AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.3.2

Reaction time

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**6**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

6.5.4.3.2 Reaction time

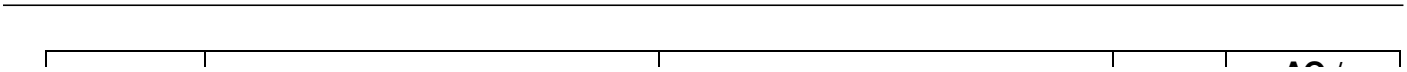
Answer 01 · Mark scheme June 2018 | 8464/P/2F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	thinking distance stays the same		1	AO1 6.5.4.3.3
	braking distance increases		1	
06.2	reaction time is increased by using a mobile phone		1	AO3 6.5.4.3.2
	hand-held mobile phones increase the thinking distance more than hands-free phone	allow thinking distance is increased by using a mobile phone	1	
	by 4 m more than the hands-free phone	allow **2** marks for a hand-held mobile phone doubles the increase of the thinking distance	1	
	so overall stopping distance increases		1	
Total			**6**	

6.5.4.3.2 Reaction time

Answer 01 · Mark scheme

June 2018 | 8464/P/2F | Original Q6



6.5.4.3.2 Reaction time

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.1	(thinking distance) will double any correct pair of points from graph eg (200,6) and (400,12)	 allow graph shows direct proportionality (after 200 ms) allow **1** mark for thinking distance increases with supporting data.	1 1	AO3 6.5.4.3.2	E
04.2	(most) people cannot react any quicker than 200 ms		1	AO1 6.5.4.3.2	E
04.3	there is variation in the measurements	allow the data is not very precise allow lots of random error ignore references to accuracy / reliability / average	1	AO3 6.5.4.3.2	E
04.4	(258+265+302+248+327) / 5 280 (ms)	an answer of 280 gains **2** marks	1 1	AO2 6.5.4.3.2	E
04.5	8.4 (m)	allow 7.9 (m) to 8.9 (m) allow ecf from **04.4**	1	AO2 6.5.4.3.2	E
04.6	any **two** from: • (material of) road surface • condition of the tyres • speed of the car • wet / icy road surface • gradient of road • mass / weight of the car	 Ignore any reference to brakes	2	AO1 6.5.4.3.3	
04.7	work done = force × distance (along the line of action of the force)	allow W = F s allow any correct re-arrangement	1	AO1 6.5.2	

6.5.4.3.2 Reaction time

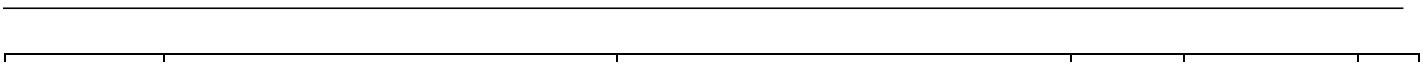
Answer 02 · Mark scheme

04.8	F = 6000 N	an answer of 450 000 scores 3 marks	1	AO2 6.5.2	
	W = 6000 × 75	allow a correct substitution using an incorrectly / not converted value of F	1		
	W = 450 000 (J)	allow a correct calculation using an incorrectly / not converted value of F	1		
Total			**13**		

6.5.4.3.2 Reaction time

Answer 02 · Mark scheme

June 2019 | 8464/P/2F | Original Q4



6.5.4.3.2 Reaction time

Answer 03 · Mark scheme

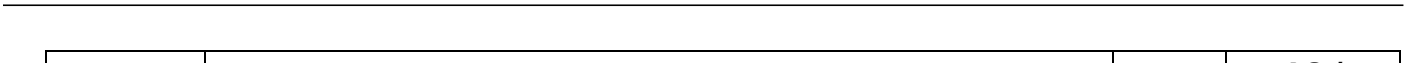
November 2021 | 8464/P/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	taking drugs tiredness		1 1	AO1 6.5.4.3.2
03.2	24 (years)		1	AO3 6.5.4.3.2
03.3	0.55 (s)	allow answer in range 0.54 to 0.56	1	AO3 6.5.4.3.2
03.4	decreases increases	this order only	1 1	AO1 6.5.4.3.4
03.5	braking distance = $\frac{(12)^2}{(2 \times 3)}$ braking distance = 24 unit = m		1 1 1	AO1 AO2 AO2 6.5.4.1.5
03.6	so they know how far behind another car they should drive **or** so they can stop safely if the car in front stops		1	AO3 6.5.4.3.3
Total			**10**	

