Mark Scheme

Q1.

Question number	Answer	Mark
(a)	Idea of a direct reading (without calculation)	(1)

Question number	Answer	Mark
(b)	If student B drops the ruler, they are not really measuring their own reaction time as they know when ruler has been dropped	(1)

Question number	Answer	Additional guidance	Mark
(c)(i)	calculating the mean (1) 18.36 rounding to 2 s.f. (1) 18 (cm)	award full marks for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	Rearrangement (1) $$t = \sqrt{\dfrac{distance}{500}}$$ Substitution and answer (1) time = 0.17 (s)	award full marks for correct numerical answer without working allow answers which round to 0.17, e.g. 0.1673	(2)

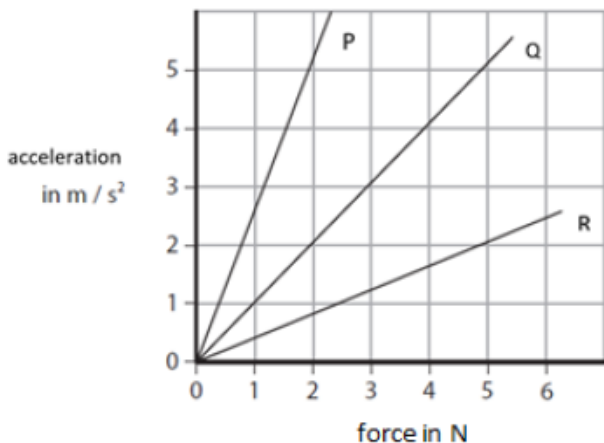| Question number	Answer	Additional guidance	Mark
(d)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (1 mark): • 25.5 is an anomalous result (1) • (because) it is much further away from the mean than the other results (1)	ignore 19	(2)

Question number	Answer	Mark
(e)	• Take more readings (1) • Idea that a third student should also measure the reaction time (1)	(2)

Question number	Answer	Additional guidance	Mark
(f)	An answer that combines the following points to provide a logical description of the plan/method/experiment: • using a larger group of students/large population of students (1) • and measure how their reaction time varies with age/height (1)	allow any suitable variable	(2)

Q2.

Question number	Answer	Additional guidance	Mark
	16.0 (m/s) read from graph (1) Substitution (1) (distance travelled =) 16 × 0.5 Answer (1) 8.0 (m) (1)	award full marks for correct numerical answer without working ecf for substitution and answer using wrong speed value	(3)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	any correct points from line Q e.g. substitution (1) mass = 2/2 evaluation (1) 1 (kg)	Accept answers in the range 1 to 1.05 (kg) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(ii)	an answer that combines points of interpretation to provide a logical description: • (trolley/it) has the smallest acceleration for the largest force • (and) m = F/a		(2)

Q4.

Question number	Answer	Additional guidance	Mark
(i)	substitution and conversion (1) v = 0.05/0.08 evaluation (1) v = 0.63 (m/s)	full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(ii)	a= (v-u) / t (1)		(1)

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) (1.1-0.72) / 0.53 evaluation (1) 0.72 m/s²	full marks will be awarded for correct numerical answer without working	(2)

Q5.

Question number	Answer	Additional guidance	Mark
	substitution (1) (a=) 12-2(.0) 4(.0) evaluation (1) 2.5 (m/s²)	award full marks for correct answer without working.	(2) AO2

Q6.

Question number	Answer	Additional guidance	Mark
	substitution (1) (average speed =) 1200 80 evaluation (1) 15 (m/s)	award full marks for the correct answer without working	(2)

Q7.

Question Number	Answer	Additional guidance	Mark
	substitution (1) $$\frac{80(^2) (- 0^2)}{2 \times 4}$$ evaluation (1) 800 (m)	allow 1 mark for seeing $\frac{80}{8}$ ignore any minus signs award full marks for the correct answer without working	**(2)**

Q8.

Question Number	Answer	Additional guidance	Mark
	substitution (1) 1800 x 1.2 evaluation (1) 2200 (N)	accept 1800 kg x 1.2 m/s^2 reject 1800 x 1.2^2 2160 (N) award full marks for the correct answer without working allow 1 mark total for 2200 OR 2160 with any other power of ten	**(2)**

Q9.

