AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.1.1.2

Changes in energy

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**12**
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.

6.1.1.2 Changes in energy

Answer 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	D needs the greatest force to extend the spring the same amount	allow 20 (N) allow fourth (newtonmeter) reason only scores if correct newtonmeter selected	1 1	AO1 6.5.3
04.2	zero (error) any **one** from: • record the value and subtract from readings taken • adjust the newtonmeter to zero	allow systematic (error) allow subtract 1 from all readings	1 1	AO3 6.5.3

6.1.1.2 Changes in energy

Answer 01 · Mark scheme

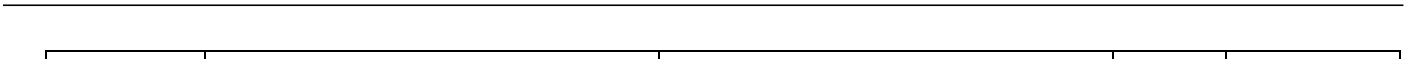
June 2018 | 8464/P/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3		an answer of 0.02 (m) gains **6** marks		AO2 6.5.3
	$4.5 \times 10^{-2} = 0.5 \times 400 \times e^2$	this mark may be awarded if the standard form value is incorrectly converted	1	
	$e = \sqrt{\frac{4.5 \times 10^{-2}}{0.5 \times 400}}$	this mark may be awarded if the standard form value is incorrectly converted allow $e^2 = \frac{4.5 \times 10^{-2}}{0.5 \times 400}$	1	
	e = 0.015 (m)	this answer only	1	
	2.0 = 400 × e		1	
	e = 0.005 (m)	this answer only	1	
	0.015 + 0.005 = 0.02 (m)	allow their initial extension + their additional extension correctly calculated	1	
	or			
	$4.5 \times 10^{-2} = 0.5 \times 400 \times e^2$ (1)	this mark may be awarded if the standard form value is incorrectly converted		
	$e = \sqrt{\frac{4.5 \times 10^{-2}}{0.5 \times 400}}$ (1)	this mark may be awarded if the standard form value is incorrectly converted allow $e^2 = \frac{4.5 \times 10^{-2}}{0.5 \times 400}$		
	e = 0.015 (m) (1)	this answer only		
	F = 400 × 0.015 F = 6 (N) (1)	allow an answer of 400 × their calculated value of e		
	total force = 6 + 2 8 = 400 × e (1)	allow an answer that is consistent with their calculated value of e		
	e = 0.02 (m) (1)			
Total			**10**	

6.1.1.2 Changes in energy

Answer 01 · Mark scheme

June 2018 | 8464/P/2H | Original Q4



6.1.1.2 Changes in energy

Answer 02 · Mark scheme

June 2019 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	force ∝ extension		1	AO1 6.5.3	A
05.2		an answer of 60 (kg) scores **4** marks		AO2 6.5.1.3	E
	$F = 0.49 \times 1\,200$		1		
	or				
	$F = 588$ (N)				
	$588 = m \times 9.8$	allow a correct substitution using an incorrectly calculated value of F	1		
	$m = \frac{588}{9.8}$	allow a correct rearrangement using an incorrectly calculated value of F	1		
	$m = 60$ (kg)	allow a correct calculation using an incorrectly calculated value of F	1		
	OR				
	0.49 = mean mass per spring × 9.8 (1)				
	mean mass per spring = $\frac{0.49}{9.8}$ (1)				
	mean mass per spring = 0.050 (1)				
	m = 0.050 × 1200 = 60 (kg) (1)				
05.3		an answer of 140 scores **3** calculation marks		3 x AO2 1 x AO1 6.5.3	E
	$0.49 = k \times 3.5 \times 10^{-3}$		1		
	$k = \frac{0.49}{3.5 \times 10^{-3}}$		1		
	140		1		
	N/m		1		

6.1.1.2 Changes in energy

Answer 02 · Mark scheme

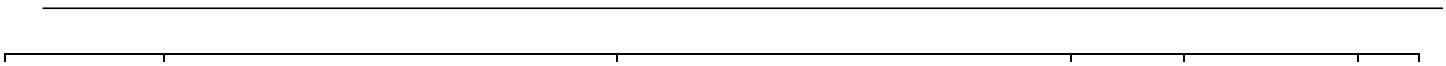
June 2019 | 8464/P/2H | Original Q5

05.4	springs with a low spring constant because they can compress by a larger amount (for a given force)	 allow they can compress by the same amount for a smaller force allow low stiffness	1 1	AO3 6.5.3	E
Total			**11**		

