AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.3

Forces and elasticity

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**10**
Available paper years	**2018–2024**

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.

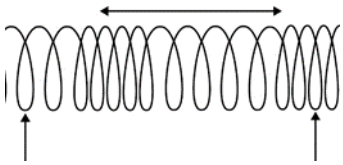
Name: _____ **Date:** _____

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

6.5.3 Forces and elasticity

Answer 01 · Mark scheme

June 2018 | 8464/P/2F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	 rarefaction compression		3	AO1 6.6.1.1
02.2	longitudinal		1	AO1 6.6.1.1

Answer 01 · Mark scheme

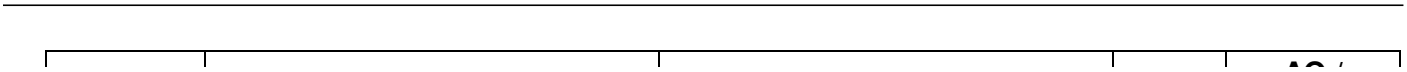
June 2018 | 8464/P/2F | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.3	**Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.	3–4	AO2
	Level 1: The method would not necessarily lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1
	No relevant content	0	
	Indicative content • measure the distance between the student with the bricks and the wall • trundle wheel or tape measure • measure the time taken from banging the bricks to the echo • double the measured distance to give the distance travelled or half the time • use: $\text{speed} = \frac{\text{distance travelled}}{\text{time}}$ • repeat timings • remove anomalies • calculate a mean		6.6.1.2
Total			**8**

6.5.3 Forces and elasticity

Answer 01 · Mark scheme

June 2018 | 8464/P/2F | Original Q2



6.5.3 Forces and elasticity

Answer 02 · Mark scheme

June 2018 | 8464/P/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	increases		1	AO1 6.5.3
05.2	the band returns to its original shape because there is an elastic force	allow band gets shorter allow because the stretching force has been removed if no other mark has been scored, allow for **1** mark the elastic potential energy decreases	1 1	AO1 6.5.3
05.3	any **two** from: • initially the band does not stretch when a force is applied • (when extending) as force increases the extension increases • the relationship is non-linear	allow a certain force is needed before the band extends allow the increase is not proportional do **not** accept directly proportional	2	AO3 6.5.3
05.4	straight diagonal line from bottom left to top right straight line through the origin	allow the line to curve upwards beyond the elastic limit	1 1	AO1 6.5.3
05.5	force = spring constant × extension	allow F = *k e*	1	AO1 6.5.3

6.5.3 Forces and elasticity

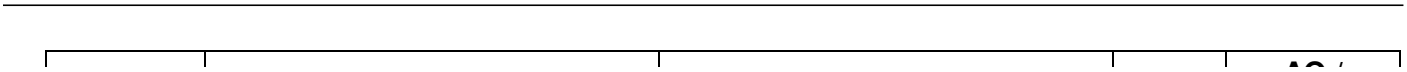
Answer 02 · Mark scheme June 2018 | 8464/P/2F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6		an answer of 120 (N) scores **3** marks an answer of 12 000 (N) scores **2** marks		AO2 6.5.3
	7.5 cm = 0.075 m		1	
	$F = 1\,600 \times 0.075$	this mark may be awarded if e is incorrectly / not converted	1	
	$F = 120$ (N)	allow an answer that is consistent with their value of e	1	
Total			**11**	

6.5.3 Forces and elasticity

Answer 02 · Mark scheme

June 2018 | 8464/P/2F | Original Q5



6.5.3 Forces and elasticity

Answer 03 · Mark scheme June 2019 | 8464/P/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	to stop the metal case of the toaster becoming live if a fault occurs		1	AO1.1 6.2.3.2	A
05.2	yellow brown blue		1 1 1	AO1.1 AO1 in isolation 6.2.3.2	G
05.3	E = 850 ×120 E = 102 000 (J)	an answer of 102 000 (J) scores **2** marks	1 1	AO2.1 6.2.4.2 6.1.1.4 WS 3.3	E
05.4	elastic potential kinetic		1 1	AO1.1 6.1.1.1	G
05.5	gravitational potential energy = mass × gravitational field strength × height or $E_p = m\ g\ h$	allow gpe allow any correct re-arrangement	1	AO1.1 AO1 in isolation 6.1.1.2	E
05.6	$0.049 = 0.050 \times 9.8 \times h$ $h = \frac{0.049}{0.050 \times 9.8}$ h = 0.10 (m)	an answer of 0.10 (m) scores **3** marks	1 1 1	AO2.1 6.1.1.2 WS 3.3	E
Total			**12**		