Question number	Answer	Additional guidance	Mark
	rearrangement (1) $$m = \frac{f}{a}$$ substitution and conversion (1) $$m = \frac{1870}{1.83}$$ answer and rounding to 3 s.f. (1) 1020 (kg)	maximum 2 marks if kN not converted to N award full marks for correct numerical answer without working	**(3)**

Q10.

Question number	Answer	Additional guidance	Mark
	rearrangement of $\frac{(v-u)}{t} = a$ (1) $v = u + at$ substitution (1) $v = 0 + 1.83 \times 16$ answer (1) 29.3 (m/s)	award full marks for correct numerical answer without working	**(3)**

Q11.

Question number	Answer	Additional guidance	Mark
	substitution (1) $(v^2 - 0 =) 2 \times 10 \times 1.5$ evaluation (1) 5.5(m/s)	accept numbers that round to 5.5 e.g. 5.477 30(m/s) gains 1 mark for correct substitution but no square root taken award full marks for correct answer without working.	(2) AO2

Q12.

Question number	Answer	Additional guidance	Mark
(i)	substitution Time = 37/ 25 (1) Evaluation (1) = 1.5 (s)	Allow 1.48 (s) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(ii)	substitution K.E. = 0.5 x 1300 x 20^2 (1) evaluation (1) = 260,000 J	260 kJ full marks will be awarded for correct numerical answer without working	(2)

Q13.

Question number	Answer	Mark
(i)	A	(1)

Question number	Answer	Additional guidance	Mark
(ii)	Obtain readings from graph (1) Substitution (1) $\dfrac{16}{2.0}$ Answer (1) 8.0 (m/s^2)	award full marks for correct numerical answer without working	(3)

Q14.

	Answer	Acceptable answers	Mark
(i)	D the same size as the driving force		(1)
(ii)	transposition: (1) (change in) speed= accelerationxtime substitution: (1) speed = 12 × 4 evaluation: (1) 48 (m/s) (1)	transposition and substitution can be in either order substitution mark can be scored when incorrectly transposed word/symbol equation is given Give full marks for correct answer no working	(3)

Q15.

Question number	Answer	Mark
(i)	any value from 19 to 20 inclusive.	(1)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that combines identification via a judgment (2 marks) to reach a conclusion via justification/reasoning (1 mark): • Idea that (approximately) equal incremental increases in speed cause equal incremental increases in thinking distance • correct reference to figures in table **and** • therefore the student's conclusion is correct	The last marking point can only be achieved if at least one of the other two marks is awarded	(3)

Q16.

Question number	Answer	Additional guidance	Mark
	A description including two from let the car roll down the slope from the same point on the slope (1) measure distance it travels (along horizontal surface) (1) change the surface/ use different surfaces (1)	 see how far it travels allow time it takes to stop	(2) AO1

Q17.

Question number	Answer	Additional guidance	Mark
	A description to include: measurement of (relevant) distance (1) measurement of (relevant) time (1) use of speed = $\dfrac{distance}{time}$ (1) detail (1)	one of distance down slope or distance along bench or length of toy car/card 'record the distance the car travels and time it' scores 2 marks For example: speed down slope × 2 mark distance along bench use a light gate speed gun at the bottom of the slope Repeating AND averaging	**(4)**

Q18.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO3** • graph starts at zero • graph increases to a maximum at 2 s • graph stays constant for 2.6 s • graph decreases to zero at 6 s • graph stays at zero after 6 s • graph decreases steeply until 5 s • graph decreases less steeply until 6 s • graph at zero between 6 and 7s **AO2** • velocity is zero at time zero • velocity increases/train accelerates until 2 s • velocity is constant for 2.6 s • velocity decreases/train decelerates until 6 s • deceleration changes at 5 s • acceleration is gradient of graph • velocity zero between 6 and 7 s	**(6)** **AO2** **AO3**

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The description attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The description is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The description is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Q19.

