AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.2.2

Newton's Second Law

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**5**
Available paper years	**2018–2023**

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/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec Ref.
01.1	its acceleration would decrease to zero the resultant force on it would decrease to zero		1 1	AO3 6.5.4.2.2
01.2	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
01.3		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	
01.4	(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 01 · Mark scheme

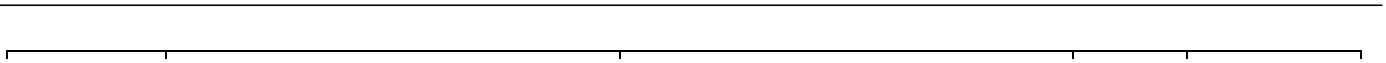
June 2018 | 8464/P/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec Ref.
01.5	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
01.6	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 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q1



6.5.4.2.2 Newton's Second Law

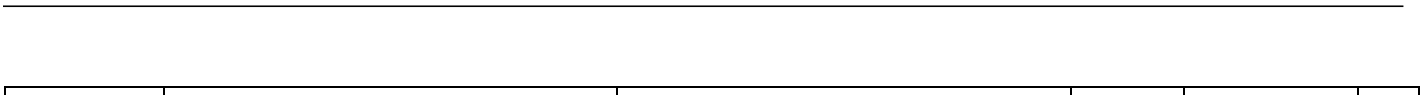
Answer 02 · Mark scheme June 2019 | 8464/P/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.1	thrust decreases	allow air resistance or drag increases ignore air resistance decreases as speed decreases	1	1xAO1 1xAO2 2xAO3 6.5.4.2.1	E
	so there is a resultant force in opposite direction	allow so air resistance or drag is greater than thrust	1		
	lift must decrease (because weight stays the same)		1		
	so there is a resultant downwards force	allow so weight is greater than lift the last two marking points cannot be awarded if there is a reference to the weight increasing	1		
06.2		an answer of 300 000 (kg) scores **5** marks		AO2 6.5.4.1.5 6.5.4.2.2	E
	$a = \frac{(10-80)}{28}$	allow $a = \frac{(80-10)}{28}$	1		
	$a = (–)2.5\ (m/s^2)$	a valid equation must have been used to calculate a to score subsequent marks	1		
	$(–)\ 750\ 000 = m \times (–)2.5$	allow a correct substitution using their calculated value of a	1		
	$m = \frac{(-)750\ 000}{(-)2.5}$	allow a correct rearrangement using their calculated value of a	1		
	m = 300 000 (kg)	allow a correct calculation using their calculated value of a	1		
Total			**9**		

6.5.4.2.2 Newton's Second Law

Answer 02 · Mark scheme

June 2019 | 8464/P/2H | Original Q6



6.5.4.2.2 Newton's Second Law

Answer 03 · Mark scheme

November 2020 | 8464/P/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**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

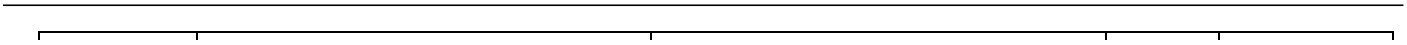
November 2020 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	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
02.3	resultant force = mass × acceleration or F = ma		1	AO1 6.5.4.2.2 RPA19
02.4	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 03 · Mark scheme

November 2020 | 8464/P/2H | Original Q2



6.5.4.2.2 Newton's Second Law

Answer 04 · Mark scheme

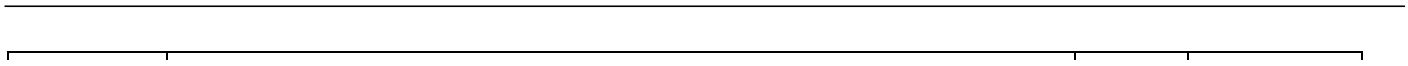
November 2021 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	a quantity with both magnitude and direction		1	AO1 6.5.1.1
02.2	displacement		1	AO1 6.5.4.1.1
02.3	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
02.4	constant deceleration	allow large deceleration allow decelerates to a stop	1	AO2 6.5.4.1.5
02.5	resultant force = mass × acceleration **or** F = ma	allow force = mass × acceleration	1	AO1 6.5.4.2.2
02.6	1800 = m × 25 m = $\frac{1800}{25}$ m = 72 (kg)		1 1 1	AO2 6.5.4.2.2
02.7	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 04 · Mark scheme

