Questions matter

GCSE

Combined Science: Trilogy

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

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 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

On the whole, 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 some standard demand calculation questions. However, it may be that in some calculations, the equation sheet caused students more of a problem. For example, on question **06.3** students needed to calculate resultant force by subtracting the total backwards force from the total forward force, but many looked for an equation and attempted to use the equation resultant force = mass × acceleration instead. And in question **07.1** It seemed that a lot of students were confused by the term deceleration, and even though they may have selected the correct equation to use, they attempted to calculate an acceleration using incorrect physics and insert this into the equation needed, which tended to lead to them gaining no marks on that question.

In explanations, some students were able to use appropriate physics terminology, but it was also common to see students using everyday expressions rather than using appropriate physics language. For example, when attempting the levels of response question, **07.2**, most students were able to write a reasonable amount, but they were often unable to use relevant physics terms. Thinking distance and braking distance were given in the question, many students wrote answers about how much time it takes to brake, rather than the distance travelled.

Question 1 (Low demand)

01.1 About four in five students were able to identify the anomalous result.

01.2 Slightly more than half of students identified that air resistance acts upwards on a body falling vertically downwards.

01.3 Nearly three quarters knew that friction is a contact force.

01.4 Just under two thirds of students correctly identified that air resistance increases with speed.

0 1 . 4 What happened to the size of the air resistance force as the speed of the person increased?

[1 mark]

Increased

0 1 . 4 What happened to the size of the air resistance force as the speed of the person increased?

[1 mark]

the air resistance becomes glater if The Persons Size got bigger.

An indication that the air resistance increased was enough to gain the mark, as in the first example above.

However, in stating that the air resistance increases *if the person's size increases*, the second student contradicted the condition being asked about in the question of increasing speed and so was not awarded the mark.

01.5 This calculation was well answered, with nearly 90% of students gaining both marks. For those who did not answer correctly, the unit for acceleration was often the cause of difficulty. When some of these students read '60 m/s^2', they were clearly not sure what to do with the 'seconds squared', and decided to square the value of the acceleration, calculating $60^2 \times 0.35$ instead of 60×0.35

Some of these students did manage to gain the first mark for substituting into the equation and including the relevant units for all quantities, only making the error when they evaluated their calculation (i.e. '60 m/s^2 × 0.35 s = 12.6 m/s'). However, those who wrote '$60^2 \times 0.35 = 12.6$' did not gain any credit as their final answer did not match the calculation they had shown.

01.6 Another well answered calculation, with around 9 in 10 students gaining both marks. This question also caused issues for a minority of students who thought that 60 m/s^2 means that the acceleration value should be squared.

Question 2 (Low demand)

02.1 About half the students correctly identified the independent variable.

02.2 Only about 40% could identify a control variable.

02.3 Slightly more than 8 in 10 students recalled that a volume of water should be measured using a measuring cylinder.

02.4 This question was answered correctly by almost three quarters of students.
Of those who answered incorrectly, it was relatively common for students to divide a temperature by time, rather than dividing the change in temperature by time.

0 2 . 4 The student also tested water with no food colouring.

The temperature of the water changed from 80.0 °C to 65.0 °C in a time of 5.0 minutes.

Calculate the average rate of change of temperature of the water.

Use the equation:

$$\text{average rate of change of temperature} = \frac{\text{change in temperature}}{\text{time taken}}$$

[2 marks]

$\frac{80-65}{300} = 0.05$ $\quad 5\times 60 = 300$ seconds

Average rate of change of temperature = 0.05 °C/minute

This student did not recognise that the answer line needed an answer given in °C/minute and calculated a rate in °C/second. Students who did this could still be awarded one mark.

02.5 The vast majority of students gained at least one mark on this question, with the most common mark awarded being for the scale on the *y*-axis. The most common mark not scored by students was because they either did not attempt to label the *y*-axis, did not include units in their label, or labelled the *y*-axis incorrectly. A common incorrect label was to write '*y*-axis' instead of writing 'rate of change of temperature in °C/minute'.

