AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.1.4

Resultant forces

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**22**
Available paper years	**2008–2025**

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.

4.5.1.4 Resultant forces

Answer 01 · Mark scheme

Question 5

question	answers	extra information	mark
(a)(i)	a single force that has the same effect as all the forces combined	accept all the forces added / the sum of the forces / overall force	1
(ii)	constant speed (in a straight line) **or** constant velocity	do **not** accept stationary	1
(b)	3	allow **1** mark for correct substitution into transformed equation accept answer 0.003 gains **1** mark answer = 0.75 gains **1** mark	2
	m/s^2		1
(c)	as speed increases air resistance increases	accept drag / friction for air resistance	1
	reducing the resultant force		1
total			7

4.5.1.4 Resultant forces

Answer 01 · Mark scheme

January 2008 | PHY2H | Original Q5 | Legacy

PHY2H

4.5.1.4 Resultant forces

Answer 02 · Mark scheme

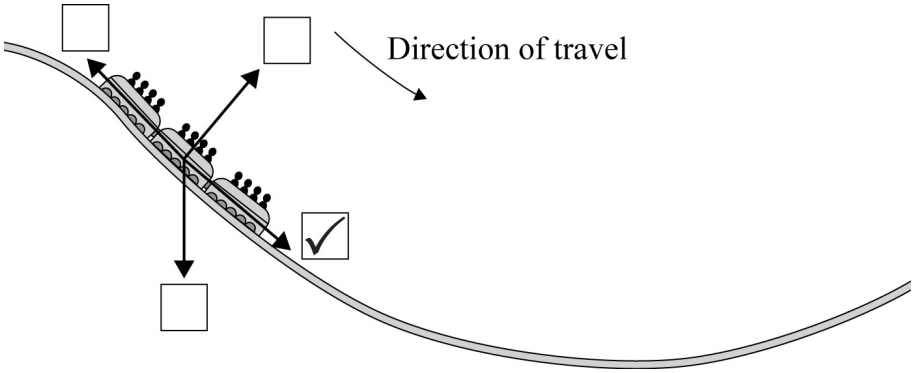
Question 8

question	answers	extra information	mark
(a)	any **two** ideas: • (acceleration occurs when) the direction (of each capsule) changes • velocity has direction • acceleration is (rate of) change of velocity		2
(b)	to(wards) the centre (of the wheel)		1
(c)	centripetal	allow minor misspellings but do **not** credit a response which could be 'centrifugal'	1
(d)	the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)	accept 'the size' both parts required for the mark accept converse	1
total			5

4.5.1.4 Resultant forces

Answer 03 · Mark scheme January 2009 | PHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	correct box ticked 		1
1(b)	each passenger has a different mass	accept weight for mass ignore other irrelevant factors about the person e.g. mass and height do **not** accept a list with incorrect factors e.g. mass and position accept passengers started with different (gravitational) potential energy	1
1(c)(i)	30	ignore added units	1
1(c)(ii)	2400	accept their (c)(i) × 80 correctly calculated for both marks allow **1** mark for correct substitution of their (c)(i) and 80 an answer of 800 gains **1** mark only if answer to (c)(i) is not 10	2
Total			**5**

4.5.1.4 Resultant forces

Answer 03 · Mark scheme

January 2009 | PHY2H | Original Q1 | Legacy

PHY2H

4.5.1.4 Resultant forces

Answer 04 · Mark scheme

January 2010 | PHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	96	allow **1** mark for correct substitution ie 80 × 1.2	2
	newton or N	allow Newton do **not** allow n	1
1(b)(i)	direction		1
1(b)(ii)	velocity <u>and</u> time are continuous (variables)	answers must refer to both variables accept the variables are continuous / not categoric accept the data / 'it' is continuous accept the data / 'it' is not categoric	1
1(b)(iii)	**C**		1
	velocity is not changing	the **2** marks for reason may be scored even if **A** or **B** are chosen accept speed for velocity accept speed is constant (9 m/s) accept **not** decelerating accept **not** accelerating accept reached terminal velocity	1
	forces must be balanced **or** resultant force is zero	accept forces are equal accept arrows are the same length / size do **not** accept the arrows are equal	1
Total			**8**

4.5.1.4 Resultant forces

Answer 04 · Mark scheme

January 2010 | PHY2H | Original Q1 | Legacy

PHY2H

4.5.1.4 Resultant forces

Answer 05 · Mark scheme

June 2019 | PHY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	75 000 newtons / N	accept correct substitution for **1** mark ie 7500 × 10 do **not** accept n full credit for using g = 9.8 **or** 9.81	2 1
1(a)(ii)	60 000 000	accept for both marks their (a)(i) × 800 correctly calculated accept correct substitution for **1** mark ie their (a)(i) × 800	2
1(b)(i)	arrow drawn parallel (to) **and** down (the) slope	accept arrow drawn anywhere on the diagram	1
1(b)(ii)	increases GPE transformed to KE **or** speed increasing	 accept is accelerating however 'speed increasing' only scores if correctly linked to increasing kinetic energy	1 1
1(c)	so more likely to wear one **or** they know wearing a helmet is likely to / will reduce (risk) head injury **or** so can make an (informed) choice (about wearing one)		1
Total			**9**

4.5.1.4 Resultant forces

Answer 05 · Mark scheme June 2010 | PHY2H | Original Q1 | Legacy

PHY2H

4.5.1.4 Resultant forces

Answer 06 · Mark scheme

June 2010 | PHY3H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)	the point at which the (total) mass seems to act / appears to be concentrated	accept 'weight' for 'mass' accept the point at which gravity seems to act do **not** accept a definitive statement eg where (all) the mass is	1
4(b)	wider / larger base	marks are for a correct comparison	1
	lower centre of mass	accept lower centre of gravity / c of g	1
4(c)	line of action (of the weight) lies / falls inside the base	in each case the underlined term must be used correctly to gain the mark	1
	the resultant moment returns mixer to its original position	accept there is no resultant moment / resultant moment is zero accept resulting moment for resultant moment do **not** accept converse argument	1
Total			**5**

