AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.5.4.1.2

Speed

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**29**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

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

6.5.4.1.2 Speed

Answer 01 · Mark scheme

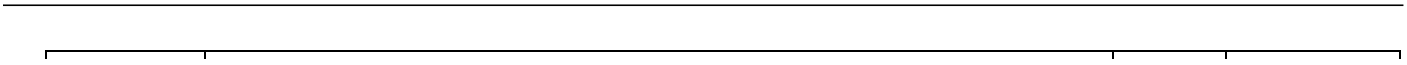
June 2018 | 8464/P/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	electron atom nucleus orbit		1 1 1 1	AO1 6.4.1.3 5.1.1.3
01.2	positive charge is provided by protons (every atom of the same element contain the) same number of protons	 do **not** accept same number of protons and neutrons ignore reference to electrons	1 1	AO1 6.4.1.2 6.4.1.3
01.3	 $v = 300\ 00\ 000 \times \left(\frac{7}{100}\right)$ v = 21 000 000 (m/s)	an answer of 21 000 000 scores **2** marks allow any correct method of determining 7% of 300 000 000 allow 2.1×10^7 (m/s)	 1 1	AO2 6.4.1.3
01.4	 $r = 6 \times 2.5 \times 10^{-11}$ $r = 1.5 \times 10^{-10}$ (m)	an answer in the range 1.4×10^{-10} to 1.6×10^{-10} scores **2** marks allow a ratio in the range of 5.7–6.3 or measurements that would give this range, correctly substituted allow 1.4×10^{-10} to 1.6×10^{-10} their ratio $\times 2.5 \times 10^{-11}$ correctly calculated scores **1** mark	 1 1	AO2 6.4.1.1
Total			**10**	

6.5.4.1.2 Speed

Answer 01 · Mark scheme

June 2018 | 8464/P/1H | Original Q1



6.5.4.1.2 Speed

Answer 02 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	in a longitudinal wave, the oscillations / vibrations are parallel to the direction of energy transfer	allow direction of travel for energy transfer	1	AO1 6.6.1.1
	in a transverse wave, the oscillations / vibrations are perpendicular to the direction of energy transfer	allow direction of travel for energy transfer	1	
		if no other mark scored allow **1** mark for (oscillations / vibrations of) longitudinal waves are parallel **and** (oscillations / vibrations of) transverse waves are perpendicular		
		if no other mark scored allow **1** mark for transverse waves have peaks and troughs **and** longitudinal waves have compressions and rarefactions		
05.2		an answer of 0.063 (m) scores **3** marks		AO2 6.6.1.2
	$3.0 \times 10^8 = 4.8 \times 10^9 \times \lambda$	allow $\lambda = \frac{3.0 \times 10^8}{4.8 \times 10^9}$	1	
		this mark may be awarded if the standard form values are incorrectly converted		
	$\lambda = 0.0625$ (m)		1	
	$\lambda = 0.063$ (m) **or** $\lambda = 6.3 \times 10^{-2}$ (m)	allow an answer to 2 sig figs that is consistent with their calculated value of λ and has required rounding	1	

6.5.4.1.2 Speed

Answer 02 · Mark scheme

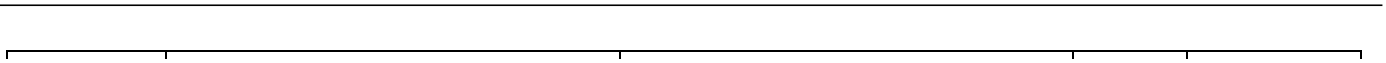
June 2018 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	any **three** from: • (the car aerial) absorbs radio waves or energy • electrons are made to vibrate (in the aerial) • creating an alternating current (in the aerial circuit) • the (signal) frequency is the same (as the radio wave)		3	AO1 6.6.2.3
Total			**8**	

6.5.4.1.2 Speed

Answer 02 · Mark scheme

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



6.5.4.1.2 Speed

Answer 03 · Mark scheme

June 2018 | 8464/P/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	either: 7.5 (m) **and** 12.3 (m) from the graph **or** 15 (m/s) × 0.32 (s) using speed extra distance = 4.8 (m)	an answer between 4.7 (m) and 4.9 (m) scores **2** marks allow 7.5 (m) and between 12.2 (m) and 12.4 (m)	1 1	AO2 6.5.4.3
06.2	there is a decrease in kinetic energy of the car so this (causes) the internal / thermal energy store of the brakes to increase	allow work is done by friction (on the brakes)	1 1	AO1 6.1.1.1 6.5.4.3.4
06.3	$19^2 - u^2 = 2 \times 2 \times 84$ $u^2 = 19^2 - (2 \times 2 \times 84)$ u = 5 (m/s)	an answer of 5 (m/s) scores **3** marks $u = \sqrt{19^2 - (2 \times 2 \times 84)}$	1 1 1	AO2 6.5.4.1.5

6.5.4.1.2 Speed

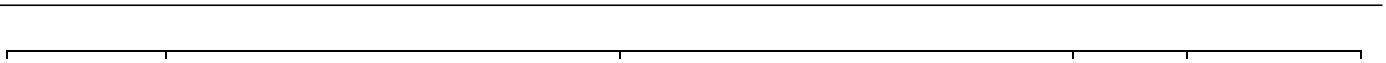
Answer 03 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
06.4	**Level 3:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	5–6	AO3
	Level 2: Scientifically relevant facts, events or processes are identified and their relevance is clear. The account is not fully accurate.	3-4	AO1 AO3
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–2	AO1
	No relevant content	0	
	Indicative content • use of drugs, alcohol, tiredness and distractions would increase the thinking distance • thinking distance increases with speed • thinking distance is directly proportional to speed • use of drugs, alcohol, tiredness and distractions would increase the gradient of thinking distance • poor brakes, poor tyres, wet / icy roads and mass would increase the braking distance • braking distance increases with speed • braking distance increases at an increasing (accept greater) rate (with speed) • poor brakes, poor tyres, wet/icy roads and mass would increase the gradient of braking distance • braking distance is directly proportional to speed squared • stopping distance = thinking distance + braking distance • factors that increase thinking and / or braking distance would increase the gradient of stopping distance • stopping distance increases at an increasing (accept greater) rate (with speed)		6.5.4.3.1
Total			**13**

6.5.4.1.2 Speed

Answer 03 · Mark scheme

June 2018 | 8464/P/2H | Original Q6



6.5.4.1.2 Speed

Answer 04 · Mark scheme

June 2019 | 8464/P/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.1	(4 - 0) + (10 - 7) **or** 4 + 3 **or** 10 - 3 7 (s)	an answer of 7 (s) gains **2** marks	1 1	AO2 6.5.4.1.5	E
01.2	gradient = $\frac{0-2}{24-14}$ (-)0.2 (m/s^2)	an answer of 0.2 (m/s^2) gains **2** marks allow readings from any two points correctly substituted allow correct use of $a = \frac{\Delta v}{t}$	1 1	AO2 6.5.4.1.5	E
01.3	(there are no wires) to get tangled / disconnected	allow easier to move arms allow wires are inconvenient allow easier to transfer data	1	AO3 6.6.2.4	E
01.4	wave speed = frequency × wavelength	allow v = f λ allow any correct re-arrangement	1	AO1 6.6.1.2	E
01.5	300 000 000 = 2 400 000 000 × λ λ = $\frac{300\,000\,000}{2\,400\,000\,000}$ λ = 0.125 (m)	an answer of 0.125 (m) or 0.13 (m) scores **3** marks allow λ = 0.13 (m)	1 1 1	AO2 6.6.1.2	E
01.6	range is far enough (for most uses) power is not too great so the battery will not drain quickly	allow power not too great so the phone will not overheat allow the range per milliwatt is greatest or 4 metres	1 1	AO3 6.6.2.4	E

6.5.4.1.2 Speed

Answer 04 · Mark scheme

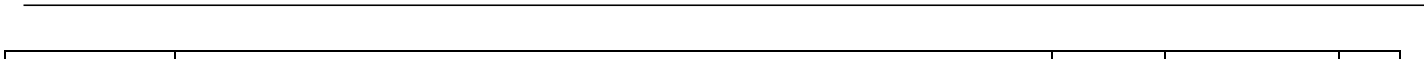
June 2019 | 8464/P/2H | Original Q1

Total			**11**		

6.5.4.1.2 Speed

Answer 04 · Mark scheme

June 2019 | 8464/P/2H | Original Q1



6.5.4.1.2 Speed

Answer 05 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.	ID
02.1	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.6.1.2	E
	Level 2: The design/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 design/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 • If two quantities have been determined, v = f λ can be used to find the third. **Frequency** • use a stopclock • count the number of waves passing a point in a fixed time period • divide the time by the number of waves to determine the time for one wave, T • f = 1/T • read the frequency off the oscillator **Wavelength** • use a camera to freeze the image • use a metre rule to measure the distance between two wavefronts • count the number of waves between the wavefronts • divide distance by the number of waves to determine λ **Velocity** • determine a mean value of frequency • determine a mean value of wavelength • measure the time it takes one wavefront to travel the length of the screen • measure the length of the screen • speed = distance / time to access Level 3 there must be a description of how frequency, wavelength and velocity can be determined			

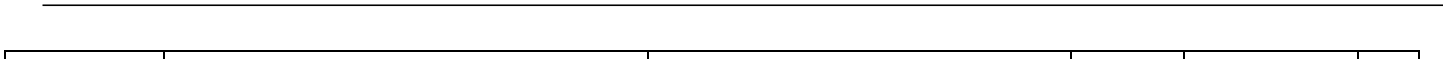
6.5.4.1.2 Speed

02.2	(the duck) moves perpendicular to the direction of wave travel	duck moves up and down is insufficient	1	AO2 6.6.1.1	E
02.3	mean maximum height = 511 **and** mean minimum height = 500 511 – 500 = 11 11 / 2 = 5.5 (mm)	an answer of 5.5 gains **3** (mm) marks allow a calculated difference from incorrect means allow their difference divided by 2 any correct method of determining the mean amplitude can score **3** marks	1 1 1	AO2 6.6.1.2	E
Total			**10**		

