into the kinetic energy equation is shown in line 2 of the answer, the student has multiplied the mass by 100 in line 3 and then used the equation with the mass multiplied by 100 (line 4). It is the equation on line 4 that ultimately leads to the student's final answer. As an incorrect value for mass is used here, this is an incorrect substitution, so marking point 2 is not awarded.

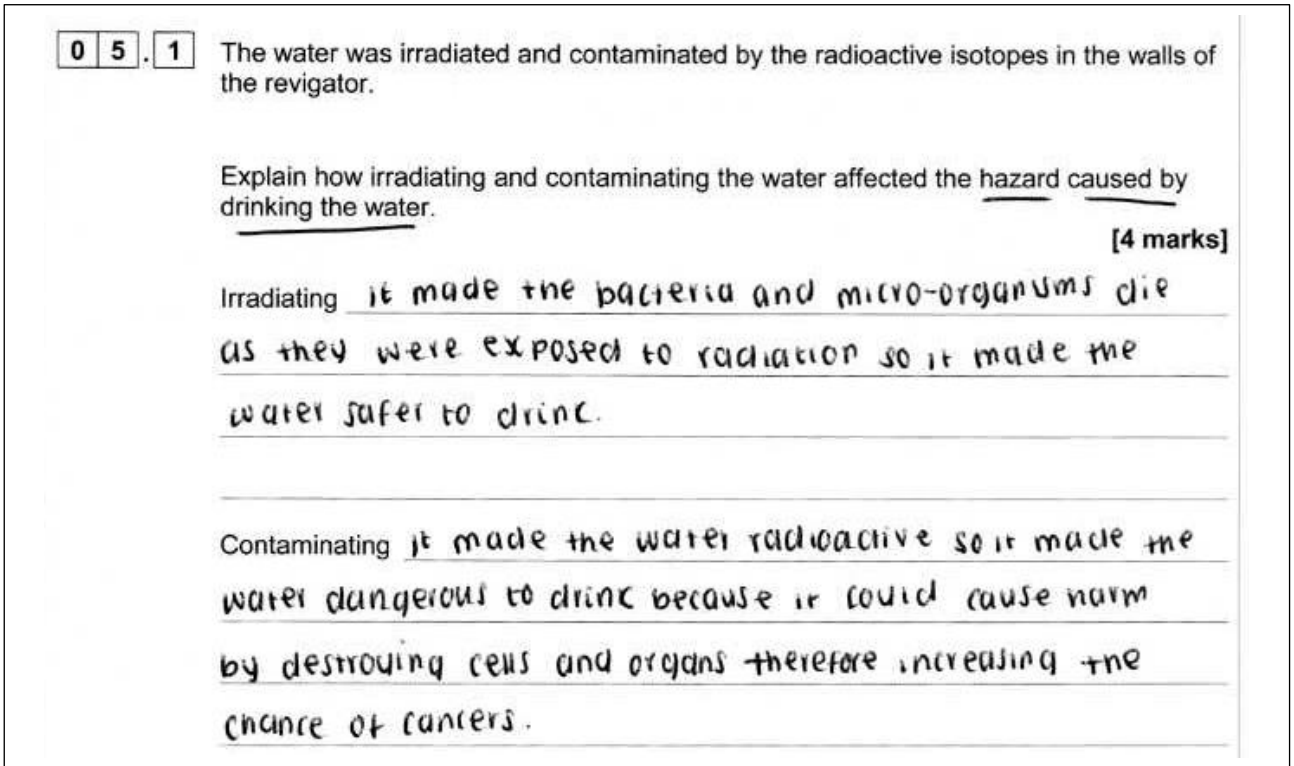
On line 6, the student has rearranged the equation to give a value of 1.2, but the answer line demonstrates that the student thinks this is the maximum possible speed of the drone rather than a value for v^2, so marking point 3 is not scored.

The common mistake of squaring the calculated value of v^2 can be seen on line 7, but the student has chosen to ignore this line of reasoning when giving the final answer. The student has not attempted to convert the calculated speed of 1.2 m/s to km/s.