Question Number	Answer	Additional guidance	Mark
	a description to include 3 points from: • measure a distance (at the bottom) / use mark(er)s (certain distance apart) (1)	use a light gate (or equivalent sensors idea) not over whole slope for this mark point	(3) AO 2 2
	• starting timer (at first mark(er)) (1)	use of video / (speed) camera /interrupts the light beam	
	• stopping timer (at 2nd mark(er)) OR measures a time (interval) (1)	accept any time measured for this mp including data logger OR timer / stopwatch	
	• (use speed) = distance/time (1)		

Q20.

Question number	Answer	Additional guidance	Mark
(i)	A plan including four of the following measurement of appropriate distance (1) measurement of appropriate time (1) use of speed = $\dfrac{\text{distance}}{\text{Time}}$ (1) detail (1) e.g. repeat and average, use ruler/stop clock, mark a line near the top and bottom of liquid		(4) AO3

Question number	Answer	Additional guidance	Mark
(ii)	An explanation linking **two** from: add more lines (at equal distances)(1) measure the time of fall for each distance (1) compare the times (1)	use longer test tube / use different heights of liquid / use different sections of the liquid e.g. {equal times =constant speed} / {shorter time = acceleration}	(2) AO3

Q21.

	Answer	Acceptable answers	Mark
	substitution into given equation (1) 1.3 × 300 000 evaluation (1) 390 000 (km)	Power of 10 error max 1 mark 3.9×10^5 (km) 2 marks for correct numerical answer with no working shown Ignore any unit given by candidate.	(2)

Q22.

Question number	Answer	Additional guidance	Mark
(i)	0.45 (s) (1)	Allow any value ≥ 0.4 and ≤ 0.5	(1)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that combines improvement of the experimental procedure (1 mark) and justification/reasoning which must be linked to the improvement (1 mark) • take pictures more frequently (1) • in order to determine exact time of the release. (1)	other responses may be acceptable	(2)

Question number	Answer	Additional guidance	Mark
(iii)	Substitution (1) $F = 7.26 \times 20.6$ Evaluation (1) 150 (N)	Accept 149.6 (N) full marks will be awarded for correct numerical answer without working	(2)

Question number	Answer	Additional guidance	Mark
(iv)	Rearrangement (1) $v = a \times t$ Substitution (1) $v = 23 \times 0.48$ Evaluation (1) 11 (m/s)	Accept 11.04(m/s) full marks will be awarded for correct numerical answer without working	(3)

Q23.

Question number	Indicative content	Mark

	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.
	
	The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.
	
	AO1 strand 1 (6 marks)
	
	factors concerning driver
	    • change in reaction time
	    • tiredness
	    • effect of drugs
	    • type of footwear
	    • how hard the driver presses the pedal
	
	effect of any of the above on stopping distance,
	    • increased stopping distance
	    • increased thinking distance
	    • increased reaction time
	
	factors concerning car or road
	    • mass / weight of car
	    • speed of car
	    • state of brakes
	    • state of tyres
	    • state of road
	
	effect of any of the above on stopping distance, e.g.
	    • increased thinking/braking distance
	    • increased stopping distance
		(6)

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

SUMMARY, for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Elements of physics, i.e. isolated factor(s) about **either** car **or** driver	Possible candidate responses worn tyres / tired driver worn tyres and icy road
Level 2	3–4	Additional guidance Some understanding shown, i.e. **either** link between factor and effect **or** a driver factor **and** a car factor	Possible candidate responses worn tyres cause increased stopping distance. **or** worn tyres and tired driver
Level 3	5–6	Additional guidance Understanding is detailed and fully developed, i.e. link between factor and effect - both for driver **AND** for car	Possible candidate responses worn tyre causes increased stopping distance. **and** tired driver causes increased stopping distance

Q24.

