OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P2.2 NEWTON'S LAWS

SCORE	PERCENTAGE
/213	%

STEMUP

These questions belong to OCR, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by OCR. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with OCR and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. OCR has not endorsed, approved or been involved in the production of it. OCR and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

OCR publishes its past papers, mark schemes and examiner reports. Always check the current specification at ocr.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Question			Answer/Indicative content	Marks	Guidance
1			D	1	
			Total	**1**	
2			C	1	
			Total	**1**	
3	a		C (1) The product of force × distance is the most / **AW** (1)	2	
	b		A and B (1)	1	Both needed for this mark Any order
	c		Reduce random errors / identify anomalies / **AW** (1) Allows a mean / average to be calculated (1)	2	
	d		Power = energy / time (1) Conversion of time into seconds (1) (120 × 12)/30 (1) 48 (W) (1)	4	**ALLOW ECF** from **(a)**
			Total	**9**	
4		i	Use of graph to calculate time / t = 2.25 – 0.75 / t = 1.5 (1) Substitution into acceleration formula: 8 / 1.5 (1) (–) 5.3 (1) m/s^2 (1)	4	
		ii	5 000 × 6 (1) 30 000 (J)	2	
			Total	**6**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
5			Re-arrange and substitute into WD = F × D: 217 000 / 6 500 (1) 33 (m) (1)	2	**ALLOW** 33.4 (m)
			Total	**2**	
6			Re-arrange and substitute into WD = F × D: 217 000 / 6 500 (1) 33.4 (m) (1)	2	
			Total	**2**	
7		i	Velocity is speed in a given / known direction / straight line (1) Direction continuously changing (1)	2	**ALLOW** higher level answers e.g. changing velocity denotes acceleration (1) Always accelerating to the centre (1)
		ii	Higher orbit (1) Less (force of) gravity / acceleration (1)	2	
			Total	**4**	
8			Lorry has more KE than a car at the same velocity (1) More absorption of energy by larger brake discs (1) Higher rate of dissipation of energy to surrounding air (1) Brakes less likely to overheat (1)	4	
			Total	**4**	
9			A	1	
			Total	**1**	
10			C	1	
			Total	**1**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
11			B	1	
			Total	**1**	
12	a	i	Change mass / Force applied (1) Release glider and idea of measuring acceleration with appropriate apparatus to do this stated (e.g. Light gates / datalogger) (1) Check results / plot graph to see if it matches F = ma formula (1)	3	e.g. Fprop a or m prop 1/a
		ii	4 m/s^2 (1)	1	
		iii	Any 2 from: The track is not perfectly frictionless / AW (1) Friction of the pulley (1) (Idea of) light gates incorrectly set up (1)	2	
	b		Attempt 1 at 4 newtons / 12.0 (1) Don't include it in the mean / repeat readings / repeat this reading during the experiment (1)	2	
	c		Another person / group gets similar results / AW (1)	1	
			Total	**9**	
13	a		The momentum at the start and at the end will be equal as long as no external forces act / **AW** (1)	1	
	b		(90 × 2) + (60 × velocity) = 0 (1) Velocity = (–)3 (m/s) (1)	2	
			Total	**3**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
14			Idea that the KE at bottom must be equal to or less than GPE at the top (1) W: KE = 4.5J and so is possible as it is likely that some energy will be lost / **AW** (1) X: KE = 8J and so is possible but it will not be 100% efficient/X is unlikely as it implies no energy is lost / **AW** (1) Y: KE = 12.5J and Z: KE = 18J and so not possible (1)	4	
			Total	**4**	
15			17600 J (2) **but If incorrect** **220 × 80** (1)	2	Examiner's Comments Candidates correctly calculated the work done as 17600J.
			Total	**2**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
16	a		2 (m/s^2) [1]	1	NOT 2m/s Examiner's Comments This motion, acceleration and power question gave the opportunity for candidates to give some good answers. Most correctly calculated the acceleration from the graph.
	b		280000 (J) [3] but if incorrect 2800 x 100 [2] but if incorrect distance = 100(m) OR 2800 x distance OR evidence of **using** work done = force x distance [1]	3	Eg 2800 x 200 or 560000 [1] Examiner's Comments This was generally poorly done as many did not obtain the correct distance from graph and simply read off a speed. Most candidates identified the correct formula (work done = force x distance) to use but were unable to calculate an appropriate distance to gain one mark for a reasonable substitution into the correct formula.
	c		56000 (W) [2] but if answer incorrect 2800 x 20 [1]	2	The power was correctly calculated by many.
			Total	6	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
17	a		<table><tr><td>A</td><td></td><td>✓</td><td></td></tr><tr><td>B</td><td>✓</td><td></td><td></td></tr><tr><td>C</td><td></td><td></td><td>✓</td></tr></table> [2]	2	**all** correct [2] **any** 1 correct [1] **ignore** any line with more than one tick **Examiner's Comments** This question from module P3 was about speed and force. This part of the question was common with the foundation paper (B751-01). Most scored 2 marks with a correct table.
	b	i	acceleration decreases (as speed increases) / non uniform change in acceleration / acceleration drops more quickly at the start [1]	1	**Examiner's Comments** They generally could describe the relationship but often expressed it unclearly e.g. As acceleration increases the speed decreases.
		ii ii	resistive force / friction / air resistance / drag increases (as speed increases) [1] idea that resultant force decreases / the driving force equals the resistive force [1]	2	 Allow forces balance [1] **Examiner's Comments** Many did not realise that drag or air resistance was involved. Better answers stated that the drag increased with speed and the (driving) force and drag force would balance. It was unusual however, for answers to get full marks here.
			Total	**5**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
18			**EITHER** 6.5 (m/s) **AND** this is less than 9m/s **OR** 6.5 (m/s) **AND** no [3] **OR** it is 2.5 (m/s) **below the speed limit** [3] But if incorrect or incomplete then: 1000 × V + 8000 × 2 = 9000 × 2.5 scores [2] But if incorrect or incomplete then: **EITHER** (momentum after): 9000 × 2.5 or 22500 [1] **OR** (momentum before): 1000 × V + 8000 × 2 [1]	3	**Speed limit mark is only available with a correct value** **Allow** 6.5 and yes / breaks speed limit scores [2] **Allow** 6.5 and no comment given [2] **qualitative** idea the momentum is conserved e.g. no momentum is lost or gained / momentum before = momentum after [1] **Examiner's Comments** About a third of candidates got the full calculation correct – '6.5 m/s and no'. A few got the idea that momentum was conserved (often by stating the equation). Others misused the equations of motion to gain various answers. Sometimes the equation would be populated with the correct substitution (1000 × V + 8000 × 2 = 9000 × 2.5) without the final calculation of V. This scored [2] marks.
			Total	**3**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>19</td><td>a</td><td></td><td>idea that the force is caused by the seat belt slowing the dummy down [1]</td><td>1</td><td>allow air bag or steering wheel or dash board or windscreen
stops slows down the dummy [1]

