



GCSE

Combined Science: Trilogy

8464/P/2H Combined Science: Trilogy Physics Paper 2H

Report on the exam

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Contents

The below table is interactive. You can press the control button and click on the title of the question to go directly to that page.

Contents	Page
Overview	4
Summary of overall performance	4
Question 1	5
Question 2	7
Question 3	9
Question 4	11
Question 5	12
Question 6	13

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

The questions that were common with the Foundation tier proved to be the most accessible on the paper; they performed as expected with most parts of the questions discriminating well and giving a good spread of marks.

The extended response question in 01.1 was not answered well, although it tested knowledge that should be acquired by undertaking Required Practical Activity 20. The weak performance on this question is not necessarily indicative of students at this level.

In some cases AO1 questions that were just assessing knowledge were not well answered. Most students could not state what a transverse wave is (question 03.2).

Some descriptions lacked detail, students often writing vague answers that were not specific enough. In question 03.5 the weaker answers did not name the group of electromagnetic waves or the specific cancer linked to UV.

Students were given all the equations again this year, so the questions requiring them to recall an equation (01.2), or where the recall was embedded into the question, were well answered. Having the equations makes the calculation questions (02.2, 03.6, 04.2, 05.4, 06.1) more accessible too. However, the calculation in question 05.1 proved to be more demanding than expected.

The questions requiring explanations at the end of the paper were targeted at the higher levels of demand and they performed as expected with only the highest-attaining students able to write creditworthy answers.

Question 1 (standard demand)

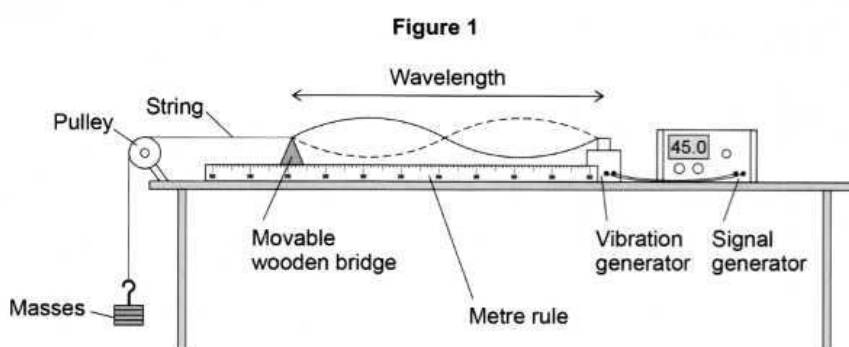
01.1 Even the Higher tier students found this question difficult with 10% gaining more than 2 marks. Although based on Required Practical Activity 20, for most students this appeared to be an unfamiliar experiment and they were unable to answer the question.

To access Level 2, the method needed to lead to a *valid* outcome: most students just described what was shown to them in Figure 11 and did not add anything of value. Most of the students that did score marks were able to describe changing the frequency with the signal generator or measuring the wavelength with a ruler.

0 1

A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 1 shows the equipment used.



The frequency of the signal generator is adjusted so that the wave shown in Figure 1 is seen.

At this frequency the string vibrates between the two positions shown in Figure 1.

0 1 . 1

Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

you would first set up by putting a metre ruler on the table place a signal generator and connect it to the vibration generator then connect a piece of string along the top of the vibration generator attaching it to the pulley holding masses to keep it ~~at~~ ^{stretched} then move the movable wooden bridge to increase/decrease string length and use the results at the signal generator to record the measurements.

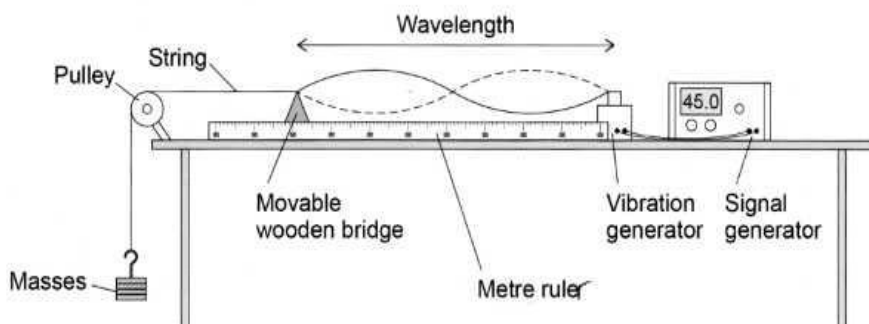
In this response the student has mostly just written a description of the equipment set-up in the diagram. There is nothing of relevance to a method here, so no marks are awarded.