	Answer	Additional guidance	Mark
(i)	an explanation linking **two** from: (wet road means) less / no friction (between tyres and road) (1) (wet weather means) increased stopping distance (1) (slower speed means) shorter braking / stopping distance (1) (dry weather / slower speed) reduces possibility of skidding / sliding / idea of losing control / crashing (1)	accept reverse arguments throughout accept road more slippery / less grip accept idea of reduced visibility accept braking or thinking distance in this context accept takes longer to slow down / stop ignore harder to brake	(2) AO1

	Answer	Additional guidance	Mark
(ii)	convert **either** distance or time (1) $(31 \text{ m} =) \frac{31}{1000}$ (km) or 0.031 (km) **OR** $(1 \text{ s} =) \frac{1}{3600}$ (h) $= \frac{1}{60 \times 60}$ (h) or 0.000 28 (h) evaluation (1) (31 m/s =) 110 (km/h)	$(130 \text{ km} =) 130 \times 1000$ (m) or 130 000 (m) **OR** $(1 \text{ h} =) 60 \times 60$ (s) or 3600 (s) (130 km/h =) 36(.1) (m/s) accept 111.6 or 112 (km/h) for 2 marks if no other marks awarded accept 1860 m/min and 2167 m/min for 1 mark each award full marks for the correct answer without working	**(2)** **AO2**

	Answer	Additional guidance	Mark
(iii)	select and substitute into distance travelled = average speed x time (1) 46 = 31 x t rearrangement and evaluation (1) (t=) 1.48(3) (s) evaluation given to 2 sf (1) (t =) 1.5 (s)	$31 = \frac{46}{t}$ $(t =) \frac{46}{31}$ award two marks for the correct evaluation without working any answer written to 2 sf independent mark 1.5 scores 3 marks 1.4 scores 2 marks 1.50 scores 2 marks 0.67 scores 2 marks 1400 scores 2 marks 0.673(9) scores 1 mark 1426 scores 1 mark	(3) AO2

Q25.

	Answer	Acceptable answers	Mark

	An explanation linking
	
	  • {acceleration of sports is 2x / time to reach 30 m/s is ½} that of family car / RA (1)
	
	  • mass of sports car LESS than ½ that of family car or RA (1)
		Attempt to use f = m × a scores one mark e.g. 4200 OR 3600 scores 1
		
		Correct numerical comparison scores both marks e.g. 4200:3600 numerically or in words scores 2 marks
			(2)

(so resultant force required is less)		

Q26.

	Answer	Additional guidance	Mark
(i)	0.54 (s)	allow any value from 0.53 and 0.55 inclusive	(1) AO3

	Answer	Additional guidance	Mark
(ii)	curve extended to a = 80° (1) 0.45 (s) (1)	judge generously allow range 0.42 to 0.48 award full marks for the correct answer without working.	(2) AO3

	Answer	Additional guidance	Mark
(iii)	mention/idea of reaction time (1) (reaction time) about the same as the times on the graph (1)	human reaction time is about 0.2 seconds (compared with) 0.4 seconds on the graph ignore accuracy ignore "human error"	(2) AO3

Q27.

Question Number	Answer	Additional guidance	Mark
	substitution (1)		**(3)**
	(F =) 0.10 x 2.0	100 x 2 (using 0.10kg = 100g)	AO 2 1
		reject 0.10 x 2.0² and the follow up evaluation (equation given should be used)	
	evaluation (1)		
	0.2(0)	correct answer without working gets 2 marks	
		allow 1 mark total for 2 with any other power of ten, so that includes 200 for example	
	unit (1)	separate unit mark	
	N	newtons / Newtons accept lowercase 'n'	
		for the abbreviated unit	
		accept kg ms⁻²	
		accept 200 g ms⁻² for 3 marks	

Q28.

	Answer	Acceptable answers	Mark
(a)(i)	8 – 0 (m/s)	8	**(1)**
(a)(ii)	substitution 8 / 5 (1) evaluation (1) 1.6 (m/s²)	ecf from (i) full marks for correct answer (or ecf) with no working shown.	**(2)**
(a)(iii)	0	Nil / nothing / zero / none (no mark for no response)	**(1)**
(b)	substitution F = 1200 × 0.8 (1) evaluation (1) 960 (N)	full marks for correct answer with no working shown.	**(2)**