6.5.4.1.2 Speed

Answer 05 · Mark scheme

June 2019 | 8464/P/2H | Original Q2



6.5.4.1.2 Speed

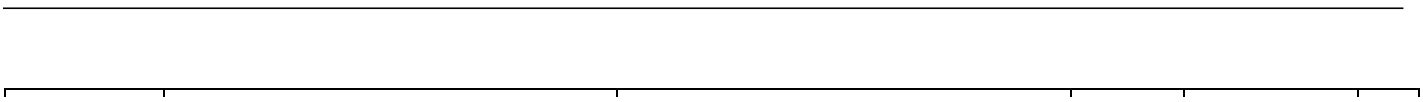
Answer 06 · Mark scheme

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**		

6.5.4.1.2 Speed

Answer 06 · Mark scheme

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



6.5.4.1.2 Speed

Answer 07 · Mark scheme

June 2019 | 8464/P/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
7.1	speed / velocity in the glass is lower	speed / velocity changes is insufficient allow the refractive index of glass is higher than that of air allow glass has a higher optical density than air	1	AO1 6.6.2.2	E
	so the edge of the wave(front) entering the glass slows down		1		
	but the part of the wave(front) in the air continues at the higher speed / velocity (causing a change in direction)		1		
7.2	correct ray in the prism bent towards the normal		1	AO1 6.2.2.2	E
	second normal at 90° at the point the ray emerges		1		
	correct emergent ray bent away from the normal	this mark can be awarded without a normal line drawn	1		
7.3	violet has the shortest wavelength (400 nm)		1	AO3 6.2.2.2	E
	violet light travels the slowest in water		1		
	violet light undergoes the greatest change in speed (and direction)		1		
Total			9		

6.5.4.1.2 Speed

Answer 08 · 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	

6.5.4.1.2 Speed

Answer 09 · Mark scheme

November 2020 | 8464/P/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(vector quantity) has magnitude and a direction (scalar quantity) has magnitude only		1 1	AO1 6.5.4.1.3
04.2	resistive force acts on the ball so (resultant) force in opposite direction to velocity **or** so work is done on the ball	allow friction or air resistance	1 1	AO2 6.5.4.2.1
04.3	momentum = mass × velocity or p = mv		1	AO2 6.5.5.1
04.4	26 = m × 5.0 $m = \frac{26}{5.0}$ 5.2 (kg)		1 1 1	AO2 6.5.5.1
04.5	momentum is conserved in the collision (assuming no external forces) momentum of the pin increases therefore the momentum of the ball must decrease.	if no other mark is awarded, allow **1** mark for when the ball exerts a force on the pin, the pin	1 1 1	AO1 6.5.5.2

6.5.4.1.2 Speed

Answer 09 · Mark scheme

November 2020 | 8464/P/2H | Original Q4

		exerts an equal and opposite force on the ball		
Total			**11**	

6.5.4.1.2 Speed

Answer 10 · Mark scheme

November 2020 | 8464/P/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	$13.5 \times \frac{2}{3}$ 9.0 (m/s) OR $13.5 \times \frac{1}{3} = 4.5$ (1) 13.5 - 4.5 = 9.0 (m/s) (1)	 allow 9 (m/s)	1 1	AO2 6.5.4.3
06.2	reduced speed reduces stopping distance means less chance of collision **OR** the car will have less kinetic energy (1) so less likely to cause injury in the event of a collision (1)	allow reduces thinking / braking distance	1 1	AO1 6.5.4.3.2 6.5.4.3.3
06.3	$14 = v \times 0.70$ $v = \frac{14}{0.70}$ v = 20 (m/s) $0^2 – 20^2 = 2 \times (–6.25) \times s$ $s = \frac{20^2}{(2 \times 6.25)}$ s = 32 (m)	 ignore minus signs throughout	1 1 1 1 1 1	AO2 6.5.4.1.2 6.5.4.1.5

6.5.4.1.2 Speed

Answer 10 · Mark scheme

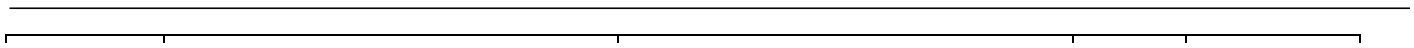
November 2020 | 8464/P/2H | Original Q6

06.4	same maximum force applied by the brakes because mass is less there is a greater deceleration braking distance is less **OR** reducing the mass reduced the kinetic energy of the van (at a given speed) (1) less work needed to be done to bring the van to a stop (1) (force from the brakes is the same) so braking distance is less (1)	allow momentum for mass	1 1 1	AO2 AO1 AO1 6.5.2
Total			**13**	

6.5.4.1.2 Speed

Answer 10 · Mark scheme

November 2020 | 8464/P/2H | Original Q6



6.5.4.1.2 Speed

Answer 11 · 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

6.5.4.1.2 Speed

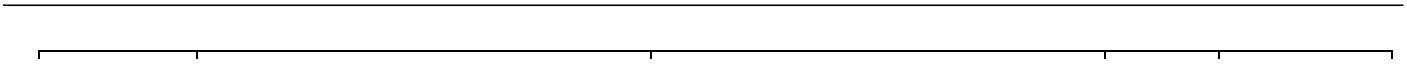
Answer 11 · Mark scheme

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	$19600 = 8000 \times 9.8 \times \Delta h$ $\Delta h = \frac{19\,600}{8000 \times 9.8}$ $\Delta h = 0.25$ m		1 1 1	AO2 6.1.1.2
Total			**12**	

6.5.4.1.2 Speed

Answer 11 · Mark scheme

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



6.5.4.1.2 Speed

Answer 12 · Mark scheme

November 2021 | 8464/P/2H | Original Q3

Question	Answers	Mark	AO / Spec. Ref.
03.1	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO1 6.6.1.2
	Level 1: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	1–2	
	No relevant content	0	
	Indicative content **Wavelength** • place a metre rule at the side of the screen perpendicular to the wave fronts • use the metre rule to measure the length of the screen • take a photograph of the shadow on the screen • count the number of complete waves on the screen • determine the wavelength by dividing the length of the by the number of complete waves **or** • place a metre rule at the side of the screen perpendicular to the wave fronts • take a photograph of the shadow on the screen • use the metre rule to measure the distance between two wave front **Frequency** • count the number of waves that pass a given point • time how long it takes for the waves to pass that point using a stop clock • frequency is number of waves divided by time taken **or** • put a stop clock on the screen • use a digital video camera to record the waves passing a point • replay in slow motion and count the number of waves passing a point in 1 second There must be a description of both frequency and wavelength measurement to access level 2		

6.5.4.1.2 Speed

Answer 12 · Mark scheme

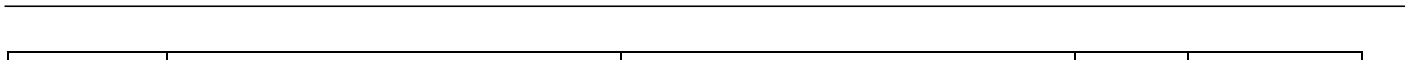
November 2021 | 8464/P/2H | Original Q3

03.2	mean f = 9.5 Hz mean λ = 0.020 m v = 9.5 × 0.020 v = 0.19 (m/s) **or** v = 9.8 × 0.017 **and** v = 9.4 × 0.022 **and** v = 9.3 × 0.021 (2) $v = \frac{(1.67 + 2.07 + 1.95)}{3}$ (1) v = 0.19 (m/s) (1)	 allow a correct substitution of an incorrect value of mean frequency and/or wavelength allow a correct calculation using an incorrect value of mean frequency and/or wavelength allow a maximum of **2** marks if a single pair of values is used	1 1 1 1 <

6.5.4.1.2 Speed

Answer 12 · Mark scheme

November 2021 | 8464/P/2H | Original Q3



6.5.4.1.2 Speed

Answer 13 · 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

6.5.4.1.2 Speed

Answer 13 · Mark scheme

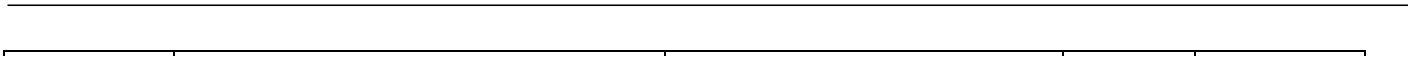
November 2021 | 8464/P/2H | Original Q5

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**	

6.5.4.1.2 Speed

Answer 13 · Mark scheme

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



6.5.4.1.2 Speed

Answer 14 · 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

6.5.4.1.2 Speed

Answer 14 · Mark scheme

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**	

6.5.4.1.2 Speed

Answer 15 · Mark scheme

June 2022 | 8464/P/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	**A** = rarefaction **B** = wavelength		1 1	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	f = 4000 Hz		1	AO2
	$T = \frac{1}{4000}$	allow a correct substitution using an incorrectly / not converted value of f	1	AO2
	T = 0.00025	allow a correct calculation using an incorrectly / not converted value of f	1	AO2
	seconds **or** s		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	wave speed = frequency × wavelength **or** $v = f\lambda$		1	AO1 6.6.1.2

6.5.4.1.2 Speed

Answer 15 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$v = 348$	allow a value in the range 347 to 348 subsequent marks may only be awarded if value for v is in the range 343 to 349	1	AO2 6.6.1.2
	$348 = 300 \times \lambda$	allow a correct substitution using an incorrect value of v read from graph	1	
	$\lambda = \frac{348}{300}$	allow a correct rearrangement using an incorrect value of v read from graph	1	
	1.16 (m)	allow 1.2 (m) allow a correct calculation using an incorrect value of v read from graph allow a maximum of **2** marks for use of $v = 330$ m/s	1	

Total Question 1		**11**

6.5.4.1.2 Speed

Answer 16 · Mark scheme

June 2022 | 8464/P/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	work done = force × distance (along the line of action of the force) **or** $W = F\ s$		1	AO1 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	3 360 000 = F × 42 000 $F = \frac{3\ 360\ 000}{42\ 000}$ F = 80 (N)		1 1 1	AO2 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	distance travelled = speed × time		1	AO1 6.5.4.1.5

6.5.4.1.2 Speed

Answer 16 · Mark scheme

June 2022 | 8464/P/2H | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	42 000 = v × 5600 $v = \frac{42\,000}{5600}$ v = 7.5 (m/s)		1 1 1	AO2 6.5.4.1.2