6.5.3 Forces and elasticity

Answer 03 · Mark scheme

June 2019 | 8464/P/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID

6.5.3 Forces and elasticity

Answer 04 · Mark scheme

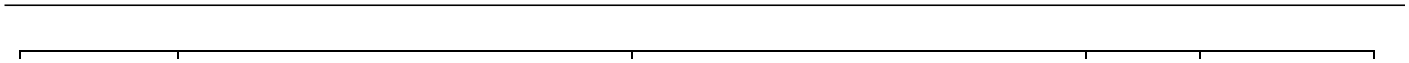
November 2020 | 8464/P/2F | Original Q2

question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	springs push the keys back to their original position		1	AO1 6.5.3
02.2	so that the same force is needed to press each key		1	AO3 6.5.3
02.3	(the length) decreases	allow the spring compresses	1	AO1 6.5.3
02.4	4.0 mm		1	AO2 6.5.3
02.5	the spring/key will not move far enough so will not press the (electrical contact) switch		1 1	AO3 6.5.3
02.6	F = 200 × 0.0040 F = 0.80 (N)	 allow 0.8 (N)	1 1	AO2 6.5.3
02.7	shorter spring spring with a lower spring constant	 allow spring that requires less force to compress allow weaker spring allow spring that is easier to compress	1 1	AO3 6.5.3
Total			**10**	

6.5.3 Forces and elasticity

Answer 04 · Mark scheme

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



6.5.3 Forces and elasticity

Answer 05 · Mark scheme

November 2021 | 8464/P/1F | Original Q2

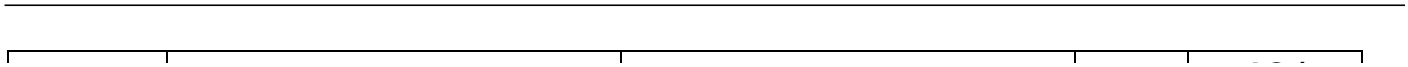
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	kinetic chemical	answers must be in this order	1 1	AO1 6.1.1.1
02.2	gravitational potential energy increases		1	AO1 6.1.1.1
02.3	$E_p = 50 \times 9.8 \times 3.0$ $E_p = 1470$ (J)	 allow 1500 (J)	1 1	AO2 6.1.1.1 6.1.1.2
02.4	speed = $\sqrt{2 \times \frac{1600}{50}}$ speed = 8 m/s	allow 8.0	1 1 1	AO2 AO2 AO1 6.1.1.1 6.1.1.2
02.5	energy has been transferred from the athlete to the air		1	AO3 6.1.2.1
02.6	the rate at which the athlete transfers energy		1	AO1 6.1.1.4

02.7	more than less than	answers must be in this order	1 1	AO1 6.1.1.4
Total			**12**	

6.5.3 Forces and elasticity

Answer 05 · Mark scheme

November 2021 | 8464/P/1F | Original Q2



6.5.3 Forces and elasticity

Answer 06 · Mark scheme

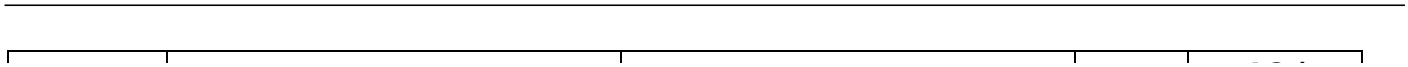
November 2021 | 8464/P/2F | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the spring will return to its original length when the force is removed		1	6.5.3 AO1
06.2	measure the original length of the spring **and** the extended length of the spring (with the metre rule) extension = extended length – original length		1 1	6.5.3 AO1
06.3	e = 0.080 m $E_e = 0.5 \times 40 \times (0.080)^2$ $E_e = 0.128$ (J)	 allow a correct substitution using an incorrectly / not converted value of e allow a correct calculation using an incorrectly / not converted value of e	1 1 1	6.5.3 AO2
06.4	force = spring constant × extension **or** F = k e		1	6.5.3 AO1
06.5	300 = k × 0.40 $k = \frac{300}{0.40}$ k = 750 (N/m)		1 1 1	6.5.3 AO2
Total			**10**	