4.5.1.4 Resultant forces

Answer 06 · Mark scheme June 2010 | PHY3H | Original Q4 | Legacy

PHY3H

4.5.1.4 Resultant forces

Answer 07 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)(i)	120		1
1(a)(ii)	20	accept 140-their (a)(i) provided answer is not negative	1
1(a)(iii)	as speed increases drag force / water resistance / friction / **D** increases (until) **D** = 140 N or (until) **D** = **T**	 forces balance is insufficient	1 1 1
1(b)(i)	(average) speed (of swimmer)		1
1(b)(ii)	any **two** from: • more data • force may vary (a lot) / change • give more <u>reliable average</u>	 accept results for data do **not** accept more accurate data ignore references to anomalies ignore accurate / precise	2

Question 1 continues on the next page . . .

PHY2H

Question 1 continued . . .

question	answers	extra information	mark
1(b)(iii)	examples of acceptable responses: • most / some females produce smaller forces • most / some males produce larger forces • some females swim as fast as males but use a smaller force • most of the faster swimmers are male • most of the slower swimmers are female • range of the (average) speed of males is smaller than the range of the (average) speed of females • range of the (average) force of the males is greater than the range of the (average) force of the females	do **not** accept <u>all</u> females produce smaller forces do **not** accept <u>all</u> males produce larger forces do **not** accept <u>all</u> males swim faster do **not** accept <u>all</u> females swim slower	1
1(b)(iv)	exert maximum (hand) force (throughout the swim / stroke)	accept (any method to) increase (hand) force practise more is insufficient	1
Total			**10**

4.5.1.4 Resultant forces

Answer 07 · Mark scheme January 2011 | PHY2H | Original Q1 | Legacy

PHY2H

4.5.1.4 Resultant forces

Answer 08 · Mark scheme

Question 7

question	answers	extra information	mark
7(a)	4.2	2 marks for correct substitution **and** transformation, ie 1155/275 allow **1** mark for correct resultant force with a subsequent incorrect method, ie 1155 allow **1** mark for an incorrect resultant force with a subsequent correct method, eg answers of 7.27 or 10.34 gain **1** mark	3
7(b)(i)	YES any **two** from: • data (from police files) can be trusted • data answers the question asked • large sample used NO any **two** from: • the sample is not representative • the sample size is too small • accident files do not indicate age / experience of riders	marks are for the explanation allow a conclusion can be made from the data an answer YES and NO can score **1** mark from each set of mark points	2

Question 7 continues on the next page

PHY2H

Question 7 continued

question	answers	extra information	mark
7(b)(ii)	more accidents with motorbikes up to 125 cc	accept for **2** marks an answer in terms of number of under 125 cc to accidents ratio compared correctly with number of over 500 cc to accidents ratio	1
	even though there are fewer of these bikes than bikes over 500 cc		1
7(c)(i)	increases the time taken to stop	accept increases collision time	1
	decreases rate of change in momentum	accept reduces acceleration / deceleration accept $F = \frac{\Delta mv}{\Delta t}$ reduces momentum is insufficient	1
	reduces the force (on the rider)		1
7(c)(ii)	YES any sensible reason, eg: • cannot put a price on life / injury • fewer (serious) injuries • reduces cost of health care / compensation NO any sensible suggestion, eg: • money better spent on … • total number of riders involved is small	the mark is for the reason accept may save lives accept reduces risk of injury needs to be specific	1
Total			**11**

4.5.1.4 Resultant forces

Answer 09 · Mark scheme

June 2013 | PH2HP | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	(produces) a force from water on the boat in the forward direction	 accept in the opposite direction this must refer to the direction of the force not simply the boat moves forwards an answer produces an (equal and) opposite force gains **1** mark	1 1
1(b)(i)	1.5 m/s^2	allow **1** mark for correct substitution, ie $\frac{16-4}{8}$ **or** $\frac{12}{8}$ provided no subsequent step shown ignore sign	2 1
1(b)(ii)	102 **or** their (b)(i) × 68 correctly calculated	allow **1** mark for correct substitution, ie 1.5 × 68 **or** their (b)(i) × 68 provided no subsequent step shown	2
1(b)(iii)	greater than need to overcome resistance forces	reason only scores if greater than chosen accept named resistance force accept resistance forces act (on the water skier) do **not** accept gravity	1 1
Total			**9**

4.5.1.4 Resultant forces

Answer 09 · Mark scheme

June 2013 | PH2HP | Original Q1 | Legacy

PH2HP

4.5.1.4 Resultant forces

Answer 10 · Mark scheme June 2014 | PH3HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO spec ref
2(a)	gravitational attraction (between the satellite and the Earth)	allow gravity allow weight of the satellite	1	AO1 3.2.4b
2(b)	any **two** from: • mass of satellite • speed / velocity (of satellite) • radius of orbit / circle	allow height above the Earth radius / height alone is insufficient	2	AO1 3.2.4c
2(c)(i)	increasing the height (above the Earth's surface) increases the time (for one orbit)	allow a positive correlation allow as one gets bigger, the other gets bigger, or vice versa ignore they are directly proportional	1	AO3 4.5.3
2(c)(ii)	there is no relationship / correlation		1	AO3 4.5.3
2(d)	Isaac Newton was a respected scientist who had made new discoveries before		1	AO3 3.2.4, SALoSE
Total			**6**	

4.5.1.4 Resultant forces

Answer 10 · Mark scheme

June 2014 | PH3HP | Original Q2 | Legacy

Question	Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information	Mark	AO spec ref