			Indicative Content	
QWC		***(c)***	an explanation linking some of the following points: compared to a car with just the driver, a fully loaded c • have a greater mass / be heavier • greater kinetic energy / momentum • experience the same braking force (when brak applied) • require a greater braking force (than available the same distance) • have a smaller acceleration / deceleration • take a longer time to come to rest (from given • travel greater distance in this time • needs to do more work with same amount of f • use of relevant equations such as F = ma, wor d • consequence of driver distractions	
Level	**0**	No rewardable content		
1	**1 - 2**	• a limited explanation using one idea from the indicative content eg fully loaded car is heavier. • in answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy		
2	**3 - 4**	• a simple explanation which links ideas from the indicative content eg it is heavier and so it takes a longer distance to stop • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy		
3	**5 - 6**	• a detailed explanation which links several ideas from the indicative content e.g. It has more momentum and so it will take a longer time to stop. This means that it will travel a further distance. The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors		

Q29.

			Indicative Content	
QWC		*	an explanation linking some of the following points: compared to a car with just the driver, a fully loaded c • have a greater mass / be heavier • greater kinetic energy / momentum • experience the same braking force (when brak applied) • require a greater braking force (than available the same distance)	

- have a smaller acceleration / deceleration
- take a longer time to come to rest (from given
- travel greater distance in this time
- needs to do more work with same amount of f
- use of relevant equations such as $F = ma$, wor d
- consequence of driver distractions

Level	0	No rewardable content
1	1 - 2	• a limited explanation using one idea from the indicative content eg fully loaded car is heavier. • in answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple explanation which links ideas from the indicative content eg it is heavier and so it takes a longer distance to stop • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed explanation which links several ideas from the indicative content e.g. It has more momentum and so it will take a longer time to stop. This means that it will travel a further distance. The answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q30.

Question Number	Answer	Acceptable answers	Mark
(a)	D driving for a long time without taking a break		(1)

Question Number	Answer	Acceptable answers	Mark
(b)(i)	substitution 1200 x 8(.0) (1) evaluation 9600 (J) OR 9.6 x 10³ (J) (1)	Give full marks for correct answer with no working. 9.6 x any other power of 10 = 1 mark	**(2)**

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	substitution 0.5 x 1400 x 25² (1) evaluation of v squared 0.5 x 1400 x 625 (1) evaluation 4.4 x 10⁵ (J) (1) OR 440 000	Give full marks for correct answer with no working. accept 625 seen anywhere for this mark e.g. 875 000 gets 1 mark (forgot ½) 437 500 (J) 4.4 x any other power of 10 = 2 marks	**(3)**

Q31.

Question number	Answer	Additional guidance	Mark
(i)	D travelling more slowly A is incorrect, more passengers would increase the stopping distance B is incorrect, worn tyres would increase the stopping distance C is incorrect, if the car needed new brakes this would increase the stopping distance		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
(ii)	identification of horizontal line as reaction time (1) evaluation (1) 0.6 (s)	award full marks for correct answer without working 0.7 scores 1 mark	(2) AO3

Q32.

Question number	Answer	Mark
	C mass	(1)

Q33.

Question number	Answer	Additional guidance	Mark
(i)	0.52		(1) AO3

Question number	Answer	Additional guidance	Mark
(ii)	addition and division (1) $\dfrac{0.35+ 0.32+ 0.38 + 0.33}{4}$ evaluation (1) 0.35 (m)	$\dfrac{0.35+ 0.32+ 0.52 + 0.38 + 0.33}{5}$ accept 0.345 (m) award full marks for correct answer without working. accept 0.38 for 2 marks (five results included in average	(2) AO2

Question number	Answer	Additional guidance	Mark
(iii)	Any **one** from make the slope steeper(1) add more books/blocks (1) push/pull the trolley (1)	accept 'higher slope/high slope accept means of reducing friction e.g. use lubricant	(1) AO1

Q34.

Question number	Answer	Mark
(i)	☒ C $F = m \times a$ A, B and D have incorrect mathematical operator	(1)

Question number	Answer	Additional guidance	Mark

(ii)	140 (1)
	
	N (1)
		no ecf from 2ai
		
		independent mark
		
		allow
		  newton(s)
		  n
		
		do **not** allow
		  Ns
		  ns
			(2)

Q35.