6.5.4.3.2 Reaction time

Answer 03 · Mark scheme

November 2021 | 8464/P/2F | Original Q3



6.5.4.3.2 Reaction time

Answer 04 · Mark scheme

June 2022 | 8464/P/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	tiredness of the driver using a mobile phone		1 1	AO1 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	increases reaction time so increases the thinking distance so more likely to have a collision	 allow travels a greater distance before stopping (in an emergency)	1 1 1	AO1 AO1 AO3 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	23 m/s		1	AO2 6.5.4.3.2

6.5.4.3.2 Reaction time

Answer 04 · Mark scheme

June 2022 | 8464/P/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	directly proportional	allow **1** mark for as speed increases thinking distance increases	2	AO3 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	straight line from the origin with a greater gradient through (15,21)	 allow a line that passes within half a small square of (15,21) dependent on MP1	1 1	AO2 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	$v^2 - 0^2 = 2 \times 5.0 \times 45$ $v^2 = 450$ **or** $v = \sqrt{450}$ $v = 21.21320343$ $v = 21$ (m/s)	 allow a correctly rounded value of v calculated using the correct equation	1 1 1 1	AO2 6.5.4.1.5

Total Question 5		14

6.5.4.3.2 Reaction time

Answer 05 · Mark scheme

June 2024 | 8464/P/2F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	reaction time of the driver		1	AO1 6.5.4.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(initial) speed	allow section of road used ignore condition of road without further qualification	1	AO3 6.5.4.3.3

6.5.4.3.2 Reaction time

Answer 05 · Mark scheme

June 2024 | 8464/P/2F | Original Q5

Question	Answers	Mark	AO / Spec. Ref.
05.3	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.	5–6	AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3
	Level 1: Relevant points are made. They are not logically linked.	1–2	AO2
	No relevant content	0	
	Indicative content • tyre A braking distance is 30 m on dry road and 31 m on wet road • tyre A has the shortest braking distance on wet road • tyre B braking distance is 42 m on dry road and 43 m on wet road • tyre B has the longest braking distance on both wet and dry road • tyre C braking distance is 29 m on dry road and 40 m on wet road • tyre C has the shortest braking distance on dry road • the difference between braking distance on wet and dry roads for tyre A and tyre B is 1m • the difference between braking distance on wet and dry roads for tyre C is 11m **<u>Judgements</u>** • the shorter the braking distance the safer the tyre • tyre A is 1 m longer on dry road, but is 9 m shorter on wet road than tyre C • tyre A has the shortest combined / average braking distance • overall tyre A is the safest • tyre C is safest on a dry road • tyre B is the least safe tyre • the manufacturer should not choose tyre B allow use of stopping distance for braking distance throughout		6.5.4.3.3

6.5.4.3.2 Reaction time

Answer 05 · Mark scheme

June 2024 | 8464/P/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	work done = force × distance **or** $W = Fs$		1	AO1 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	300 000 = 6000 × s $s = \frac{300\,000}{6000}$ s = 50 (m)		1 1 1	AO2 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	the greater the force the shorter the braking distance (because) deceleration will be greater **or** (because) the work done to stop the car will be the same		1 1	AO2 6.5.4.3.4 6.5.4.2.2

Total Question 5	14

6.5.4.3.2 Reaction time

Answer 06 · Mark scheme

June 2025 | 8464/P/2F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$(0^2 -)\ 18^2 = 2 \times a \times 24$	allow $18^2 = 2 \times a \times 24$	1	AO2 6.5.4.1.5
	$a = \frac{(-)18^2}{2 \times 24}$		1	
	$a = (-)\ 6.75\ (m/s^2)$	allow $(-)\ 6.8\ (m/s^2)$	1	

6.5.4.3.2 Reaction time

Answer 06 · Mark scheme

June 2025 | 8464/P/2F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.2	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	6.5.4.2.2 6.5.4.3.1 6.5.4.3.3 6.5.4.3.4
	Indicative Content **Thinking distance** • condition of brakes and tyres does not affect thinking distance • speed does not affect reaction time • decreased speed decreases thinking distance **Braking distance** • condition of tyres affects friction between tyres and road • poor condition of tyres and brakes increases braking distance • decreased speed decreases braking distance **Safety** • stopping distance = thinking distance + braking distance • poor condition of brakes and tyres increases stopping distance • decreased speed decreases stopping distance • decreased speed decreases the chance of the driver losing control of the vehicle • decreased speed decreases the chance of a collision • decreased speed decreases the risk of injury during a collision for **Level 3,** answers must include references to brakes / tyres, speed, thinking distance, braking distance, and safety.		