6.5.4.1.2 Speed

Answer 16 · Mark scheme

Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 6.5.4.1.2
	Level 1: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	1–2	
	No relevant content	0	
	Indicative content the effect on speed must be consistent with the cause of the change • competitors accelerate at the start • so speed increases • the road is not flat • so speed increases going downhill and / or speed decreases going uphill • the competitor goes round a bend • so speed decreases • competitors may tire towards the end (so the force they exert decreases) • so they slow down • competitors may sprint during the race • causing speed to increase • may get a puncture • so speed would decrease or they would stop • resistive forces on competitors may increase/decrease • so speed would decrease/increase		

Total Question 2		**12**

6.5.4.1.2 Speed

Answer 17 · 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

6.5.4.1.2 Speed

Answer 18 · Mark scheme

June 2023 | 8464/P/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	peer review		1	AO1 6.4.2.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	it is ionising	ignore references to penetrating ability	1	AO1 6.4.2.4 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	becquerel / Bq		1	AO1 6.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	not all the radiation emitted (by the sample) is detected (because) the radiation spreads out **or** (because) some radiation is absorbed before reaching the detector **or** (because) some of the radiation entering the detector is **not** detected	 allow because the radiation is emitted in all directions	1 1	AO1 6.4.2.1

6.5.4.1.2 Speed

Answer 18 · Mark scheme

June 2023 | 8464/P/1H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	alpha radiation		1	AO1 6.4.2.1
	because the radiation is not detected beyond 5 cm **or** because alpha radiation cannot travel 10 cm (in air) **or** because beta **and** gamma radiation would be detected at 10 cm	dependent on MP1 allow because alpha radiation cannot travel more than a few cm (in air)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	60 minutes is 4 half-lives	allow 15 minutes is 1 half-life allow 1568 → 784 → 392 → 196 → 98 allow $\frac{1568}{98} = 2^4$ allow $\frac{98}{1568} = \frac{1}{2^4}$	1	AO3 6.4.2.3
	30 minutes is 2 half-lives		1	
	X = 392		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	radioactive decay is a random process		1	AO1 6.4.2.3

Total Question 4	11

6.5.4.1.2 Speed

Answer 19 · Mark scheme

June 2023 | 8464/P/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	(air) particles move faster **or** (air) particles have increased kinetic energy		1	AO1 6.3.3.1
	(so air) particles collide more frequently with the wall / chamber **or** (so air) particles collide with more force with the wall / chamber		1	
	(so) the pressure increases	dependent on MP1 or MP2	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	(metals) have a high(er) thermal conductivity	allow metals are good/better (thermal) conductors	1	AO1 6.1.2.1
	which allows a greater rate of (thermal) energy transfer	allow (thermal) energy is transferred more quickly	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	(a low) specific heat capacity		1	AO1 6.1.1.3 6.3.2.2

6.5.4.1.2 Speed

Answer 19 · Mark scheme

June 2023 | 8464/P/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	any **one** from: • lubrication • use hotter coffee • decrease the temperature of the surroundings	allow oil the device/wheel	1	AO3 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	$1.1 \times 10^3 = \frac{\text{mass}}{1.9 \times 10^{-4}}$		1	AO2 6.1.1.3 6.3.2.2 6.3.1.1
	mass = 0.209 (kg)	allow m = $1.9 \times 10^{-4} \times 1.1 \times 10^3$ the equation density = $\frac{\text{mass}}{\text{volume}}$ must have been used to score subsequent marks	1	
	15 000 = 0.209 × 4200 × Δθ	allow a correct substitution using their calculated value of mass	1	
	$\Delta\theta = \frac{15\,000}{0.209 \times 4200}$	allow a correct re-arrangement using their value of mass and/or an incorrectly / not converted energy value	1	
	Δθ = 17(.088…)	allow a correct calculation using their value of mass and / or an incorrectly / not converted energy value	1	
	final temperature (= 76 – 17.088) = 59 (°C)	allow 58.9… (°C) allow an answer consistent with their value of mass and / or an incorrectly / not converted energy value	1	

Total Question 6	13

6.5.4.1.2 Speed

Answer 20 · Mark scheme

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

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	**A** radio waves **B** microwaves **C** X-rays	allow **1** mark if 2 correct	2	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	**Similarity** any **one** from: • same speed (in a vacuum) • both transfer energy • both transverse **Difference** any **one** from: • gamma has a higher frequency • gamma has a shorter wavelength • gamma is more ionising • gamma is more penetrating	allow both can travel through a vacuum allow both are ionising allow both can harm living tissue allow both can be used for medical treatment / imaging allow gamma has more energy	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	refraction		1	AO1 6.6.2.2

6.5.4.1.2 Speed

Answer 20 · Mark scheme

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	wave speed = frequency × wavelength **or** $v = f \lambda$		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	$3.0 \times 10^{8} = f \times 5.0 \times 10^{-7}$ $f = \frac{3.0 \times 10^{8}}{5.0 \times 10^{-7}}$ $f = 6 \times 10^{14}$ (Hz)	 allow a correct rearrangement using incorrect powers of 10 allow a correct calculation of f using incorrect powers of 10 allow 6.0×10^{14} (Hz)	1 1 1	AO2 6.6.1.2

Total Question 1	9

6.5.4.1.2 Speed

Answer 21 · Mark scheme

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

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$a = \frac{26 - 0}{5.25 - 2.0}$	allow any pair of correct points substituted allow ± half a small square for reading of time	1	AO2 6.5.4.1.5
	$a = 8$	allow 8.0 allow a correct calculation using their acceptable values from the graph ignore any minus sign	1	
	m/s^2		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2		allow ecf for acceleration and initial velocity from question **07.1**		
	thinking distance			
	$s = 26 \times 0.75$	to award MP1 and MP2 a time of 0.75 must have been used	1	AO3
	$s = 19.5$ (m)		1	AO2
	braking distance			
	$s = \frac{(5.25 - 2.0) \times 26}{2}$ **or** $s = \frac{26^2 - 0^2}{2 \times 8.0}$	allow a range of 5.2 to 5.3 for final time	1	AO3
	$s = 42.25$ (m)		1	AO2
		marks for thinking distance and braking distance may be awarded independently		
	stopping distance			
	$s = 19.5 + 42.25 = 61.75$ (m)	for this mark to be awarded both the thinking distance and braking distance must have been calculated using correct equations allow an answer correctly rounded to 2 or 3 sig figs	1	AO2 6.5.4.1.5

6.5.4.1.2 Speed

Answer 21 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	the brakes can overheat		1	AO1 6.5.4.3.4
	(so) the brakes will not work properly	dependent on MP1	1	
	OR			
	can lead to loss of control (1)	allow the car may skid		
	(because) the tyres lose traction / grip (1)	dependent on MP1		
	OR			
	the greater the deceleration the greater the force (1)			
	(and) large forces can cause injury (1)	dependent on MP1		
		ignore accidents and crashes throughout		

Total Question 7	10

6.5.4.1.2 Speed

Answer 22 · Mark scheme

June 2024 | 8464/P/1H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	kinetic energy (of the beater / food) internal / thermal energy (of the surroundings / whisk / food)	ignore sound	1 1	AO1 6.2.4.2 6.1.2.1 6.1.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	power = $\frac{\text{work done}}{\text{time}}$ or $P = \frac{W}{t}$		1	AO1 6.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$92 = \frac{23\,000}{\text{time}}$ $\text{time} = \frac{23\,000}{92}$ 250 (s)		1 1 1	AO2 6.1.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	$P = I^2 R$		1	AO1 6.2.4.1

6.5.4.1.2 Speed

Answer 22 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	I = 0.500 A		1	AO2 6.2.4.1
	$P = 0.500^2 \times 640$	allow a correct substitution of an incorrectly / not converted current	1	
	P = 160 (W)	allow a correct calculation using an incorrectly / not converted current	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	230 (V)		1	AO1 6.2.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.7	decreases		1	AO1 6.2.4.1

Total Question 1	12

6.5.4.1.2 Speed

Answer 23 · Mark scheme

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

6.5.4.1.2 Speed

Answer 23 · 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

6.5.4.1.2 Speed

Answer 24 · Mark scheme

June 2024 | 8464/P/2H | Original Q1

Question 1

Question	Answers	Mark	AO / Spec. Ref.
01.1	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	3–4	AO1 6.6.1.2 RPA20
	Level 1: The method 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 • use the signal generator to adjust the frequency • keep the number of masses the same • move the wooden bridge • observe a steady / stationary wave pattern • use the metre rule to measure the wavelength • repeat using different values of frequency • repeat for different stationary wave patterns		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	$v = f \times \lambda$		1	AO1 6.6.1.2

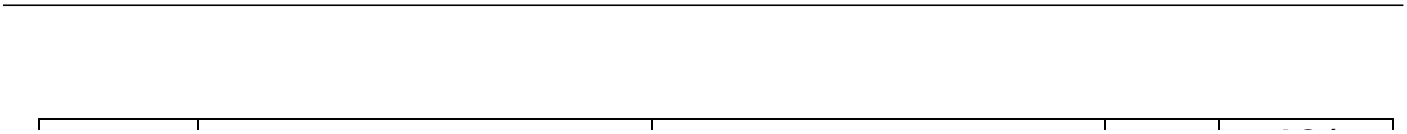
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	$35.1 = 45.0 \times \lambda$		1	AO2 6.6.1.2
	$\lambda = \frac{35.1}{45.0}$		1	
	$\lambda = 0.78$	allow 0.780	1	

Total Question 1	8

6.5.4.1.2 Speed

Answer 24 · Mark scheme

June 2024 | 8464/P/2H | Original Q1



6.5.4.1.2 Speed

Answer 25 · Mark scheme

June 2024 | 8464/P/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	$5.8 = \frac{\Delta v}{2.5}$		1	AO2 6.5.4.1.5
	$\Delta v = 5.8 \times 2.5$		1	
	$\Delta v = 14.5$		1	
	$v = (20 - 14.5) = 5.5$ (m/s)	allow use of an incorrectly calculated Δv if the correct equation has been used	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	multiply the speed of the car by the reaction time		1	AO3 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	braking distance $\propto$ speed^2		1	AO3 6.5.4.3.4

