AQA GCSE Physics | 8463

SPECIFICATION POINT 4.5.6.3.4

Factors affecting braking distance 2

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**14**
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.

4.5.6.3.4 Factors affecting braking distance 2

Answer 01 · Mark scheme June 2008 | PHY2H | Original Q3 | Legacy

Question 3

	answers	extra information	mark
(a)(i)	as one goes up so does the other **or** (directly) proportional	 accept change by the same ratio	1
(ii)	steeper straight line through the origin	judge by eye	1
(iii)	Yes with reason eg data would have been checked / repeated **or** No with reason eg does not apply to all conditions / cars / drivers **or** are only average values **or** Maybe with a suitable reason eg cannot tell due to insufficient information	 accept produced by a reliable/ official/ government source do **not** accept it needs to be reliable	1
(b)(i)	stopping distance = thinking distance + braking distance		1

4.5.6.3.4 Factors affecting braking distance 2

(ii)	any **two** from: • smooth road / loose surface • rain / snow / ice • badly maintained brakes • worn tyres • downhill slope/gradient • heavily loaded car	factors must be to do with increasing braking distance accept wet road/ petrol spills do **not** accept condition of road unless suitably qualified accept worn brakes accept bad/ worn/ rusty brakes do **not** accept old brakes accept bald tyres accept lack of grip on tyres do **not** accept old tyres	2
total			6

4.5.6.3.4 Factors affecting braking distance 2

Answer 01 · Mark scheme June 2008 | PHY2H | Original Q3 | Legacy

PHY2H

4.5.6.3.4 Factors affecting braking distance 2

Answer 02 · Mark scheme June 2009 | PHY2H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)	47250	answers of 1350/ 33750/ 48600 gain **1** mark allow **1** mark for correct substitution using both 18 and 3	2
5(b)(i)	47250 or their (a)	accept statement 'same as the KE (lost)' ignore any units	1
5(b)(ii)	transformed into heat/ thermal energy	sound on its own is insufficient accept transferred/ lost/ for transformed do **not** accept any other form of energy included as a list	1
Total			**4**

4.5.6.3.4 Factors affecting braking distance 2

Answer 02 · Mark scheme June 2009 | PHY2H | Original Q5 | Legacy

PHY2H

4.5.6.3.4 Factors affecting braking distance 2

Answer 03 · Mark scheme

Question 1

question	answers	extra information	mark
1(a)	gravitational / gravity / weight	do **not** accept gravitational potential	1
1(b)	accelerating the distance between the drops increases but the time between the drops is the same	accept speed / velocity increases accept the time between drops is (always) 5 seconds accept the drops fall at the same rate	1 1 1
1(c)(i)	any **one** from: • speed / velocity • (condition of) brakes / road surface / tyres • weather (conditions)	 accept specific examples, eg wet / icy roads accept mass / weight of car friction is insufficient reference to any factor affecting thinking distance negates this answer	1

Question 1 continues on the next page . . .

4.5.6.3.4 Factors affecting braking distance 2

PH2HP

Question 1 continued . . .

question	answers	extra information	mark
1(c)(ii)	75 000	allow **1** mark for correct substitution, ie 3000 × 25 provided no subsequent step shown **or** allow **1** mark for an answer 75 **or** allow **2** marks for 75 k(+ incorrect unit), eg 75 kN	2
	joules / J	do **not** accept j an answer 75 kJ gains **3** marks for full marks the unit and numerical answer must be consistent	1
Total			**8**