06

A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 11 shows the equipment used.

Figure 11



The frequency of the signal generator is adjusted so that the wave shown in Figure 11 is seen.

At this frequency the string vibrates between the two positions shown in Figure 11.

06.1

Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

To investigate how the frequency of the wave-length affects the wave, the teacher ~~can~~ could adjust the frequency of the signal generator and measure the wavelength of the string with the metre ruler, recording the results. Repeating this a few times; everytime adjusting the frequency of the signal generator, the teacher can then look at the results and see if there is any correlation between the two (the frequency of the wave and the wavelength).

In this response from a Foundation tier paper the student has described how to change the independent variable and then how to measure the dependent variable. This answer does not quite get into Level 2 as it is not clear that this is repeated at different frequencies and it would not lead to a valid outcome. However, 2 marks are awarded.

- 01.2** This question was well answered with nearly all students selecting the correct equation.
- 01.3** This calculation was very well answered with approximately 90% of students gaining full marks. Most students that correctly substituted into the equation were able to correctly rearrange and evaluate. Most students that did not score any marks substituted into an incorrectly rearranged equation.

Question 2 (standard demand)

- 02.1** This question was more demanding than expected, with 40% of students able to gain any marks, although half of these students scored 2 marks. Students find the idea of energy stores very confusing. As in previous series, the mark scheme allows students to be awarded marks for answering in terms of transfers or transformations: this is the only way students were able to score marks on this question.
- 02.2** Nearly 90% of students did the calculation correctly and gained 2 of the 4 marks. Most of the students that scored 3 marks got the unit correct but missed the conversion of centimetres to metres. Less than 50% of students gave the correct unit, some clearly under the impression that elastic potential energy has a different unit from energy.
- 02.3** A little under 50% of students were able to gain a mark for suggesting that the length of the spring should be measured before and after it is compressed. Of those that did, approximately half suggested subtracting the two measured values for the second mark.
- 02.4** Approximately 30% of students identified that the large masses meant that the experiment should be done on the laboratory floor rather than on the table for safety reasons. Most students gained no marks as they wrote that the table would not be level or that as it was higher that would affect the readings.
- 02.5** Just under 80% of students correctly used the values from the graph to determine the value for Δy . Most incorrect answers gave it as either 300 or 330.
- 02.6** About three-quarters of students correctly determined Δx . The most common incorrect answer was 0.52.

02.7 This question was reasonably well answered, with 75% of students gaining at least 1 mark. The error carried forward (ecf) meant that students could use their answers from questions 02.5 and 02.6 and many students were able to gain 2 marks for doing so even if their previous answers were wrong.

About 20% of students were able to do the calculation correctly but then couldn't give the answer to 2 significant figures. An answer of 595 was frequently seen.

The spring constant is the gradient of the line of best fit shown on **Figure 4**.

0 2 . 5 Determine the value Δy on **Figure 4**. [1 mark]

$330 - 80 = 250$

$\Delta y = 250$ N

0 2 . 6 Determine the value Δx on **Figure 4**. [1 mark]

$0.012 - 0.01 = 0.002$

$\Delta x = 0.002$ m

0 2 . 7 Determine the spring constant of the spring.
Use your answers to Question **02.5** and Question **02.6**.
Give your answer to 3 significant figures. [2 marks]

$\frac{250}{0.002} = 125000$

Spring constant (3 significant figures) = 125000 N/m

When ecf is allowed, students who give one value incorrectly can still gain subsequent marks in the next part of the question.

In this example the student gained the mark for question 02.5 but not for question 02.6. In their answer to question 02.7 they were awarded the first mark for dividing their answer to question 02.5 by their answer to question 02.6 and the second mark for giving the correct answer to this calculation to the correct number of significant figures.