Question Number	Answer	Mark
(i)	The only correct answer is **C 20 m/s** A is not correct because 0.2 m/s is too slow B is not correct because 2 m/s is too slow D is not correct because 200 m/s is too fast	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	 recall (1) $(\Delta GPE) = m \times g \times \Delta h$ substitution (1) $(\Delta GPE =)$ 75 x 10 x 20 evaluation (1) 15 000 (J)	NO PoT error NO ecf from wrong equation mgh or m x g x h 75 x 10 x 20 scores the first 2 marks accept 14700 (J) from using g = 9.8 (N/kg) award full marks for the correct answer without working	(3)

Q36.

Question number	Answer	Additional guidance	Mark
	B force A is incorrect, mass is a scalar quantity C is incorrect, energy is a scalar quantity D is incorrect, distance is a scalar quantity		(1) AO1

Q37.

Question number	Answer	Mark
	D	(1)

Q38.

Question number	Answer	Mark
	C reaction time	(1)

Q39.

Question number	Answer	Mark
	☒ **B** force Options A, C and D are all scalars.	(1)

Q40.

Question number	Answer	Additional guidance	Mark
	Any three improvements from: • suitable instrument to measure distance (1) • using a greater distance (to reduce effect of reaction times) (1) • suitable instrument to measure time (1) • use of one student at the {first/second} lamp post to signal when to {start/stop} timing (1) • two of three sets of students taking readings for the same car (1)	allow tape measure, trundle wheel allow stop watch/clock or timing app. on phone	(3)

Q41.

Question Number	Answer	Mark
(i)	all three correct (2) one or two correct (1) 	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	Q and S Q (1) (and) S (1) OR S (1) (and) Q (1)	in either order maximum of 1 mark if 3 letters given no marks if 4 or more letters given	**(2)**

Question Number	Answer	Additional guidance	Mark
(iii)	substitution (1) (distance =) 30 x 100 evaluation (1) 3000 (m)	for 1st mp accept 100 x 30 OR (30 x 50) x 2 award full marks for the correct answer without working allow **1 mark** for EITHER 30 x 50 OR 30 x 150 OR 30 x 250	**(2)**

Q42.

Question Number	Answer	Mark
	weight / force (accept circle around weight if not contradicted on answer line)	**(1)** AO 1 2

Q43.

		Answer	Acceptable answers	Mark	

(i)	B to the left ←			**(1)**
(ii)	A accelerating			**(1)**
(iii)	substitution 625 × 10 (1) Evaluation 6250 (N) (1)	625 × 9.8 6125 (N) give full marks for correct answer, no working		**(2)**

Q44.

	Answer	**Acceptable answers**	**Mark**
(a)	D		**(1)**
(b)(i)	12 (m/s) (1)	Range from 11(m/s) to 14 (m/s)	**(1)**
(b)(ii)	Substitution (1) <u>20-0</u> 5 evaluation (1) 4 (m/s^2)	<u>20</u> 5 Full marks for correct answer with no working Allow answers between 3.6 and 4.7 for 2 marks to reflect readings taken from the graph	**(2)**
b(iii)	• velocity/ speed (measured in) m/s (1) • <u>divided</u> by time in s (1)	velocity/ speed (measured in) ms^{-1} acceleration is rate of change of velocity m/s/s m per s per s [accept per for divide] do not accept m/s <u>times</u> time	**(2)**
b(iv)	at constant vel • distance = 60 (m) (1) slowing down • distance = ½×2×20 (1) • = 20 (m) (1)	 correct answer scores 2 marks	**(3)**

Total for question = 10 marks

Q45.

Question Number	Answer	Acceptable answers	Mark
	{steady/constant} speed (at first) (1)	accept velocity for speed ignore as time increases distance travelled increases	(2)
	(then) slows down (1)	(then) slower/less speed/decelerates/negative acceleration	

Q46.