4.5.6.3.4 Factors affecting braking distance 2

Answer 03 · Mark scheme

January 2013 | PH2HP | Original Q1 | Legacy

PH2HP

4.5.6.3.4 Factors affecting braking distance 2

Answer 04 · Mark scheme

June 2013 | PH2HP | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	distance vehicle travels during driver's reaction time	accept distance vehicle travels while driver reacts	1
4(a)(ii)	any **two** from: • tiredness • (drinking) alcohol • (taking) drugs • speed • age	accept as an alternative factor distractions, eg using a mobile phone	2
4(b)(i)	320 000	allow **1** mark for correct substitution, ie $\frac{1}{2} \times 1600 \times 20^2$ provided no subsequent step shown	2
4(b)(ii)	320 000 **or** their (b)(i)		1
4(b)(iii)	40 **or** $\frac{\text{their (b)(ii)}}{8000}$ correctly calculated	allow **1** mark for statement work done = KE lost **or** allow **1** mark for correct substitution, ie 8000 × distance = 320 000 **or** their (b)(ii)	2
4(b)(iv)	any **one** from: • icy / wet roads • (worn) tyres • road surface • mass (of car and passengers) • (efficiency / condition of the) brakes	accept weather conditions accept number of passengers	1

Question 4 continues on the next page . . .

4.5.6.3.4 Factors affecting braking distance 2

PH2HP

Question 4 continued . . .

question	answers	extra information	mark
4(b)(v)	(work done by) friction (between brakes and wheel) (causes) decrease in KE and increase in thermal energy	do **not** accept friction between road and tyres / wheels accept heat for thermal energy accept KE transferred to thermal energy	1 1
4(c)	the battery needs recharging less often **or** increases the range of the car as the efficiency of the car is increased the decrease in (kinetic) energy / work done charges the battery (up)	accept car for battery accept less demand for other fuels **or** lower emissions **or** lower fuel costs environmentally friendly is insufficient accept it is energy efficient accept because not all work done / (kinetic) energy is wasted	1 1 1
Total			**14**

4.5.6.3.4 Factors affecting braking distance 2

Answer 04 · Mark scheme

June 2013 | PH2HP | Original Q4 | Legacy

PH2HP

4.5.6.3.4 Factors affecting braking distance 2

Answer 05 · Mark scheme

Question 4

question	answers	extra information	mark
4(a)	liquids are (virtually) incompressible		1
4(b)	84	allow **1** mark for correct substitution, ie $1.5 \times 10^{6} = \frac{F}{5.6 \times 10^{-5}}$ numbers may not be written in standard form, ie $1\,500\,000 = \frac{F}{0.000\,056}$ allow **1** mark for an answer 216	2
4(c)	it (the force on the slave pistons) is greater / larger	accept force (at slave piston) = 216 (N)	1
	the area (touching the liquid) of the slave piston is greater than the area of the master piston	accept it has a bigger area just quoting numbers, eg the master piston is 5×10^{-5} and the slave piston is 14.4×10^{-5} is insufficient	1
Total			**5**

4.5.6.3.4 Factors affecting braking distance 2

Answer 05 · Mark scheme June 2013 | PH3HP | Original Q4 | Legacy

PH3HP

Answer 06 · Mark scheme June 2014 | PH2HP | Original Q3 | Legacy

3(a)(i)	friction		1	AO1 2.1.3a

3(a)(ii)	air resistance	accept drag friction is insufficient	1	AO1 2.1.3a

3(a)(iii)	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 on page 5, and apply a 'best-fit' approach to the marking.		**Mark** **6**	**AO spec ref**
0 marks	**Level 1 (1–2 marks)**	**Level 2 (3–4 marks)**	**Level 3 (5–6 marks)**	AO2 AO3 2.1.4c
No relevant content.	There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points **or** a description of how the velocity changes between any two points.	There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z **or** a complete description of how the velocity changes from X to Z. **or** an explanation and description of velocity change for either X to Y or Y to Z	There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z **and** a description of the change in velocity between X and Z.	