6.1.1.2 Changes in energy

Answer 02 · Mark scheme

June 2019 | 8464/P/2H | Original Q5



6.1.1.2 Changes in energy

Answer 03 · Mark scheme

November 2020 | 8464/P/1H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	the (maximum tendon) extension increases (as speed increases)	allow the tendons stretch more (as speed increases)	1	AO3 6.1.2.2
	so the elastic potential energy increases	allow so the (elastic) force increases	1	
	which is transferred to gravitational potential energy		1	
07.2	E = 770 × 0.14	allow E = 107.8 (J)	1	AO2 6.1.1.2
	extension = 0.070m		1	
	$107.8 = 0.5 \times k \times 0.070^2$	this mark may be awarded if extension is incorrectly/not converted and/or if the efficiency equation has not been applied	1	
	$k = 2 \times \frac{107.8}{0.070^2}$	this mark may be awarded if extension is incorrectly/not converted and/or if the efficiency equation has not been applied	1	
	k = 44 000 (N/m)	this mark may be awarded if extension is incorrectly/not converted this mark may not be awarded if the efficiency equation has not been applied	1	
Total			**8**	

6.1.1.2 Changes in energy

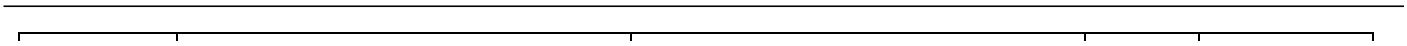
Answer 04 · Mark scheme November 2020 | 8464/P/2H | Original Q3

question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	the spring will return to its original length when the force is removed		1	AO1 6.5.3
03.2	Any **two** from: • spring constant • (original) length • diameter		2	AO3 6.5.3
03.3	0.80 = k × 0.0040 $k = \frac{0.80}{0.0040}$ k = 200 (N/m)		1 1 1	AO2 6.5.3
03.4	the upward force on the spring is equal to the downward force the spring is inelastically deformed		1 1	AO3 6.5.3
Total			**8**	

6.1.1.2 Changes in energy

Answer 04 · Mark scheme

November 2020 | 8464/P/2H | Original Q3



6.1.1.2 Changes in energy

Answer 05 · Mark scheme

November 2021 | 8464/P/1H | Original Q3

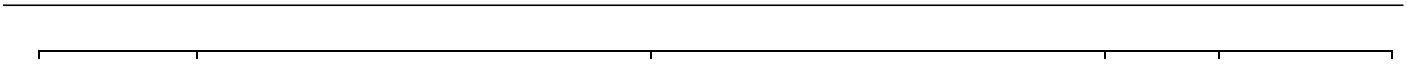
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	solar	allow biofuel / biodiesel allow wave power	1	AO1 6.1.3
03.2	sometimes there is no wind (but the battery can still be charged using the generator) when there is wind less fuel is burned	allow if the generator breaks then the turbine can still generate electricity allow a disadvantage of burning fossil fuel	1 1	AO1 6.1.3
03.3	carbon dioxide increases global warming **OR** sulfur dioxide or NOx emissions (1) increases acid rain (1) **OR** particulates or NOx emissions (1) can harm living organisms (1)	 allow increases the greenhouse effect	1 1	AO1 6.1.3

03.4	81 kJ = 81 000 J $81000 = 0.5 \times 8000 \times v^2$ $v = \sqrt{\frac{81\,000}{0.5 \times 8000}}$ v = 4.5 (m/s)	allow a correct substitution using an incorrectly/not converted value of energy allow a correct re-arrangement using an incorrectly/not converted value of energy allow a correct calculation using an incorrectly/not converted value of energy	1 1 1 1	AO2 6.1.1.2
03.5	$19600 = 8000 \times 9.8 \times \Delta h$ $\Delta h = \frac{19\,600}{8000 \times 9.8}$ Δh = 0.25 m		1 1 1	AO2 6.1.1.2
Total			**12**	

6.1.1.2 Changes in energy

Answer 05 · Mark scheme

November 2021 | 8464/P/1H | Original Q3



6.1.1.2 Changes in energy

Answer 06 · Mark scheme

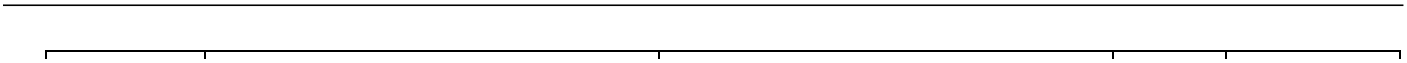
November 2021 | 8464/P/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	the spring will return to its original length when the force is removed		1	6.5.3 AO1
01.2	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
01.3	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
01.4	force = spring constant × extension **or** F = k e		1	6.5.3 AO1
01.5	$300 = k \times 0.40$ $k = \frac{300}{0.40}$ k = 750 (N/m)		1 1 1	6.5.3 AO2
Total			10	

