AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.2.2

Newton's Second Law

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**9**
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.

6.5.4.2.2 Newton's Second Law

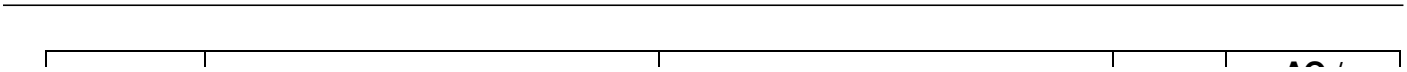
Answer 01 · Mark scheme June 2018 | 8464/P/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	equal to		1	AO1 6.5.4.2.3
03.2		an answer of 833 (N) **or** 830 (N) scores **2** marks		AO2 6.5.1.3
	weight = 85 × 9.8		1	
	weight = 833 (N)	allow weight = 830 (N)	1	
03.3		an answer that rounds to 525 (J) scores **2** marks		AO2 6.5.2
	work done = 833 × 0.63	allow their calculated value from question **03.2** × 0.63	1	
	work done = 525 (J)	allow an answer that is consistent with their calculated value from question **03.2**	1	
03.4	work done = 0 (J)		1	AO2 6.5.2
03.5		an answer of 682 (N) **or** 680 (N) scores **2** marks		AO2 6.5.4.2.2
	force = 62 × 11		1	
	force = 682 (N)	allow force = 680 (N)	1	
Total			**8**	

6.5.4.2.2 Newton's Second Law

Answer 01 · Mark scheme

June 2018 | 8464/P/2F | Original Q3



6.5.4.2.2 Newton's Second Law

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.1	its acceleration would decrease to zero the resultant force on it would decrease to zero		1 1	AO3 6.5.4.2.2
07.2	any **one** from: • move the second light gate closer to the first • shorten the string length	allow use a taller table	1	AO3 6.5.4.2.2
07.3		each mistake and its correction may be given in any order		AO3 6.5.4.2.2
	1.26667 (m/s^2) (is wrong)	allow (mean value calculated at) 0.20 (N)	1	
	give value to 2 significant figures	allow give value to 1 decimal place allow 1.3 (m/s^2)	1	
	6.7 (m/s^2) (is wrong)	allow (mean value calculated at) 0.98 (N) allow test 2 for 0.98 (N) or 7.2 is an anomaly	1	
	discard the anomalous result and recalculate the mean	allow repeat the anomalous test result and re-calculate the mean allow 6.4 (m/s^2)	1	
07.4	(resultant) force is directly proportional to acceleration	allow the larger the (resultant) force, the greater the acceleration allow positive correlation between (resultant) force and acceleration allow mass / weight (of the holder) for (resultant) force	1	AO3 6.5.4.2.2

6.5.4.2.2 Newton's Second Law

Answer 02 · Mark scheme

June 2018 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.5	all points correctly plotted within ½ small square curved line of best fit	allow **1** mark for 3 or 4 points correctly plotted	2 1	AO2 6.5.4.2.2
07.6	inversely proportional	allow as mass increases, acceleration decreases	1	AO3 6.5.4.2.2
Total			**12**	

6.5.4.2.2 Newton's Second Law

Answer 02 · Mark scheme

June 2018 | 8464/P/2F | Original Q7

			AO /

Answer 03 · Mark scheme

November 2020 | 8464/P/2F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	AO1
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content	0	6.5.4.2.2 RPA19
	Indicative content **<u>measurements</u>** • place one wooden block under the ramp • vary the height by placing a different number of wooden blocks • measure the height of the ramp using a metre rule • measure the distance travelled using a metre rule • measure time taken using light gates (and computer/datalogger) • measure time taken using a stopclock or ticker timer • release trolley from the same position each time • release the trolley without applying a force **<u>results</u>** • repeat at the same height and calculate a mean • repeat for different heights • calculate acceleration using a = (v-u)/t or a = $\frac{v^2 - u^2}{2s}$		