Question Number	Answer	Acceptable answers	Mark
(a)	stopwatch /stopclock (1)	(electronic) timer timing app (on 'phone) clock and watch on their own are insufficient	(2)
	{trundle/measuring} wheel/measuring tape or tape measure (1)	any suitable length measuring device e.g. accept metre {rule(r)/stick}	
	ignore speedometer/speed camera/radar	but ruler on its own is insufficient **Answers may be in either order**	

Question Number	Answer	Acceptable answers	Mark
(b)(i)	white (car) (1)	Allow the use of other columns that identify correct car e.g. 5.6(s)	(1)

Question Number	Answer	Acceptable answers	Mark
(b)(ii)	substitution (1) $80 \div 4.3$ evaluation (1) 19 (m/s) Throughout the paper do not penalise answers to many places of decimal e.g. here 18.604651 gets both marks	Allow full marks for correct answer with no working seen. accept 18.6 (m/s) ignore 18 and 18.0 as incorrect rounding accept any power of 10 error for 1 mark	(2)

Question Number	Answer	Acceptable answers	Mark
(b)(iii)	40 (miles per hour) (1)	accept answers in range 39 – 43 (miles per hour) ecf from b(ii) multiply bii by 2.222 range +/- 2.0	(1)

Q47.

Question Number	Answer	Mark
	B 1.0 m/s The only correct answer is B A 0.1 m/s is incorrect, being 1 metre every 10s, insect crawling pace C 10 m/s is incorrect, being an Olympic sprinter's pace, much too fast for 'walking' D 100 m/s is incorrect, being a very fast sport's car's pace	(1) AO 1 1

Q48.

	Answer	Acceptable answers	Mark
	substitution $F = 1200 \times 0.8$	full marks for correct answer with no working shown.	(2)

evaluation

(1)

960 (N)

Q49.

Question number	Answer	Additional guidance	Mark
(i)	acceleration = $\dfrac{\text{change in velocity}}{\text{time (taken)}}$	$a = \dfrac{v-u}{t}$ $a = \dfrac{\Delta v}{t}$ $\dfrac{v}{t}$ allow correct rearrangements seen here or in bii	**(1)**

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) $\dfrac{20 - 2}{12}$ evaluation (1) 1.5 (m/s²)	$\dfrac{18}{12}$ -1.5 (m/s²) award full marks (1 in bi and 2 in bii) for the correct answer without working, award 1 mark if 20-2 or 18 or 2-20 is seen and no other marks are scored If (incorrectly) $a = \dfrac{v^2 - u^2}{t}$ given in 3bi $a = \dfrac{20^2 - 2^2}{12}$ OR = 33 scores 1 mark	**(2)**

Q50.

Question number	Answer	Additional guidance	Mark
	any two from: measure {distance / length of pace} (1) use marks on the track (1) use an electronic timer (1) stand midway between the posts/stand closer to a post (1) place posts further apart/increase distance used or measured (1) use 2 people in the timing (1)	Suitable measuring device including trundle wheel / tape/ GPS light gate(s) idea of reducing systematic error such as parallax Do NOT credit repeats	(2)

Q51.

Question Number		Indicative Content	Mark
QWC	*	An explanation including some of the following points: • Statement of what is meant by stopping distance Factors affecting driver • factors affecting driver's thinking distance/reaction time Factors dependent on the car • factors affecting braking distance e.g. tyre tread, condition of brakes • cars may be carrying different loads • cars may have different masses External factors • road surface • weather • uphill / downhill Use of data • calculation of thinking, braking and or stopping distances for average driver • calculation of thinking, braking and or stopping distances for driver A • calculation of thinking, braking and or stopping distances for driver B	(6)

