AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.1.4

Resultant forces

Mark schemes and examiner comments

Tier	**Higher**
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.

6.5.1.4 Resultant forces

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

6.5.1.4 Resultant forces

Answer 01 · Mark scheme

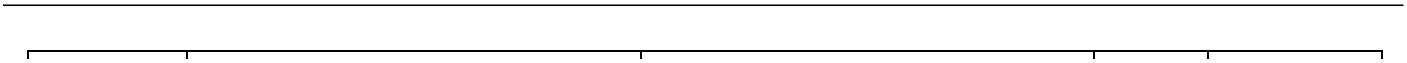
June 2018 | 8464/P/2H | Original Q1

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**	

6.5.1.4 Resultant forces

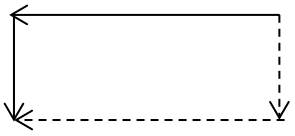
Answer 01 · Mark scheme

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



6.5.1.4 Resultant forces

Answer 02 · Mark scheme June 2018 | 8464/P/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	constant velocity	allow constant speed ignore references to stationary	1	AO1 6.5.4.2.1
07.2		allow drag for force B		AO1 6.5.4.2.1
	the man will accelerate		1	
	so force B increases		1	
	until force B equals force A	allow until resultant force is 0 (N)	1	
	the man moves at a higher constant velocity		1	
07.3	horizontal arrow pointing left (3000 N) and vertical arrow pointing down (1000 N) drawn to the same scale		1	AO2 6.5.1.4
	resultant force with a value in the range 3100 N–3200 N	allow and answer of 3000 N if a scale diagram has been drawn using the cm squares	1	
	direction in the range 251º–253º (clockwise from north)	allow 17º–19º (to the horizontal)	1	
07.4	the magnitude will increase	allow size	1	AO1 6.5.1.4
	direction will change towards the south	allow answers consistent with their response to question **07.3**	1	
Total			**10**	

6.5.1.4 Resultant forces

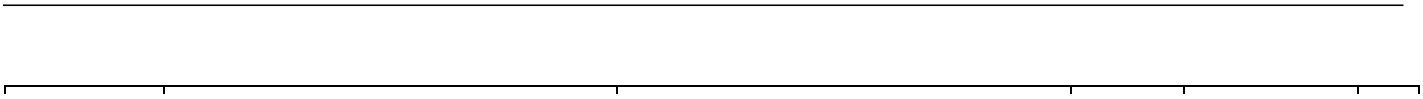
Answer 03 · Mark scheme June 2019 | 8464/P/2H | Original Q6

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**		

6.5.1.4 Resultant forces

Answer 03 · Mark scheme

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



6.5.1.4 Resultant forces

Answer 04 · 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 $a = \frac{v^2 - u^2}{2s}$		

6.5.1.4 Resultant forces

Answer 04 · Mark scheme

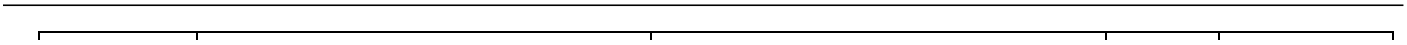
November 2020 | 8464/P/2H | Original Q2

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**	

6.5.1.4 Resultant forces

Answer 04 · Mark scheme

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



6.5.1.4 Resultant forces

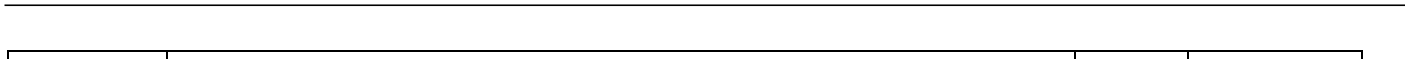
Answer 05 · Mark scheme November 2021 | 8464/P/2H | Original Q2

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**	

6.5.1.4 Resultant forces

Answer 05 · Mark scheme

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



6.5.1.4 Resultant forces

Answer 06 · Mark scheme

November 2021 | 8464/P/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec.
06.1	at maximum power the forward force of the engines is constant		1	AO3
	as it accelerates the air resistance increases		1	AO1
	resultant force = force from engines – air resistance		1	AO1
	therefore resultant force decreases		1	AO3
	acceleration is directly proportional to resultant force		1	AO1
				6.5.1.4 6.5.4.2.2 6.5.4.1.5