6.5.4.1.2 Speed

Answer 25 · Mark scheme

June 2024 | 8464/P/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	6250 = m × 5.0		1	AO2 6.5.4.2.2
	$m = \frac{6250}{5.0}$		1	6.5.5.1
	m = 1250 (kg)		1	
	v = 12 (m/s)		1	
	p = 1250 × 12	allow a substitution using a value of v in the range 11.8 to 12.2 allow a correct substitution using their incorrectly calculated value for m using the correct equation	1	
	p = 15 000 (kgm/s)	allow a calculation using a value of v in the range 11.8 to 12.2 allow a correct calculation using their incorrectly calculated value for m using the correct equation	1	

Total Question 5	12

6.5.4.1.2 Speed

Answer 26 · 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

6.5.4.1.2 Speed

Answer 27 · Mark scheme

June 2025 | 8464/P/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	$(0^2 -)\ 18^2 = 2 \times a \times 24$	allow $18^2 = 2 \times a \times 24$	1	AO2 6.5.4.1.5
	$a = \frac{(-)18^2}{2 \times 24}$		1	
	$a = (-)\ 6.75\ (m/s^2)$	allow $(-)\ 6.8\ (m/s^2)$	1	

6.5.4.1.2 Speed

Answer 27 · Mark scheme

June 2025 | 8464/P/2H | Original Q2

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	6.5.4.2.2 6.5.4.3.1 6.5.4.3.3 6.5.4.3.4
	Indicative Content **Thinking distance** • condition of brakes and tyres does not affect thinking distance • speed does not affect thinking / reaction time • decreased speed decreases thinking distance **Braking distance** • condition of tyres affects friction between tyres and road • poor condition of tyres and brakes increases braking distance • decreased speed decreases braking distance **safety** • stopping distance = thinking distance + braking distance • poor condition of brakes and tyres increases stopping distance • decreased speed decreases stopping distance • decreased speed decreases the chance of the driver losing control of the vehicle • decreased speed decreases the chance of a collision • decreased speed decreases the risk of injury during a collision for **Level 3,** answers must include references to brakes / tyres, speed, thinking distance, braking distance, and safety.		

6.5.4.1.2 Speed

Answer 27 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	frictional / braking force is greater (for the faster car) **or** the faster car has more kinetic energy		1	AO1
	(so) more work done (by the brakes to stop the faster car)	allow so more energy is transferred (by the brakes to stop the faster car) ignore more heating	1	AO3
	(so) the risk of the brakes overheating is greater (for the fast car)	allow (at greater speed) there is a risk of overheating MP3 dependent on MP1 or MP2	1	AO3 6.5.4.3.4

Total Question 2	12

6.5.4.1.2 Speed

Answer 28 · Mark scheme

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

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	oscillations / vibrations are perpendicular to the direction of energy transfer	allow oscillations / vibrations are perpendicular to the direction of wave travel allow **1** mark for oscillations/ vibrations are perpendicular	2	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	skin cancer **or** causes skin to age (prematurely)	allow skin cell mutation ignore cancer unqualified	1	AO1 6.6.2.3

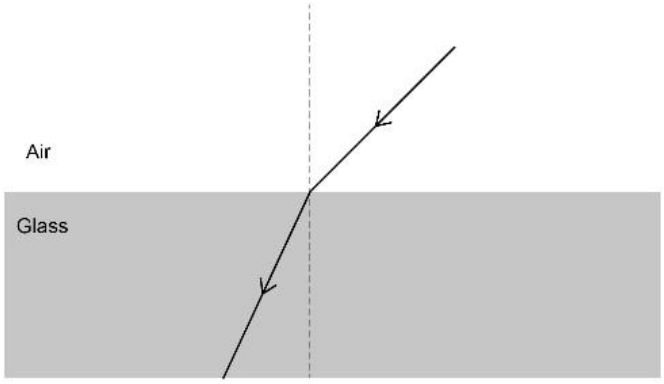
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	shorter		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$3.00 \times 10^{8} = 6.25 \times 10^{14} \times \lambda$ $\lambda = \frac{3.00 \times 10^{8}}{6.25 \times 10^{14}}$ $\lambda = 4.80 \times 10^{-7}$ (m) $\lambda = 480$ (nm)	 allow a correct conversion to nm of their incorrectly calculated value of λ using the numbers from the question	1 1 1 1	AO2 6.6.1.2

6.5.4.1.2 Speed

Answer 28 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	the speed of the light / waves / wavefronts decreases (when entering the lens) (so) one end of the wavefront slows before the other end	allow the speed of light / waves / wavefronts is less in the lens (than in air) ignore lens has a higher density than air ignore references to refractive index	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	normal line drawn ray drawn with an angle of refraction of 28°  ignore ray below the glass	allow a normal line that only extends from the boundary into the glass	1 1	AO2 6.6.2.2

Total Question 3	12

6.5.4.1.2 Speed

Answer 29 · Mark scheme

June 2025 | 8464/P/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	athlete's swimming speed = typical walking speed		1	AO1 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	time taken = 1400	subsequent marks may be awarded if time taken is determined from the graph	1	AO3 6.5.2 6.5.4.1.5
	mean speed = $\frac{7.5 + 6.2}{2}$ (= 6.85 m/s)	allow mean speed calculated using a maximum speed between 7.4 m/s and 7.6 m/s	1	
	distance (= 6.85 × 1400) = 9590 (m)	allow a distance consistent with their calculated mean speed subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance	1	
	110 000 = F × 9590		1	
	$F = \frac{110\,000}{9590}$		1	
	F = 11(.470…) (N)		1	

6.5.4.1.2 Speed

06.2 cont.	**OR**			
	time taken = 1400 (1) area of triangle (1) = 0.5 × 1400 × (7.5 - 6.2) (= 910) **and** area of rectangle = 1400 × 6.2 (= 8680) distance (1) (= 910 + 8680) = 9590 (m) 110 000 = F × 9590 (1) $F = \frac{110\,000}{9590}$ (1) F = 11(.470…) (N) (1)	subsequent marks may be awarded if time taken is determined from the graph allow area calculated using a maximum speed between 7.4 m/s and 7.6 m/s allow a distance consistent with their calculated areas subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance		

6.5.4.1.2 Speed

06.2 cont.	**OR**			
	time taken = 1400 (1) acceleration= $\frac{6.2 - 7.5}{1400}$ (1) (= (-)0.00092857…) distance (1) $\left(= \frac{6.2^2 - 7.5^2}{(-)2 \times 0.00092857 \ldots}\right)$ = 9590 (m) 110 000 = F × 9590 (1) $F = \frac{110\ 000}{9590}$ (1) F = 11(.470…) (N) (1)	subsequent marks may be awarded if time taken is determined from the graph allow acceleration calculated using a maximum speed between 7.4 m/s and 7.6 m/s subsequent marks may be awarded if their calculated value for acceleration is rounded allow a distance consistent with their calculated acceleration subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance		

6.5.4.1.2 Speed

Answer 29 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	constant magnitude (of velocity)	allow speed was constant allow speed was 4 m/s allow (magnitude of) velocity was 4 m/s do **not** accept constant velocity	1	AO2
	direction (of velocity) kept changing		1	AO1
		if no other mark awarded allow **1** mark for the velocity is constantly changing		6.5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	the gradient is equal to the deceleration / acceleration		1	AO3 6.5.4.1.5
	(and) the (magnitude of the) gradient increased		1	

Total Question 6	11

6.5.4.1.2 Speed

Answer 01 · Examiner comments

June 2018 | 8464/P/1H | Original Q1

Question 1 (Standard demand)

01.1 This question required students to label diagrams with given labels and the majority gained all 4 marks.

01.2 59% of students scored zero on this item. Of the students who gained 1 mark, this was usually for identifying that a proton has a positive charge. Many answers were ambiguous.

01.3 Students were required to calculate 7 per cent of the speed of light and many students managed to do this from either multiplying by 0.07, by 7/100, or by finding 10%, 5% and 1% or similar and adding appropriately. Occasionally the latter method led to a wrong answer because adding large numbers with plenty of zeros it was possible to slip a zero somewhere and so only the method mark was gained.

The most common mistake arose when students simply multiplied 300,000,000 by 7. Problems arose when students either used a totally incorrect method, struggled with the arithmetic, or then went on to calculate 93% instead. A fifth of students scored zero marks.

01.4 Nearly 40% of students scored a mark on this question with 27% scoring two marks.

The range of values acceptable for full marks ensured that most students who knew what to do gained the two marks.

A few students obtained an incorrect ratio these could gain one mark if they then calculated correctly with their ratio value. Some students assumed that they needed to measure radii, these students were more likely to get an incorrect ratio with smaller measurements and the centre not clearly defined. Some chose a number to multiply by with no evidence of a ratio attempt, or substituted the 2.5 from the hydrogen radius with a measurement of 7.5 or similar from the magnesium diagram.

Powers of 10 were confusing for weaker students – some changed the 10^{-11} by multiplying, adding or subtracting this power

6.5.4.1.2 Speed

Answer 02 · Examiner comments

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

Question 5 (standard & standard / high demand)

05.1 Nearly 13% gave accurate answers to score both marks. A further 20% were able to score a compensation mark by vague references to parallel and perpendicular, but it was clear that many students do not realise the importance of what is oscillating and the direction of energy transfer. There were many vague incorrect descriptions of 'up and down' and 'side to side'.

05.2 25% gained full marks, and a further 18% gained two marks, usually not giving the answer to two significant figures. There were a large number of responses using an incorrect rearrangement of the equation and generally the use of standard form was not the cause of the errors.

Answer 02 · Examiner comments

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

05.3 This was very poorly done, with just over 1% gaining full marks. There were many vague responses and a significant number of candidates wrote about transverse and longitudinal waves. There was also considerable reference to radio waves being reflected off the ionosphere.

A significant minority of students did not attempt this question which might suggest that they were unfamiliar with the material.

6.5.4.1.2 Speed

Answer 03 · Examiner comments

June 2018 | 8464/P/2H | Original Q6

Question 6 (standard / high & high demand)

06.1 About 30% gained both marks, with fewer than 1% gaining just one mark. There was widespread misreading of the graph, in some cases misreading the scale but in a very large proportion there was little attempt to read between the grid lines.

Those who were successful adopted one of three routes: reading the distance off the graph between the given times; finding the time interval from the data given and reading that off the graph from the origin; using the data from the graph along with distance = speed x time to find the extra distance.

06.2 This was not answered well, with many students simply talking about heat energy, and many of those who referred to kinetic energy talking about kinetic energy in the brakes.

