



GCSE

# Combined Science: Trilogy

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

**Report on the exam**

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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 seven questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 60% of marks target Low demand and 40% of marks target Standard demand.

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

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

- **Low demand** questions are designed to broadly target grades 1–3.
- **Standard demand** questions are designed to broadly target grades 4–5.

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 of students attempting to answer all questions.

The physics question papers inevitably include a fair amount of maths, and there were some common errors that showed themselves in this area. As in previous years, there was evidence that a small number of students did not have access to a calculator during the exam. Students were provided with a Physics Equations Sheet that included all equations needed. This meant that questions which asked students to recall and then use an equation tended to be particularly well answered when compared with exam papers that were taken when students were not given this information in the exam.

Many students demonstrated a lack of understanding of units. Notably, when a unit includes a square or a cube (eg  $\text{m}^2$  or  $\text{kg}/\text{m}^3$ ), a lot of students also squared or cubed the value. For example, in questions 02.3 and 05.6, both of which included an area, many students squared the value for that area. Seconds and kilograms seem to cause students particular consternation and attempts to unnecessarily convert kilograms to grams or seconds to minutes were very common.

Substituting into equations and rearranging equations were generally demonstrated well. However, many students were not precise in their notation, and often omitted brackets where they were necessary.

There were some questions, notably 03.7 and 05.5, where students needed to take more care when reading the question. In both these questions, there were many responses which indicated an understanding of the scenario, but which failed to answer the question asked. In particular, taking note of the command word at the start of a question (eg describe, explain etc) may help students to both give more concise answers and to answer the question asked.

## Question 1 (low demand)

- 01.1** Roughly half of all students recognised that the current in two lamps connected in series is the same.
- 01.2** Approximately 1 in 2 students answered this question correctly.

Students who demonstrated that they had arrived at the answer of 3.0 V by using incorrect physics did not score this mark. This included those who divided 4.5 V by 1.5 V, and, less commonly, those who calculated a mean of 4.5 V and 1.5 V. If a student gave the correct answer without showing their reasoning, it was assumed that they had used correct physics and the mark was awarded.

**0 1 . 2** Lamp X and lamp Y are **not** identical.

The potential difference across the battery is 4.5 V.

The potential difference across lamp X is 1.5 V.

Calculate the potential difference across lamp Y.

[1 mark]

$$4.5 \text{ V} \div 1.5 \text{ V} = 3$$

Potential difference across lamp Y = 3 V

**0 1 . 2** Lamp X and lamp Y are **not** identical.

The potential difference across the battery is 4.5 V.

The potential difference across lamp X is 1.5 V.

Calculate the potential difference across lamp Y.

[1 mark]

$$4.5 - 1.5$$

Potential difference across lamp Y = 3 V

Both these students have the correct numerical answer of 3 V. However, the first student used incorrect physics to arrive at their answer, so did not gain the mark. The second student scored 1 mark.

**01.3** This question was generally very well answered, with around 90% of students able to substitute into the equation and calculate the correct answer.

**01.4** Nearly 85% of all students calculated the correct resistance and gained both marks.

**01.5** The majority of students gained full marks on this question.

A common mistake was to divide the 40 seconds by 100, before using the time in the equation given. Students who made this error arrived at an incorrect answer but could still gain a mark if their answer was consistent with the current multiplied by their time.

**01.6** Slightly less than a third of students recognised that the resistance of a filament lamp increases because the temperature increases. The most common incorrect answer was from students who stated that the power of the battery increases to cause the resistance of the lamp to increase.

**01.7** Approximately 35% of students identified that lamp X would no longer emit light if lamp Y breaks, with a high proportion of students selecting that lamp X would get brighter. Approximately 2 in 5 of those students who selected the correct answer were able to articulate a valid reason for this.