Examiner's Comments

This about the action of safety features in a car was not well answered across the ability range

Very few recognised that the force applied by the seat belt or air bag slowed he passenger down. Many answers were poorly described in terms of the dummy jolting forwards.</td></tr>
<tr><td></td><td>b</td><td></td><td>particles move/ AW or spread out [1]

particles hit inside (surface) of airbag / AW [1]</td><td>2</td><td>allow moving particles push the bag outwards [2]

Examiner's Comments

This about the action of safety features in a car was not well answered across the ability range

Most candidates had little idea about the kinetic theory of gases when applied to an air bag. This area was very unfamiliar to almost all candidates.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>20</td><td></td><td></td><td><table><tr><td>A</td><td></td><td>✓</td><td></td></tr><tr><td>B</td><td>✓</td><td></td><td></td></tr><tr><td>C</td><td></td><td></td><td>✓</td></tr></table>[2]</td><td>2</td><td>all correct [2]
any 1 correct [1]

ignore any line with more than one tick

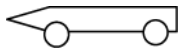
<u>Examiner's Comments</u>

Most candidates completed the table correctly.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>2</td><td></td></tr>
</table>

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
21			decrease speed / travel at a lower speed [1] make the car (more) streamlined /aerodynamic [1]	2	**allow** diagram streamlining e.g  [1] **Allow** examples eg close the windows /remove roof-rack (1) Examiner's Comments Candidates were asked to suggest how air resistance could be reduced for cars. The majority of candidates gave an answer of streamlining (or a description) for one mark, but hardly any candidates stated that reducing the speed reduced air resistance.
			Total	2	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
22	a		8.3 (m/s) [2] **but if incorrect** $\frac{100}{12}$ [1]	2	**allow** 8.333 (m/s) [1] Examiner's Comments Most candidate calculated average speed correctly to two significant figures. Very few candidates did not follow the instruction and used more than two figures.
	b	i	2.5 [2] **but if incorrect** $\frac{10}{4}$ [1] m/s^2 [1]	3	**allow** m/s/s [1] Examiner's Comments Whilst the majority of candidates correctly calculated the acceleration as 2.5 few gave the correct units of ms^{-2}.
		ii	150 (N) [2] **but if incorrect** 60 x 2.5 [1]	2	**allow** ecf answer to b x 60 correctly calculated [2] **allow** ecf answer to b x 60 uncalculated [1] Examiner's Comments Candidates had no problem with calculating the force as 150N.
			Total	7	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
23	a		(some hot) gas escapes backwards / downwards / AW (1) (hot other gas) pushes or forces the rocket forwards / hot gas creates thrust or lift / AW (1)	2	**second marking point must give an indication of a force or reaction (on the rocket)** **allow** gas released out of the bottom of the rocket / gas leaves the bottom of the rocket **ignore** just gases are released **allow** descriptions e.g. force pushing gas particles backwards equals **force** pushing rocket forwards (2) **allow** idea of equal and opposite reactions (2) **Examiner's Comments** About half of candidates scored on this question. Many candidates described the buildup of pressure inside the rocket and about collisions between energetic particles and the walls of the rocket. Candidates often scored from the description of the force acting on the rocket. One unexpected misconception from a significant minority was that the rocket was lifted due to the reduced density of the gas inside - as a hot air balloon.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
	b		**idea of more acceleration (no mark)** **and any 2 from** more gas (or fuel) (1) (so) higher temperature / AW (1) (so) more pressure / AW (1) (so) more force (1) **or** **idea of less acceleration (no mark)** more fuel (to move) (1) **BUT** more (gas or) fuel **so** more mass or inertia (to move) (2)	2	**ignore** references to speed increasing or top speed being higher **ignore** more heat **allow** greater mass per second / gas escapes faster **allow as additional marking points** higher level explanations in terms of kinetic / particulate theory **allow** heavier or more mass (so less acceleration) **allow** acceleration increases as mass is lost (2) **if no marks awarded** **allow** rocket travels for longer or travels further (1) **Examiner's Comments** Most candidates scored on this question and focused on increased acceleration due to the increased pressure of hot gases but few went on to link this to an acceptable consequence e.g. more force. A significant number realised that the rocket would be heavier and therefore acceleration would be less. When candidates did not achieve any marks it was often due to disregarding the question and writing about the speed of the rocket.
			Total	4	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
24		i	instantaneous deceleration at point P is (more representative of) when diver enters water [1] idea of ignoring anomalous results / point Q is not on the line / (1) Elaine's method covers more data / more appropriate data / AW [1] (gradient gives a more) accurate result (1)	2	**allow** Q is (some time) after diver enters water [1] allow deceleration / acceleration changes (after P) [1] **eg** point Q is anomalous [1] Examiner's Comments This question was set in the context of diving into water from a diving board. In part (i), there were a few good answers described in terms of Elaine and these discriminated well. Usually the idea of more data or gradient showing the real or more accurate deceleration gave candidates a route into successful answers. It was a challenging question, which gave a good range of responses.