4.5.1.4 Resultant forces

Answer 11 · Mark scheme June 2015 | PH3HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.
2(a)(i)	D		1	AO2 P3.2.4b
2(a)(ii)	friction		1	AO1 P3.2.4b
2(a)(iii)	any **two** from: • the speed / velocity • the radius of the bend • the mass (of the car)	 the radius is insufficient accept curvature of the road size of the bend is insufficient accept distance of car from centre (of bend) accept weight for mass	2	AO1 P3.2.4c
2(b)	the car has a wide base the car has a low centre of mass / gravity	accept any description of a wide base e.g. the wheels are far apart accept wide wheel base do **not** accept long wheel base a large surface area is insufficient wide tyre(s) is insufficient accept any description of low centre of mass e.g. mass is close to the ground a down force is insufficient	1 1	AO2 P3.2
Total			6	

4.5.1.4 Resultant forces

Answer 11 · Mark scheme

June 2015 | PH3HP | Original Q2 | Legacy



4.5.1.4 Resultant forces

Answer 12 · Mark scheme

November 2020 | 8463/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	Move the wooden block to the left.		1	AO3 4.5.6.2.2 RPA7
01.2	use a pulley (on the edge of the bench)	allow any feasible method to stop the string from rubbing	1	AO3 4.5.6.2.2 RPA7
01.3	suitable scale points plotted correctly line of best fit	 allow 5 correctly plotted for **2** marks **OR** 3–4 correctly plotted for **1** mark	1 2 1	AO2 4.5.6.2.2 RPA7
01.4	(directly) proportional	allow a correct description of direct proportionality ignore positive correlation allow weight (added to mass holder) for force allow f = ma for **1** mark	1	AO3 4.5.6.2.2 RPA7
01.5	repeat the measurements/investigation ignore anomalies **and** calculate the mean / average		1 1	AO3 4.5.6.2.2 RPA7
01.6	resultant force = mass × acceleration **or** F = m a		1	AO1 4.5.6.2.2 RPA7

4.5.1.4 Resultant forces

Answer 12 · Mark scheme

November 2020 | 8463/2H | Original Q1

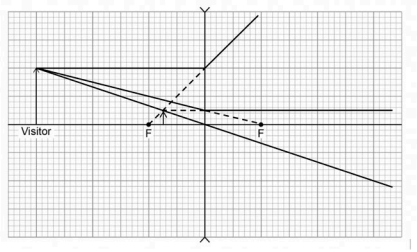
01.7	$0.375 = 0.60 \times a$ $a = \frac{0.375}{0.60}$ $a = 0.625\ (m/s^2)$ $a = 0.63\ (m/s^2)$		1 1 1 1	AO2 4.5.6.2.2 RPA7
Total			**14**	

4.5.1.4 Resultant forces

Answer 13 · Mark scheme

November 2020 | 8463/2H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	any **two** correct lines drawn from the top of the visitor and passing through the lens image drawn at the correct position and with the correct orientation	allow construction lines that are not dashed mark only scores if first two marks scored. a convex lens diagram scores **0** marks 	2 1	AO2 4.6.2.5
04.2	Decreases		1	AO3 4.6.2.5
04.3	Iron		1	AO1 4.7.2.1
04.4	there is a current in the solenoid / circuit creating a magnetic field attracting the bolt	allow a charge flows through the solenoid / circuit allow the solenoid / coil is magnetised	1 1 1	AO1 4.7.2.1

4.5.1.4 Resultant forces

Answer 13 · Mark scheme

November 2020 | 8463/2H | Original Q4

04.5	1.50 cm = 0.015 m 2.88 = k × 0.015 k = 2.88 / 0.015 k = 192 (N/m)	 this mark may be awarded if distance is incorrectly/not converted this mark may be awarded if distance is incorrectly/not converted allow a correctly calculated answer using an incorrectly/not converted distance	1 1 1 1	AO2 4.5.3

04.6	Any **two** from: • increase the current (in the solenoid / circuit) • add more turns to the solenoid • use a spring with a lower spring constant	 allow any sensible suggestion for increasing the current such as increasing the p.d. / power of the battery **OR** using lower resistance wire in the solenoid do **not** allow increase the number of coils allow use a weaker spring	2	AO3 4.7.2.1
Total			**14**	

Answer 14 · Mark scheme

November 2020 | 8463/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	320 MHz = 3.2×10^8 Hz	allow 320 000 000	1	AO2
	$3.0 \times 10^8 = 3.2 \times 10^8 \times \lambda$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	$\lambda = \frac{3.0 \times 10^8}{3.2 \times 10^8}$	this mark may be awarded if frequency is incorrectly/not converted	1	AO2
	wavelength = 0.9375	allow correct calculation using an incorrectly/not converted frequency allow an answer that rounds to 0.94	1	AO2
	metres **or** m		1	AO1 4.6.1.2
06.2	(alternating) current <u>induced</u> (in the electrical circuit)	allow <u>electrons</u> vibrate / oscillate (in the electrical circuit)	1	AO1 4.6.2.3
	with the same frequency as the radio wave		1	
06.3	Any **two** from: • (radio waves are) transverse	allow sound waves are longitudinal allow a description of transverse/longitudinal waves	2	AO1 4.6.1.1 4.6.1.2
	• (radio waves) travel at a higher speed • (radio waves) don't need a medium • (radio waves are) electromagnetic	allow (only) radio waves travel through a vacuum allow sound waves are mechanical		
06.4	accelerating	allow speeding up	1	AO3 4.5.6.1.4

4.5.1.4 Resultant forces

Answer 14 · Mark scheme

06.5	appropriate tangent drawn correct reading from graph for change in distance and change in time (eg 5.6 (m) and 20 (s)) gradient of tangent shown (eg 5.6/20) 0.28 (m/s)	 allow correct reading from their tangent for change in distance and change in time allow correct gradient from their tangent this answer only allow 0.25 to 0.30 (m/s) if the tangent is appropriate allow 2.8 / 20 = 0.14 (m/s) for **1** mark	1 1 1 1	AO2 4.5.6.1.4
06.6	$0.52^2 - 0.12^2 = 2 \times 0.04 \times s$ $s = \frac{0.52^2 - 0.12^2}{2 \times 0.04}$ s = 3.2 (m) 0.48 = F x 3.2 $F = \frac{0.48}{3.2}$ F = 0.15 (N) **OR**	 this mark may be awarded if the displacement is incorrectly calculated this mark may be awarded if the displacement is incorrectly calculated allow a correctly calculated F using an incorrectly calculated displacement	1 1 1 1 1 1	AO2 4.5.2 4.5.6.1.5