6.5.3 Forces and elasticity

Answer 06 · Mark scheme

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



Answer 07 · Mark scheme

June 2022 | 8464/P/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	the same distance as the lift		1	AO2 6.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	it decreases		1	AO2 6.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	E = 1300 × 9.8 × 4.0 E = 50960 (J)	 allow 51000 (J)	1 1	AO2 6.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	kinetic internal	this order only	1 1	AO1 6.1.1.1 6.3.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	the distance moved by the lift the weight of the people in the lift		1 1	AO2 6.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2.6	$E_e = 0.5 \times 880\,000 \times 0.015^2$ $E_e = 99$ (J)		1 1	AO2 6.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2.7	less energy is transferred		1	AO1 6.1.2.2

Total Question 2		**11**

Answer 08 · Mark scheme

June 2023 | 8464/P/2F | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	weight acts downwards		1	AO2 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	a gravitational		1	AO1 6.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$W = 12\,000 \times 0.070$ $W = 840$ (N)		1 1	AO2 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$E_e = 0.5 \times 12\,000 \times (0.070)^2$ $E_e = 29.4$ (J)	 allow 29 (J)	1 1	AO2 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	the spring will not go back to its original length when the force is removed		1	AO1 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	B		1	AO3 6.5.3 RPA18

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	B		1	AO1 6.5.3 RPA18

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.8	any **two** from: • use a greater range of forces • use forces that are similar to the weight of a person • test more (identical) springs • find the limit of proportionality • repeat (discard anomalous results) and calculate a mean	allow test more forces allow elastic limit	2	AO3 6.5.3 RPA18

Total Question 1	**11**

Answer 09 · Mark scheme

June 2023 | 8464/P/2F | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	compression rarefaction	this order only	1 1	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	longitudinal waves transfer energy		1	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	amplitude		1	AO2 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	340 (m/s)	allow answers in the range 339 to 340 (m/s)	1	AO2 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	$s = 340 \times 0.20$ $s = 68$ m	 allow ecf from question **04.4**	1 1	AO2 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	the higher the temperature the greater the speed (so) time taken is less	do not accept the greater the speed the higher the temperature	1 1	AO3 6.6.1.2

Total Question 4	9

Answer 10 · Mark scheme

June 2024 | 8464/P/2F | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	(as a spring decompresses) the elastic potential energy of the spring decreases (as the gymnast leaves the floor) the kinetic energy of the gymnast increases **or** the gravitational potential energy of the gymnast increases **OR** (as a spring decompresses) the spring exerts a force on the gymnast (1) (so) work is done on the gymnast (1)		1 1	AO1 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	e = 0.012 m		1	AO2
	E_e= 0.5 × 8500 × 0.012^2	allow a correct substitution using an incorrectly / not converted value of e	1	AO2
	E_e = 0.612	allow 0.61 allow a correct calculation using an incorrectly / not converted value of e	1	AO2
	J **or** joule		1	AO1 6.5.3

Answer 10 · Mark scheme

June 2024 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	measure the original length of the spring **and** the compressed length of the spring (using a metre rule) compression = original length − compressed length **OR** calculate / measure the weight of the mass on the spring (1) use the equation $e = \frac{F}{k}$ (1)		1 1	AO3 6.5.3 RPA18

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	masses could fall (off the spring) (so) less likely to cause injury / damage (if done on the floor)	 allow less hazardous allow lower risk (of injury) allow specific cause of injury eg landing on foot	1 1	AO1 6.5.3 RPA18

Answer 10 · Mark scheme

June 2024 | 8464/P/2F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	Δy = (330 – 80 =) 250 (N)		1	AO3 6.5.3 RPA18

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.6	Δx = (0.052 – 0.010 =) 0.042 (m)		1	AO3 6.5.3 RPA18

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.7		allow ecf from question **07.5 and** question **07.6**		AO3 6.5.3 RPA18
	$k = \frac{250}{0.042}$	allow k = 5952.38	1	
	5950 (N/m)	allow their calculated gradient to 3 significant figures	1	

Total Question 7	14

6.5.3 Forces and elasticity

Answer 03 · Examiner comments — June 2019 | 8464/P/1F | Original Q5

Question 5

05.1 Just under half the students knew the function of the earth wire.

05.2 Nearly 80% of students gained at least one mark and around 37% gained all three marks for knowing the colours of the wires in a plug.