6.5.1.4 Resultant forces

Answer 06 · Mark scheme

November 2021 | 8464/P/2H | Original Q6

06.2	$\Delta v = (25.5 - 5.5) \times 330$	allow 6600 m/s	1	AO2 6.5.4.1.5 6.5.5.1
	$a = \frac{((25.5 \times 330) - (5.5 \times 330))}{300}$	allow a correct substitution using incorrectly / not converted values of u and v	1	
	$a = 22\ m/s^2$	allow a correct calculation using incorrectly / not converted values of u and v $a = \Delta v / t$ must have been used to score subsequent marks	1	
	$m = 630\ 000 / 22$	allow a correct substitution using an incorrectly calculated value of a	1	
	$m = 28636.36$ (kg)	allow a correct calculation using an incorrectly calculated value of a	1	
	$m = 29000$ (kg)	this mark can only be awarded for a calculation using the correct equations	1	
Total			**11**	

6.5.1.4 Resultant forces

Answer 07 · Mark scheme

June 2022 | 8464/P/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$21 = 30 \times t$ $t = \frac{21}{30}$ $t = 0.7$ (s)	allow use of any correct pair of values from the graph allow 0.70 (s)	1 1 1	AO2 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	one square represents 5 (m) number of squares = 9 braking distance = 9 × 5 = 45 (m)	 allow number of squares in the range 8.5 to 10 allow an answer in the range 42.5 (m) to 50 (m)	1 1 1	AO2 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gradient is equal to acceleration gradient / acceleration is not constant so resultant force is not constant because resultant force is directly proportional to acceleration (for constant mass)	 allow resultant force is not constant because F = ma	1 1 1	AO1 AO3 AO3 6.5.4.2.2

Total Question 6		9

6.5.1.4 Resultant forces

Answer 08 · 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		

Answer 08 · Mark scheme

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**

6.5.1.4 Resultant forces

Answer 09 · Mark scheme

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

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	distance travelled = speed × time		1	AO1 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	1 500 000 = v × 670 000 $v = \frac{1\ 500\ 000}{670\ 000}$ V = 2.2… (m/s)		1 1 1	AO2 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	F = (6 × 370) - 520 F = 1700 (N)	if no other mark awarded allow **1** mark for 370 - 520 = (-)150 (N)	1 1	AO2 6.5.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	speed	allow velocity	1	AO1 6.5.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	friction + air resistance = pull of the rope on the sled		1	AO1 6.5.1.4 6.5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	the force of the sled on the rope		1	AO1 6.5.4.2.3

Total Question 1	9

6.5.1.4 Resultant forces

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”.

Answer 02 · Examiner comments

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

Question 7 (standard / high & high demand)

07.1 Only 27% gained this mark, with many referring to the swimmer being pulled down by gravity and/or sinking. A large number referred to the swimmer being stationary, although this was permissible providing a constant speed was also given as an option.

07.2 Over 75% were able to score on this question although very few gained more than two marks as they did not give sufficient detail.

Answers scoring three of the four marks often did not say that the final constant speed was higher than the initial speed.

07.3 This appeared to be an accessible question for those who had drawn vector diagrams, with one mark being allocated for the very basic scale diagram. However, nearly 10% did not attempt this question.

There were a number of responses where students had used calculation rather than a diagram to determine the resultant and this was given some credit. Many incorrect responses simply stated the difference in the two forces, suggesting that students were familiar with forces acting in a straight line.

07.4 Over 50% scored on this question, usually noting that the force increased, although the error in question **07.3** reappeared as some students used the same method, incorrectly stating that the resultant force was smaller as the difference between the two components was now smaller.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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

6.5.1.4 Resultant forces

Answer 05 · 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.

6.5.1.4 Resultant forces

Answer 06 · Examiner comments

November 2021 | 8464/P/2H | Original Q6

Question 6 (high demand)

06.1 Very few answers to this question were well structured or contained anything creditworthy. Many did not contain any scientific terminology, and most that did used it incorrectly. There were lots of incidences of students describing acceleration as being equal to air resistance, or stating that because speed is increasing acceleration can't be constant.