## Question 2 (low demand)

- 02.1** Just under two-thirds of students correctly identified geothermal energy as a renewable energy resource that uses hot rocks underground.
- 02.2** This calculation question was answered well, with almost 90% of students gaining both marks. A small minority of students incorrectly converted the mass from kilograms to grams as part of their calculation.
- 02.3** Some students were confused by the unit of  $m^2$  and decided that the 120 should also be squared. The correct value of energy was given by approximately 65% of students.
- 02.4** Around 55% of students correctly identified that 1 J/s is equivalent to 1 W.
- 02.5** Roughly 70% of students were able to answer this question correctly. Amongst students who did not calculate the correct height, it was relatively common to see substitutions made where brackets should have been used, but were not, eg height =  $196 \text{ J} \div 5.0 \text{ kg} \times 9.8 \text{ N/kg}$ .
- 02.6** Almost two-thirds of students gained at least 1 mark on this question, with approximately a fifth of students gaining both marks. Of those who scored both marks, the most common answers referred to a release of carbon dioxide contributing to global warming.

Many students gave vague answers which were not creditworthy, often referring to pollution or toxic chemicals rather than named pollutants. It was also relatively common for students to refer to a 'carbon footprint', which did not prevent marks from being awarded but did not answer the question.

Some students stated that an environmental disadvantage of fossil fuels is that they are non-renewable, which did not score any credit.

**0 2 . 6** The water in some swimming pools is heated by burning fossil fuels.

Explain **one** environmental **disadvantage** of burning fossil fuels.

[2 marks]

It emits the greenhouse gas carbon which goes into the atmosphere polluting our sky's contributing with air pollution leading to thinning of the o zone layer

This student scored marking point 1 for identifying that carbon is released. This scored against the third alternative in the mark scheme, as carbon is equivalent to soot. However, marking point 2 was not awarded, as the environmental disadvantages associated with soot are global dimming, reduced air quality, or smog. There was a small, but noticeable, minority of students who incorrectly linked carbon dioxide with thinning of the ozone layer or holes in the ozone layer.

## Question 3 (low demand)

- 03.1** The most common answer to this question was from students who incorrectly selected the second option (radium-228 atoms have two more protons than radium-226 atoms). Slightly over a third of students identified that the difference is only in the number of neutrons.
- 03.2** Only about 30% of students were able to identify the half-life from the graph. Over half of all students selected 7 years, half the maximum time shown on the x-axis of the graph.
- 03.3** This question was answered correctly by nearly 60% of students.

Incorrect answers that were relatively common included suggestions to use more toothpaste or to use a more sensitive detector. Some students showed a lack of familiarity with a Geiger-Muller tube, mistaking the detector for a microscope and leading to incorrect answers.

**03.3** When the equipment was arranged as shown in **Figure 5**, it was **not** possible to detect alpha particles from the toothpaste.

Suggest how the scientist adjusted the equipment to detect alpha particles from the toothpaste. [1 mark]

Put the detector closer to the sample.

**03.3** When the equipment was arranged as shown in **Figure 5**, it was **not** possible to detect alpha particles from the toothpaste.

Suggest how the scientist adjusted the equipment to detect alpha particles from the toothpaste. [1 mark]

The changed the distance between the sample of toothpaste and the detector by the clamp.

The first student gave a correct answer. However, the second student did not give enough detail about whether the distance should be increased or decreased, so scored zero.

- 03.4** Nearly three-quarters of all students gave the correct range.
- 03.5** Just over a third of students correctly identified the independent variable.
- 03.6** Slightly less than 40% of students correctly identified the dependent variable.

**03.7** Just under half of all students could identify how the level of risk changed.

It was reasonably common for students to describe what happened to the activity of the toothpaste rather than the risk. It was also common to state that there would be no risk, but this contradicted the results from the scientist's investigation so did not score. Descriptions of a reduction in the rate of emission of radiation were not enough to score a mark.

Some students misinterpreted the question and, instead of referring to the risk from the radioactive toothpaste, described the risk from toothpaste generally. Statements that referred to modern toothpaste being safer did not answer the question.

**03.8** Nearly 40% of students correctly identified that the ionising nature of nuclear radiation makes it hazardous. About a third of students showed the misconception that nuclear radiation makes objects radioactive.

## Question 4 (low & standard demand)

**04.1** While the majority of students demonstrated that they recalled the symbol for a voltmeter, a small minority were able to position the voltmeter in parallel with the diode.

**04.2** Nearly 60% correctly identified the variable resistor as the component that should be used to adjust the potential difference across the diode.