4.5.1.4 Resultant forces

Answer 14 · Mark scheme

November 2020 | 8463/2H | Original Q6

	Alternative method 1 $t = \frac{0.52 - 0.12}{0.04}$ (1) t = 10 (s) (1) s = 0.32 × 10 = 3.2 (m) (1) 0.48 = F x 3.2 (1) $F = \frac{0.48}{3.2}$ (1) F = 0.15 (N) (1) **OR** Alternative method 2 $0.48 = (0.5 \times m \times 0.52^2) - (0.5 \times m \times 0.12^2)$ (1) 0.48 = 0.1352m – 0.0072m (1) 0.48 = 0.128m (1) m = 3.75 (1) F = 3.75 x 0.040 (1) F = 0.15 (N) (1)	allow a correctly calculated displacement from an incorrectly calculated t this mark may be awarded if the displacement is incorrectly calculated this mark may be awarded if the displacement is incorrectly calculated allow a correctly calculated F from incorrectly calculated values for displacement and / or t allow their calculated m allow correctly calculated F using an incorrectly calculated m		

4.5.1.4 Resultant forces

Answer 14 · Mark scheme

November 2020 | 8463/2H | Original Q6

06.7	there is a maximum forward force (provided by the motor) as the speed of the car increases air resistance increases until air resistance is equal in size to forward force so the car can no longer accelerate	allow driving force for forward force - throughout the car has a maximum acceleration is insufficient allow friction / drag for air resistance - throughout allow (until) the resultant force is zero allow forces are in equilibrium / balanced allow the car travels at terminal velocity	1 1 1 1	AO1 4.5.6.1.5
Total			**24**	

4.5.1.4 Resultant forces

Answer 15 · Mark scheme

November 2021 | 8463/2H | Original Q1

Question 1

Question	Answers	Extra information	Mark	AO/ Spec. Ref
01.1	**Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.		3–4	AO1 4.5.6.3.3 4.5.6.3.4 4.1.1.2
	Level 1: Point are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.		1–2	
	No relevant content		0	
	Indicative content Factors • poor condition of tyres • poor road surface • wet or icy road • poor/worn brakes Explanation • because of decreased friction Factors • increased mass of car/passengers Explanation • increases kinetic energy of car • more work needs to be done to stop car • increases momentum of the car Factor • road slopes downhill Explanation • (a component of) gravity opposes the braking force • resultant (braking) force is reduced allow answers in terms of reducing braking distance throughout A single factor with no related explanation is insufficient to score a mark			

4.5.1.4 Resultant forces

Answer 15 · Mark scheme

01.2	resultant force = mass × acceleration		1	AO1 4.5.6.2.2
01.3	7200 = 1600 × *a* $a = \frac{7200}{1600}$ *a* = 4.5 (m/s^2)	ignore negatives throughout	1 1 1	AO2 4.5.6.2.2
01.4	15 (m) 38 (m) = 53 (m)	two correct values identified allow the correct addition of a misread braking distance and /or a misread thinking distance taken from the graph	1 1	AO3 4.5.6.3.1
01.5	$p = \frac{F}{A}$		1	AO1 4.5.5.1.1
01.6	120 000 = $\frac{60}{A}$ $A = \frac{60}{120\,000}$ *A* = 0.0005 *A* = 5 (.0) × 10^{-4} m^2	allow an answer given to 2 sig figs from an incorrect calculation using the given data	1 1 1 1 1	AO2 AO2 AO2 AO2 AO1 4.5.5.1.1
Total			**16**	

4.5.1.4 Resultant forces

Answer 16 · Mark scheme

November 2021 | 8463/2H | Original Q7

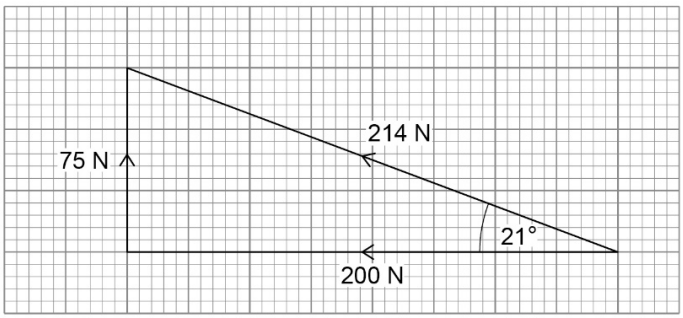
Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	friction		1	AO1 4.5.1.2
07.2	(area of rectangle =) 108 (m) (area of triangle =) 54 (m) (total area / distance =) 162 (m)	 allow a correctly calculated total area / distance from an incorrectly calculated area of rectangle and / or triangle	1 1 1	AO2 4.5.6.1.5
07.3	(the force on the pedal) causes a moment about the pedal axle which causes a force on the chain (which causes a moment about the rear axle)	 allow gear B for chain	1 1	AO1 4.5.4
07.4	$2.4^2 (- 0^2) = 2 \times a \times 18$ $a = \frac{2.4 \times 2.4}{36}$ $a = 0.16$ (m/s^2) alternative method t = 18 / 1.2 t = 15 (s) (1) a = 2.4 / 15 (1) $a = 0.16$ (m/s^2) (1)	 this mark may be awarded if the time is incorrectly calculated allow a correctly calculated acceleration from an incorrectly calculated time	1 1 1	AO2 4.5.6.1.5