6.1.1.2 Changes in energy

Answer 06 · Mark scheme

November 2021 | 8464/P/2H | Original Q1



6.1.1.2 Changes in energy

Answer 07 · Mark scheme

November 2021 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	different temperatures emit different intensities of infrared which are represented (on the infrared camera) as different shades / colours	 allow wavelength / frequency / amount for intensity throughout	1 1	AO1 AO3 6.6.2.4
05.2	visible light		1	AO3 6.6.2.1
05.3	both ionising radiation so some risk of cancer the whole body is irradiated by gamma rays when an X-ray is taken only part of the body is exposed exposure time for gamma rays is longer		1 1 1 1	AO1 AO3 AO3 AO3 6.6.2.3
05.4	$1.2 \times 10^{-13} = F \times 0.015$ $F = \frac{1.2 \times 10^{-13}}{0.015}$ $F = 8.0 \times 10^{-12}$ N	 allow a correct rearrangement using an incorrectly / not converted value of s allow 8×10^{-12} allow a correct calculation using an incorrectly / not converted value of s	1 1 1	AO2 6.5.2

6.1.1.2 Changes in energy

Answer 07 · Mark scheme

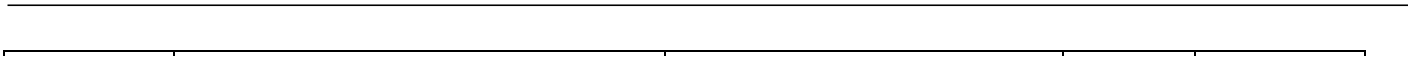
November 2021 | 8464/P/2H | Original Q5

05.5	some of the energy of the electrons causes heating (therefore) increasing the temperature (so using tungsten) allows more electrons to be collided per second than using any other metal	 allow (so using tungsten) enables more energy per second to be transferred than using any other metal	1 1 1	AO1 AO3 AO3 6.5.2
Total			**13**	

6.1.1.2 Changes in energy

Answer 07 · Mark scheme

November 2021 | 8464/P/2H | Original Q5



6.1.1.2 Changes in energy

Answer 08 · Mark scheme

June 2022 | 8464/P/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	**Child** gravitational potential energy decreases	ignore descriptions of energy transfers before the child reaches position A	1	AO1 6.1.1.1 6.1.2.1
	kinetic energy increases **and** then decreases (to zero)		1	
	Springs elastic potential energy increases	ignore references to kinetic energy of the springs	1	
	Surroundings internal / thermal store of energy increases	allow energy is dissipated allow (average) kinetic energy of the particles increases	1	

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	**At position A** $4.9 = 0.5 \times k \times 0.056^2$ $k = \frac{2 \times 4.9}{0.056^2} = 3125$ (N/m) **At position B** $8.1 = 0.5 \times 3125 \times e^2$ $e = \sqrt{\left(\frac{2 \times 8.1}{3125}\right)}$ $e = 0.072$ (m)	 allow a correct substitution of an incorrectly calculated value of k using 0.056 m **and** 4.9 J allow $e^2 = 0.005184$ allow a correct re-arrangement using an incorrectly calculated value of k allow an answer consistent with their calculated value of k	1 1 1 1 1	AO2 6.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the total energy transferred by the child		1	AO1 6.1.1.4

Total Question 3		10

Answer 09 · Mark scheme

June 2023 | 8464/P/1H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	the measurement will be more accurate	allow parallax error is reduced	1	AO3
	because (in position B) the eye is level with (the maximum height of) the toy		1	AO1 6.1.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	64 cm = 0.64 m		1	AO2 6.1.1.2
	$0.049 = m \times 9.8 \times 0.64$	allow a correct substitution using an incorrectly / not converted height	1	
	$m = \frac{0.049}{9.8 \times 0.64}$	allow a correct rearrangement using their incorrectly / not converted height	1	
	$m = 0.0078125$ (kg)	allow an answer consistent with their incorrectly / not converted height	1	
	$m = 0.0078$ (kg)	this mark can only be scored if the equation $E_p = m\ g\ h$ has been used	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	energy from the toy is dissipated (to the surroundings / air)	allow energy from the toy is transferred to the surroundings / air	1	AO1 6.1.2.1 6.1.1.1
	(but) in a closed system the total energy remains constant		1	

Total Question 5	9

Answer 10 · Mark scheme

June 2023 | 8464/P/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	$W \propto e$		1	AO1 6.5.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	750 = k × 0.060		1	AO2 6.5.3
	$k = \frac{750}{0.060}$	allow a correct rearrangement using an incorrectly / not converted value of *e*	1	
	k = 12 500 N/m	allow a correct calculation using incorrectly / not converted value of *e*	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(an object that is inelastically deformed) will not go back to its original length	allow shape for length	1	AO1 6.5.3
	when the force is removed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	$1800 = ½ \times 225 \times e^2$		1	AO2 6.5.3
	$e = \sqrt{\frac{2\times1800}{225}}$	allow $e^2 = \frac{2\times1800}{225}$	1	
	e = 4 (m)	allow e = 4.0 (m)	1	