4.5.6.3.4 Factors affecting braking distance 2

Answer 06 · Mark scheme

examples of the points made in the response	extra information
X to Y • at X force A is greater than force B • cyclist accelerates • and velocity increases • as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity) • resultant force decreases • cyclist continues to accelerate but at a smaller value • so velocity continues to increase but at a lower rate **Y to Z** • from Y to Z force B (air resistance) increases • acceleration decreases • force B becomes equal to force A • resultant force is now zero • acceleration becomes zero • velocity increases until… • cyclist travels at constant / terminal velocity	accept speed for velocity throughout

4.5.6.3.4 Factors affecting braking distance 2

Answer 06 · Mark scheme

Question	Answers	Extra information	Mark	AO spec ref
3(b)(i)	3360	allow **1** mark for correct substitution, ie 140 × 24 provided no subsequent step accept 3400 for **2** marks if correct substitution is shown	2	AO1 AO2 2.2.1b
	joule / J	do **not** accept j do **not** accept Nm	1	
3(b)(ii)	decreases	accept an alternative word / description for decrease do not accept slows down	1	AO1 2.1.3e
	temperature	accept thermal energy accept heat	1	
Total			**13**	

4.5.6.3.4 Factors affecting braking distance 2

Answer 06 · Mark scheme

June 2014 | PH2HP | Original Q3 | Legacy

Question	Answers	Extra information	Mark	AO spec ref

4.5.6.3.4 Factors affecting braking distance 2

Answer 07 · Mark scheme June 2015 | PH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
4(a)(i)	distance travelled under the braking force	accept distance travelled between applying the brakes and stopping	1	AO1 2.1.3c	**E**
4(a)(ii)	any **one** from: • icy/wet roads • (worn) tyres • road surface • mass (of car and passengers) • (efficiency/condition of the) brakes	accept weather (conditions) accept gradient of road accept number of passengers friction/traction is insufficient	1	AO1 2.1.3f	**E**
4(a)(iii)	greater the speed the greater the braking force (required)	must mention both speed and force	1	AO1 2.1.3b	**E**
4(b)	22.5	allow **1** mark for showing correct use of the graph with misread figures **or** for showing e.g. 90÷4 an answer 17 gains **1** mark any answer such as 17.4 or 17.5 scores 0	2	AO2 2.1.2b/c	**E**
4(c)(i)	momentum before = momentum after **or** (total) momentum stays the same	accept no momentum is lost accept no momentum is gained ignore statements referring to energy	1	AO1 2.2.2b	**E**

Question 4 continues on the next page . . .

4.5.6.3.4 Factors affecting braking distance 2

Question 4 continued . . .

Question	Answers	Extra information	Mark	AO / Spec. ref.	ID
4(c)(ii)	5	allow **2** marks for correctly obtaining momentum before as 12 000 **or** allow **2** marks for 1500 x 8 = 2400 x v **or** allow **1** mark for a relevant statement re conservation of momentum **or** allow **1** mark for momentum before = 1500 x 8	3	AO2 2.2.2a/b	**E**
4(d)	the seat belt stretches driver takes a longer *(impact)* time to slow down and stop (than a driver hitting a hard surface/windscreen/ steering wheel) for the (same) change of momentum a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt) **or** the seat belt stretches ***(1)*** driver travels a greater distance while slowing down and stopping (than a driver hitting a hard surface/windscreen/ steering wheel) ***(1)*** for (same) amount of work done (**1**) a smaller force is exerted (so driver less likely to have serious injury than driver without seat belt) ***(1)***	 accept so smaller deceleration/negative acceleration do not accept impact for force accept for (same) change of KE do not accept impact for force	1 1 1 1	AO1/3 2.2	**E**