		ii	1200 (N) (1)	1	**Allow** ? 1200 (N) [1] Examiner's Comments This question was set in the context of diving into water from a diving board. In part (ii), most gave 1200N as the correctly calculated answer.
			Total	3	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
25			(Level 3) calculates the force AND Gives a detailed linked answer in terms of forces or acceleration Quality of written communication does not impede communication of the science at this level (5 – 6 marks) (Level 2) calculates the force AND Gives a simplistic answer in terms of forces or acceleration Quality of written communication partly impedes communication of the science at this level (3 – 4 marks) (Level 1) calculates the force OR Gives a simplistic answer in terms of forces or acceleration Quality of written communication impedes communication of the science at this level (1 – 2 marks) (Level 0) Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted up to grade C Indicative scientific points at level 3 may include: The calculation from level 1 and 2 and a link between change in distance or stopping time to acceleration or force. • increases distance travelled by dummy so this reduces force / acceleration of dummy • increase stopping time of dummy so this reduces force / acceleration of dummy • reduced acceleration so reduced force • reduces the rate of change of momentum Indicative scientific points at level 1 and 2 may include: • force = 28020 or 28000 N seatbelts • hold dummy in seat / stop dummy hitting windscreen • stretches • reduce forces on dummy • increase stopping time of dummy • decrease acceleration of dummy Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This six mark extended prose level of response question was about seatbelts. Most calculated the force correctly (level 1 – [2] marks) and described the simple action of the seatbelt (eg. 'stops driver hitting windscreen). Better answers at level 3 needed to link the longer (stopping) distance or (stopping) time to the lower acceleration or forces.
			Total	6	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
26			**maximum of three marks from:** **more** collision **time** (1) **more** collision **distance** (1) **less acceleration** (1) same quantity of energy absorbed / same change of momentum for each car (1)	3	**allow** ora for an old car longer collision (1) **allow** areas under graph correctly compared (1) **allow** higher level answers in terms of force = change in momentum / time: Eg. force = $\frac{\text{change in momentum}}{\text{time}}$ (1) **but** stating and using the equation can score (3): Eg. force = $\frac{\text{change in momentum}}{\text{time}}$ (1) so a longer collision time (1) means a smaller **rate** of change of momentum (1) **Examiner's Comments** Most got the idea that the collision took a longer time [1]. Rather fewer realised the acceleration was reduced. Some good answers used the equation 'force = change in momentum/time' [1], referred to a longer time [1] and even mentioned that the momentum change was the same [1]. Many answers focussed on some lower demand points: crumple zones absorb the kinetic energy (or just the energy). A common misconception was that crumple zones absorb the force or impact of the collision.
			Total	**3**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
27	a		weight / gravity (1)	1	**allow** gravitational force but not gravitational potential force **Examiner's Comments** In the region of half of the entry were able to decide what was happening to the ball's speed from the graph. Those that did could therefore identify the forces required in part AB of the graph. Some candidates, on the right lines, reversed the correct forces in their answers. Poor answers gave energy (kinetic / potential) for forces.
	b		drag / friction / air resistance (1)	1	**ignore** upthrust / resistance on its own / wind
	c	i	BC (1)	1	if answer line is blank **allow** correct answer ticked circled or underlined **Examiner's Comments** BC was usually correctly chosen, with CD being the frequent incorrect selection. AB and DE were offered as answers less often.
		ii	forces are / become balanced (1)	1	**allow** higher level answers eg weight and drag are equal eg gravity and air resistance are equal or balanced eg drag increases to the same level as weight **Examiner's Comments** The concept of balanced forces (or named forces being equal) is difficult at Foundation level. Often answers restated the idea of constant speed or that the football could not travel any faster; others contained descriptions about gravity and energy 'balancing out'. Very few correct answers were given.
			Total	**4**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
28		i	144000 (2) **but** if answer is incorrect 600 × 8 × 30 (1)	2	**allow** 600 × 30 = 18000 **or** force × distance =18000 **Examiner's Comments** Approximately 80% of candidates gained credit in the calculation, although a significant number failed to appreciate the importance of '8 people' and gained only one mark for correctly computing 600 × 30 = 18000.
		ii	more work is done in the second journey ✓ the same amount of work is done in the second journey less work is done in the second journey (1)	1	**Examiner's Comments** A sizeable majority correctly identified that more work would be done in the second journey.
			Total	3	