Many students overcomplicated their responses to this question. Over three quarters of students gained no marks.

06.3 This calculation was fairly well done with just over 42% gaining full marks. There were not many able to score compensation marks and so 40% scored zero.

The major problem was the inability to rearrange the equation, and substitution marks were rare as students were trying to substitute into an incorrect equation. A significant minority divided rather than subtracted when moving v^2 from one side of the equation to the other.

06.4 Many students did not grasp that a specific requirement of the question was to include factors that would affect the gradient and only a minority talked about the gradient being altered by factors rather than simply describing the graphs presented.

Lower attaining students described the graphs, often saying that “everyone has stopped by 112 km/h” as this was seen as an end point. Many mentioned factors that would affect each of the distances but the factors were not always attributed to the correct distance. A significant number of students cited factors that affected the stopping distance in their own right.

Fewer than 6% of responses achieved level three.

6.5.4.1.2 Speed

Answer 11 · 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.

Answer 11 · 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.

6.5.4.1.2 Speed

Answer 12 · Examiner comments

November 2021 | 8464/P/2H | Original Q3

Question 3 (standard demand and standard/high demand)

03.1 Over 10% of students did not attempt the question. Very few students demonstrated a good understanding of this Required Practical Activity. Approximately 35% of students were able to suggest an appropriate measurement using correct equipment, but did not give any description of what these measurements were for. Fewer than 10% of students wrote level 2 answers that would produce a valid outcome.

03.2 Nearly 30% of students calculated a mean value for the wavelength and the frequency, and then went on to determine the speed the wave. These students were given 3 marks. Only approximately 5% of students also converted the wavelength from cm to m and were awarded full marks.

Over 30% of students were awarded 1 or 2 marks for a mean calculation or for calculating the speed without calculating means first.

03.3 15% of students correctly gave the advantage of taking repeat readings and then calculating a mean as reducing the effect of random errors. Most incorrect answers stated that it makes the answer more accurate.

03.4 Just under 20% of students scored marks on this question. Most that scored 0 marks did not refer to the information given in the question. Many stated that the deeper the water the slower the wave.

Answer 13 · 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.

6.5.4.1.2 Speed

Answer 13 · 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.

6.5.4.1.2 Speed

Answer 14 · 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.

6.5.4.1.2 Speed

Answer 14 · Examiner comments

Mark Ranges and Award of Grades

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

6.5.4.1.2 Speed

Answer 15 · Examiner comments June 2022 | 8464/P/2H | Original Q1

Question 1 (Standard demand)

01.1 Of the 90% of students that scored marks on this question, the majority were able to identify the wavelength for 1 mark. 35% of students also identified the rarefaction to score 2 marks.

01.2 10% of students scored full marks on this question. 25% of students scored 3 marks, the majority of whom did the conversion, but did not give the unit. 50% of students scored 2 marks on this question, failing to do the conversion or recall the unit.

01.3 Over 99% of students were able to select the correct equation.

01.4 The majority of students understood what was required to answer this question. Nearly 65% of students gained full marks. Some students read the correct value from the graph, but then wrote this as their final answer. Some students just multiplied 300 by 28.

Answer 16 · Examiner comments June 2022 | 8464/P/2H | Original Q2

Question 2 (Standard demand)

02.1 Over 99% of students were able to select the correct equation.

02.2 This was a relatively straight forward calculation, with nearly 90% of students gaining full marks.

02.3 Over 99% of students were able to select the correct equation.

02.4 Over 95% of students gained full marks on this speed calculation.

02.5 30% of students were able write a response that contained logically linked statements. The most common creditworthy responses described competitors getting tired. Of the students that did not get into level 2, most just gave reasons why the speed may change, but did not link this to an increase or decrease in speed.

6.5.4.1.2 Speed

Answer 17 · 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.

6.5.4.1.2 Speed

Answer 18 · Examiner comments

June 2023 | 8464/P/1H | Original Q4

Question 04 (Standard, standard/high and high demand)

04.1 Only about a fifth of students correctly identified peer review as the process. It was common for students to suggest peer assessment, and some students wrote about double-blind trials.

04.2 About 35% of students answered this question correctly. Many students answered by giving a type of radiation (alpha, beta, or gamma) rather than stating a property.

04.3 Just under a quarter of students gave the correct unit. Phonetic spelling was acceptable, but if students abbreviated their answer to Bq, they had to use a capital B and a lower case q.

04.4 About 20% of students scored at least 1 mark on this question. Some suggested the idea of background radiation, which was not relevant to answering the question and is not mentioned on this specification. A number of students confused count-rate with half-life, and some students suggested that the radiation would be too fast for the detector to detect.

04.5 Approximately 55% of students identified that alpha radiation was emitted by the source, but only about a fifth of students could explain how the data showed this. Stating that alpha has a low range in air was too vague to gain the mark. Other answers which were insufficient for the second marking point included that it was alpha because as distance increases the count rate decreases.

04.6 Around a third of students gained all three marks on this calculation, with most other students scoring no marks. It was reasonably common for students to calculate 1568/98, and decide that 16 half-lives had passed, which scored no marks. Another common incorrect answer was to find the value halfway between 1568 and 98.

04.7 Just over 70% of students selected the correct answer, that radioactive decay is a random process.

6.5.4.1.2 Speed

Answer 19 · Examiner comments

June 2023 | 8464/P/1H | Original Q6

Question 06 (Standard, standard/high and high demand)

06.1 Approximately 35% of students scored 2 or 3 marks for their explanation. Explanations of gas pressure need to mention the idea of particles, and those who did not mention particles (or atoms, molecules etc.) scored no marks. Those who did mention the idea of particles often mentioned collisions but did not state that the collisions were between particles and the wall of the container. It was also common for students to say that the number of collisions increased, but not include any reference to rate of collisions or to a time period.

06.2 Slightly more than half the students scored at least 1 mark, although only the best students gained both marks on this question. It was quite common for students to refer to plastic having a lower melting point than metal, which was ignored. A fair number of students contradicted themselves by stating that metal is a good thermal conductor and a good insulator so that it keeps the coffee hot, which gained no credit.

06.3 Only a very small proportion of students identified that the property is (a low) specific heat capacity.

06.4 A little less than 50% of students suggested a valid way to increase the speed.

06.5 Roughly 30% of students scored 2 marks, and just under 25% scored all 6 marks on this extended calculation. About 20% of students gained no marks at all. Most students got as far as calculating the mass of 0.209 kg. The majority of students did not convert 15kJ to J, and many then incorrectly re-arranged the specific heat capacity equation.

6.5.4.1.2 Speed

Answer 19 · Examiner comments

Mark Ranges and Award of Grades

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

6.5.4.1.2 Speed

Answer 20 · Examiner comments

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

Question 1 (Standard demand)

01.1 60% of students correctly identified all three parts of the electromagnetic spectrum and scored both marks. However, 30% of students scored no marks.

01.2 50% of students were able to gain at least one mark on this question. The similarity was more accessible and was how the majority of the 35% that scored one mark got the mark. Many identified that both waves are transverse. For the difference, most students did not refer to a property of electromagnetic waves.

01.3 A little over 65% of students correctly identified that the process is called refraction.

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

01.5 Over 70% of students were able to substitute correctly and give the correct answer to the question, to the correct order of magnitude. Approximately 20% of students correctly rearranged and substituted but did not use their calculator to evaluate the numbers in standard form, so scored 2 marks.

6.5.4.1.2 Speed

Answer 21 · Examiner comments

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

Question 7 (high demand)

07.1 25% of students gained three marks on this question. 20% of students correctly determined the gradient but could not recall the unit for acceleration. A significant number of students knew to calculate the gradient but mis-read the graph and used an initial velocity of 25 m/s.

07.2 5% of students gained full marks on this question. 20% of students gained two marks for correctly calculating the thinking distance. Of the 65% of students that scored zero marks the majority neither attempted to determine the area under the graph or used a correct equation.

07.3 15% of students scored a mark on this question. Most of those that did score a mark wrote that large decelerations could lead to a loss of control.

6.5.4.1.2 Speed

Mark Ranges and Award of Grades

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

Answer 22 · Examiner comments

June 2024 | 8464/P/1H | Original Q1

Question 1 (standard demand)

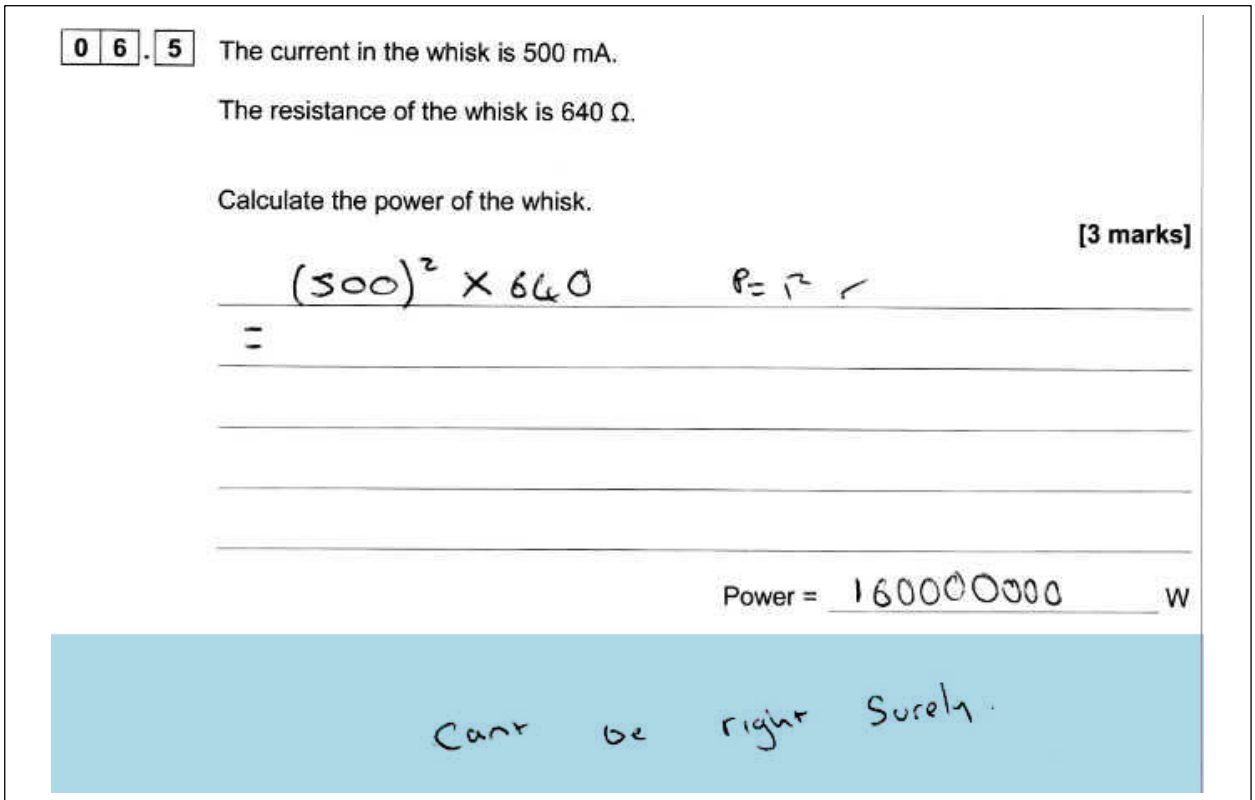
01.1 Almost all students scored at least 1 mark on this question, with nearly two-thirds scoring both marks. The most common incorrect answers were an increase in electrical energy and an increase in chemical energy.