Answer 10 · Mark scheme

June 2023 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	$e = \frac{750}{225}$ e = 3.3… (m) the extension will be too great so not suitable for use in the chair **OR** F = 225 x 0.3 (1) F = 67.5 (N) (1) the weight of a person will be too great so (spring is) not suitable for use in the chair (1)	 allow a conclusion consistent with their calculated extension allow the chair would rest on the ground allow the spring will not stretch beyond its elastic limit	1 1 1	AO3 6.5.3

Total Question 5	12

Answer 11 · Mark scheme

June 2024 | 8464/P/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	chemical store of energy decreases gravitational potential energy of the drone increases		1 1	AO2 6.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	$3920 = 2.5 \times 9.8 \times \Delta h$ $\Delta h = \frac{3920}{2.5 \times 9.8}$ $\Delta h = 160$ (m) $(840 - 160) = 680$ (m) **OR** Initial $E_p = 2.5 \times 9.8 \times 840$ (1) Final $E_p (= 20580 - 3920) = 16660$ (1) $h = \frac{16660}{2.5 \times 9.8}$ (1) = 680 (m) (1)	 allow an answer consistent with their calculated value of Δh using the correct equation allow initial $E_p = 20580$ allow correct use of an incorrectly calculated value of E_p using the gravitational potential energy equation allow a correct substitution and rearrangement using their calculated value of E_p using the gravitational potential energy equation allow an answer consistent with their calculated value of E_p using the gravitational potential energy equation	1 1 1 1	AO2 6.1.1.2

6.1.1.2 Changes in energy

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	max E_k = 3920 + 150 (= 4070 J)	allow max E_k = 4070 J	1	AO2 6.1.1.2
	$4070 = 0.5 \times 2.5 \times v^2$	allow a substitution using their value for kinetic energy	1	
	$v = \sqrt{\frac{4070}{0.5 \times 2.5}}$	allow a correct re-arrangement using their value for kinetic energy allow $v^2 = \frac{4070}{0.5 \times 2.5}$	1	
	v = 57.06… (m/s)	allow v = 57 (m/s)	1	
	v = 0.057… (km/s)	allow an answer consistent with their calculated value for v using the kinetic energy equation	1	

Total Question 4	11

6.1.1.2 Changes in energy

Answer 12 · Mark scheme June 2024 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	(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.
02.2	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

6.1.1.2 Changes in energy

Answer 12 · Mark scheme

June 2024 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	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.
02.4	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 12 · Mark scheme

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

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7		allow ecf from question **02.5 and** question **02.6**		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 2	14

Answer 01 · Examiner comments June 2018 | 8464/P/2H | Original Q4

Question 4 (standard / high & high demand)

04.1 Nearly 70% identified the correct newtonmeter but very few stated that it was the extension being the same for all of the newtonmeters that was the key factor.

04.2 Fewer than 10% could correctly identify the type of error, with many giving descriptions rather than stating zero error or systematic error. Terms used incorrectly with some frequency included human error.

Over 50% were then able to say how the error could be corrected. Some suggested that the newtonmeter might just be 'sticky' and need to be pulled down and released which, whilst showing practical experience, would not be a solution in all cases.

04.3 Whilst only just over 5% gained all 6 marks, correct solutions, when seen, were clear and well set out. A significant number, nearly 17%, calculated the initial extension, but did not complete the calculation to determine the total extension.

Those managing to do the second part of the question opted in about equal numbers for each of the two expected methods.

Typical errors in the first part included not finding the square root of the answer for the extension and in dividing by 2 twice.

A few candidates realised there were two parts but worked out incorrect values. They were able to gain the final mark by adding the two incorrect extensions correctly.

Answer 05 · Examiner comments November 2021 | 8464/P/1H | Original Q3

Question 03 (Standard/high demand)

03.1 Slightly over half of students answered correctly. The most common incorrect answer was to suggest that the boat could utilise tidal power.

03.2 It appeared that some students did not assimilate all of the information in the question, with answers stating that the boat can move using the generator. It was also fairly common for students to describe why using wind power is beneficial, but not to give reasons why it is useful to have both a wind turbine and a generator. Approximately 15% of students gained both marks, with nearly 60% gaining at least 1 mark.

03.3 This question proved to be accessible to all students, and differentiated well between them. Approximately a third of students gained both marks, a third gained one mark, and a third of students gained no marks.