4.5.6.3.4 Factors affecting braking distance 2

Answer 07 · Mark scheme

June 2015 | PH2HP | Original Q4 | Legacy

Total			**13**

4.5.6.3.4 Factors affecting braking distance 2

Answer 08 · Mark scheme June 2017 | PH2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	The distance the lorry travels during the driver's reaction time.		1	AO1 2.1.3c
4(a)(ii)	the greater the speed (of the lorry) the greater the (thinking) distance **or** they are directly proportional		1	AO1 2.1.3b
4(b)(i)	24 (m)	allow **1** mark for ½ x 12 x 4 an answer of 30 gains **1** mark	2	AO2 2.1.2h
4(b)(ii)	15000 (N) **or** 360 000÷ their **(b)(i)** correctly calculated	allow **1** mark for correct substitution ie 360 (000) = F x 24 or their **(b)(i)** an answer 15 with the unit changed to kN gains **2** marks an answer 15 gains **1** mark 360 ÷ their **b(i)** correctly calculated gains **1** mark	2	AO2 2.2.1b
4(c)(i)	any one from: • height (of the ramp) • speed of the trolley at the bottom (of the ramp) • angle (of the ramp) • start point (on the ramp)	the following are insufficient length of ramp or string same trolley or same ramp	1	AO2 HSW
4(c)(ii)	(measure maximum) distance the weight is lifted from the floor		1	AO3 HSW

4.5.6.3.4 Factors affecting braking distance 2

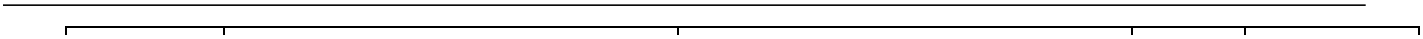
Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(c)(iii)	increase accuracy (in measurement of braking distance)	accept results would be more reliable ignore reference to validity	1	AO3 HSW
	by allowing a mean/average to be calculated **or** by allowing anomalous results to be discarded	accept by allowing anomalous results to be identified accept shows results are repeatable reproducible is insufficient	1	
4(c)(iv)	As (braking) force increases (braking) distance decreases	accept weight (lifted) for braking force	1	AO3 HSW
	justification by correct numerical example eg increasing the force from 2 to 8 you can decrease the braking distance from 80 to 20 cm	An answer of (braking) distance is inversely proportional to (braking) force gains **2** marks	1	
Total			**12**	

4.5.6.3.4 Factors affecting braking distance 2

Answer 08 · Mark scheme

June 2017 | PH2HP | Original Q4 | Legacy



4.5.6.3.4 Factors affecting braking distance 2

Answer 09 · Mark scheme

June 2019 | 8463/2H | Original Q3

Question 3

Question	Answers	Mark	AO/ Spec. Ref
3.1	**Level 3**: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1/1 AO2/1 4.5.6.3.2 4.5.6.3.3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points 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 • reaction time explained in terms of longer reaction times increase thinking distance (from a given speed) • taking drugs • drinking alcohol • tiredness • age • distractions explained in terms of the effect on driver's reaction time • speed explained in terms of the faster the vehicle the greater the distance travelled in the driver's reaction time (or converse) **OR** explained in terms of increased speed increases KE so increases work done to stop the vehicle • condition of the tyres • condition of road surface • wet/icy roads explained in terms of condition of tyres and road surface (including weather considerations) affecting <u>friction</u> (between tyres and road) • condition of brakes explained in terms of effect on braking force (applied to the wheels) or reduced <u>friction</u>		

4.5.6.3.4 Factors affecting braking distance 2

	• mass / weight of vehicle explained in terms of deceleration force or kinetic energy or change in momentum answers do not need to reference thinking / braking distance a Level 1 answer would list factors only **or** one factor with one linked explanation a Level 2 answer lists at least three factors with one linked explanation **or** two factors with two linked but different explanations a Level 3 answer lists at least three factors with at least two linked but different explanations			
3.2	work (done) = force x distance	allow W = F s	1	AO1/1 4.5.2
3.3	900 000 = 60 000 × distance distance = $\frac{900\ 000}{60\ 000}$ distance = 15 (m)	an answer 15 (m) scores **3** marks	1 1 1	AO2/1 4.5.2
3.4	brakes overheating **or** brakes locking (causing) loss of control **or** (causing) a skid	allow brake fade allow wheels locking allow increasing the stopping / braking distance **ONLY** if the first marking point is scored ignore any effects on passengers or possible accidents	1 1	AO1/1 4.5.6.3.4
Total			**12**	