4.5.1.4 Resultant forces

Answer 16 · Mark scheme

November 2021 | 8463/2H | Original Q7

07.5	horizontal (200N) **and** vertical (75N) forces drawn to the same scale		1	AO2 4.5.1.4
	resultant force drawn in the correct direction	shown by an arrow head from bottom right to top left	1	
	resultant force with a value in the range 212 to 218 (N)	allow a calculated value of 213.6 **or** 214 (N)	1	
	direction in the range 20–22 (degrees from the horizontal)	allow 68–70 (degrees from the vertical) allow a bearing in the range 290–292 to gain full marks a vector diagram must have been drawn	1	
				
Total			**13**	

4.5.1.4 Resultant forces

Answer 17 · Mark scheme

June 2023 | 8463/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	7.1 (cm) 497 (m)	allow 7.0 to 7.3 (cm) allow 70 × their incorrect measurement of displacement	1 1	AO2 4.5.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	0 (N)		1	AO2 4.5.1.4

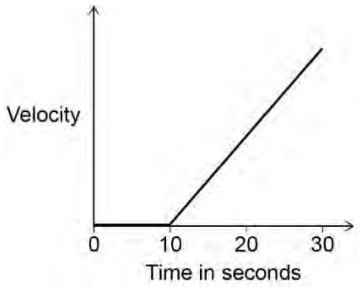
Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	constant velocity	allow constant speed (in a straight line) do **not** accept stationary allow constant acceleration if a **mathematical error** in 02.2 gives a non-zero value for resultant force	1	AO1 4.5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	any **one** from: • tension • normal contact (force) • upthrust	allow lift, thrust and water resistance allow normal reaction (force) ignore drag	1	AO1 4.5.1.2

4.5.1.4 Resultant forces

Answer 17 · Mark scheme

June 2023 | 8463/2H | Original Q2

Question	Answers		Mark	AO / Spec. Ref.
02.5	horizontal line drawn to 10s along the *x*-axis		1	AO3 4.5.6.1.4
	line with a positive gradient starting from 10 s	allow an upward curving line with increasing gradient starting from 10 s  	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	line of best fit drawn and extrapolated to 10 km	do **not** accept a straight line	1	AO2 4.5.5.2
	28 (kPa)	allow 26 to 32 (kPa) allow a value correctly extrapolated from their line allow 2 marks for a correct mathematically extrapolated value	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	the average density of the air above the aeroplane decreases		1	AO3 4.5.5.2

Total Question 2	10

4.5.1.4 Resultant forces

Answer 18 · Mark scheme

June 2024 | 8463/2H | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	0 (N) the child isn't accelerating (vertically) **or** upwards forces are equal to the downwards forces	 MP2 dependent on MP1 allow forces are balanced	1 1	AO2 4.5.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	work done = force × distance **or** $W = F \times s$		1	AO1 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	$35 = F \times 2.8$ $F = \frac{35}{2.8}$ $F = 12.5$ (N)	 allow 13 (N)	1 1 1	AO2 4.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	the resistive force has decreased so the resistive force increases	allow friction (between the wheels and the floor) has decreased	1 1	AO3 4.5.1.4 4.5.6.2.1 4.5.6.2.2

4.5.1.4 Resultant forces

Answer 18 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	moment = force × distance **or** $M = F \times d$		1	AO1 4.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	7.5 cm = 0.075 m $M = 2.0 \times 0.075$ $M = 0.15$ (Nm)	 allow a correct substitution of an incorrectly / not converted value of d allow an answer consistent with an incorrectly / not converted value of d	1 1 1	AO2 4.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.7	gear B rotates in the opposite direction (to gear A) **or** gear B rotates clockwise **or** gear B rotates faster than gear A (because) gear A exerts a force on gear B **or** (because) gear A causes a moment about the pivot of gear B		1 1	AO2 4.5.4

Total Question 2	14

4.5.1.4 Resultant forces

Answer 19 · Mark scheme

June 2024 | 8463/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	tension		1	AO2 4.5.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	(combined) mass of trolley and mass hanger	allow mass / weight of trolley / hanger	1	AO1 4.5.6.2.2 RPA7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3		allow speed for velocity throughout		AO3 4.5.6.1.5 4.5.6.1.2 4.5.6.2.2 RPA7
	divide distance travelled by time taken to give (average / mean) velocity		1	
	double mean velocity (to give maximum velocity)		1	
	divide change in velocity by time taken (to give acceleration)	allow divide maximum velocity by time (to give acceleration) allow use of $v^2 = u^2 + 2as$ allow correct use of $s = ut + \frac{1}{2}at^2$	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	(range =) 0.06 (m/s^2) **or** (mean =) 1.36 (m/s^2)		1	AO3 4.5.6.2.2 RPA7
	uncertainty = ±0.03 (m/s^2)		1	

4.5.1.4 Resultant forces

Answer 19 · Mark scheme

June 2024 | 8463/2H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	a component of the weight of the trolley acts parallel to runway (so) resultant force increases so acceleration increases	allow work is done (by raising the trolley) so the trolley gains gravitational potential energy (1) gravitational potential energy is transferred to kinetic energy increasing the final velocity and the acceleration (1)	1 1	AO3 4.5.6.2.2

Total Question 5	9

4.5.1.4 Resultant forces

Answer 20 · Mark scheme

June 2025 | 8463/2H | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	single arrow starting from dot, pointing vertically upwards and shorter than weight arrow		1	AO2
	labelled air resistance	allow drag	1	AO1
				4.5.1.4 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	2.5 minutes = 150 s	all subsequent marks may be awarded if time is incorrectly / not converted	1	AO2 4.5.6.1.5
	$0.64 = \frac{v-0}{150}$		1	
	$v = 0.64 \times 150$		1	
	$v = 96$ (m/s)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(as the skydiver's velocity / speed increased) the air resistance increased	allow drag for air resistance throughout	1	AO1 4.5.6.1.5
	until the air resistance was equal to the weight of the sky diver (and in the opposite direction)		1	
	(so) the resultant force was zero		1	
	(so) the acceleration was zero (so the velocity was constant)		1	