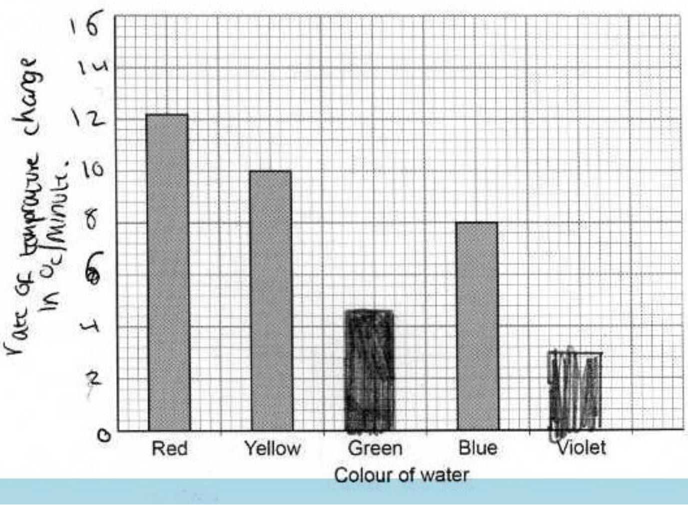
0 2 . 5 Complete **Figure 4**.

You should:

- label the *y*-axis
- add a scale to the *y*-axis
- draw bars for the green water and the violet water.

[3 marks]

Figure 4



This student added an incorrect scale. The height of the bars was marked independently from the scale the students chose – the heights needed to be consistent with the bars for Red, Yellow and Blue already drawn on the paper – so even if this student had drawn their two bars to be consistent with their incorrect scale, they would have not gained credit for this.

02.6 Just over half of students estimated a valid answer. A common incorrect approach was to determine the difference between the values for red and yellow, rather than to determine a value between these two values.

02.7 About 50% of students recognised that colour affects the rate of emission of infrared.

02.8 Slightly more than 60% identified that cooling occurred because the radiation transfers energy.

Question 3 (Low demand)

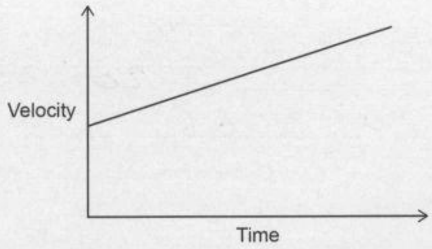
03.1 Almost two thirds of students were able to interpret the scale on the diagram and arrive at a correct answer.
Some students calculated the correct distance but then contradicted this by multiplying their answer by 20, which prevented them from scoring any marks.

03.2 The majority of students answered this calculation correctly. A small proportion of students decided that the unit for mass should be grams and ended up with an answer that was too large by a factor of a thousand, so were unable to gain one of the marks.

03.3 Only about 4 in 10 students were able to state that gradient was constant or that the line was straight, to gain the mark. Some students struggled to express the idea of a constant gradient, giving answers such as ‘the line is straight and moves at a constant speed’, or just giving a description of acceleration instead of referring to the graph.

0 3 . 3 **Figure 6** shows a velocity–time graph for a downhill part of the journey.

Figure 6



The gradient of the graph represents acceleration.

How does **Figure 6** show that the acceleration was constant?

[1 mark]

A straight line with a constant
velocity

A proportion of incorrect answers were contradictory, by stating that the straight line had a constant velocity or a constant speed.

03.4 About 90% of students correctly calculated the distance travelled.

03.5 Nearly two thirds of students were able to identify how distance compared with displacement for the cyclist.

03.6 Only about a third of students selected the correct reason for distance being a scalar quantity.

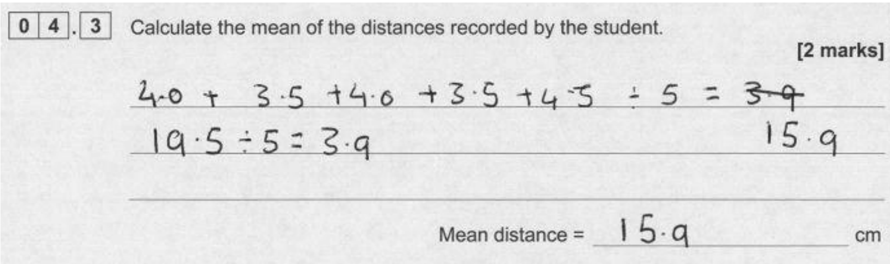
3.7 About three quarters of students correctly determined the total distance travelled by the cyclist. Incorrect answers were often caused by misinterpreting the scale on the graph and reading, for example, 53 km instead of 56 km for the distance travelled on the Monday.