4.5.6.3.4 Factors affecting braking distance 2

Answer 10 · 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			

4.5.6.3.4 Factors affecting braking distance 2

Answer 10 · 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**	

4.5.6.3.4 Factors affecting braking distance 2

Answer 11 · Mark scheme

June 2022 | 8463/2HR | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: • wet / icy road conditions • poor condition of brakes • poor condition of tyres • increased mass of car • negative gradient of the road	ignore weather allow weight for mass allow going downhill	2	AO1 4.5.6.3.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	distance = speed × time (so) longer reaction time = longer distance		1 1	AO1 4.5.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	mean reaction time increases after drinking alcohol the change in reaction time is not the same for all people after drinking alcohol		1 1	AO3 4.5.6.3.3

4.5.6.3.4 Factors affecting braking distance 2

Answer 11 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	distance = 1500 (m)		1	AO2 4.5.6.1.2
	$1500 = 20 \times t$	allow a correct substitution using an incorrectly / not converted value of distance	1	
	$t = \frac{1500}{20}$	allow a correct rearrangement using an incorrectly / not converted value of distance	1	
	75 (s)	allow a correctly calculated value using an incorrectly / not converted value of distance	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	velocity is a vector and speed is a scalar	allow velocity includes direction (speed does not)	1	AO3 4.5.6.1.2
	road is not straight	allow driver may change lanes	1	
	therefore direction changes so the velocity changes		1	

Total Question 3		**13**

4.5.6.3.4 Factors affecting braking distance 2

Answer 12 · Mark scheme

June 2023 | 8463/2H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	apply the force further away from the pivot	do not allow increase the length of the lever	1	AO2 4.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	v = 15 (m/s)		1	AO2 4.5.7.1
	24 000 = m × 15	allow a value of v = 14.5 (m/s)	1	
	$m = \frac{24\,000}{15}$		1	
	m = 1600 (kg)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	distance travelled during first 3 seconds = 22.5 (m)		1	AO2 4.5.6.1.5
	distance travelled during last 2 seconds = 30 (m)		1	
	total distance = 52.5 (m)	allow 53 (m) allow 1 mark for the correct addition of their calculated distances allow a maximum of 2 marks for total distance = 50.75 (m) if velocity used = 14.5 (m/s)	1	

4.5.6.3.4 Factors affecting braking distance 2

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	stopping distance includes thinking distance	allow stopping distance = braking distance + thinking distance	1	AO1
	there is an additional time before the driver applies the brakes.	allow the driver's reaction time will increase (due to the distraction)	1	AO2
	(so) the thinking distance will increase		1	AO2
				4.5.6.1.1 4.5.6.3.1 4.5.6.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	work is done due to friction (in the brakes)	ignore friction alone	1	AO1 4.5.6.3.4
	(causing) an increase in the internal / thermal energy (of the brakes)		1	

Total Question 3	13

4.5.6.3.4 Factors affecting braking distance 2

Answer 13 · Mark scheme

June 2024 | 8463/2H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	$(\frac{1}{2} \times 56 \times 220) = 6160$ $(56 \times 380) = 21280$ $(6160 + 21280) = 27\,440$ (m)	 allow a correctly calculated total distance from an incorrectly calculated area of the rectangle and / or the triangle	1 1 1	AO2 4.5.6.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	the gradient is less after 720 s so the deceleration is smaller so the braking force is smaller	allow the gradient is less after (velocity decreases to) 20 m/s	1 1 1	AO3 4.5.6.1.5 4.5.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	correct section of line identified attempt to calculate a gradient using values from the correct section of the graph eg gradient $= \frac{(-)36}{120}$ correct calculation using their correct values eg $a = (-)0.3$ (m/s^2)	judge by values used allow use of correct values obtained from the section of the graph after 720 s allow a correct calculation using correct values obtained from the section of the graph after 720 s if no other marks scored, an answer that rounds to 0.16 (m/s^2) scores 1 mark	1 1 1	AO2 4.5.6.1.5