6.5.4.2.2 Newton's Second Law

Answer 03 · Mark scheme

November 2020 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	all points plotted correctly height of ramp in metres on x-axis **and** acceleration in m/s^2 on y-axis) correct line of best fit	allow **1** mark for 3 points plotted correctly both quantity and unit required for both axes	2 1 1	AO2 6.5.4.2.2 RPA19
07.3	resultant force = mass × acceleration or F =ma		1	AO1 6.5.4.2.2 RPA19
07.4	0.63 = m × 2.1 $m = \frac{0.63}{2.1}$ m = 0.30 (kg)	 allow 0.3 (kg)	1 1 1	AO2 6.5.4.2.2 RPA19
Total			**14**	

6.5.4.2.2 Newton's Second Law

Answer 04 · Mark scheme

November 2021 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	a quantity with both magnitude and direction		1	AO1 6.5.1.1
07.2	displacement		1	AO1 6.5.4.1.1
07.3	gradient = $\frac{(4-0)}{(1.6-0)}$ acceleration = 2.5 m/s^2	 allow use of a = Δv / t	1 1	AO2 6.5.4.1.5
07.4	constant deceleration	allow large deceleration allow decelerates to a stop	1	AO2 6.5.4.1.5
07.5	resultant force = mass × acceleration **or** F = ma	allow force = mass × acceleration	1	AO1 6.5.4.2.2
07.6	1800 = m × 25 m = $\frac{1800}{25}$ m = 72 (kg)		1 1 1	AO2 6.5.4.2.2
07.7	performance can be monitored during the game	allow do not have to wait until the end of the game to download data	1	AO3 6.6.2.4
Total			**10**	

6.5.4.2.2 Newton's Second Law

Answer 05 · Mark scheme

June 2022 | 8464/P/2F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	vertical arrow from **X** pointing downwards	ignore any labels	1	AO2 6.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	$W = 0.150 \times 9.8$ $W = 1.47$ (N)	 allow 1.5 (N)	1 1	AO2 6.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the resultant force on the apple is zero		1	AO1 6.5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	the resultant force on the apple is downwards		1	AO1 6.5.4.2.2

6.5.4.2.2 Newton's Second Law

Answer 05 · Mark scheme

June 2022 | 8464/P/2F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$t = \frac{4.9}{9.8}$ t = 0.5 (s)	 allow 0.50 (s)	1 1	AO2 6.5.4.1.2

Total Question 3		7

6.5.4.2.2 Newton's Second Law

Answer 06 · Mark scheme

June 2023 | 8464/P/2F | Original Q7

Question 7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 3:** The plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.5.4.2.2
	Level 2: The plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content **method of varying force** • clamp a pulley onto the edge of the desk • attach a string to the trolley and place the string over the pulley • attach a mass holder to the string **or** • vary the height of the runway • use wooden blocks **measurements** • place a slotted mass on the mass holder • use $W = mg$ to calculate the force • mark the starting and finishing points of the trolley on the runway • measure the distance between the two marks with a metre rule • time how long it takes to travel between the two marks with a stopclock / timer • use $v = \frac{s}{t}$ and $a = \frac{\Delta v}{t}$ **or** • use light gate(s) to determine time and / or speed • computer calculates acceleration • repeat for different numbers of slotted masses allow a description of a method using a ticker timer		

6.5.4.2.2 Newton's Second Law

Answer 06 · Mark scheme

June 2023 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	second law		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	$\frac{3.6}{1.2} = 3$ $1.6 \times 3 = 4.8$ (m/s^2) **OR** (use of $F = ma$) $m = \frac{1.2}{1.6} = 0.75$ (1) $a = \frac{3.6}{0.75} = 4.8$ (m/s^2) (1)		1 1	AO3 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	resultant force = mass × acceleration **or** $F = ma$		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	$0.42 = m \times 1.2$ $m = \frac{0.42}{1.2}$ $m = 0.35$ kg		1 1 1	AO2 6.5.4.2.2

Total Question 7	13

6.5.4.2.2 Newton's Second Law

Answer 07 · Mark scheme

June 2024 | 8464/P/2F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	X = south Y = north	allow S for south allow N for north allow **1** mark if they are the wrong way round	1 1	AO2 6.7.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	→		1	AO1 6.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	iron nickel		1 1	AO1 6.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	the force is always attractive		1	AO3 6.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	$F = 0.030 \times 9.8$ 0.294 (N)	 allow 0.29 (N)	1 1	AO1 6.5.4.2.2