Question 4 (Low and standard demand)

04.1 Just over half scored at least one mark for correctly identifying the poles, with around 40% being able to give a correct reason for their answer.
Many students had misconceptions about the poles of magnets, with common answers including east and west poles, or positive and negative poles.

04.2 About four in five students were able to correctly identify the range of the values given.

04.3 Slightly less than three quarters of the students correctly calculated the mean value. Some students just added up all the values. Others apparently did not read the question carefully, with some students building on their answer to the previous question by calculating the size of the range, or by determining the uncertainty in the mean value.



0 4 . 3 Calculate the mean of the distances recorded by the student.

[2 marks]

$4.0 + 3.5 + 4.0 + 3.5 + 4.5 \div 5 = \cancel{3.9}$

$19.5 \div 5 = 3.9$ 15.9

Mean distance = 15.9 cm

When calculating a mean, students would be well advised to use brackets appropriately, or to break the calculation down into an addition, and then a division.
This student incorrectly added the first four numbers to one-fifth of the final number, arriving at the incorrect answer, so gained no credit.
They also demonstrated that they could calculate the answer correctly, but by putting the answer of 15.9 on the answer line, they had chosen the incorrect line of working.

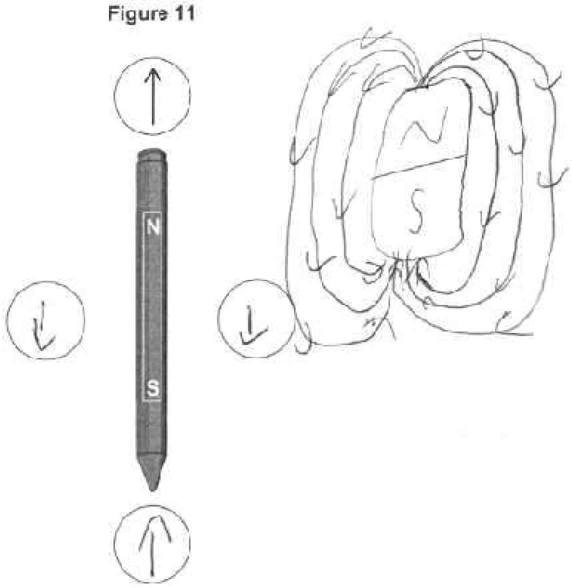
04.4 Approximately half the students recognised that repeating and calculating a mean reduces the effect of random errors.

04.5 Nearly two thirds recognised that increasing the distance between two magnets causes the magnetic forces between them to decrease.

04.6 Only about 40% knew that steel is magnetic.

04.7 This question proved to be difficult for the majority of students, with only about a fifth gaining any credit, and less than one in ten students gaining both marks. The most common answer by far was to have all of the arrows pointing away from the magnet in the pen.

Figure 11



This student draws a diagram of the field pattern that they had clearly learned. This helped them to add the arrows to the plotting compasses in the diagram and gain both marks. In physics questions, whether completing diagrams or writing descriptions or explanations, it can often help students to draw a quick sketch of a situation to help them gather their thoughts.

Question 5 (Low and standard demand)

05.1 About 40% of students recalled that microwaves are used to transfer data to satellites.

05.2 Slightly more than half the students remembered that gamma rays have the greatest frequency.

05.3 Just under half selected the definition for the period of a wave.

05.4 Nearly three quarters of students gained at least some credit, but a very small proportion of students were able to calculate the correct answer and give the correct unit. About a third of students scored 3 marks.
It was relatively common to see students writing incorrect calculations, such as ‘1/48 = 48’, and there was a surprising number who decided to give their answer to one significant figure to this question, which is rarely 6.

0 5 . 4 Data is transmitted to the satellites by electromagnetic waves with a frequency of 48 GHz.

Calculate the period of waves with a frequency of 48 GHz.

Use the Physics Equations Sheet.

Choose the unit from the box.