01.2 A very low proportion of students answered this incorrectly.

01.3 Nearly 90% of students arrived at the correct final answer for this calculation, gaining 3 marks.

01.4 Most students selected the correct equation, with about 1% of students not gaining this mark.

01.5 For this calculation, many students did not correctly convert the current into amps. Some students forgot to show that the current should be squared in their substitution. Others showed a valid substitution but forgot to square the current when they entered it in their calculator. About 40% scored all 3 marks, but about 50% gained 2 marks, and over 95% scored at least 1 mark.



This student did not realise that the current was given in milliamps, so only scored marking points 2 and 3. However, the comment 'Can't be right, surely' indicates that they realise that the power of an electric whisk ought to be a lot lower. Students who think about how realistic their answer is may give themselves a much better chance of spotting their mistakes and doing something to rectify them.

01.6 Slightly more than one in two students could recall the potential difference between the live and neutral wires.

01.7 Over 80% of students identified that an increase in current would be caused by a decrease in resistance.

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Answer 23 · 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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6.5.4.1.2 Speed

Answer 23 · 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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6.5.4.1.2 Speed

Answer 24 · Examiner comments

June 2024 | 8464/P/2H | Original Q1

Question 1 (standard demand)

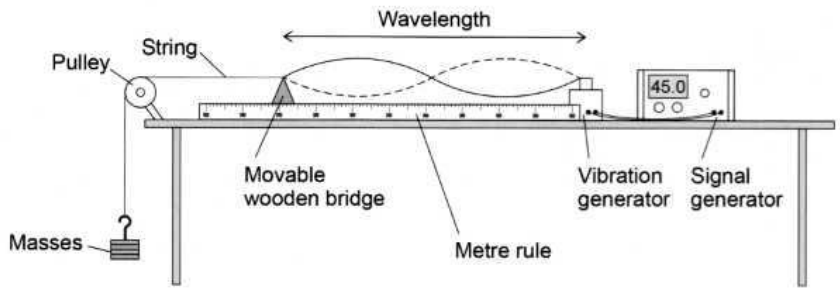
01.1 Even the Higher tier students found this question difficult with 10% gaining more than 2 marks. Although based on Required Practical Activity 20, for most students this appeared to be an unfamiliar experiment and they were unable to answer the question.

To access Level 2, the method needed to lead to a *valid* outcome: most students just described what was shown to them in Figure 11 and did not add anything of value. Most of the students that did score marks were able to describe changing the frequency with the signal generator or measuring the wavelength with a ruler.

0 1 A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 1 shows the equipment used.

Figure 1



The frequency of the signal generator is adjusted so that the wave shown in **Figure 1** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 1**.

0 1 . 1 Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

you would first set up by ~~putting~~ adding a metre ruler on the table place a signal generator and connect it to the vibration generator then connect a piece of string along the top of the vibration generator attaching it to the pulley adding masses to keep it ~~tight~~ balanced then move the movable wooden bridge to increase/decrease the string length and use the results on the signal generator to record the measurements.

In this response the student has mostly just written a description of the equipment set-up in the diagram. There is nothing of relevance to a method here, so no marks are awarded.

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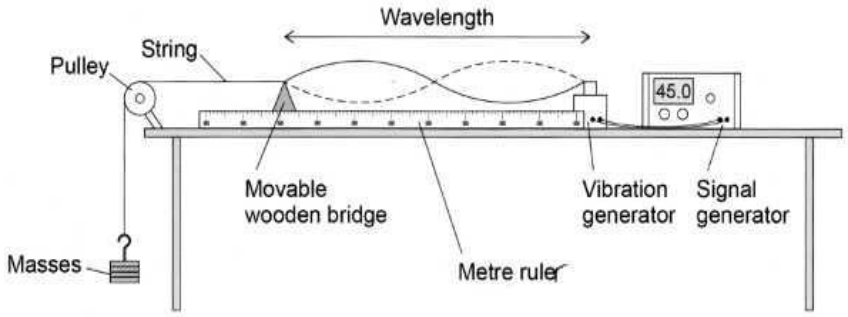
6.5.4.1.2 Speed

Answer 24 · Examiner comments June 2024 | 8464/P/2H | Original Q1

0 6 A teacher demonstrated how the frequency of a wave on a string affects the wavelength of the wave.

Figure 11 shows the equipment used.

Figure 11



The frequency of the signal generator is adjusted so that the wave shown in **Figure 11** is seen.

At this frequency the string vibrates between the two positions shown in **Figure 11**.

0 6 . 1 Describe a method the teacher could use to investigate how the frequency of the wave affects the wavelength.

[4 marks]

To investigate how the frequency of the wave- ~~length~~ affects the wave, the teacher ~~the~~ could adjust the frequency of the signal generator and measure the wavelength of the string with the metre ruler, recording the results. Repeating this a few times; everytime adjusting the frequency of the signal generator, the teacher can then look at the results and see if there is any correlation between the two (the frequency of the wave and the wavelength.)

In this response from a Foundation tier paper the student has described how to change the independent variable and then how to measure the dependent variable. This answer does not quite get into Level 2 as it is not clear that this is repeated at different frequencies and it would not lead to a valid outcome. However, 2 marks are awarded.

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6.5.4.1.2 Speed

Answer 24 · Examiner comments June 2024 | 8464/P/2H | Original Q1

01.2 This question was well answered with nearly all students selecting the correct equation.

01.3 This calculation was very well answered with approximately 90% of students gaining full marks. Most students that correctly substituted into the equation were able to correctly rearrange and evaluate. Most students that did not score any marks substituted into an incorrectly rearranged equation.

Answer 25 · Examiner comments June 2024 | 8464/P/2H | Original Q5

Question 5 (standard/high & high demand)

05.1 This calculation was the most demanding on the paper, with 80% of students not gaining any marks. Most students used an incorrect equation and substituted the value of acceleration as the displacement. Of the approximately 20% of students that did use the correct equation, the vast majority gained full marks.

05.2 This question was not well answered, with less than 10% of students gaining the mark. It is common for students when answering questions on this topic to not make the distinction that reaction time is a time and thinking distance is a distance.

05.3 Approximately 33% of students identified the correct relationship between speed and braking distance. Inversely proportional was a more popular response.

05.4 Nearly 50% of students were able to calculate the mass of the car and achieve the first 3 marks. Of the 20% of students that did not gain any further marks, most did not use the graph to determine the speed from the given braking distance, despite being instructed to use it in the question, and so could not go on to calculate the momentum.

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6.5.4.1.2 Speed

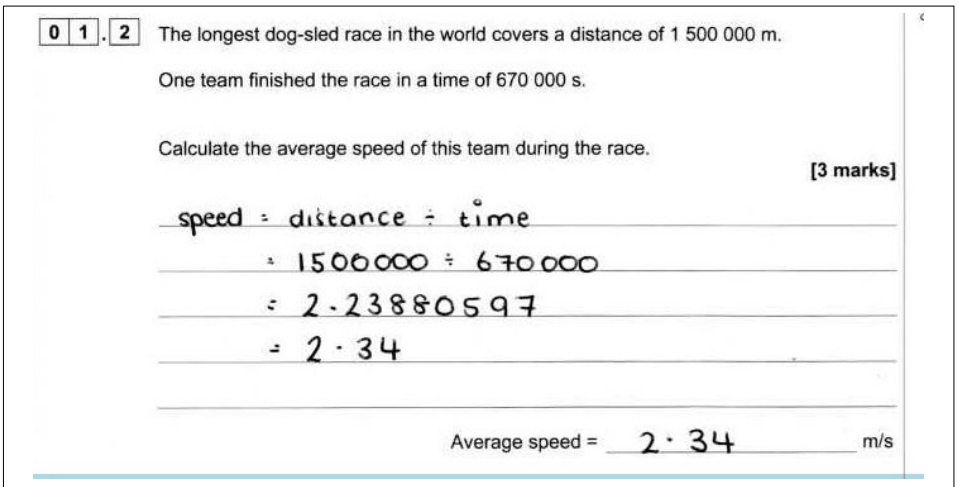
Answer 26 · Examiner comments

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.

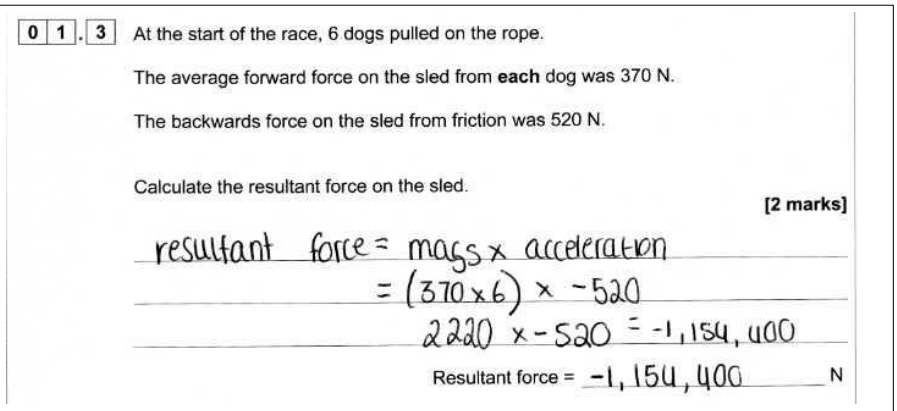
If this student had left their answer as 2.23880597 they would have scored all three marks, but the incorrect rounding meant that their final answer was incorrect and so only two marks were awarded.