4.5.6.3.4 Factors affecting braking distance 2

Answer 13 · Mark scheme

June 2024 | 8463/2H | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	(–)270 000 = 240 000 × a		1	AO2 4.5.6.1.5
	$a = \frac{(-)270\,000}{240\,000}$		1	
	a = (–) 1.125 (m/s^2)	the equation $F = ma$ must have been used to score subsequent marks	1	
	0 = 60^2 + (2 × (–1.125) × s)	allow a correct substitution using their value of deceleration	1	
	$s = \frac{3600}{2.25}$	allow a correct re-arrangement using their value of deceleration	1	
	s = 1600 (m)	allow a correct calculation using their value of deceleration	1	
	OR			
	$E_k = \frac{1}{2} \times 240\,000 \times 60^2$ (1)			
	= 432 000 000 (1)			
	Δ E_k = work done (1)			
		the equation $E_k = \frac{1}{2}mv^2$ must have been used to score subsequent marks		
	432 000 000 = 270 000 × s (1)	allow a correct substitution using their value of E_k		
	$s = \frac{432\,000\,000}{270\,000}$ (1)	allow a correct re-arrangement using their value of E_k		
	s = 1600 (m) (1)	allow a correct calculation using their value of E_k		

07.4 cont.	**OR** $p = 240\,000 \times 60\ (= 14\,400\,000)$ (1) $270\,000 = \frac{14\,400\,000}{t}$ (1) $t = 53.333\ldots$(s) (1) mean speed $= \frac{60}{2} = 30$ (1) $s = 30 \times 53.333\ldots$ (1) $s = 1600$ (m) (1)	allow $t = 53$ (s) the equation $F = \frac{\text{change in momentum}}{\text{time taken}}$ must have been used to score subsequent marks allow a correct substitution using their value of t allow a correct calculation using their value of t		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5	stopping distance includes both braking distance and thinking distance alcohol increases driver's reaction time which will increase the thinking distance so stopping distance increases		1 1 1	AO1 4.5.6.3.1 4.5.6.3.2

Total Question 7	**18**

4.5.6.3.4 Factors affecting braking distance 2

Answer 14 · 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

4.5.6.3.4 Factors affecting braking distance 2

Answer 14 · Mark scheme June 2025 | 8463/2H | Original Q6

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 × (–) 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 × 24 (1)			
	$F = \frac{226\,800}{24}$ (1)			
	9450 (N) (1)			
	OR			
	average velocity = (18 + 0) / 2 (1)			
	24 = 9 × 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)			

4.5.6.3.4 Factors affecting braking distance 2

Answer 14 · 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**

4.5.6.3.4 Factors affecting braking distance 2

Answer 09 · Examiner comments — June 2019 | 8463/2H | Original Q3

Question 3 (Standard demand)

03.1 Just over 32% of the students gave a level 3 answer with 20% of those scoring full marks. Most of the students were able to give a good number of factors, and then tried to give at least one linked explanation. Many of the students used half a page to describe the meaning of Thinking Distance, Braking Distance and Stopping Distance, which was not required. There was a great deal of confusion about how to explain and link reaction time to a factor or group of factors. Many of the students confused reaction time and thinking distance. A significant number of students seemed to think that slower reactions meant a shorter reaction time and that the thinking distance was consequently shorter. When giving condition of tyres/road surface/wet/icy as a factor the explanation was often written in terms of grip/traction/sliding rather than using friction as a scientific term. Where speed was a factor, an explanation in terms of 'greater distance travelled in the reaction time' was seen a few times, but mainly the 'in the reaction time part' was missing. A greater distance to stop was the common explanation. Very few students linked kinetic energy and work done, most getting the idea of increased kinetic energy but then not linking it to work done. Even students that had an idea about work done being force × distance seemed to think that a larger force would be required from the brakes to stop in a certain distance, rather than the idea that the distance for a fixed braking force would be longer.

03.2 Nearly all of the students were able to recall this equation. Those students who did not score the mark just seemed to put an equal and a multiply sign in the quantity order of the stem or rearranged incorrectly.