06.2 Nearly 30% of students scored some marks on this question. 10% were able to convert the change in velocity to m/s and score 1 mark. Only 10% of students scored 5 or 6 marks. The answer line now reminds students to give their answer to 2 significant figures, however, some students still did not do this.

6.5.1.4 Resultant forces

Mark Ranges and Award of Grades

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

6.5.1.4 Resultant forces

Answer 07 · Examiner comments

June 2022 | 8464/P/2H | Original Q6

Question 6 (Standard/high and high demand)

06.1 As students were provided with the equations, this question proved to be more straight-forward than originally expected. Students had to interpret the graph to determine the reaction time. As they were given the equation over 70% were able to read two values off the graph, and correctly determine the reaction time. Nearly all students that did read two correct values scored full marks. Those that did not usually rearranged the equation incorrectly.

06.2 Only a small percentage of students appreciated that they had to determine the area under the graph. Of those that did, only about 1% failed to go on and score all the marks. About 6% of students scored on this question. Most incorrect answers gave two values from the graph and multiplied them together.

06.3 This was a high demand question, and approximately 30% of students gained some marks. Nearly all answers that did not gain any marks did not mention the gradient at all. Only about 3% of students went on to say that the gradient represents the acceleration, and very few stated that acceleration was proportional to force or that force is equal to mass times acceleration.

6.5.1.4 Resultant forces

Answer 08 · 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.

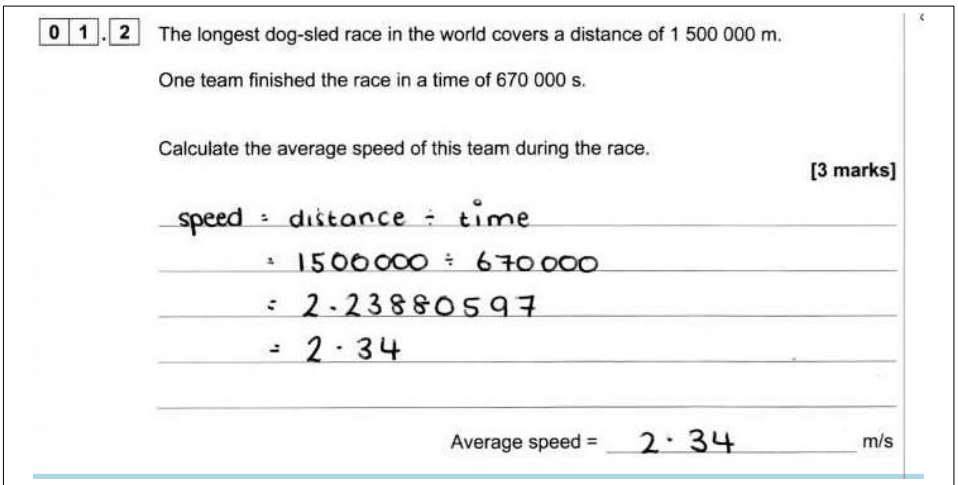
6.5.1.4 Resultant forces

Answer 09 · Examiner comments June 2025 | 8464/P/2H | Original Q1

Question 1 (Standard demand)

01.1 Almost all students selected the correct equation.

01.2 Almost all students were able to calculate the answer using the relevant equation. Of those who did not, it was surprisingly common to see answers where the student had attempted to round their answer to two significant figures and decided that 2.23 should be rounded to 2.3. This led to an incorrect final answer.



0 1 . 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]

speed = distance ÷ time
= 1500000 ÷ 670000
= 2.23880597
= 2.34

Average speed = 2.34 m/s

This student's response shows incorrect rounding after calculating their answer. A small but significant proportion of students made errors such as this.