**04.3** Around a quarter of students correctly identified that fluctuations in readings, when everything else remained the same, must be examples of random error. The most common answer given was systematic errors.

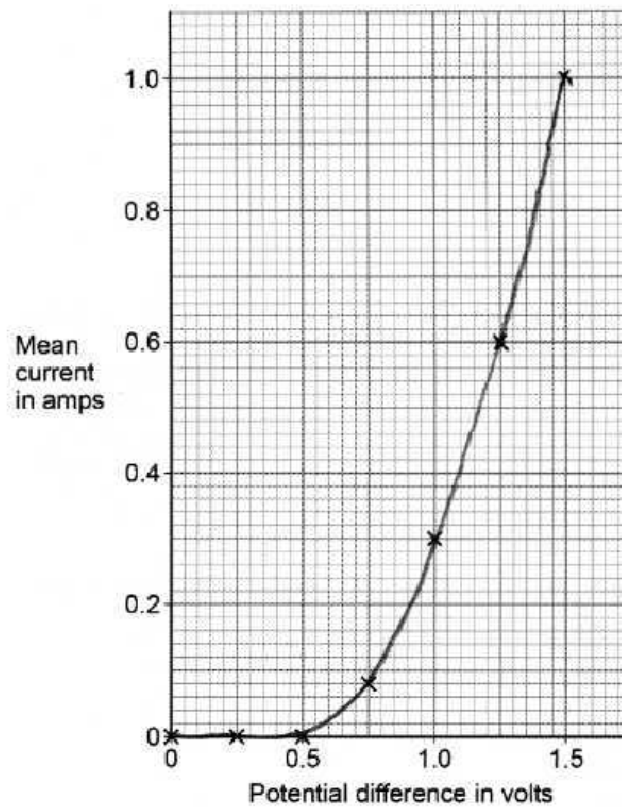
**04.4** This question was generally well answered, with nearly three-quarters of all students gaining both marks. Errors seen from those who did not score any marks included multiplying the numbers together instead of adding them, forgetting to divide the answer by 3, and giving the median value instead of calculating the mean.

**04.5** There were many good attempts at drawing the line using a sharp pencil, and clearly marking the points with a cross.

Many students accurately plotted the points on this graph. A lower proportion managed to draw a valid line of best fit, with around 30% of students gaining full marks for the question. A relatively common incorrect attempt at the line was to draw a single straight line.

Figure 7 shows some of the results.

Figure 7



A good example of a well-plotted graph. This student scored both marks.

- 04.6** Approximately a third of students correctly described the current-potential difference relationship for a diode as non-linear.
- 04.7** Slightly less than 40% of students recalled that, when reversed, the current in a diode becomes 0.00 A. Slightly more than 40% ticked the box to suggest that the current would remain the same.

## Question 5 (low and standard demand)

- 05.1** Just under half of students correctly identified that metal has a high thermal conductivity.
- 05.2** The vast majority of students were able to draw a diagram to represent the arrangement of particles in a gas.
- 05.3** Just over 55% of students recalled that pressure on the walls of a container is caused by air particles colliding with the walls. Almost 30% of students showed the misconception that particles in a gas expand to fill the container, causing pressure on the walls.
- 05.4** Slightly less than two-thirds of students recalled that at lower temperatures the average speed of particles is less.
- 05.5** Roughly 20% of students gained both marks on this question, with about a third of students scoring one mark.

A sizeable proportion of students appeared not read the question correctly and, instead of describing how the pressure changed, gave explanations of why the pressure changed. In doing so, many of these responses did not include a description of how the pressure was affected and so scored no marks.

Misconceptions included the idea of air particles expanding as temperature increases, and the idea of pressure being caused by 'pressure particles'.

**0** **5** **5** After the temperature of the air in the container had decreased, the computers were switched on.

The computers caused the temperature of the air to then increase.

Describe how the air pressure in the container changed as the temperature decreased and then increased. **[2 marks]**

The air pressure would have been low  
when the computers were off then it  
would have increased when they were  
turned on.

Although an ideal answer would have indicated that the pressure would initially decrease, for this question the idea that the pressure was initially low was sufficient to score the first marking point. This response scored both marks.

0 5 . 5

After the temperature of the air in the container had decreased, the computers were switched on.