Question 3 (standard, standard/high & high demand)

- 03.1** This question proved to be more demanding than expected, with just over 20% of students able to give a correct property of electromagnetic waves. Many students simply repeated the wording of the stem (that they can travel through a vacuum) even though they were asked of one *other* property. Some students attempted to describe a transverse wave.
- 03.2** Just over 20% of students were able to describe a transverse wave. Most demonstrated some understanding, but answers were often insufficient or too vague for the mark. When describing transverse waves, it must be clear that oscillations are perpendicular to the direction of energy transfer. Most answers were missing some part of the description.

03.2 What is meant by 'transverse wave'?

[1 mark]

Transverse wave is a wave where the particles in the wave move by going up and down.

03.2 What is meant by 'transverse wave'?

[1 mark]

waves which are perpendicular to the energy transfer

03.2 What is meant by 'transverse wave'?

[1 mark]

a wave which the oscillation is perpendicular towards the direction of the energy transferred.

The first two examples here are not sufficient to gain the marks. In the first, the student demonstrates some understanding but the language is very vague and there is no mention of energy transfer. The second response gives an *almost* complete description but there is no mention of oscillations/vibrations so the mark cannot be awarded.

The third response has all the required aspects of the description so the mark is awarded.

- 03.3** This AO1 question was well answered with 85% of students giving the correct response.

- 03.4** Just over 25% of students gave the correct colour for the shortest wavelength of visible light. Most of those that gained the mark did write violet but some stated purple, which was allowed. The most common incorrect answer was red, but a wide range of colours was given, including black and white.
- 03.5** Nearly 75% of students gained at least 1 mark for giving a risk, although less than 20% of students listed the three groups and correctly linked each to a specific risk such as UV causes skin cancer. Most of the 1-mark answers gained the compensation mark for stating that high-frequency electromagnetic waves cause cancer.
- 03.6** This question required students to manipulate numbers in standard form and 60% of students gained all 3 marks. The equation is relatively simple as it contains only two variables. However, this seemed to throw some students, who substituted correctly but then rearranged incorrectly and multiplied the period by one, so gave their final answer as the same number as the period. Approximately 10% of students inputted the power of ten incorrectly into their calculators; these students were, however, still able to score 2 marks.

The electromagnetic waves emitted by the mobile phone send information to the laptop.

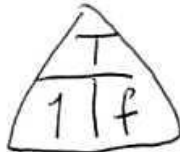
03.6 The electromagnetic waves emitted by the mobile phone have a period of 4.0×10^{-10} s.

Calculate the frequency of the waves.

Use the Physics Equations Sheet.

Give your answer in standard form.

[3 marks]



$$T = \frac{1}{f} \quad 4.0 \times 10^{-10} = \frac{1}{f}$$

$$\frac{4.0 \times 10^{-10}}{1} = 4 \times 10^{-10}$$

Frequency (in standard form) = 4×10^{-10} Hz

The student has rearranged the equation incorrectly and divided by 1, giving the same number as the period as their answer. However, because they have clearly shown that they have correctly substituted into a correct equation they can be awarded the first mark. To be awarded the substitution mark this work *must* be seen.

The electromagnetic waves emitted by the mobile phone send information to the laptop.

0 3 . 6

The electromagnetic waves emitted by the mobile phone have a period of 4.0×10^{-10} s.

Calculate the frequency of the waves.

Use the Physics Equations Sheet.

Give your answer in standard form.

[3 marks]

Period = $\frac{1}{\text{frequency}}$ 

Frequency (in standard form) = 4×10^{-10} Hz

This example demonstrates the importance of showing working. The student's answer (like that in the previous example) is the same as the period of the wave. However, this student is not awarded the first mark because the substitution is not seen and it is therefore not clear that they have actually done anything with the calculation.

- 03.7** The concepts being assessed in this high-demand question are very abstract and complex. Some students had obviously learnt this and wrote excellent explanations. 10% of students scored more than 1 mark.