Total Question 4	8

6.5.4.2.2 Newton's Second Law

Answer 08 · Mark scheme

June 2025 | 8464/P/2F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	1.3 s		1	AO3 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	A		1	AO2 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	friction		1	AO1 6.5.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	(air resistance) increased		1	AO1 6.5.1.2 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$\Delta v = 60 \times 0.35$ $\Delta v = 21$ (m/s)	 allow − 21 (m/s)	1 1	AO2 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	$F = 75 \times 60$ $F = 4500$ (N)	 allow − 4500 (N)	1 1	AO2 6.5.4.2.2

Total Question 1	8

6.5.4.2.2 Newton's Second Law

Answer 09 · Mark scheme

June 2025 | 8464/P/2F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	distance travelled = 3.0 × 20	both marks may be awarded if a length in the range 2.9 to 3.1 cm is used	1	AO3 6.5.4.1.1
	distance travelled = 60 (m)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	weight = 15 × 9.8		1	AO2 6.5.1.3
	weight = 147 (N)	allow weight = 150 (N)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the line has a constant gradient	allow the line is straight do **not** accept directly proportional	1	AO2 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	distance travelled = $\frac{4500}{250}$		1	AO2 6.5.2
	distance travelled = 18 (m)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	total distance travelled is greater than the displacement		1	AO1 6.5.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	distance has magnitude only		1	AO1 6.5.1.1 6.5.4.1.1

6.5.4.2.2 Newton's Second Law

Answer 09 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	total distance = 158 (km)	allow **1** mark for 56, 40 and 62 read from graph allow **1** mark for a total distance calculated using two correct values and one incorrect value from the bar chart	2	AO3 6.5.4.1.4

Total Question 3	**11**

6.5.4.2.2 Newton's Second Law

Answer 04 · Examiner comments

November 2021 | 8464/P/2F | Original Q7

Question 7 (standard demand)

07.1 75% of students knew that a vector was a quantity with both magnitude and direction.

07.2 30% of students knew that displacement was the vector.

07.3 Approximately 10% of students were able to determine the acceleration from the graph.

07.4 Nearly 20% of students were able to describe the motion of the player. Of those that were unable to and scored no marks, most gave answers such as ‘the motion decreased’.

07.5 Just under 50% of students correctly recalled the equation.

07.6 This standard demand calculation was reasonably well answered. Nearly 75% were able to substitute into the correctly rearranged equation, and the vast majority of those went on to correctly evaluate the answer and score full marks.

07.7 Nearly 20% of students wrote a reasonable suggestion that the data could be analysed during the game. Many of the incorrect answers suggested that the data could be analysed after the game.

6.5.4.2.2 Newton's Second Law

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

6.5.4.2.2 Newton's Second Law

Answer 05 · Examiner comments

June 2022 | 8464/P/2F | Original Q3

Question 3 (Low demand)

03.1 The vast majority of students were unaware that the arrow should be drawn from the centre of mass. The majority of students just labelled the apple 'weight'.

03.2 90% of students were able to correctly calculate the weight.

03.3 60% of students knew that the resultant force on the stationary apple was zero.

03.4 80% of students knew that the resultant force on the accelerating apple was downwards.

03.5 A little over 75% of students calculated the time correctly. A significant number of students substituted the numbers incorrectly and arrived at an answer of 2.

6.5.4.2.2 Newton's Second Law

Answer 06 · Examiner comments

June 2023 | 8464/P/2F | Original Q7

Question 7 (standard demand)

07.1 Students found describing the method for this investigation very challenging. This is a required practical, but fewer than 1% of students wrote a level 3 response that would lead to a valid outcome. The vast majority of students just suggested some measurements that could be taken, such as timing with a stopwatch or measuring the length of the runway with a ruler. Very few students suggested a valid way of varying the force and described taken measurements, so 50% of students wrote level one responses.

07.2 Approximately 50% of students knew that Newton's second law predicts that the acceleration of the trolley is proportional to the resultant force on the trolley.

07.3 A third of students calculated the correct acceleration. A variety of methods were seen, and any that used ratios and gave the correct answer were given credit. A third of students scored one mark for calculating the mass, but then not continuing with the calculation.

07.4 This question was well answered with nearly 90% of students getting the mark. Students were given the equation sheet, which will have contributed to the overall performance on this question.