4.5.1.4 Resultant forces

Answer 20 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	greater weight of air above the skydiver as distance fallen increases and pressure = *F/A* (so pressure increases) **OR** the density of the air surrounding the skydiver increases as the skydiver falls (1) more frequent collisions of air particles with skydiver (so pressure increases) (1)	allow the mass / number of air molecules above the skydiver increases	1 1	AO1 4.5.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	triangle / parallelogram drawn with vertical line longer than horizontal line resultant force arrow in correct direction magnitude of resultant force in range 300 N to 320 N angle to vertical of resultant force in range 38 °– 42 °		1 1 1 1	AO2 AO2 AO3 AO3 4.5.1.4

Total Question 5	16

4.5.1.4 Resultant forces

Answer 21 · Mark scheme

June 2025 | 8463/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	car **X** has a smaller maximum acceleration (than car **Y)**		1	AO3 4.5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	increases the time taken (for the driver to come to a stop) (so) the rate of change of momentum decreases **or** the deceleration / acceleration of the driver is less (so) the force (on the driver) is reduced	allow for MP1 **and** MP2 the change of momentum is the same but over a greater time	1 1 1	AO1 4.5.6.2.2 4.5.7.3

4.5.1.4 Resultant forces

Answer 21 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	$0 - 18^2 = 2 \times a \times 24$		1	AO2 4.5.2
	$a = -\frac{324}{48}$		1	4.1.1.2 4.5.6.2.2 4.5.6.1.5
	$a = -6.75$	the equation $v^2 - u^2 = 2as$ must have been used to score subsequent marks	1	4.5.7.3
	$F = 1400 \times (-) 6.75$		1	
	9450 (N)		1	
	OR			
	$E_k = \frac{1}{2} \times 1400 \times 18^2$ (1)			
	$=226\ 800$ (1)	the equation $E_k = \frac{1}{2} m v^2$ must have been used to score subsequent marks		
	$226\ 800 = F \times 24$ (1)			
	$F = \frac{226\ 800}{24}$ (1)			
	9450 (N) (1)			
	OR			
	average velocity = (18 + 0) / 2 (1)			
	$24 = 9 \times t$ (1)			
	$t = \frac{24}{9}$ (1)	subsequent marks may be awarded if t has been calculated using initial velocity rather than average velocity		
	$F = \frac{1400 \times 18}{\frac{24}{9}}$ (1)			
	9450 (N) (1)			

4.5.1.4 Resultant forces

Answer 21 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	work is done by friction (in the brakes) (some of the kinetic) energy (of the vehicle) is transferred as thermal energy (in the brakes)	ignore friction alone	1 1	AO1 4.5.6.3.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	the brakes will overheat the driver will lose control of the car		1 1	AO1 4.5.6.3.4

Total Question 6	13

4.5.1.4 Resultant forces

Answer 22 · Mark scheme

June 2025 | 8463/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	B		1	AO3 4.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$F = 0.30 \times 2.0 \times 0.070$		1	AO2 4.7.2.2
	$F = 0.042$ (N)	the equation $F = BIl$ must have been used to score subsequent marks	1	
	$0.042 = 0.005 \times a$	subsequent marks may be awarded if an incorrectly / not converted mass is used	1	
	$a = \frac{0.042}{0.005}$		1	
	$a = 8.4$ (m/s^2)		1	

4.5.1.4 Resultant forces

Answer 22 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	(the interaction of) the magnetic fields produce forces on the sides of the coil (AB and CD)	do **not** accept answers describing a generator	1	AO1 4.7.2.3
	AB and CD move in opposite directions		1	
	(each half-revolution) the ends of the coil swap from one contact to the other	*allow 'split ring commutator' for ends of the coil'*	1	
	(so) current in each side of the coil is reversed, so the forces on each side of the coil are reversed		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	there is no current in the wire		1	AO1
	(so) there is no (magnetic) force acting (therefore there is no moment)	MP2 is dependent on MP1	1	AO3 4.5.1.4 4.7.2.3

Total Question 7	12

4.5.1.4 Resultant forces

Answer 12 · Examiner comments — November 2020 | 8463/2H | Original Q1

Question 1 (Standard demand)

01.1 Approximately 85% of students identified the correct change to the apparatus.

01.2 To gain credit, the suggestions should be feasible. The most popular correct answers were 'to add a pulley' and 'lubricate the string'.

01.3 Suitable scales should cover at least half of the graph paper and start at the origin. Lines of best fit are either straight as in this case or smooth curves, never 'wiggly' lines. Approximately 70% of students scored all four marks.

01.4 Students should understand that 'direct proportion' and 'positive correlation' do not have the same meaning.

Answer 12 · Examiner comments — November 2020 | 8463/2H | Original Q1

01.5 The question was about improving this investigation and not changing to a different investigation. Those students scoring one mark generally did so for the idea of 'repeating the investigation'. A significant number of students added 'to take a mean' but did not score the mark as the idea of 'ignoring anomalies' was omitted.

01.6 Approximately 88% of students were able to recall this equation.

01.7 This calculation was generally well answered, although a significant number of the students failed to give the answer to 2 significant figures.

4.5.1.4 Resultant forces

Answer 13 · Examiner comments

November 2020 | 8463/2H | Original Q4

Question 4 (Standard and standard/high demand)

04.1 This part was poorly answered. Many students drew the ray diagram for a convex lens.

04.2 75% of students correctly identified how the image changed.

04.3 80% of students knew that the bolt should be made from iron.

04.4 There were some good, clear and logical explanations given. However some of the students failed to link the switch closing to a current in the circuit. The final marking point was missed by a significant number of the students who failed to give an 'action' acting on the bolt i.e. attraction or pulling etc.

04.5 There were many correct answers given with the working out clearly shown. A significant number of the students failed to score all 4 marks as the attempt to convert to metres was incorrect. A smaller proportion of the students tried calculating energy stored. Some of those scored 1 mark for showing a correct conversion from 1.50cm to 0.015m.