03.4 Many students did not convert 81 kJ into J. Re-arranging the kinetic energy equation to give *v* also caused problems for a fair proportion of students. Roughly one in four students gained at least 3 marks. Over half the students gained no marks at all.

6.1.1.2 Changes in energy

Answer 05 · Examiner comments November 2021 | 8464/P/1H | Original Q3

03.5 This calculation was carried out correctly by just over a third of students, with about 50% of students gaining no marks.

Answer 06 · Examiner comments November 2021 | 8464/P/2H | Original Q1

Question 1 (Standard demand)

01.1 30% of students correctly selected the meaning of elastically deformed.

01.2 Approximately 25% of students scored at least 1 mark on this question for suggesting that the length of the spring should be measured with a ruler. Nearly 15% correct suggested that the initial and final length should be measured, then subtracted.

01.3 85% 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. Around 15% of these students converted 80 mm to metres and scored full marks.

01.4 Approximately 65% of students correctly recalled the equation.

01.5 Approximately 65% of students were able to substitute the numbers into the correctly rearranged equation and evaluate the answer to score full marks.

6.1.1.2 Changes in energy

Answer 07 · Examiner comments — November 2021 | 8464/P/2H | Original Q5

Question 5 (standard/high demand and high demand)

05.1 Only 10% of students scored marks on this question. At high demand it is expected that where a question follows a figure, students should use information from the figure. Very few students linked the amount of infra-red radiation to temperature, or stated that different temperatures are displayed at different colours, despite that information being given in Figure 8.

05.2 This was a demanding question - students had to compare wavelengths given in nm and mm and in standard form. They then had to use their understanding of the electromagnetic spectrum. Less than 30% of students answered this question correctly.

05.3 The vast majority of the 40% of students that scored marks on this question only scored 1 mark, and that was mostly for saying that there is some risk of cancer with both.

05.4 This question performed as expected with 30% of students scoring 2 marks. Only 8% of students included the conversion to gain full marks.

Answer 07 · Examiner comments — November 2021 | 8464/P/2H | Original Q5

05.5 20% of students gained at least 1 mark. Most of those stated that the energy from the electrons would cause heating and increase the temperature. Some went on to say that tungsten could be heated to a higher temperature than any other metal. No student scored full marks for explaining this meant that more electrons could be collided.

6.1.1.2 Changes in energy

Answer 08 · Examiner comments

June 2022 | 8464/P/1H | Original Q3

Question 03 (Standard and standard/high demand)

03.1 Many students struggled with this question, which revealed a number of misconceptions held by students. Around 70% of students gained at least one mark, but very few managed to score all 4 marks.

Many students began by describing energy changes as the child moved from the trampoline to the maximum height. This was ignored, and most of these responses went on to describe what happened as the child then fell downwards.

A lot of students described the forces acting on the child, which did not answer the question, and it was reasonably common to see descriptions of gravitational potential energy being a force which acts on the child. The concept of energy stores continues to be widely misunderstood by students, with some students making statements suggesting that there is a gravitational potential energy store when the child is in the air, for example. Lots of responses to the question described a transfer of gravitational potential energy to kinetic energy as the child descended, which gained the first marking point. Very few students realised that the kinetic energy of the child would decrease after landing on the trampoline.

For the springs, it was common to read descriptions of the springs stretching, rather than descriptions of changes to energy stores. Some students identified that the elastic potential energy of the springs would increase, but added that the chemical energy of the springs would decrease, and therefore did not gain the mark. A fair number of students made statements that elastic energy was used to stretch the springs, which was not credit-worthy.

For the surroundings, a lot of students stated that there was no change to the energy stores, and a lot of students described an increase in sound energy. This is not a store of energy, and was ignored. A fair proportion of students did identify that energy would be dissipated to the surroundings, thus gaining the mark.

6.1.1.2 Changes in energy

Answer 08 · Examiner comments June 2022 | 8464/P/1H | Original Q3

03.2 This calculation proved to be very challenging, with nearly three quarters of all students failing to gain any marks.

A lot of students calculated the difference between the energies at positions A and B, which is incorrect physics so was unable to gain credit. A lot of students substituted 0.056 m in for the spring constant in position A, and some students forgot to square the extension when using the elastic energy equation.

Students who realised that they needed to use the value of elastic potential energy at position A to calculate the spring constant, tended to do very well in this question, with nearly two thirds of those who gained any credit scoring all 5 marks. A few students arrived at the correct final answer, but then subtracted the original extension to find the change in extension, an approach which scored a maximum of 4 marks.

03.3 Over 60% of students selected the correct definition of work done.

Answer 09 · Examiner comments June 2023 | 8464/P/1H | Original Q5

Question 05 (Standard/high and high demand)

05.1 Around half of students gained at least 1 mark on this question. There were many acceptable ways to describe the toy being at eye level in position B. A fair number of students suggested that in position B the student could push down harder on the toy so that it would reach a greater height, which missed the point of the question and tended to score no marks.