07.5 This was a challenging calculation for foundation students, but nearly 60% of them scored full marks. Most students substituted into the correctly rearranged formula and then calculated correctly. Only a small percentage of students scored one or two marks.

6.5.4.2.2 Newton's Second Law

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

6.5.4.2.2 Newton's Second Law

Answer 07 · Examiner comments

June 2024 | 8464/P/2F | Original Q4

Question 4 (low demand)

04.1 About 70% of students knew that the poles of a permanent magnet are called North and South. However, most named them the wrong way round and so only received the 'allow' mark.

04.2 Only about a third of students were able to draw the arrow in the correct direction.

04.3 25% of students were able to select the two magnetic materials from the list. A number of students selected an incorrect number of responses despite being instructed to tick two boxes.

04.4 Just under 40% of students knew that the force between a magnet and a magnetic material is always attractive.

04.5 This calculation of resultant force on the tag was well answered, with just over 80% of students gaining 2 marks. Some students appeared to find the unit of acceleration (m/s^2) confusing and squared 9.8. There were also a large number of spurious conversions of mass into grams.

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6.5.4.2.2 Newton's Second Law

Answer 08 · Examiner comments June 2025 | 8464/P/2F | Original Q1

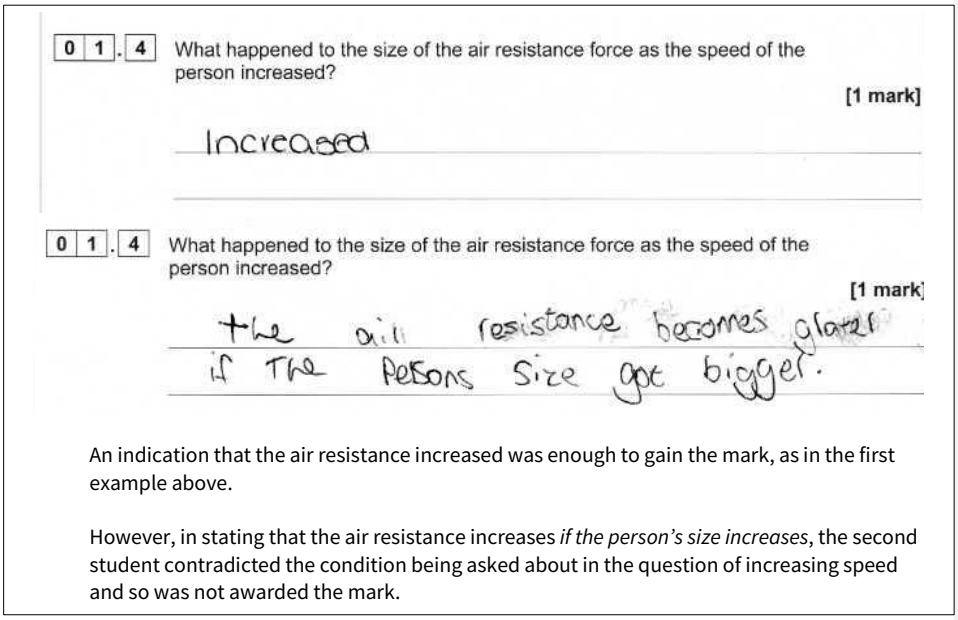
Question 1 (Low demand)

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 greater 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.

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6.5.4.2.2 Newton's Second Law

Answer 09 · Examiner comments June 2025 | 8464/P/2F | Original Q3

Question 3 (Low demand)

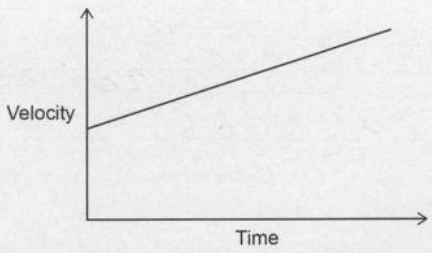
03.1 Almost two thirds of students were able to interpret the scale on the diagram and arrive at a correct answer.
Some students calculated the correct distance but then contradicted this by multiplying their answer by 20, which prevented them from scoring any marks.

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.

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6.5.4.2.2 Newton's Second Law

Answer 09 · Examiner comments

June 2025 | 8464/P/2F | Original Q3

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.