6.5.4.3.2 Reaction time

Answer 06 · Mark scheme

June 2025 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	frictional / braking force is greater (for the faster car) **or** the faster car has more kinetic energy		1	AO1
	(so) more work done (by the brakes to stop the faster car)	allow so more energy is transferred (by the brakes to stop the faster car) ignore more heating	1	AO3
	(so) the risk of the brakes overheating is greater (for the fast car)	allow (at greater speed) there is a risk of overheating MP3 dependent on MP1 or MP2	1	AO3 6.5.4.3.4

Total Question 7	**12**

6.5.4.3.2 Reaction time

Answer 03 · Examiner comments — November 2021 | 8464/P/2F | Original Q3

Question 3 (Low demand)

03.1 This question was very well answered. Over 90% of students were able to identify one factor that affected the reaction time of the driver. Over 75% of students were able to identify both factors.

03.2 This question was also well answered. 80% of students were able to correctly read the age of 24 from the graph.

03.3 This question was not as well answered as the previous part. 50% of students were able to read the value of 0.55 for the lowest mean reaction time from the graph.

03.4 The vast majority of students scored at least 1 mark on this question. 90% were able to score 1 mark, and over 50% scored 2 marks. Of those that scored one mark, there was a mix of correct answers.

03.5 Over 40% of students scored full marks on this question - 2 marks for the calculation and 1 for the unit.

Many students were able to correctly substitute the values into the equation, but could not correctly evaluate the answer. If they correctly selected the unit, they were awarded 2 of the

Answer 03 · Examiner comments — November 2021 | 8464/P/2F | Original Q3

3 marks. This is a good example of why students should be encouraged to show their working, even for low demand calculations.

03.6 Less than 15% of students answered this correctly. Moss incorrect answers merely stated that the reason was to prevent accidents, without giving the reason why it would prevent an accident.

6.5.4.3.2 Reaction time

Answer 04 · Examiner comments

June 2022 | 8464/P/2F | Original Q5

Question 5 (Low and standard demand)

05.1 65% of students scored 2 marks, and 85% scored at least 1 mark, for identifying the factors affecting thinking distance.

05.2 50% of students were able to correctly state that there would be an increased risk of a collision. Very few were able to explain why. Approximately 10% identified that the reaction time would increase, but very few explained that this would increase the thinking distance.

05.3 60% of students were able to read the correct value from the graph. Of those that did not, most read from the wrong axis.

05.4 A minority of students described the relationship as directly proportional. Fewer than half of students were able to state that as speed increases thinking distance increases.

05.5 Fewer than 10% of students scored any marks for drawing the line on the graph. 30% of students did not attempt to answer the question.

05.6 20% of students scored some marks. This was a standard demand question due to the initial velocity being zero. Most students appeared to be confused by $v^2 = 450$ and either squared 450, or wrote 450 as their final answer.