03.3 Nearly all of the students scored all three marks. Where marks were not scored it was usually for putting the numbers into a calculator incorrectly or by missing powers of 10.

03.4 This was poorly answered with just below here quarters of the students scoring zero. There were lots of answers in terms of the effect on passengers, their momentum, possible crashes into the back because of braking too quickly, whiplash injury, what would happen if a seatbelt was not worn and the idea that the car would flip over. Few students wrote about

Answer 09 · Examiner comments — June 2019 | 8463/2H | Original Q3

the brakes overheating and of those that did only around 6% then linked this to possible loss of control.

4.5.6.3.4 Factors affecting braking distance 2

Answer 10 · 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.

Answer 12 · Examiner comments June 2023 | 8463/2H | Original Q3

03.1

32% of students gained this mark. Common mistakes included physically changing the length of the lever, increasing the distance from the pivot without any reference to force, and increasing the distance of the lever to the pivot.

03.2

87% of students gained all 4 marks on this question. There were not many incorrect readings of velocity from the graph, and the most common error was usually 14.5 m/s. Those who did not score all the marks had made mathematical errors, such as incorrect rearranging.

03.3

55% of students gained all 3 marks. Those not scoring full marks, were often awarded the second marking point for calculating the distance travelled when the velocity was constant, and the third mark for adding up their two values.

34% scored zero because they had not appreciated that the area under the graph represented the distance travelled. A large number of students used distance = speed × time, not recognising that speed was not constant.

03.4

This question demonstrated that incorrect use, or lack of use, of scientific terminology has a negative effect. Students frequently confuse distance and time when answering this type of question. In addition, many talk about reaction times being slower, which implies time can slow down. Credit was given for slower reaction times, as was the use of ‘thinking time’ or descriptions of a greater response time. Only 17% gained full marks, as the link between stopping distance and thinking distance was often not made.

03.5

The majority of students did not answer this question in terms of work done. Most mentioned friction which on its own was not creditworthy. The second mark point was expressed correctly as kinetic energy being transferred to thermal energy. Unspecific answers about the release of energy were not credited, but the use heat energy instead of thermal was accepted.. Only 4% of students scored both marks, with 35% scoring one mark.

4.5.6.3.4 Factors affecting braking distance 2

Answer 13 · Examiner comments June 2024 | 8463/2H | Original Q7

07.1
Most students appreciated the idea of using the area under the graph to calculate the distance travelled with 55% scoring full marks. Some, however, tried to calculate the area under the whole graph rather than limiting their calculation to the first 600 s. Common mistakes were seen in those who could not read the scale on the axes correctly, or who tried to calculate the areas of incorrect triangles or rectangles.

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Answer 13 · Examiner comments June 2024 | 8463/2H | Original Q7

07.2
A minority of students gained the first mark point for interpreting the velocity-time graph. Weaker responses referred to acceleration, or a slower deceleration, or stated that the rate of deceleration was slower. Only 49% gained marks on this question.

07.3
Students needed to determine the maximum deceleration from the velocity – time graph. Many incorrectly used the whole of the final section of the graph, calculating 2 gradients and adding them together, or used the section from 720s to 960 s. A minority calculated the average deceleration and were awarded a compensation mark. Most gradients were calculated with the correct values, but a small number read the velocity as 58 m/s or the time as 700 s or 1000 s. 41% scored all 3 marks.

07.4
30% of students scored full marks on this multi-step calculation of distance. These students tended to use the preferred method, or the first alternative method, given on the mark scheme. 45% scored 3 marks, usually because they used the final velocity instead of the mean velocity in distance = speed × time, so could not access the final 3 marks.

07.5
77% of students scored at least one mark in this question about how alcohol affects stopping distance. There was references to time being slowed down, and confusion between distance and time. 15% scored all 3 marks.

4.5.6.3.4 Factors affecting braking distance 2

Answer 14 · 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 14 · 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.