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
29	a		**A – (acceleration section)** acceleration because weight is greater than drag (1) OR acceleration reduces because drag increases (1) **B – (terminal speed section)** terminal speed because weight = drag (1) OR forces are equal and opposite/balanced (1) **C – (deceleration section)** decelerating as drag increases (greatly) (1) OR decelerating as drag now greater than weight (1) **D – ((**lower) **terminal speed section)** drag = weight (1) **OR** forces are equal and opposite/balanced (1)	4	for max marks (4) the links must be there on all four points e.g. part A – acceleration **because** weight is greater than drag (1) without links max (2) for correctly describing the motion OR the forces in the 4 sections without links max (1) for correctly describing the motion OR the forces in 2 or 3 sections **ignore** gravity (rather than weight) **ignore** upthrust **ignore** GPE and KE **allow** air resistance / friction (rather than drag) **allow** for terminal speed – steady / constant speed **allow** for acceleration – increasing speed **allow** for deceleration – decreasing speed **allow** negative acceleration (for deceleration) **Three links plus one description scores 3** **Two links and two descriptions scores 3** **Two links and one description scores 2** **One link and two or three descriptions scores 2** **One link and one description scores 1** **The links and the descriptions must be from different sections.** **Examiner's Comments** This part effectively asked candidates to describe and explain the parts of the fall. For full marks each section needed to be described correctly and explained, e.g. part A shows acceleration and the weight is greater than the drag [1]. Some only referred to the descriptions, e.g. A is accelerating and B is terminal velocity [1]. Many answers fell short in their