05.3 Over 90% of students gained at least 1 mark and the vast majority of these gained 2 marks for a calculation using a given formula. A few students incorrectly converted the time in seconds into minutes.

05.4 More than half of the students gained both marks for correctly identifying both energy stores from the given list. Around a quarter of the students made one correct choice. Often, the correct energies were chosen but placed in the wrong order.

05.5 About 30% of students could write an equation linking gravitational field strength, gravitational potential energy, height and mass. Some kept the order in which quantities were written the same and inserted incorrect mathematical operators into the given

Answer 03 · Examiner comments — June 2019 | 8464/P/1F | Original Q5

sequence (GFS = GPE × h × g was a very common incorrect answer, as was GFS = GPE ÷ h × g without brackets around h × g). 15% of students did not attempt the question. For this examination, the abbreviations GFS and GPE were acceptable, as were upper and lower case letters E for energy, h for height and m for mass. A capital G was not acceptable for g, as G is the universal gravitational constant which has a different meaning to g, the gravitational field strength.

05.6 Students found rearrangement of $E_p = mgh$ difficult, even if they had written the correct equation in the previous question. About 15% of students scored marks on this question and about 10% did not attempt it. Many students just multiplied all of the numbers in the question together. Some students produced answers that could not be reasonable for the change in height of the toast – such as 1mm or less, and 1 000m.

6.5.3 Forces and elasticity

Answer 05 · Examiner comments November 2021 | 8464/P/1F | Original Q2

Question 2 (Low demand)

02.1 Almost a quarter of students gained both marks, with about 45% giving one correct answer only.

02.2 Just over half of all students answered correctly. Almost a quarter of students stated that the gravitational potential energy of the athlete would decrease.

02.3 Nearly 90% calculated this correctly. A small minority tried to convert 50kg to g before calculating their answer, allowing them to gain a maximum of 1 mark.

02.4 Many students were unable to correctly recall the unit for speed. Many students made no attempt to use the square root sign when substituting values into the equation. Those who did use the sign often did not take the square root of the denominator, and some students merely took the square root of 2 before multiplying by kinetic energy and dividing by mass. The question differentiated well, with just over a quarter gaining full marks, about 20% gaining 2 marks, and roughly 25% gaining 1 mark.

02.5 More than three quarters of students gave the correct answer to this question.

02.6 Less than a quarter of all students gave the correct answer, with nearly half of the students thinking that power is the same as total energy transfer.

02.7 Around a quarter of the students gained both marks, with about 40% of students gaining one mark.

Answer 06 · Examiner comments November 2021 | 8464/P/2F | Original Q6

Question 6 (standard demand)

06.1 30% of students correctly selected the meaning of elastically deformed.

06.2 10% of students scored marks on this question. Most of the answers that did not score marks did not refer to any practical procedure or equipment. Some answers did mention measuring the spring, but did not identify which property should be measured, nor which piece of equipment should be used to take the measurement.

06.3 80% of students were able to select the correct equation from the physics equations sheet, and substitute the values into the equation. Nearly all these students correctly evaluated the answer and were awarded 2 marks. Only 2 students converted 80 mm to metres and scored full marks.

06.4 Approximately 25% of students correctly recalled the equation.

06.5 Approximately 25% of students were able to substitute the numbers into the correctly rearranged equation and evaluate the answer to score full marks.

6.5.3 Forces and elasticity

Answer 07 · Examiner comments

June 2022 | 8464/P/1F | Original Q2

Question 02 (Low demand)

02.1 Approximately half of all students used the diagram to work out that the counterweight and the lift would move through the same distance.

02.2 Only about 40% of students realised that the gravitational potential energy of the counterweight would decrease as it moved down.

02.3 Just under 90% of students gained both marks in this calculation.

02.4 About half of all students gained at least 1 mark, with about 15% gaining both marks.

It was more common for students to identify that the kinetic energy of the lift would decrease, than to identify that the internal energy of the brakes would increase.

02.5 Nearly 90% gained at least 1 mark, with just under 40% ticking both of the correct boxes.

02.6 Just under 70% of students scored both marks.

The fact that extension should have been squared was missed or misunderstood by a fair proportion of students, who either calculated 0.5 × spring constant × extension, or calculated (0.5 × spring constant × extension)^2.