Question 5 (standard/high & high demand)

05.1 Just over 40 % of students gained some credit on this question, but very few scored full marks. Many students showed confusion between a radioactive substance and the radiation emitted by that substance.

It was quite common for students to have some grasp of the meaning of contamination, but a surprisingly large proportion of students wrote answers referring very clearly to bacterial contamination of the water, rather than contamination by the radioactive isotopes.



0 5 . 1 The water was irradiated and contaminated by the radioactive isotopes in the walls of the revigator.

Explain how irradiating and contaminating the water affected the hazard caused by drinking the water.

[4 marks]

Irradiating it made the bacteria and micro-organisms die as they were exposed to radiation so it made the water safer to drink.

Contaminating it made the water radioactive so it made the water dangerous to drink because it could cause harm by destroying cells and organs therefore increasing the chance of cancers.

This response scored full marks. The student gave a very clear explanation of why irradiation could reduce the hazard, and why contamination would increase the hazard.

05.2 Less than half of all students selected the correct nuclear equation.

05.3 While nearly two-thirds of students gained some credit on this question, less than 5% scored all 4 marks. A lot of students demonstrated some knowledge of how activity changes with time, but there were also a number of misconceptions that were revealed by answers to this question.

Some students worked out that two half-lives would have passed for vanadium, but then went on to state that this meant that a ‘full life’ had passed so no more radiation would be emitted by the sample. Other students linked the mass number of the element with the half-life, and it was common to read answers suggesting that after two half-lives, vanadium-52 would have become vanadium-13.

It was also relatively common to see answers suggesting that the activity of a sample during a half-life would remain constant until the half-life was reached. At this point activity would then suddenly halve. This misconception was demonstrated by statements such as ‘Radon has not reached a half-life, so its activity has not changed’, which would still score marking point 1.

A small number of students suggested that the half-life would change as time increased, and some students suggested that activity would increase with time.

0 5 . 3 **Table 2** shows the half-lives of radon-222 and vanadium-52.

Table 2

Isotope	Half-life
Radon-222	3.8 days
Vanadium-52	3.7 minutes

The scientist measured the radiation emitted by a sample of radon-222 and the radiation emitted by a sample of vanadium-52.

The scientist repeated the measurements 7.4 minutes later.

Explain how the activity of the radon-222 and vanadium-52 had changed after 7.4 minutes.

[4 marks]

Radon-222 the radon-222 has not changed at all as its half life is 3.8 days this means that it won't change until that point

Vanadium-52 3.7+2=7.4 => enough time for 2 half-lifes.

- from vanadium-52 -> Vanadium-13

The response about Radon demonstrates the misconception that activity remains constant, and then suddenly halves when the half-life is reached.

The response about vanadium illustrates the misconception that the mass number of an element will decrease by a factor of two for each half-life that passes.