6.5.4.3.2 Reaction time

Answer 05 · Examiner comments

June 2024 | 8464/P/2F | Original Q5

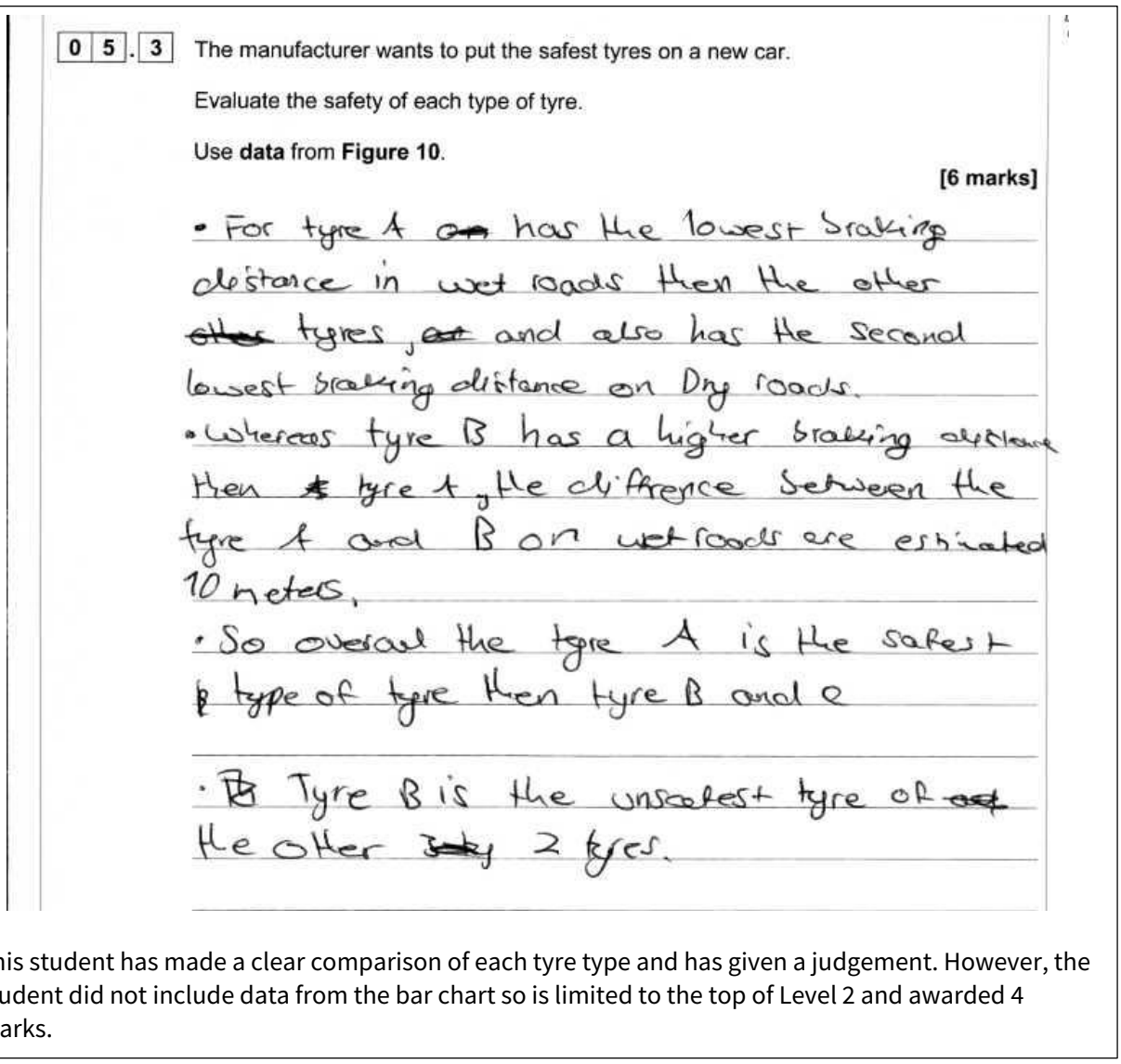
Question 5 (low & standard demand)

05.1 This question was well answered with the vast majority of students able to identify that the reaction time affects the thinking distance.

05.2 30% of students were able to correctly give a variable that should be kept the same. Many students wrote incorrect answers such as 'same driver'.

05.3 Most students attempted this extended response evaluation, with two-thirds gaining marks in Level 2 and a quarter reaching Level 3.

To access Level 3, students needed to give a judgement and support it with data from the bar chart. The majority of students that wrote Level 2 answers did not get into Level 3 because even though they clearly evaluated the data correctly, they did not include data in support of their arguments.



0 5 . 3 The manufacturer wants to put the safest tyres on a new car.

Evaluate the safety of each type of tyre.

Use **data** from **Figure 10**.

[6 marks]