02.7 About half of all students gained this mark.

6.5.3 Forces and elasticity

Answer 08 · Examiner comments

June 2023 | 8464/P/2F | Original Q1

Question 1 (Low demand)

01.1 Over 95% of students knew that weight acts downwards.

01.2 Approximately 90% of students knew that weight is a gravitational force.

01.3 A little over 90% of students correctly calculated the weight. Nearly all students that substituted correctly also gave the correct final answer.

01.4 Over 80% of students scored 2 marks for this calculation. Again, nearly all students that substituted correctly also gave the correct final answer.

01.5 Approximately 85% of student knew that inelastically deformed meant that the spring will not go back to its original length when the force is removed.

01.6 This question was not as well answered, but over 60% of students were able to identify which length was the extension.

01.7 Nearly 80% of students were able identify which graph shows that the extension of the spring is directly proportional to the force applied to the spring.

01.8 Only 5% of students were able to suggest two improvements to the investigation. Most of the 45% of students that gained one mark suggested using a greater number of forces, or a bigger force. There were lots of vague responses that suggested repeating but not taking a mean.

6.5.3 Forces and elasticity

Answer 09 · Examiner comments June 2023 | 8464/P/2F | Original Q4

Question 4 (Low demand and standard demand)

04.1 Nearly 30% of students scored two marks on this question. Of the 50% that scored one mark, the majority correctly labelled the compression.

04.2 75% of students knew that longitudinal waves transfer energy.

04.3 Approximately 40% of students knew that the amplitude changes. The most popular incorrect response was wavelength.

04.4 90% of students read the correct speed off the graph. As the line does not cross at exactly 340, a tolerance was allowed and many students picked up the mark for an answer between 339 and 340.

04.5 Over 80% of students used their value from question 04.4 in the equation and scored two marks. A small number of students did not use their value from question 04.4 despite the instruction to do so.

04.6 Approximately 25% of students identified that when the temperature of the air increases, the speed increases. Of those that did, only a very small minority of students went on to state that therefore the time would decrease. Many students contradicted themselves by stating that the speed would increase with temperature, but then said that the time would increase.

Answer 10 · Examiner comments

June 2024 | 8464/P/2F | Original Q7

Question 7 (standard demand)

07.1 This question was not well answered with nearly 90% of students gaining no marks and 1% gaining full marks. Students find the idea of energy stores very confusing. As in previous series, the mark scheme allows students to be awarded marks for answering in term of transfers or transformations: this is the only way students were able to score marks on this question.

07.2 Two-thirds of students scored 2 or 3 marks for this calculation. Very few students converted the centimetres into metres, so less than 1% of students scored full marks.

07.3 15% of students described measuring the length of the spring and were awarded marks; 5% of students gained 2 marks. Most students did not describe measuring anything and wrote vague answers about energy.

07.4 Approximately 20% of students identified that the large masses meant that the experiment should be done on the laboratory floor rather than on the table for safety reasons. However, most students gained no marks as they wrote that the table would not be level or that as it was higher that would affect the readings.