The computers caused the temperature of the air to then increase.

Describe how the air pressure in the container changed as the temperature decreased and then increased.

[2 marks]

When the temperature decreased  $\rightarrow$  less energy  
 $\rightarrow$  less collisions.

When increased  $\rightarrow$  more energy  $\rightarrow$  more collisions.

This student appears to understand what is happening inside the container, but does not describe how this affects the pressure. The response scored no marks.

- 05.6** This question was generally well answered, with more than three-quarters of students calculating the correct volume.

For those who did not answer correctly, by far the most common error was to treat  $7.5 \text{ m}^2$  as  $7.5^2 \text{ m}^2$ , which led to an incorrect answer of  $675 \text{ m}^3$ .

- 05.7** Given that students had an equation sheet, this question was well answered, with slightly less than 90% of students answering correctly.

Of those who answered incorrectly, the most common answer was caused by students who misread  $\rho$  as  $p$ , and misread  $V$  as  $v$ . This led them to the equation linking mass, momentum and velocity rather than the equation linking density, mass and volume.

- 05.8** The error carried forward from question 05.6 meant that even those who had incorrectly calculated the volume of the container could still score all 3 marks on this question. However, a small minority of students used the number 5.6 in their calculation instead of using their answer from question 05.6.

Rather than showing an initial substitution into the equation (eg  $1100 = m \div 90$ ), the majority of students have a tendency to start questions such as this by writing down the calculation they intend to carry out (eg  $90 \times 1100$ ). If they did this correctly, these students tended to score all 3 marks, but if they had rearranged incorrectly their responses tended to score 0. On this question about 50% earned 3 marks, while roughly 45% did not gain any marks. Students who substituted into the equation first, and then rearranged, were able to earn some credit even if they made a mistake somewhere along the way.

## Question 6 (standard demand)

- 06.1** Roughly two-thirds of students gained at least 1 mark on this question, with about half of these gaining both marks. The most common incorrect answers were an increase in electrical energy and an increase in chemical energy.
- 06.2** Almost 90% of students wrote the correct equation.
- 06.3** Over half of all students arrived at the correct final answer, gaining 3 marks.
- 06.4** Just under 90% of students selected the correct equation.
- 06.5** For this calculation, very few students correctly converted the current from milliamps 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. Less than 5% scored all 3 marks, but about 65% gained 2 marks on this question.

**0 6 . 5** The current in the whisk is 500 mA.  
The resistance of the whisk is 640  $\Omega$ .

Calculate the power of the whisk. **[3 marks]**

$(500)^2 \times 640$        $P = I^2 R$  ✓

=

Power = 160000000 W

Can't be right surely.

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.

- 06.6** The proportion of students who recalled the potential difference between the live and neutral wires was very low, with less than 15% of students answering correctly.
- 06.7** Slightly more than half of all students identified that an increase in current would be caused by a decrease in resistance.

## Question 7 (standard demand)

- 07.1** Most students were unable to accurately recall the structure of an alpha particle, with less than one in 10 students giving a full description.
- 07.2** The number of neutrons was correctly determined by just under half the students.
- 07.3** Foundation tier students tended to struggle with this question. Most were unable to describe details of either the plum pudding model or the nuclear model of the atom, and so made very little progress with their answers. The question was not attempted by about a fifth of students, and about a third gained any credit.

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.

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.

It was relatively common for students to be unable to distinguish between the predicted results and the actual results, with many answers treating both of these as results gained by experiment.

A significant minority of students stated that the nuclear model was so called because it contains neutrons. Such statements may have been caused by students looking ahead at question 07.4 and incorrectly guessing that neutrons were discovered by conducting alpha particle scattering experiments.

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 pudding modelle  
is a Ball of positive charge with  
negative electrons but this modelle  
was replaste when it was  
discovered that the atom was  
<sup>mostly</sup> empty space and the  
electrons resided in shell  
orbiting the nucleus.

This 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 orbiting 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.

- 07.4** About 40% of students correctly identified the scientist who provided evidence for the existence of neutrons.

# 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](mailto:gcsescience@aqa.org.uk)

[aqa.org.uk](http://aqa.org.uk)