Question 4 (standard & standard/high demand)

- 04.1** A third of students were able to use Fleming's left-hand rule and give the correct direction.
- 04.2** The majority of students were able to access this calculation, with 80% gaining at least 2 marks and 13% full marks. 25% of students either did not know the unit or missed the conversion, so were limited to gaining 2 of the 3 marks available.
- 04.3** About two-thirds of students knew that the forces were an example of Newton's Third Law. The most common incorrect answer was Newton's First Law.
- 04.4** About a third of students gave two correct changes and a third of students one correct change. The most popular correct answer was to increase the current. Students should be encouraged to state that the number of turns *on the coil* should be increased, as 'increasing the number of coils' is ambiguous and would not gain the mark.

- 04.5** This question was more demanding than question 04.4 with less than 50% of students gaining a mark. 10% of students were able to give two changes that would reverse the direction of the force.

0 4 . 5

Give **two** changes to the electromagnet that would reverse the direction of the force exerted on the permanent magnet.

[2 marks]

1 Reversing the current.

2 Flipping the power supply.

This example shows the most popular correct response, which was to reverse the direction of the current. The second answer would have gained the mark on its own because it will result in the current's direction reversing. However, both answers are the same marking point so only 1 mark is awarded.

Question 5 (standard/high & high demand)

- 05.1** This calculation was the most demanding on the paper, with 80% of students not gaining any marks. Most students used an incorrect equation and substituted the value of acceleration as the displacement. Of the approximately 20% of students that did use the correct equation, the vast majority gained full marks.
- 05.2** This question was not well answered, with less than 10% of students gaining the mark. It is common for students when answering questions on this topic to not make the distinction that reaction time is a time and thinking distance is a distance.
- 05.3** Approximately 33% of students identified the correct relationship between speed and braking distance. Inversely proportional was a more popular response.
- 05.4** Nearly 50% of students were able to calculate the mass of the car and achieve the first 3 marks. Of the 20% of students that did not gain any further marks, most did not use the graph to determine the speed from the given braking distance, despite being instructed to use it in the question, and so could not go on to calculate the momentum.

Question 6 (standard/high & high demand)

- 06.1** Nearly 60% of students gained at least 1 mark in this question, for substituting into a correct equation or converting the distance from kilometres to metres. About 15% of students were awarded 3 marks for using the equation correctly but not converting the distance, and 20% gained full marks.

0 6 . 1 The rocket was initially stationary on the ground.
 Then the rocket accelerated upwards until it reached a height of 40 km.
 The constant acceleration of the rocket was 6.48 m/s².
 Calculate the velocity of the rocket at a height of 40 km.
 Use the Physics Equations Sheet. [4 marks]

D
↑

6.48 6.48 = $\frac{x-0}{6.2}$

40 ÷ 6.48 = 6.2 (Ans)

~~Ans~~ 6.48 = $\frac{40}{6.2}$

$(v)^2 - 0^2 = 2 \times 6.48 \times 40$ $\sqrt{518.4}$

$-0 = 518.4$ = 22.8

Velocity = 22.8 m/s

This example shows a student that has not converted the distance from kilometres to metres so does not gain marking point 1 but has carried out the rest of the calculation correctly to gain 3 marks. There is some rough working at the top, but this is ignored and the working that supports the final answer is marked.

- 06.2** Nearly 40% of students were able to gain 1 or more marks on this question, 20% gained 2 marks and 5% all 3 marks. Most of the students that did get a mark correctly stated that the gravitational field strength decreased. Most students who understood that weight depends on mass and gravitational field strength gained full marks. Some students incorrectly stated that the rocket would have no weight.
- 06.3** Of the 25% of students that gained marks for this question most received 1 mark for either describing the lack of a forward force or stating that air resistance or gravity acts. There were many misconceptions demonstrated about momentum and acceleration.

- 06.4** This was the most demanding question on the paper, with 75% not being able to give a creditworthy response and less than 1% able to achieve more than 1 mark. There was one more accessible mark (marking point 1: increase of surface area), and 25% of students gained this. Much imprecise language was also seen in this question: when students are asked to compare two things they should make their answer comparative and use for example 'larger' not just 'large'.

Contact us

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