November 2021 | 8464/P/2H | Original Q2



6.5.4.2.2 Newton's Second Law

Answer 05 · Mark scheme

June 2023 | 8464/P/2H | Original Q2

Question 2

Question	Answers	Mark	AO / Spec. Ref.
02.1	**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		

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$\frac{3.6}{1.2} = 3$ $1.6 \times 3 = 4.8$ (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.
02.4	resultant force = mass × acceleration **or** $F = ma$		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	$0.42 = m \times 1.2$ $m = \frac{0.42}{1.2}$ $m = 0.35$ kg		1 1 1	AO2 6.5.4.2.2

Total Question 2	**13**

6.5.4.2.2 Newton's Second Law

Answer 01 · Examiner comments

June 2018 | 8464/P/2H | Original Q1

Question 1 (standard demand)

01.1 This was generally well answered with nearly 40% scoring both marks. The most common incorrect responses were that acceleration and the resultant force would increase.

01.2 Many students did not realise that it was distance that was important and a significant number spoke of needing to have less weight so that the glider moved more slowly. About 40% scored this mark. Correct responses of raising the table and shortening the string were given fairly equally.

01.3 Many students were not clear about how means were calculated and spoke of the mode being used instead at 0.59 N. There was widespread misunderstanding about accuracy with many stating that the more decimal places, the more accurate a result.

There were many references to recurring decimals. Those who scored in this question often did so by the 'decimal point' route rather than the 'significant figure' route.

Nearly 40% scored 2 marks, with a fairly even spread between those who identified one error and corrected it, or for identifying the 2 errors but not adequately describing how they would correct them.

01.4 This was well done with over 80% scoring the mark, but common errors were to refer to 'faster' or 'quicker' acceleration. A few made reference to the investigation not being a fair test.

01.5 46% scored all 3 marks. The quality of the plotting was generally good, but lines of best fit were often mistakenly given as straight lines, 50% gaining 2 marks. Where a curve was drawn these were generally of a credit worthy standard.

01.6 This was well done, with 73% gaining the mark, but a common error was to refer to “slower” acceleration. There were a number of answers which were insufficient, for example “negative correlation”.

6.5.4.2.2 Newton's Second Law

Answer 04 · Examiner comments November 2021 | 8464/P/2H | Original Q2

Question 2 (standard demand)

02.1 85% of students knew that a vector was a quantity with both magnitude and direction.

02.2 50% of students knew that displacement was the vector.

02.3 Approximately 40% of students were able to determine the acceleration from the graph.

02.4 Just over 35% of students were able to describe the motion of the player. Of those that were unable to and scored no marks, most wrote answers such as 'the motion decreased'.

02.5 Just under 80% of students correctly recalled the equation.

02.6 This standard demand calculation was very well answered. Over 85% 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.

02.7 Nearly 25% 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.

Answer 05 · Examiner comments June 2023 | 8464/P/2H | Original Q2

Question 2 (standard demand)

02.1 Students found describing the method for this investigation very challenging even on the higher tier paper. This is a required practical, but fewer than 10% of students wrote a level 3 response that would lead to a valid outcome. About 25% of students suggested a valid way of varying the force and described taking measurements, so wrote a level 2 response. Approximately 50% 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, so wrote a level 1 response.

02.2 Approximately 60% of students knew that Newton's second law predicts that the acceleration of the trolley is proportional to the resultant force on the trolley.

02.3 75% 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 small percentage of students scored one mark for calculating the mass, but did not then continue with the calculation.

02.4 Over 99% of students gained the mark. Students were given the equation sheet, which will have contributed to the overall performance on this question.

02.5 Just over 90% of students substituted into the correctly rearranged equation and then calculated correctly. Approximately 3% of students were able to substitute, but then did not rearrange the equation correctly.