05.2 About 85% of students gained at least 1 mark for this calculation, with about 20% scoring full marks, about 25% on 4 marks and about 15% on 3 marks. Most students did not attempt to convert the height into metres. Many students struggled to give the answer to 2 significant figures, perhaps caused by students not understanding how their calculators were giving the answer in standard form. So, for example, 7.8125×10^{-3} as an answer might have been rounded to 7.8 without any power of 10 shown.

Answer 09 · Examiner comments June 2023 | 8464/P/1H | Original Q5

05.3 Approximately a quarter of students scored at least 1 mark, with many not knowing how the specification defines a closed system.

6.1.1.2 Changes in energy

Answer 10 · Examiner comments

June 2023 | 8464/P/2H | Original Q5

Question 5 (standard/high demand and high demand)

05.1 Approximately 70% of students selected the correct relationship.

05.2 90% of students correctly substituted and calculated a spring constant. However, only 35% of students converted the extension to metres and scored three marks. 55% of students did not do the conversion or did it incorrectly and scored two marks.

05.3 Approximately 60% of students knew that an object that is inelastically deformed will not go back to its original length but did not refer to when the force is removed. Only 2% of students were awarded both marks for this question. Many students who scored zero marks wrote vague statements such as the object will not go back to its original form.

05.4 50% of students scored full marks. Many students who scored zero used an incorrect equation despite having the equation sheet. Many students tried to substitute into the correct equation but omitted the squared symbol.

05.5 Many students find evaluate questions challenging, particularly when they have to do a calculation. 30% of students did score at least two marks for a calculation, and 12% went on to draw a sensible conclusion and were awarded all three marks.

Answer 11 · Examiner comments

Question 4 (standard/high & high demand)

04.1 Many students just named energy stores and did not describe how the stores changed. A fair proportion of students stated that the kinetic energy of the drone would remain constant, which is not an incorrect statement, but is not a change to a store of energy so did not gain any credit. A small proportion of students referred to the chemical store of energy decreasing.

Approximately two-thirds of students gained at least 1 mark, although only about 10% of students scored both marks.

04.2 There were two routes that students could use to answer this question. Many students who took the first route got as far as the third marking point but then did not subtract their answer from 840 m.

Just under a third of students gained full credit, with slightly over half gaining 3 marks.

04.3 Most students omitted the first step in this calculation and did not add the 3920 J to the initial kinetic energy of the drone. However, marking point 2 could still be scored using any energy value when substituting into the kinetic energy equation. The most common approach was to use 150 J as the maximum kinetic energy.

A noticeable minority of students converted 2.5 kg into grams.

Some students forgot to square the speed when substituting into the equation. Other students struggled to re-arrange the equation. One relatively common mistake was to correctly rearrange the equation for v^2 (eg $v^2 = \frac{4070}{05 \times 2.5}$) but then square this value to determine v (eg $v = \left(\frac{4070}{0.5 \times 2.5}\right)^2$) rather than determining the square root.

A minority of students remembered to convert their final answer into km/s.

Almost 60% of students scored 2 marks, with only the highest-attaining students managing to gain 4 or 5 marks.