05.4 About a third of students identified the process as peer review.

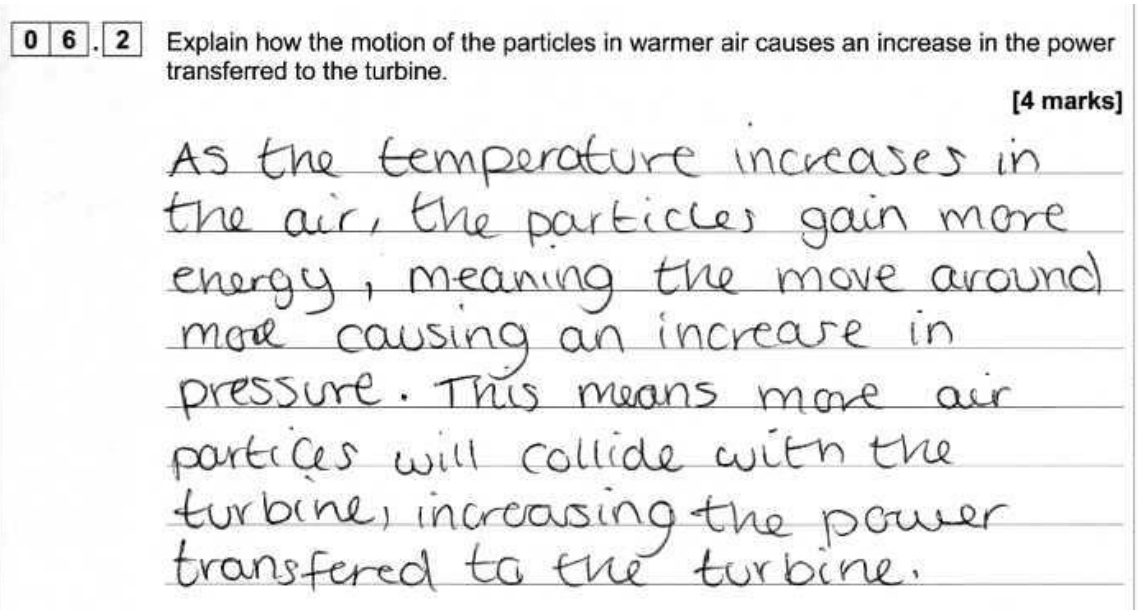
Question 6 (standard/high & high demand)

06.1 Most students struggled to appreciate that the process of compressing the air would reduce the useful energy, and that releasing the air would then reduce this energy further. This lack of understanding of the physics involved meant that a very small proportion of students were able to carry out the correct calculation. Most students who correctly multiplied the two efficiency values tended to also round their answer correctly.

Roughly 20% of students scored 3 marks.

06.2 Many students demonstrated some understanding of how the temperature affects the rate of energy transfer to the turbine. However, many of these answers lacked crucial details. Statements such as 'the number of collisions between the particles and the turbine increases' were common, but without a reference to frequency, or to the collisions happening in a fixed time, marking point 2 was not scored. The proportion of students who referred to the force from each collision was very low.

About 70% of students gained some credit for their answers.



0 6 . 2 Explain how the motion of the particles in warmer air causes an increase in the power transferred to the turbine.

[4 marks]

As the temperature increases in the air, the particles gain more energy, meaning the move around more causing an increase in pressure. This means more air particles will collide with the turbine, increasing the power transfered to the turbine.

This answer demonstrates some understanding, but lacks the detail needed to gain any marks. The student refers to particles gaining more energy but needed to refer to kinetic energy to gain the point. If the particles 'move around more' it could mean that they move a greater distance, rather than moving at a greater speed, so again marking point 1 is not scored. Similarly, 'more particles will collide with the turbine' does not have a reference to frequency or to time, so is not sufficient to score the second marking point.

06.3 This question proved to be relatively straightforward for a high proportion of students, with over 60% gaining full marks. Having an equation sheet which included all of the physics equations was, no doubt, helpful to many students.

Common errors included spurious conversions of the calculated mass into grams. Some students calculated the correct answer, but then tried to apply the efficiency equation to their answer, often going back to question 06.2 to find an efficiency to use. These responses could still score the first 3 marking points for calculating the mass of air in the tank.

Some students used their calculator to obtain an answer in standard form, but then wrote the answer out in full on the answer line, demonstrating that they did not understand how to give their answer in standard form.

06.4 Many students scored marks for referring to a reduction in wasted energy, but very few discussed both a reduction in the use of fossil fuels and an increase in the use of renewables, so it was very rare for a student to score full marks on this question. Roughly two-fifths of students gained at least 1 mark.

A large number of students seemed confused about what was being asked. Some students wrote about the use of transformers in the National Grid. Some appear to have misread ‘efficient energy storage’ as ‘renewable energy resources’ and based their answers around the relative benefits of solar panels and wind turbines. It was common to read answers explaining the impact of carbon dioxide in the atmosphere, but not actually answering the question. Many students seemed to think that the compressed air energy storage system was part of a carbon-capture and storage system.

Contact us

Our friendly team will be happy to support you between 8am and 5pm, Monday to Friday.

Tel: 01483 477756
Email: gcsescience@aqa.org.uk

aqa.org.uk