[4 marks]

J	**N/kg**	**s**

48 ÷ 1000 = 0.048

1 ÷ 0.048 = 20.8

Period = 20.8 Unit s

This student clearly identified that 48 GHz needed to be converted to Hz but was unsure how to go about this. They scored 2 marks for the calculation, and a further mark for selecting the correct unit.

05.5 Only a small minority of students gave a property that is the same for all electromagnetic waves. Many wrote about uses of the waves, rather than their properties, and it was relatively common to see answers that described the waves as something that can be used to transmit data, for example.

0 5 . 5 The satellites receive and transmit data using electromagnetic waves with different frequencies.

Give **one** property that is the same for electromagnetic waves with different frequencies.

[1 mark]

do not need mediums to travel through

This response was awarded the mark for the idea that electromagnetic waves can travel through a vacuum. Alternative wording to express correct physics is always acceptable, unless a mark scheme term is underlined.

05.6 Approximately a fifth of students gave an acceptable answer to this question. Many were confused about the difference between a connection to the internet and a connection to the national grid or to a power source, with many answers referring to solar power, and some referring to benefits to the environment of solar power.

0 5 . 6 Most homes are connected to the internet using cables.

Suggest **one** reason why homes in some areas of the UK are connected to the internet by satellites.

[1 mark]

satellites give off energy, each solar panel is charged by sun, therefore each ~~of~~ satellite gives electric energy

This response illustrates the incorrect link shown by many students between a connection to an electrical energy supply and a connection to the internet.

Question 6 (Standard demand)

06.1 Approximately 90% of students were either able to recall the equation linking distance, speed and time, or used the Physics Equations Sheet to look it up.

06.2 Nearly two thirds were able to correctly rearrange the equation selected and arrive at the correct answer. This was perhaps aided by some students recalling the equation as 'speed = distance / time' and arriving at the correct answer using this memorised form of the equation rather than by re-arranging the equation they selected in the previous question.

0 6 . 2 The longest dog-sled race in the world covers a distance of 1 500 000 m.

One team finished the race in a time of 670 000 s.

Calculate the average speed of this team during the race.

[3 marks]

1,500,000 × 670 000 = 1.005 × 10^12

1,005,000,000,000

Average speed = 1 005 000 000 000 m/s

This student has arrived at a speed that should seem unlikely. In some calculations, students struggle to have an idea of what a reasonable answer should be. However, when calculating a speed, even of a relatively unfamiliar object such as a team of husky dogs, most students would probably have an idea that to move this far in one second would be faster than an animal can manage. Teaching students to consider whether an answer seems reasonable could help them decide when it might be worth going back to check their calculations for errors.

06.3 About a third of students scored at least one mark on this question. The instruction to calculate a resultant force had many of them using the equation sheet. However, this question required students to consider the difference between the total forward force from the dogs, and the backwards force caused by friction. Students who attempted this, but only included the force from one dog, could score a mark if they showed their working.

0 6 . 3 At the start of the race, 6 dogs pulled on the rope.

The average forward force on the sled from **each** dog was 370 N.

The backwards force on the sled from friction was 520 N.

Calculate the resultant force on the sled.

[2 marks]

Resultant force = mass × acceleration

520 N+ 370 N × 6

= 5,340

Resultant force = 5340 N

An example of a student reading 'calculate the resultant force' and using the equation sheet. This approach was seen in a large number of responses.

06.4 Only about 10% of students were able to recall that the gradient of a distance-time graph represents speed. Many responses gave descriptions of the distance increasing with time, or the steepness of the line. A description of the trend shown in the graph is not the same as what the gradient represents, so these answers did not gain any credit. Other common incorrect answers included suggestions that the gradient shows the average speed of the sled.

06.5 Just over half of students correctly identified that at a constant speed the resultant force would be zero, so the total forward force must equal the total backwards force on the sled.

06.6 About a quarter of students were able to correctly select the Newton's third law pair to the force of the rope on the sled.