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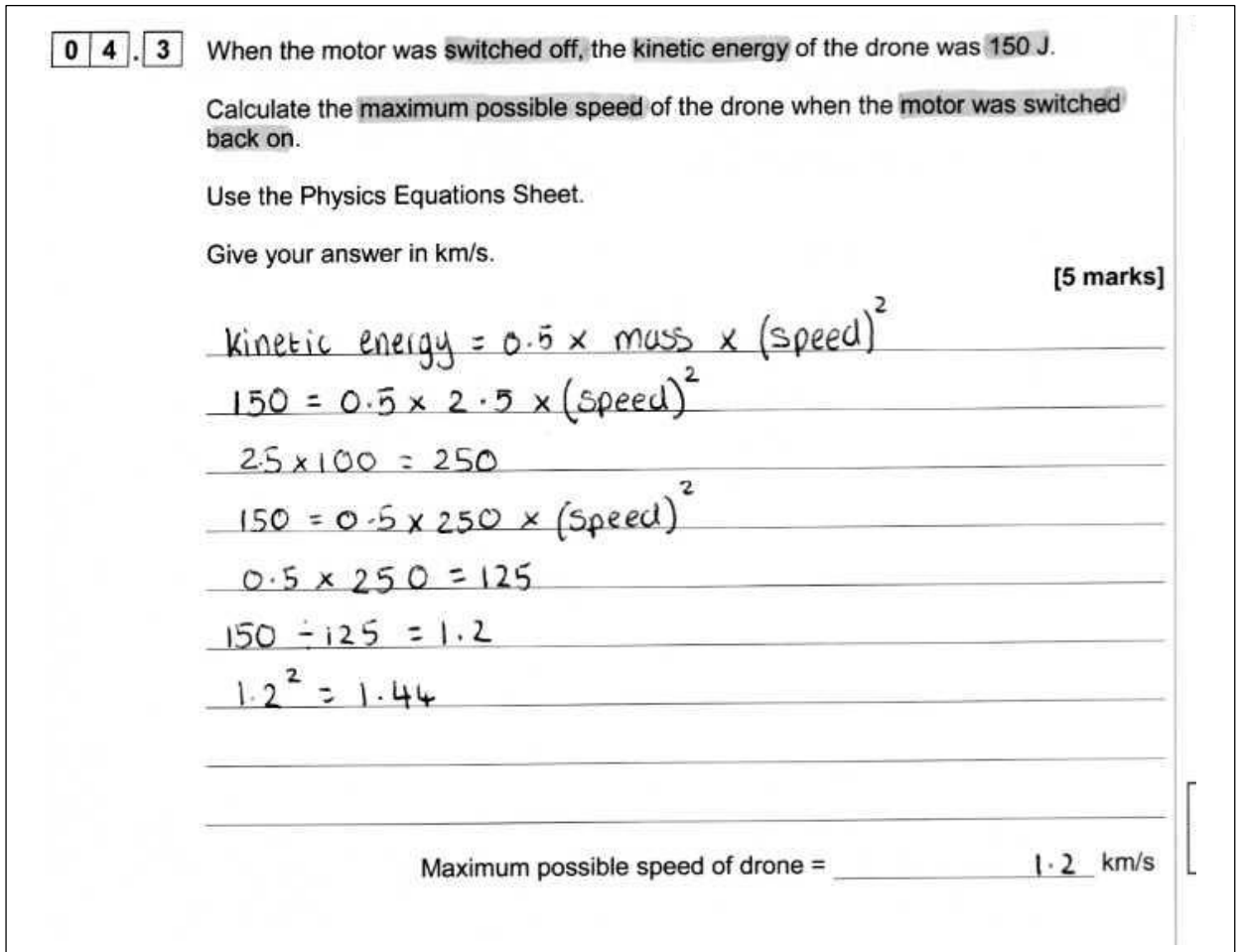
6.1.1.2 Changes in energy

Answer 11 · Examiner comments June 2024 | 8464/P/1H | Original Q4



0 4 . 3 When the motor was switched off, the kinetic energy of the drone was 150 J.

Calculate the maximum possible speed of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

Give your answer in km/s.

[5 marks]

Kinetic energy = 0.5 × mass × (speed)^2

150 = 0.5 × 2.5 × (speed)^2

2.5 × 100 = 250

150 = 0.5 × 250 × (speed)^2

0.5 × 250 = 125

150 ÷ 125 = 1.2

1.2^2 = 1.44

Maximum possible speed of drone = 1.2 km/s

This student has tried to use the kinetic energy equation but has made several errors along the way and, as a result, does not gain any marks.

The student used an incorrect value for the maximum kinetic energy, so does not score marking point 1.

Although a correct substitution of 150 J into the kinetic energy equation is shown in line 2 of the answer, the student has multiplied the mass by 100 in line 3 and then used the equation with the mass multiplied by 100 (line 4). It is the equation on line 4 that ultimately leads to the student's final answer. As an incorrect value for mass is used here, this is an incorrect substitution, so marking point 2 is not awarded.

On line 6, the student has rearranged the equation to give a value of 1.2, but the answer line demonstrates that the student thinks this is the maximum possible speed of the drone rather than a value for v^2, so marking point 3 is not scored.

The common mistake of squaring the calculated value of v^2 can be seen on line 7, but the student has chosen to ignore this line of reasoning when giving the final answer. The student has not attempted to convert the calculated speed of 1.2 m/s to km/s.

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Answer 12 · Examiner comments

June 2024 | 8464/P/2H | Original Q2

Question 2 (standard demand)

02.1 This question was more demanding than expected, with 40% of students able to gain any marks, although half of these students scored 2 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 terms of transfers or transformations: this is the only way students were able to score marks on this question.

02.2 Nearly 90% of students did the calculation correctly and gained 2 of the 4 marks. Most of the students that scored 3 marks got the unit correct but missed the conversion of centimetres to metres. Less than 50% of students gave the correct unit, some clearly under the impression that elastic potential energy has a different unit from energy.

02.3 A little under 50% of students were able to gain a mark for suggesting that the length of the spring should be measured before and after it is compressed. Of those that did, approximately half suggested subtracting the two measured values for the second mark.