04.6 It was not always clear if the students were writing about the spring or the solenoid. The most common way of scoring one mark was for 'increasing the current' or a correct description of how this could be achieved. Answers simply in terms of 'increasing the magnetic field' were insufficient for credit to be awarded.

4.5.1.4 Resultant forces

Answer 14 · Examiner comments November 2020 | 8463/2H | Original Q6

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

06.1 The majority of the students were able to convert MHz to Hz correctly. A large number of the students did not know the unit of wavelength with the symbol 'λ' being a common incorrect answer.

06.2 Only 3% of students were able to write a complete answer to this question. Many of the students described the final movement of the car rather than what happens in the electrical circuit. A significant number of the students thought that absorbing radio waves would result in sound being produced. Some of the students realised that there would be a current in the aerial but used terms such as 'produce a current' and 'produce an electrical signal' which were insufficient for credit to be awarded.

06.3 The most frequent correct answer was to state that radio waves are transverse and sound waves are longitudinal. Another popular correct answer was the idea of radio waves being able to travel through a vacuum / space. Comparisons of wavelength / frequency did not gain any marks due to the overlapping range of wavelength and frequency of radio waves and sound waves.

06.4 83% of students correctly described the motion of the car during the first 30 seconds.

06.5 The majority of the students knew how to calculate velocity from a straight line graph but failed to realise the significance of the curved line. Those few students that drew an appropriate tangent to the line at 20s generally went on to score all four marks.

06.6 Whilst 25% of the students gained all six marks for this calculation, a significant number of the remaining students gained partial credit for clearly showing the working out, part of which was correct.

06.7 There were very few complete and correct answers to this question. A significant number of the students correctly referred to air resistance increasing with speed but then went on to state that air resistance becomes equal to speed. It was common for answers to be in terms of real cars, the effect of speed on braking distances or the likely increase in accidents.

Answer 15 · Examiner comments November 2021 | 8463/2H | Original Q1

Question 1 (Common Question)

Part **01.1** asked students to explain factors and not simply list them. However, this is what many of the students did. Another common error was to explain factors affecting thinking distance rather than as asked, braking distance. The required equations were well known and the calculation required to answer **01.3** was often given correctly. Reading values from a graph proved difficult with only about half of the students answering **01.4** correctly.Less than 50% of the students scored full marks in part **01.6**. Generally only those students completing the calculation correctly scored the unit mark. However many of the students did score the mark for correctly giving a calculated incorrect numerical answer in standard form.

4.5.1.4 Resultant forces

Answer 16 · Examiner comments November 2021 | 8463/2H | Original Q7

Question 7

In part **07.1**, few students could name a force. Most of the students gave answers such as ‘energy’, momentum’ and ‘speed’. Once again reading a correct value from a graph proved difficult and prevented many of the students from scoring full marks. Despite part **07.3** using both the word ‘force’ and the word ‘moment’ few of the answers used either word and so scored no marks. Clear working out in part **07.4** allowed some students to gain some credit even when the final answer was wrong. An approach that was often seen was to first calculate time and then acceleration. However, those doing this tended to use the final velocity, instead of the average velocity. The final part produced few totally correct answers. Common errors included: showing the wrong direction, or not indicating the direction, of the resultant force; inaccurate scale drawing; no indication of what angle was being given; and giving a calculated answer with no vector diagram attempted.

4.5.1.4 Resultant forces

Answer 17 · Examiner comments June 2023 | 8463/2H | Original Q2

02.1

58% of students calculated the displacement correctly. Those who did not gain the mark simply measured the route taken by the aircraft and scaled that distance up, showing that many students do not appreciate the difference between displacement and distance.

02.2

82% of students successfully calculated the resultant force to be zero.

02.3

Having successfully calculated the resultant force to be zero, few students stated that the plane was moving at a constant speed. Many said it was stationary or accelerating, not appreciating the lack of resultant force.

02.4

Students did not appear to understand the concept of a contact force, often quoting gravity as one. In addition, they gave forces already quoted in the question as answers.

02.5

This was successfully done by the majority of students, with 64% correctly linking distance and velocity and drawing correct graphs.

02.6

The minority attempted to draw a smooth curve and extrapolate this to the 10km line. Those who did generally used the graph correctly, with 44% of students gaining both marks. A number of students misread the scale on the graph and quoted incorrect values from their line. It was common to see a straight line, which often allowed the award of 1 mark for a correct reading of the value.

02.7

84% of students knew that as the height of the aeroplane above the ground increased, the average density of the air decreased.

4.5.1.4 Resultant forces

Answer 18 · Examiner comments June 2024 | 8463/2H | Original Q2

02.1
79% of students scored the first mark, with a minority citing 9.8 N / gravity for the resultant vertical force. Many quoted Newton's laws as an explanation; very few students said, 'the child isn't accelerating' and a number stated that the forces were equal but failed to explain that the forces were in opposite directions.

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Answer 18 · Examiner comments June 2024 | 8463/2H | Original Q2

02.2
99.6% of students wrote down the correct equation for work done.

02.3
95% of students scored all 3 marks for this calculation of force. There were some errors rearranging.

02.4
84% of students gained the first mark point for explaining why the speed of the baby walker increased as the baby moved onto the hard floor, but few referred to the resultant force. A significant number of students thought there was no friction on the hard floor. Some responses were in terms of energy rather than forces.

02.5
99.7% of students wrote down the correct equation for the moment of a force.

02.6
75% of students scored all 3 marks for the calculation of the moment; 24% did not convert 7.5cm to 0.075m or converted incorrectly.

02.7
This question related to interaction of two gears. When marks were gained, this was primarily for the first mark point. Some expressed ideas for the second mark point and but rarely in the correct terms, sometimes referring to momentum, rather than moments. There were a number of responses in terms of energy transfers. 10% of students scored both marks, 73% scored 1 mark.