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>descriptions by using vague terms such as ‘gravity’ for weight or ‘upthrust’ for drag.</td></tr>
<tr><td></td><td>b</td><td></td><td><table><tr><td>At A all of Susie’s energy is GPE.</td><td>(✓)</td></tr><tr><td>Between A and B Susie gains both GPE and KE.</td><td>✖</td></tr><tr><td>Between A and B Susie gains only KE.</td><td>✓</td></tr><tr><td>At B her KE is exactly half her GPE at A.</td><td>✖</td></tr><tr><td>Just before touching the ground at C Susie has her maximum KE.</td><td>✓</td></tr><tr><td>On the ground at C Susie has zero KE.</td><td>✓</td></tr><tr><td>On the ground at C Susie has her maximum GPE.</td><td>✖</td></tr></table></td><td>3</td><td>Use marking tool on scoris to identify the crosses

all 6 correct (3)

4 or 5 correct (2)

2 or 3 correct (1)

only 1 correct (0)

ignore blank boxes

Examiner's Comments

Although this was an objective question it remained high demand. 10% gained all marks here. Some candidates ticked but did not cross in the boxes. Blank boxes were ignored by examiners. Most candidates gained [1] or [2] marks here.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
</table>

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
30			[Level 3] calculates the force AND Gives a detailed linked answer in terms of forces or acceleration Quality of written communication does not impede communication of the science at this level (5 – 6 marks) [Level 2] calculates the force AND Gives a simplistic answer in terms of forces or acceleration Quality of written communication partly impedes communication of the science at this level (3 – 4 marks) [Level 1] calculates the force OR Gives a simplistic answer in terms of forces or acceleration Quality of written communication impedes communication of the science at this level (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted up to grade C Indicative scientific points at level 3 may include: The calculation from level 1 and 2 and a link between change in distance or stopping time to acceleration or force. • increases distance travelled by dummy so this reduces force / acceleration of dummy • increase stopping time of dummy so this reduces force / acceleration of dummy • reduced acceleration so reduced force • reduces the rate of change of momentum Indicative scientific points at level 1 and 2 may include: • force = 28020 or 28000 N seatbelts • hold dummy in seat / stop dummy hitting windscreen • stretches • reduce forces on dummy • increase stopping time of dummy • decrease acceleration of dummy Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This six mark extended prose level of response question was targeted up to grade C. It was about seatbelts and most candidates were willing to answer. Most calculated the force correctly (level 1 – [2] marks) and described the simpleaction of the seatbelt (eg. ‘stops driver hitting windscreen). Both thesequalified for level 2and [4] marks. Better answers at level 3