02.4 Approximately 30% 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. 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.

02.5 Just under 80% 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.

02.6 About three-quarters of students correctly determined Δx. The most common incorrect answer was 0.52.

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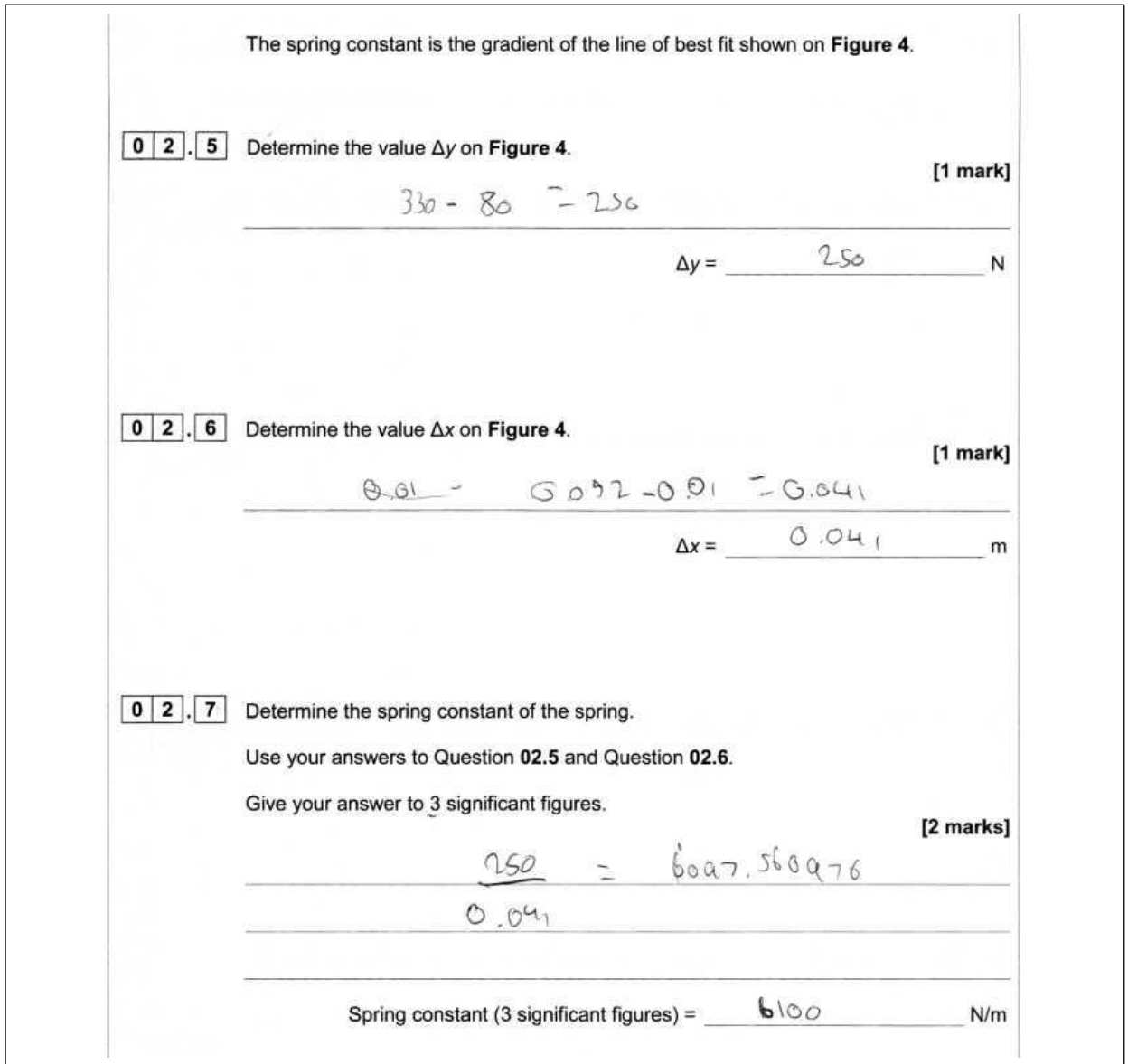
6.1.1.2 Changes in energy

Answer 12 · Examiner comments June 2024 | 8464/P/2H | Original Q2

02.7 This question was reasonably well answered, with 75% of students gaining at least 1 mark. The error carried forward (ecf) meant that students could use their answers from questions 02.5 and 02.6 and many students were able to gain 2 marks for doing so even if their previous answers were wrong.

About 20% of students were able to do the calculation correctly but then couldn't give the answer to 2 significant figures. An answer of 595 was frequently seen.



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

$\Delta y =$ 250 N

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

0.01 - 0.092 - 0.01 = 0.041

$\Delta x =$ 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 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.

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