Level	0	No rewardable content
1	1 - 2	• a limited explanation of the differences using one fact OR one piece of data from the chart OR factor(s) affecting thinking/braking distance. e.g. A has a longer thinking distance OR B is a longer braking distance OR thinking distance can be affected by a driver using their phone • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple explanation, giving more than one fact using data from the chart about either car OR at least one piece of data about each OR using one piece of data from the chart about one car AND at least one factor affecting thinking/braking distance OR a statement linking data from the chart to the cause for one car but nothing correct about the other car e.g. A has a braking distance of (about) 33 m, its thinking distance is longer than an average car. OR B has a longer stopping distance. B's reaction time is faster than the Highway code. OR B has a very short thinking time. Car B's brakes may be worn out OR Driver A may have drunk alcohol making his reaction time slower. Car B has better brakes (NB 2nd sentence is incorrect) • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed explanation linking data from the chart to the cause for one car AND at least one statement about the other OR two statements linking data from the chart to the cause for one car e.g. B has a braking distance of (about) 60 m. This means B might be on a wet road. A has a longer thinking distance. OR B has a shorter thinking distance than A. A has a longer thinking distance compared to the average (in highway code). He may be a drink driver. • the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately • spelling, punctuation and grammar are used with few errors

Q52.

Question Number	Answer	Additional guidance	Mark
(i)	(metre) rule(r) (1)	accept measuring tape/stick tape measure light gate	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	A description that combines the following points to produce a logical method: hang/attach/add/put/increase {masses / weights} (1) on/to (the end of) the string (over the pulley wheel) (1) OR apply a force to the trolley /string (1) (by a) pull / push / rubber band (1) OR putting trolley on a slope (1) allow the trolley to run down (1)	accept on/at/from the pulley wheel 'pull the string' OR push the trolley scores 2 marks slanting the bench (let) gravity pull the trolley	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	Any one from: speed (at the start/end of the run) (1) time (between changes in speed) (1)	(different/additional) speed / velocity appropriate ticker tape(s)	(1)

Q53.

Question number	Indicative content	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.	
	The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.	
	AO2	
	• fuel forms a store of chemical (potential) energy • chemical energy is transferred to kinetic energy and thermal energy when the car moves • kinetic energy transferred to thermal energy as the car slows down	
	AO3	
	• during X, kinetic energy increases as the car's speed increases/car accelerates and the increase in kinetic energy is provided by the chemical energy store • during all three sections, work is done against frictional forces in the moving parts of the car and against the drag from the air • during Y, kinetic energy stays constant when the car moves at constant speed but energy is still transferred to thermal energy • during Z, kinetic energy decreases as the car slows down	**(6)**

Level	Mark	Descriptor
	0	No awardable content.
1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The description attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The description is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)

| 3 | 5–6 | • Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)
• The description is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) |

Q54.

Question number	Answer	Additional guidance	Mark
	distance = area under graph (1)	attempt to find area seen on graph	(3)
	½ × 7 × 15 (1)	correct area(s) identified including calculation	
	52(.5) (m) (1)	53 (m) allow 7 × 15 or 105 for 1 mark only award full marks for the correct answer with no working	

Q55.

Question Number	Answer	Additional guidance	Mark
	• direction (1)	answers only acceptable in given order	(2) AO 2 1
	• size (1)	or magnitude	

Q56.

	Answer	Acceptable answers	Mark
(i)	12 (m/s) (1)	Range from 11(m/s) to 14 (m/s)	(1)
(ii)	Substitution (1) <u>20-0</u> 5	<u>20</u> 5 Full marks for correct answer with no	(2)

		Answer	Acceptable answers	Mark
		evaluation (1) 4 (m/s²)	working Allow answers between 3.6 and 4.7 for 2 marks to reflect readings taken from the graph	
(iii)		• velocity/ speed (measured in) m/s (1) • <u>divided</u> by time in s (1)	velocity/ speed (measured in) ms⁻¹ acceleration is rate of change of velocity m/s/s m per s per s [accept per for divide] do not accept m/s <u>times</u> time	**(2)**
(iv)		at constant vel • distance = 60 (m) (1) slowing down • distance = ½×2×20 (1) • = 20 (m) (1)	 correct answer scores 2 marks	**(3)**

Q57.

	Answer	Acceptable answers	Mark
	D		**(1)**

Q58.

		Answer	Acceptable answers	Mark
(i)		8 – 0 (m/s)	8	**(1)**
(ii)		substitution 8 / 5 (1) evaluation (1) 1.6 (m/s²)	ecf from (i) full marks for correct answer (or ecf) with no working shown.	**(2)**
(iii)		0	Nil / nothing / zero / none (no mark for no response)	**(1)**