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
					needed to link thelonger (stopping) distance or (stopping) time to the lower acceleration or forces. This discriminated well with only strong grade C candidates gaining [5] or [6] marks.
			Total	6	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
31		i	1.2 (kg m/s) (2) **but if answer incorrect** 4 × 0.3 (1)	2	**Examiner's Comments** The momentum calculation was usually correct [2].
		ii	**any two from** (correct use of) drag / air resistance / weight (1) forces are balanced (1) not accelerating (1)	2	**e.g.** weight / (force of) gravity pulls downwards [1] **e.g.** air resistance pushes upwards [1] **ignore** wind resistance (1) **allow** gravity = drag (1) **allow** higher level answer e.g. weight = drag or air resistance (2) **not** merely steady speed **allow** drag stops it accelerating (2) **Examiner's Comments** This question on terminal speed saw candidates struggling to communicate their ideas clearly. Good concise answers such as 'it is when drag = weight scored [2].Gravity = air resistance was common [1] as was gravity = upthrust [0]. Some alsorealised that terminal velocity meant zero acceleration [1].
		iii	(Moon has) no atmosphere / no drag (1)	1	**allow** less / no drag or less / no air resistance / no upward force (1) **ignore** less / no gravity **Examiner's Comments** A common misapprehension here was highlighted by the many answers describing themoon as having no gravity. Better answers referred to the lack of atmosphere or air resistance [1].
			Total	**5**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
32	a		(work is done) when you lean against a wall (1) (work done depends on) the time it takes (1) (energy is) never transferred when work is done (1)	3	Look at parts (a) and (b) together. Eg. If work depends on distance and time in part (a) and part (b) corrects it to work depends on distance and force give credit in both parts. If part (a) has work depends on distance and time but this is not corrected in part (b) then the answer in (a) should be marked incorrect in line with the guidance below. If full statement or any correct part of statement is included in the answer to (a) then the answer is incorrect unless fully corrected in (b). Give marks for each statement if clear which parts were wrong even if written in correct form in this section.
	b		**any one from:** no work is done when you lean against a wall / AW (1) work done depends on the distance and the force / AW (1) energy is transferred when work is done / AW (1)	1	
			Total	**4**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
33			Maximum of **TWO** marks from: • increase stopping / collision **time** (1) • decrease **acceleration** (1) • reduces the rate of change of momentum / AW scores (2) **and ONE** mark for: • increase stopping / collision **distance** (1)	3	**ignore** references to energy / changing shape assume 'longer' refers to time unless indicated otherwise **Not** merely 'Slows it down more gradually' / 'less suddenly' **NOT** merely 'slower acceleration' or 'rate of acceleration' Look for **use** of the equation rather than simply stating it.
			Total	3	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

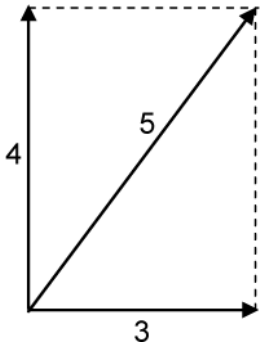
STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
34			Level 3: 5–6 marks Forces discussed and linked to acceleration at three points AND drag linked to acceleration / velocity / speed. Quality of written communication does not impede communication of science at this level. Level 2: 3–4 marks Forces discussed and linked to acceleration at two points. Quality of written communication partly impedes communication of science at this level. Level 1: 1–2 marks Forces discussed and linked to acceleration at one point OR forces discussed at two points OR acceleration described at two points Quality of written communication impedes the communication of science at this level Level 0: 0 marks Insufficient or irrelevant science. Not worthy of credit.	6	This question is targeted up to grade A Ignore references to energy Drag is equivalent to air resistance or friction Indicative scientific points may include (but are not limited to) the following: At point A • drag is zero / minimal • weight is greater than drag • there is a resultant force • object accelerates (maximum acceleration) At point B • as speed / velocity increases, drag increases • increasing drag means a smaller resultant force • acceleration is reduced, but still positive • object has lower acceleration At point C • drag equals weight so no acceleration / terminal velocity • no resultant force so no acceleration / terminal velocity
			Total	6	
35		i	Any one from the following pairs Car slows down **and** tree moves right (1) Car stops **and** tree remains stationary (1) Car carries on moving **and** tree is knocked down (1) Car recoils **and** tree remains stationary (1) Car recoils **and** tree moves right (a little) (1)	1	
		ii	forces are equal and in opposite directions (1)	1	more than one answer = 0 marks if answer line blank allow correct answer indicated in list
			Total	2	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
36			Vectors / lines labelled 4 and 3 **OR** drawn to scale (by eye) at right angles to each other (1) **BUT vectors / lines labelled 4 and 3 AND** drawn to scale (by eye) at right angles to each other (2) Correct resultant **drawn** (north east) from scale diagram **indicating** magnitude of 5 (allow 4.8 to 5.2) (1) **Calculation route (maximum 2 marks):** size of resultant velocity **calculated** at 5 (m / s) (1) angle **calculated** as 37° / 53° (1)	3	If diagram and calculation routes are both shown do not combine marks but award highest mark. 
			Total	**3**	
37			**any one from:** make it lighter / AW (1) make it more streamlined / AW (1) increase traction / AW (1)	1	
			Total	**1**	
38			**B ✓**	1 (AO2.1)	<u>Examiner's Comments</u> This was the hardest multiple-choice question, with one in six candidates getting it right. Most candidates did not convert cm into m.
			Total	**1**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