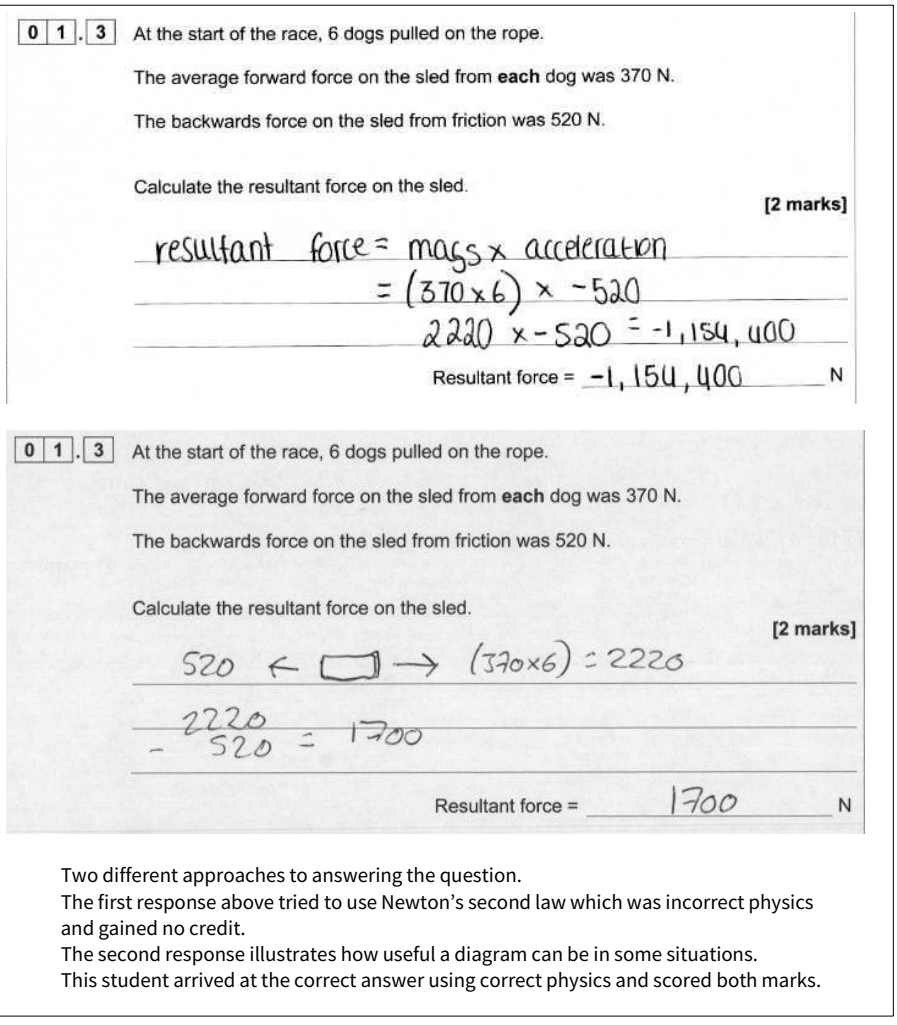
If this student had left their answer as 2.23880597 they would have scored all three marks, but the incorrect rounding meant that their final answer was incorrect and so only two marks were awarded.

© 2024 AQA and its licensors. All rights reserved.

6.5.1.4 Resultant forces

Answer 09 · Examiner comments June 2025 | 8464/P/2H | Original Q1

01.3 Slightly more than 60% of students answered this question correctly, with another fifth scoring 1 mark. The instruction to 'Calculate the resultant force…' had many students attempting to use $F = ma$ which was not possible given the information provided. Some students drew sketch diagrams to help them answer, which tended to lead them along the right lines.



0 1 . 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 x acceleration
= (370 x 6) x -520
2220 x -520 = -1,154,400

Resultant force = -1,154,400 N

0 1 . 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]

520 ← □ → (370×6) = 2220

2220
- 520 = 1700

Resultant force = 1700 N

Two different approaches to answering the question.
The first response above tried to use Newton's second law which was incorrect physics and gained no credit.
The second response illustrates how useful a diagram can be in some situations.
This student arrived at the correct answer using correct physics and scored both marks.

01.4 Fewer than half the 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.

© 2024 AQA and its licensors. All rights reserved.

6.5.1.4 Resultant forces

Answer 09 · Examiner comments

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

01.5 Just under three quarters recalled that at a constant speed the resultant force is zero and therefore selected the correct option.

01.6 Only about four in ten students were able to identify the Newton's third law pair to the force of the rope on the sled.

© 2024 AQA and its licensors. All rights reserved.