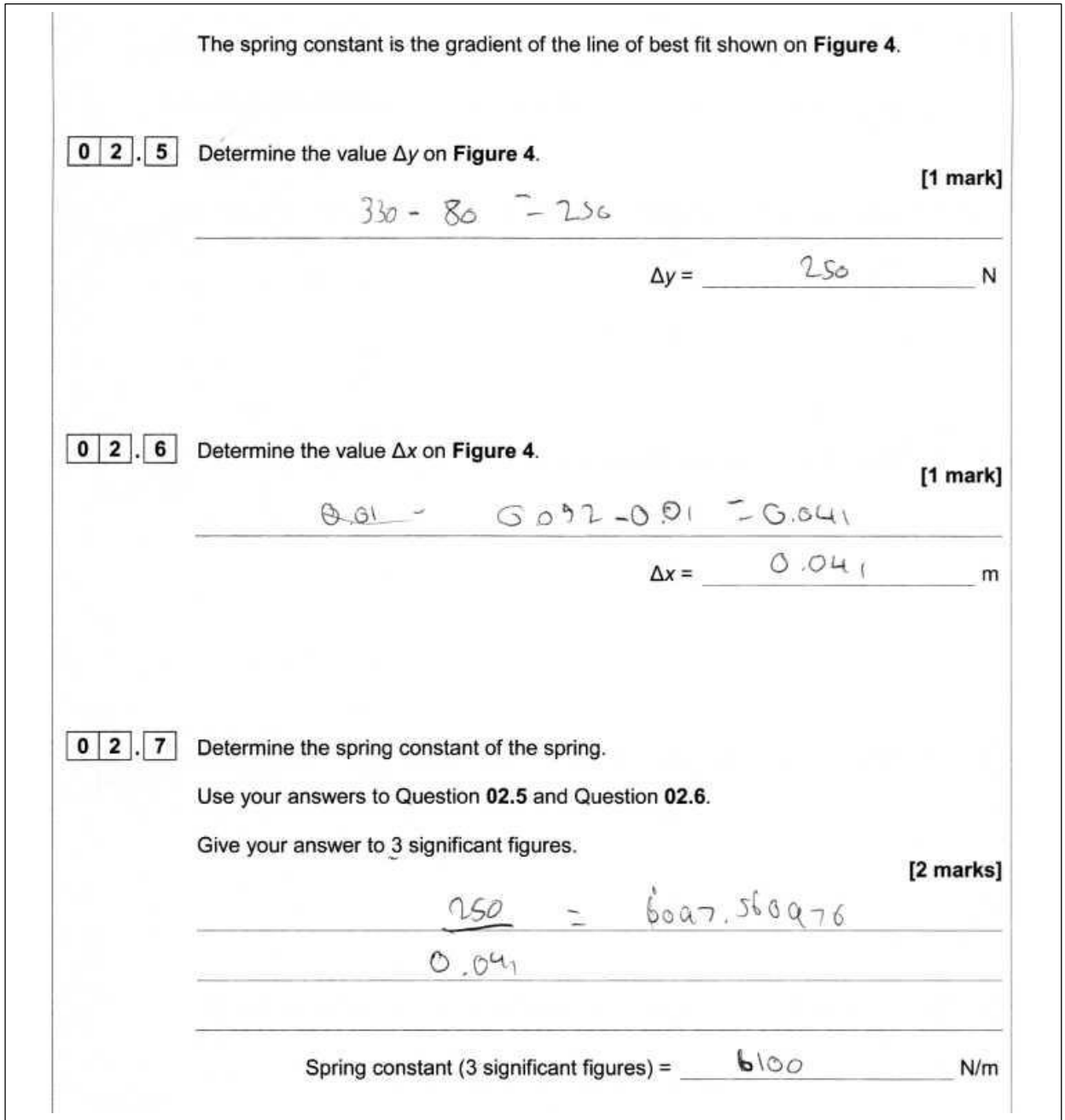
07.5 Just under 30% of students correctly used the values from the graph to determine the value for Δy. Most incorrect answers gave it as either 300 or 330.

07.6 About a quarter of students correctly determined Δx. The most common incorrect answer was 0.52.

© 2024 AQA and its licensors. All rights reserved.

Answer 10 · Examiner comments June 2024 | 8464/P/2F | Original Q7

07.7 This question was reasonably well answered with 35% of students gaining at least 1 mark. The error carried forward (ecf) meant that students could use their answers from questions 07.5 and 07.6 and many students were able to gain 2 marks for doing so, even if their previous answers were wrong.



The spring constant is the gradient of the line of best fit shown on **Figure 4**.

0 2 . 5 Determine the value Δy on **Figure 4**. **[1 mark]**

330 - 80 = 250

Δy = 250 N

0 2 . 6 Determine the value Δx on **Figure 4**. **[1 mark]**

0.01 - 0.092 - 0.01 = 0.041

Δx = 0.041 m

0 2 . 7 Determine the spring constant of the spring.

Use your answers to Question **02.5** and Question **02.6**.

Give your answer to 3 significant figures. **[2 marks]**

250 = 6097.560976

0.041

Spring constant (3 significant figures) = 6100 N/m

When ecf is allowed, students who give one value incorrectly can still gain subsequent marks in the next part of the question.

In this example from a Higher tier paper, the student gained the mark for question 02.5 but not for question 02.6. In their answer to question 02.7 they were awarded the first mark for dividing their answer to question 02.5 by their answer to question 02.6 and the second mark for giving the correct answer to this calculation to the correct number of significant figures.

© 2024 AQA and its licensors. All rights reserved.

Answer 10 · Examiner comments

June 2024 | 8464/P/2F | Original Q7

Contact us

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

Tel: 01483 477756
Email: gcsescience@aqa.org.uk

aqa.org.uk

© 2024 AQA and its licensors. All rights reserved.