Question 7 (Standard demand)

07.1 This calculation proved to be challenging for many students, with less than 10% gaining any credit. There may be some reasons for this. With the expanded equation sheet that has been used for the last few years, it is perhaps harder to find the correct equation, particularly when there is more than one equation dealing with acceleration. There also seemed to be a lack of understanding from some students that deceleration and acceleration are effectively referring to the same quantity. This led to many students not selecting the equation $v^2 - u^2 = 2as$ to calculate a deceleration but thinking that they needed to calculate an acceleration using $a = \frac{\Delta v}{t}$ before substituting into that equation.
For students who selected the correct equation, some forgot to square the value for the initial speed.

0 7 . 1 The driver applies the brakes when the car is 24 m away from the roadworks.

The velocity of the car changes from 18 m/s to 0 m/s.

Calculate the constant deceleration needed to stop the car in a distance of 24 m.

Use the Physics Equations Sheet.

[3 marks]

$a = \frac{\Delta V}{t}$

$a = \frac{18}{24}$

$= \underline{\underline{0.75}}$

Deceleration = 0.75 m/s^2

An example of a student selecting the wrong equation from the equation sheet and substituting incorrect values into it. Answers such as this were seen relatively often.

07.2 For these levels of response question, the majority of students were able to write a reasonable amount in their attempts to give an answer, but only about half managed to gain any credit, and few of these were able to give Level 2 responses.
Many students showed confusion with their language, often referring to braking time rather than braking distance, or giving statements which were contradictory such as ‘slow down faster’ or ‘thinking distance affects braking distance’ or ‘quicker thinking distance’. Some students reverse-engineered their argument, giving answers such as if cars are slower, there will be more cars on the road so there will be more collisions.
Some students listed all the factors that can affect thinking distance or braking distance. This did not prevent them from gaining credit, but these students often did little more than this.

It was also common for answers to suggest that moving at a slower speed causes reaction time to increase, so thinking distance decreases. There was a relatively common misconception that the thinking distance is the maximum distance a vehicle has before the brakes must be applied in order to stop before a collision, rather than referring to the distance travelled as a driver reacts in an emergency.

0 7 . 2 As a safety measure, the speed limit on the road was reduced.

Explain how the safety of road users is affected by:

- the condition of the brakes and tyres
- reduced speed.

You should refer to thinking distance and braking distance.

[6 marks]

Firstly, the safety of road uses is affected by the condition of the brakes and tyres. If they are in bad condition and do not work very ~~un~~ well, braking distance increases. This means that vehicles may not be able to stop quickly enough to avoid accidents. ~~R~~ This decreases the safety of road users. However, reduced speed on vehicles shortens the braking distance (as less force is needed to stop the vehicles) and so more accidents can be avoided. It also helps to reduce the effects of thinking distance,

Extra space as this can make the driver stop the vehicle too late to avoid accidents. Therefore, reduced speed increases the safety of road users.

This student referred to braking distance and refers to both the condition of the brakes and tyres, and the speed of the vehicle. It is a good attempt to answer the question and scored 4 marks.

0 7 . 2 As a safety measure, the speed limit on the road was reduced.

Explain how the safety of road users is affected by:

- the condition of the brakes and tyres
- reduced speed.

You should refer to thinking distance and braking distance.

[6 marks]

The conditions of the brakes and
Tyres, needs to be good. ~~to~~ because
if your brakes don't work properly,
it'll take longer to stop the car, this
could be affected by if the person
driving is drunk. they aren't thinking
properly and endanger other people. If the
Tyres aren't fit, if they are driving on
icy, wet conditions, it'll take longer
for the car to stop. With the
reduced speed, it means that cars
aren't driving on the road as fast.
Extra space Which means it endangers
less people, as a result, making
it ~~safe~~ ~~safer~~ safe to drive on the road

This student did not refer to braking distance, instead referring to time with the phrase 'taking longer to stop the car'. The answer also demonstrates a relatively common approach to give factors (driving while drunk, in this case) that affect thinking distance but not answering the question. The response gained no credit.

07.3 About a third were able to score some credit on this question. Many had the idea of braking causing heating, but this was given in the question, so students needed to give more detail. The answer needed to be comparative, with a faster car having greater kinetic energy, or needing more friction. Only a small proportion referred to the increased risk at a greater speed, with students far more likely to just state that braking from a greater speed will cause the brakes to overheat, which was not enough to gain the third marking point.

Contact us

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

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