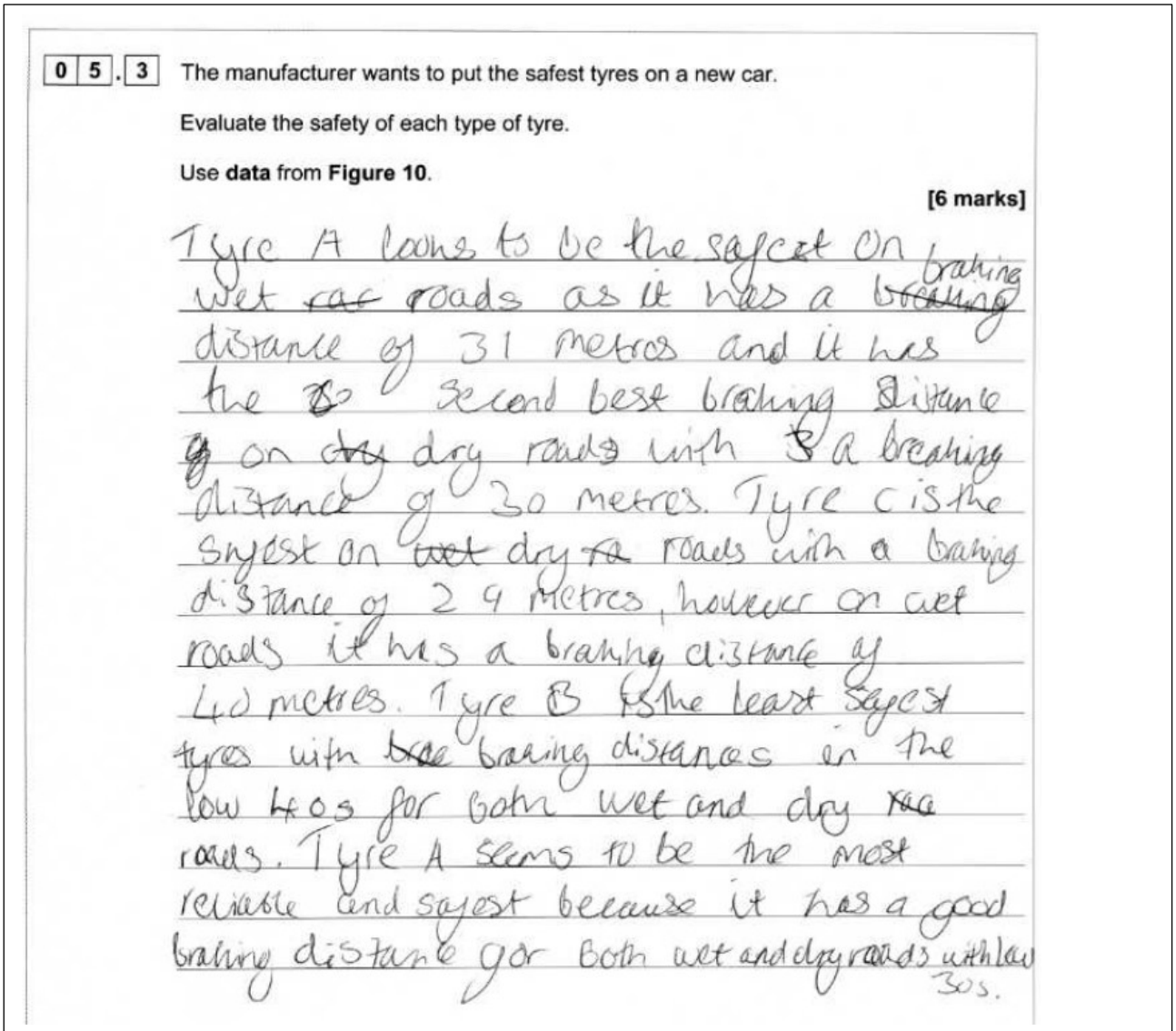
- For tyre A ~~on~~ has the lowest braking distance in wet roads then the other ~~other~~ tyres, ~~on~~ and also has the second lowest braking distance on Dry roads.
- Whereas tyre B has a higher braking distance then ~~the~~ tyre A, the difference between the tyre A and B on wet roads are estimated 10 meters.
- So overall the tyre A is the safest ~~type~~ type of tyre then tyre B and C
- ~~The~~ Tyre B is the unsafest tyre of ~~out~~ the other ~~tyres~~ 2 tyres.

This student has made a clear comparison of each tyre type and has given a judgement. However, the student did not include data from the bar chart so is limited to the top of Level 2 and awarded 4 marks.

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6.5.4.3.2 Reaction time

Answer 05 · Examiner comments June 2024 | 8464/P/2F | Original Q5



0 5 . 3 The manufacturer wants to put the safest tyres on a new car.

Evaluate the safety of each type of tyre.

Use **data** from **Figure 10**.