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6.5.4.1.2 Speed

Answer 26 · 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.

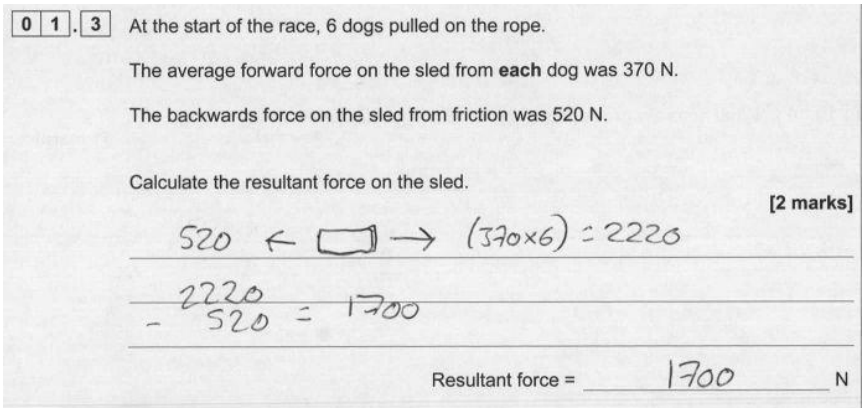
The backwards force on the sled from friction was 520 N.

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 ← □ → (370x6) = 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.

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6.5.4.1.2 Speed

Answer 26 · 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.

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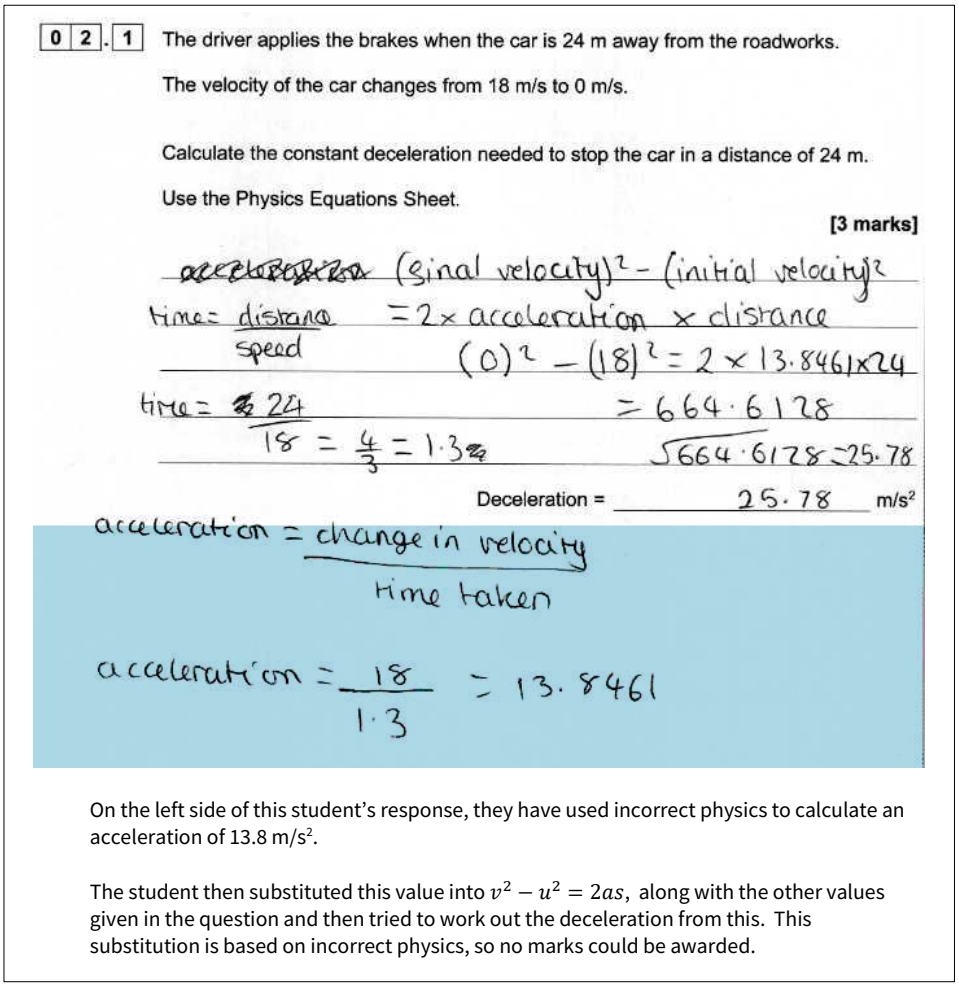
6.5.4.1.2 Speed

Answer 27 · Examiner comments June 2025 | 8464/P/2H | Original Q2

Question 2 (Standard demand)

02.1 Slightly more than half the students answered this question correctly, with the vast majority of those who managed a correct substitution going on to score all 3 marks.

There seemed to be a lack of understanding from some students that deceleration and acceleration are effectively referring to the same quantity. This led to many students correctly selecting the equation $v^2 - u^2 = 2as$ to calculate a deceleration but thinking that they needed to calculate an acceleration using $a = \frac{\Delta v}{t}$ before substituting into that equation. This approach tended to lead to a mark of zero, because the substitution into $v^2 - u^2 = 2as$ was not correct.



0 2 . 1 The driver applies the brakes when the car is 24 m away from the roadworks.

The velocity of the car changes from 18 m/s to 0 m/s.

Calculate the constant deceleration needed to stop the car in a distance of 24 m.

Use the Physics Equations Sheet.

[3 marks]

~~acceleration~~ (final velocity)² − (initial velocity)² = 2 × acceleration × distance

time = distance / speed

(0)² − (18)² = 2 × 13.8461 × 24

time = 24 / 18 = 4/3 = 1.3

= 664.6128

√664.6128 = 25.78

Deceleration = 25.78 m/s²

acceleration = change in velocity / time taken

acceleration = 18 / 1.3 = 13.8461

On the left side of this student's response, they have used incorrect physics to calculate an acceleration of 13.8 m/s².

The student then substituted this value into $v^2 - u^2 = 2as$, along with the other values given in the question and then tried to work out the deceleration from this. This substitution is based on incorrect physics, so no marks could be awarded.

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6.5.4.1.2 Speed

Answer 27 · Examiner comments June 2025 | 8464/P/2H | Original Q2

02.2 Only a small proportion of students managed to give a Level 3 response, with slightly more than a third of students giving answers above Level 1.

When discussing the conditions of the tyres, some students mentioned that slick tyres have more friction, whereas some described worn tyres as having less friction with the road. The level of physics knowledge expected of the students did not go to this level, so if students linked the idea of friction (either increasing or decreasing) with the condition of the tyres, they gained credit.

Part of the issue was with students describing the situation using more colloquial terms. Mentions of good or bad braking distance were insufficient to gain credit, because it was not clear whether students thought that a greater braking distance was better or worse. It was also common to see students describing braking time instead of braking distance, or using expressions such as 'slows down faster', neither of which were sufficient.

Some students expressed the misconception that at lower speeds, drivers had more time to react so the thinking distance would increase. The thinking distance is the distance travelled as the driver is reacting, and driver reaction time is not affected by speed.

A significant minority of students argued that a lower speed limit is more dangerous, giving reasons such as:

- driving at a lower speed can lead to drivers in the car behind becoming impatient
- driving at lower speeds means cars can be closer together
- driving at lower speeds means there are more cars on the road at any given time.

It was relatively common for students to list as many factors as they could which would affect the braking distance or thinking distance.

Students who referred to any of these ideas could still go on to score marks.

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6.5.4.1.2 Speed

Answer 27 · Examiner comments June 2025 | 8464/P/2H | Original Q2

0 2 . 2 As a safety measure, the speed limit on the road was reduced.

Explain how the safety of road users is affected by:

- the condition of the brakes and tyres
- reduced speed.

You should refer to thinking distance and braking distance.

[6 marks]

Thinking distance is the distance travelled in the time taken for someone to react to a hazard and braking distance is the distance travelled after the brakes are pushed. If brake pads are worn, braking distance will increase, however it would not affect thinking distance. ~~As~~ Similarly to worn tyres. If the tread is not ~~thick~~ deep enough the braking distance increases. Reduced speed affects both thinking and braking distance as if you react at the same time going 40mph or 10mph you would've travelled further going 40mph in the same amount of time. Also braking distance ~~increases~~ decreases ~~also as it takes~~ ion with reduced speed as it takes less time (therefore distance) to reduce speed at a lower starting speed than a higher one.

Extra space

This student gave a strong Level 2 response, but gave no reference to safety which prevented them from accessing Level 3.

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6.5.4.1.2 Speed

Answer 27 · Examiner comments June 2025 | 8464/P/2H | Original Q2

02.3 About two thirds were able to score some credit on this question.

Many had the idea of braking causing heating, but this was given in the question, so students needed to give more detail. The answer needed to be comparative, with a faster car having greater kinetic energy, or needing more friction.

Some students described the brakes 'working harder' which was taken as a description of the effort put into braking, rather than using the physics terminology of doing more work. A fair number of students included incorrect descriptions such as 'friction becomes thermal energy' or 'heat is produced', and some included statements that were insufficient, such as 'more energy is needed to stop the car'.

Less than half referred to the increased risk at a greater speed, with students far more likely to just state that braking from a greater speed will cause the brakes to overheat, which was not enough to gain the third marking point.

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6.5.4.1.2 Speed

Answer 28 · Examiner comments

Question 3 (Standard, standard/high and high demand)

03.1 About a quarter of students were able to give a complete and correct definition of a transverse wave, with just under a fifth giving a definition that gained partial credit.

03.2 Nearly two thirds were able to give another risk caused by exposure to ultraviolet.

03.3 Just over 60% identified that ultraviolet has a shorter wavelength than visible light.

03.4 Giving an answer in nm proved to be very challenging, with just under 10% managing to work out the correct final answer.