4.5.1.4 Resultant forces

Answer 19 · Examiner comments June 2024 | 8463/2H | Original Q5

05.1
Only 25% of students were able to name the force acting through the string. There are a significant number of students on higher tier who are unable to distinguish between forces and types of energy.

05.2
29% of students gained this mark by identifying a control variable. There is a misconception that 'keeping things the same' equates to a control variable. The idea that you would, for example, change the string or the bench in the middle of an investigation is not creditworthy.

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Answer 19 · Examiner comments June 2024 | 8463/2H | Original Q5

05.3
Very few students (0.94%) scored full marks for a description of how to calculate acceleration with the given data. Very few appreciated the necessity to use the maximum velocity in the calculation and did not gain the second mark point as a result. Many students merely quote two formulae, often simply using symbols and not quoting the correct subject of the formula. Describing a calculation, rather than performing one, appears to be a skill that few students have practised.

05.4
This uncertainty calculation was generally well done, and those students who knew the difference between range, mean and uncertainty found the question straightforward. 62% gained both marks. However, it was clear that many students were unsure of the meaning of these terms and were therefore unable to calculate an uncertainty successfully.

05.5
This was a demanding question, requiring an explanation of how the raising of the runway affected the acceleration of the trolley. Very few students (0.3%) scored the full 2 marks. Many were able to appreciate the idea of acceleration increasing because of an increased resultant force, but virtually none could link this to the correct component of the weight. Those who adopted the energy approach in their answer similarly found the question challenging and failed to give a complete response relating work done to the energy transfer causing the increase in final velocity and hence acceleration.

4.5.1.4 Resultant forces

Answer 20 · Examiner comments — June 2025 | 8463/2H | Original Q5

5.1

Students answered this free-body diagram question well with just over 60 % gaining both marks. Some students failed to realise that the air resistance should be represented by a smaller arrow than the one given in the diagram. Some students had drawn the dot again with labels added to their dot. Other arrows were occasionally added stating 'gravity' alongside weight.

5.2

Just over 60% of the students completed this calculation correctly. Most students understood the need to convert minutes into seconds. However, some students took data from elsewhere in the question, instead of using that given in the stem of this question part.

5.3

Students answered this question well. They generally had a good understanding of how the skydiver reached terminal velocity and described that air resistance increased to become

Answer 20 · Examiner comments — June 2025 | 8463/2H | Original Q5

equal to the weight of the skydiver. A lot of the students were also correctly stating that the resultant force was zero.

5.4

There were two ways to explain why the atmospheric pressure changed as the sky diver fell. In both methods many students were awarded only one mark, often by giving both versions of the 1st mark point.
Method 1: Some students described more air above not referring to more weight of air. The second mark point was often missed as many students just stated so pressure increases, without referring to P=F/A.
Method 2: Many students correctly described that the density of the air increases, but the second mark point was often missed as students did not describe more ‘frequent’ collisions with the skydiver.

5.5

Only a small proportion of the students were able to draw a completely correct vector diagram and find the magnitude and direction of the resultant force. Most students were able to draw a triangle/parallelogram with the correct shape and orientation. The resultant force arrow head was often missing and when drawn was sometimes difficult to see. The magnitude was often correctly measured from the diagram or calculated. However, a significant number of the students measured the wrong angle.

4.5.1.4 Resultant forces

Answer 21 · Examiner comments June 2025 | 8463/2H | Original Q6

6.1

This question was well answered with a number of students explaining their answer by linking it to F=ma showing a clear understanding of the link between variables. Students sometimes expanded their answers unnecessarily adding a detailed explanation as to why car X would have a lower maximum acceleration. Converse argument of car Y would have a greater maximum acceleration were common for this question.

6.2

This question topic proved difficult, as it has in previous exam series with only 15 % of the students scoring all 3 marks. Many answers did not show a scientific understanding of the concept, merely referring to the cushioning effect of airbags. Very few students scored the 2nd mark point being unaware of how the rate of change of momentum changed or deceleration. There were also a significant number of incorrect references to 'slowing down time'.

6.3

Just over 40 % of the students gained full marks for this multi-step calculation. Those who did mostly chose to use the equations of motion method before substituting their value of acceleration into F=ma. Very few students approached the problem from the kinetic energy method. The method using the average velocity was commonly used. However, very few students realised the necessity to use average velocity in their solution and were as a result a factor of two out in their final answer. This method also highlights that many students do not know which equations relate to constant velocity, and which relate to changing velocity.

Answer 21 · Examiner comments June 2025 | 8463/2H | Original Q6

6.4

Only a tiny minority of the students gained the 1st mark point for explaining why braking causes an increase in the temperature of the brakes, the majority failing to grasp the link between work done and frictional force. Many incorrectly referred to friction between the wheels and the road.

6.5

Just over half of the students gained marks for stating the risks of a large deceleration. Many students referenced crashes in their responses, notably involving the vehicle behind. Students rarely mentioned overheating, failing to make the link between this question and 6.4.

4.5.1.4 Resultant forces

Answer 22 · Examiner comments June 2025 | 8463/2H | Original Q7

7.1

Just over 60% of the students were able to use Flemings Left Hand rule to work out which direction the copper rod would accelerate.

7.2

Just over half of the students scored all the marks on this multi-step calculation of acceleration. Those students not scoring full marks often failed to convert the mass correctly or did not rearrange the equation F=ma correctly.

7.3

This motor question was targeted at the most able students and proved very challenging. Only about one third of the students scored any marks at all. Only a very few of the students scored four marks. Most of the students who scored any marks were most likely to gain the 2nd and/or 3rd mark points. A significant number of the students confused motors with generators.

7.4

Another poorly answered high demand question. Many answers were to do with the coil being parallel to the field and there being no force. The majority of the students had missed that there would be no current flowing at that point due to the position of the coil. If this marking point was scored, responses usually continued to the idea of there being no forces acting. The 2nd mark point was dependent on the students scoring the 1st mark point.