[6 marks]

Tyre A looks to be the safest on wet ~~car~~ roads as it has a ~~breaking~~ braking distance of 31 metres and it has the ~~B~~ second best braking distance ~~of~~ on ~~dry~~ dry roads with ~~B~~ a breaking distance of 30 metres. Tyre C is the safest on ~~wet~~ dry ~~ro~~ roads with a braking distance of 24 metres, however on wet roads it has a braking distance of 40 metres. Tyre B ~~is~~ the least safest tyres with ~~brae~~ braking distances in the low 40s for both wet and dry ~~race~~ roads. Tyre A seems to be the most reliable and safest because it has a good braking distance for both wet and dry roads with low 30s.

This student has made a clear comparison of each tyre type, using data from the bar chart. The student has included an overall judgement. This is a Level 3 response and was awarded 6 marks.

05.4 This question was well answered with 89% of students writing the correct equation.

05.5 To calculate the braking distance of the car, 70% of students were able to rearrange the equation correctly and score full marks.

05.6 This question proved extremely challenging, with 30% of students gaining a mark. and very few gaining both marks. Most students wrote vague responses about braking.

6.5.4.3.2 Reaction time

Answer 06 · Examiner comments

June 2025 | 8464/P/2F | Original Q7

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

Calculate the average speed of this team during the race. **[3 marks]**

1500,000 × 670 000 = 1.005 × 10^{12}

Average speed = 1005000000000 m/s

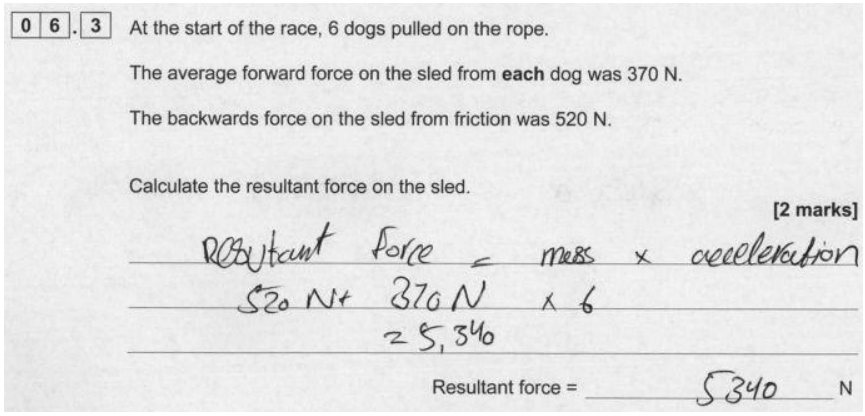
This student has arrived at a speed that should seem unlikely. In some calculations, students struggle to have an idea of what a reasonable answer should be. However, when calculating a speed, even of a relatively unfamiliar object such as a team of husky dogs, most students would probably have an idea 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.

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6.5.4.3.2 Reaction time

Answer 06 · Examiner comments June 2025 | 8464/P/2F | Original Q7

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.



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.

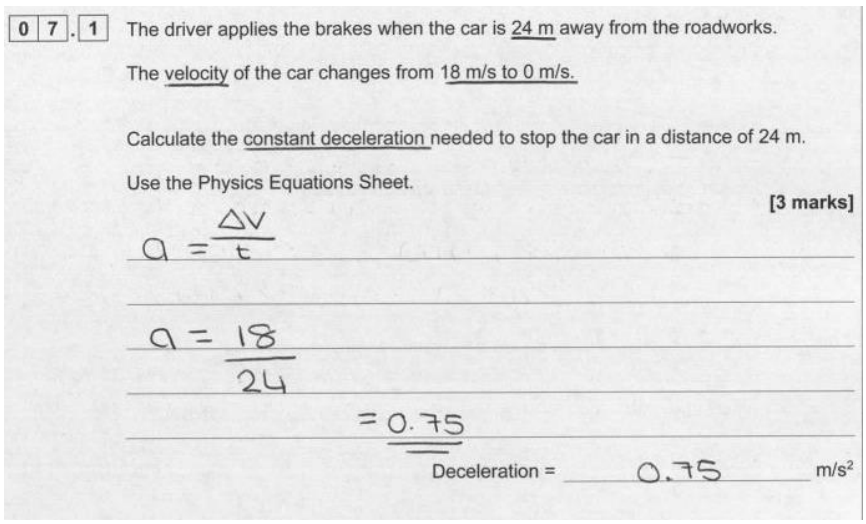
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6.5.4.3.2 Reaction time

Answer 06 · Examiner comments June 2025 | 8464/P/2F | Original Q7

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]

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

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

$= 0.75$

Deceleration = 0.75 m/s²

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.