A surprisingly large proportion of students struggled to calculate the correct power of ten to their answer, with working such as $\frac{3\times10^{8}\ \text{m/s}}{6.25\times10^{14}\ \text{Hz}} = 4.8\times10^{21}\ \text{m}$ being relatively common. Students who did this could then go on to convert their calculated value into nm and gain the final mark, but it was very common for students to multiply their answer by 10^{-9} instead of dividing by 10^{-9}, so the final mark was not often gained. Many students who attempted the conversion to nm thought that nano referred to 10^{-3} or 10^{-6}.

0 3 . 4 A wave of visible light has a frequency of 6.25×10^{14} Hz.

speed of light = 3.00×10^{8} m/s

Calculate the wavelength of this light.

Use the Physics Equations Sheet.

Give your answer in nanometres (nm).

[4 marks]

wave speed = frequency x wavelength.

wave speed / frequency = wavelength.

$3.00\times10^{8} / 6.25\times10^{14} = 4.8\times10^{21}$ m

$4.8\times10^{21} / 1000 = 4.8\times10^{18}$ nm

Wavelength = 4.8×10^{18} nm

This student correctly substituted into and rearranged the equation but made errors when calculating the wavelength in metres. This answer also illustrates the difficulties many students had in converting a value from metres to nanometres.

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6.5.4.1.2 Speed

Answer 28 · Examiner comments

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

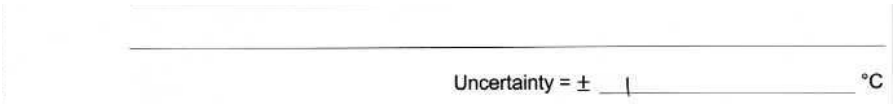
03.5 Students struggled to explain why refraction occurs using the idea of wavefronts. It was very common for students to refer to the density of the glass, and sometimes to optical density. All of these references were ignored. Some students recalled that the wave speed changes but did not make it clear whether they thought the waves were increasing or decreasing in speed, so did not score any marks. Only about a fifth of students gained any credit in this question.

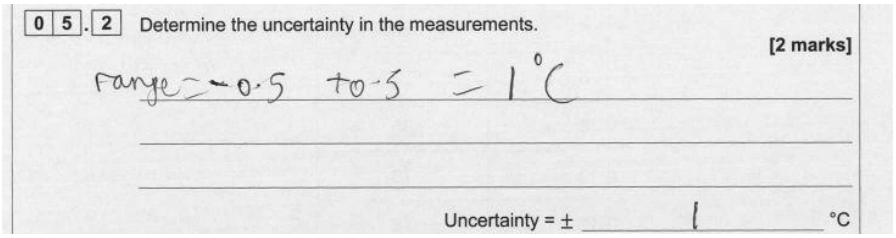
03.6 About four in ten students gained at least one mark, with approximately 20% giving a fully correct answer. The refracted rays drawn were in many different directions, but those who were able to draw the ray in the correct direction usually did so with accuracy and gained the second mark, and those that did not score the second mark tended to draw their refracted rays in completely the wrong direction. Some students gained the mark for drawing the refracted ray without having drawn a normal.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments





By giving an answer of 1 on the answer line, the top answer above shows that the student thinks that the uncertainty is 1 and does not identify that the value determined is the range. This response scored no marks.

The second answer clearly demonstrates that the student knows that the range is 1°C, and so scored the first mark, but did not then halve this value to determine the uncertainty.

05.3 Almost all students gained at least 3 marks, but the line of best fit, ignoring the anomaly, proved to be challenging to many. Approximately 40% gained full marks for plotting this graph.

05.4 Nearly two thirds of students gained full marks, with many others gaining some credit. Some of those arriving at an incorrect answer appeared to be using strange numbers – perhaps they had read values from their line of best fit describing the white cube, rather than using the values for the black cube given in the question. These students could still score one mark for converting 2 minutes into seconds.

05.5 About a third scored two marks, most commonly for identifying that black surfaces are good absorbers of infrared while white surfaces are not. Explaining the idea of a thermal equilibrium in terms of absorbing and emitting infrared radiation at the same rate was a far more challenging idea, and very few students were able to express this with sufficient detail.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments June 2025 | 8464/P/2H | Original Q6

It was relatively common for students to express that the cubes were absorbing heat, but this was not given any credit. Heat was taken to be a reference to the internal energy of the cubes, but answers should have been referring to the cube absorbing and emitting infrared radiation, which would then affect the internal energy of the cube.

When attempting to explain why the black cube initially increased in temperature at a greater rate, common misconceptions shown in answers included the idea that white surfaces are the best emitters and, less commonly, that black surfaces attract heat. Some stated that black surfaces conduct heat better or are better at absorbing temperature. It was also quite common for students to write about Leslie's cube.

When attempting to explain why both cubes stopped changing temperatures, it was common for students to think that the cubes had reached room temperature, or to illustrate another misconception that the cubes had reached their specific heat capacity and so could not get any hotter.

0 5 . 5 The student made two observations:

1. The rate of change of temperature was initially greater for the black cube than for the white cube.

2. After a few minutes, both cubes stopped changing temperature.

Explain the student's observations.

You should refer to the absorption and emission of radiation from the surfaces of the cubes.

[4 marks]

outside the box

Matte black surface of the cube is a better absorber and emitter of IR radiation, than white or shiny surfaces. It's because if to fill Leslie cube with hot water from freshly-boiled kettle and use IR detector/ thermometer at fixed distance from each surface - black ~~tub~~ side will emit more IR radiation. Both cubes stopped changing Extra space temperature, because they emitted all IR radiation. Hotter objects emit more IR radiation too.

14

Despite giving an answer about Leslie's cube, this answer explains why the black cube increased in temperature at a greater rate than the white cube and goes on to state that hotter objects emit more infrared (IR) than cooler objects, gaining 3 marks in total.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments

Question 6 (Standard, standard/high and high demand)

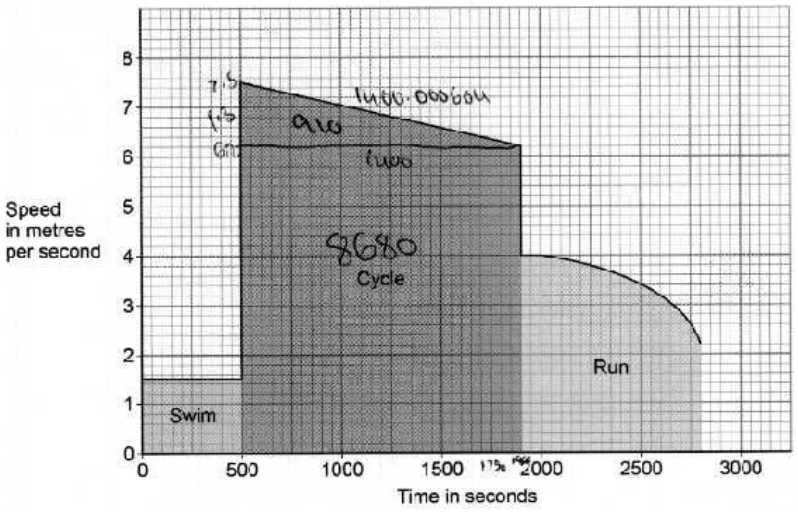
06.1 Less than half of the students correctly identified that the swimming speed of the triathlete was equal to a typical walking speed.

06.2 There were several different approaches that students could take to determine the distance moved by the bicycle. Most students struggled to do this correctly but did demonstrate that they were attempting to determine an appropriate distance and so went on score the last three marks.

Common errors, no matter which approach was taken, included misreading the initial or final values of the speed of the cycling section, or using a time of 1900 s instead of 1400 s.

Figure 8 shows a speed–time graph for the athlete for the whole triathlon.

Figure 8



Annotations to the graph were common and could gain credit.
This student went on to score all 6 marks, using the area under the graph to determine the distance moved by the cyclist before using the equation for work done by a force.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments June 2025 | 8464/P/2H | Original Q6

06.3 About a quarter of students gained at least one mark, usually for identifying that the speed of the runner was constant. It was very common for students to state that the velocity was constant, which prevented them from scoring the first mark. Only a small proportion scored both marks. Some students did not read the question correctly and described how the speed changed during the entire 'run' section of the graph.

0 6 . 3 The first part of the **run** was on a circular track.

The time taken for the athlete to run round the track was 100 s.

Describe the velocity of the athlete during the first 100 s of the **run**.

Use **Figure 8**.

[2 marks]

Velocity is a vector quantity, the run was on a circular track, therefore the direction keep changing which mean the velocity will ~~keep~~ changing.

This answer scored the second mark, for identifying that direction constantly changes when moving in a circle.

0 6 . 3 The first part of the **run** was on a circular track.

The time taken for the athlete to run round the track was 100 s.

Describe the velocity of the athlete during the first 100 s of the **run**.

Use **Figure 8**.

[2 marks]

decelerating running at a constant speed ~~by~~ of 4 m/s but at changing directions (in a circular track)

This student clearly understands how velocity changes when moving at a constant speed on a circular path and gained both marks.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments June 2025 | 8464/P/2H | Original Q6

06.4 Just over 10% of students gained at least one mark, with very few giving a full explanation and scoring both marks. It was quite common for students to suggest reasons why the athlete slowed down, with statements such as the runner becoming tired. Those who did try to explain using the graph often did not use precise enough language and did not refer to the gradient of the graph. Descriptions of the trend shown in the graph, such as 'it is a downwards curved line' or 'slowed down as time increased' did not answer the question but did not prevent marks from being scored.

0 6 . 4 After running round the track once, the rest of the run was on a straight, horizontal road.

Explain how **Figure 8** shows that the magnitude of the deceleration of the athlete increased.

[2 marks]

Shows the athlete began to decrease in speed as the athlete became more tired towards the end of the run.

The above example is an answer suggesting why the speed may have decreased, but not explaining how the graph shows the acceleration, or how the graph shows that the deceleration increased.

0 6 . 4 After running round the track once, the rest of the run was on a straight, horizontal road.

Explain how **Figure 8** shows that the magnitude of the deceleration of the athlete increased.

[2 marks]

the gradient represent acceleration or deceleration, it is getting steeper toward 0, so deceleration increased

The second example is from a student who scored both marks, clearly using the graph to explain how the deceleration changed.

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6.5.4.1.2 Speed

Answer 29 · Examiner comments

Contact us

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

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