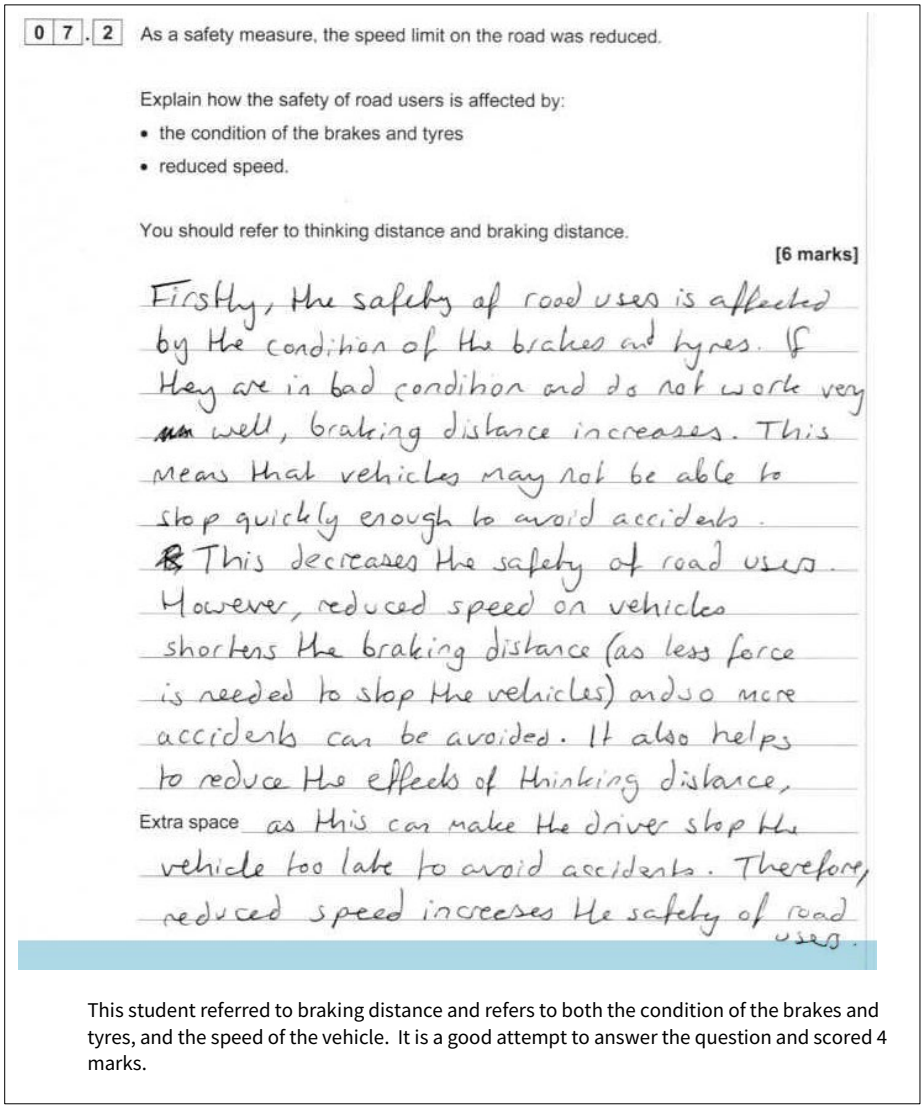
It was also common for answers to suggest that moving at a slower speed causes reaction time to increase, so thinking distance decreases. There was a relatively common misconception that the

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6.5.4.3.2 Reaction time

Answer 06 · Examiner comments June 2025 | 8464/P/2F | Original Q7

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 users is affected by the condition of the brakes and tyres. If they are in bad condition and do not work very well, braking distance increases. This means that vehicles may not be able to stop quickly enough to avoid accidents. 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, as this can make the driver stop the vehicle too late to avoid accidents. Therefore, reduced speed increases the safety of road users.

Extra space

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.

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6.5.4.3.2 Reaction time

Answer 06 · Examiner comments June 2025 | 8464/P/2F | Original Q7

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 will 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, will take longer for the car to stop. With the reduced speed, it means that cars aren't driving on the road as fast. Which means is endangers less people, as a result, making it ~~safer~~ safe to drive on the road

Extra space

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.

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6.5.4.3.2 Reaction time

Answer 06 · Examiner comments

Contact us

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

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