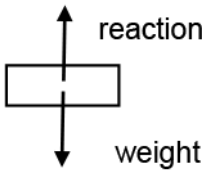
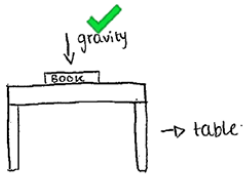
STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
39	a		Any one from: electrostatics ✓ gravity/weight ✓ magnetism ✓ (normal) contact force ✓ friction ✓	1 (AO1.1)	Allow ‘static electricity’ but not just ‘static’ ALLOW reaction force ALLOW drag/air resistance Examiner’s Comments Most candidates were able to name an appropriate force. The most common misconception was to name kinetic energy as a type of force.

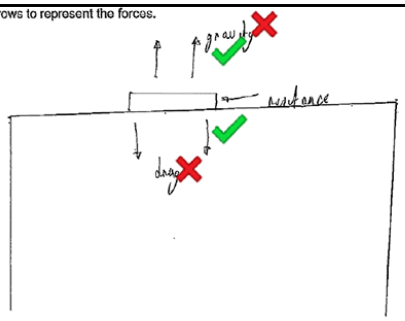
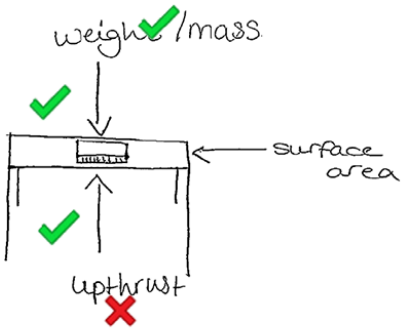
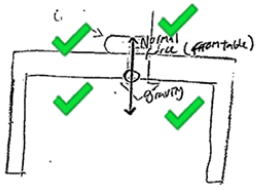
© OCR 2022. You may photocopy this page.

Created in ExamBuilder

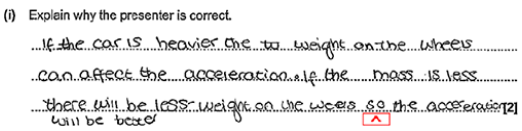
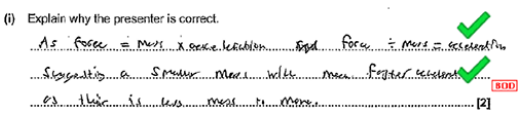
STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
	b		Two arrows drawn of equal length ✓ One up and one down ✓ The downwards arrow labelled weight/gravity ✓ The upwards arrow labelled contact/reaction force ✓	4 (AO4 × 2.1)	e.g.  Examiner's Comments The best answers were offered by candidates who drew diagrammatic side view of a book on a table with opposing vertical forces shown by arrows pointing outwards from the centre of the book (see exemplar 11 below). Many candidates had drawn vertical arrows of equal length with the downward force labelled 'gravity' (see exemplars 8 and 9), the use of the correct force ''weight' was rare (see exemplars 10 and 11). Fewer candidates labelled the counter-force 'reaction' or 'contact force'. The position of the arrows emanating from a point/box representing the centre of mass of the book was not an enforced marking point. Exemplar 8 Use arrows to represent the forces.  [4] Exemplar 9

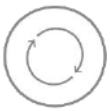
STEMUP.CO.UK

Question	Answer/Indicative content	Marks	Guidance
			Use arrows to represent the forces.  [4] Exemplar 10  [4] Exemplar 11  [4]

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
	c		Any two from: (glider) accelerates during the push ✓ (then has) constant/steady/uniform speed/velocity ✓ (because) there are no other/horizontal/external (unbalanced) forces acting on it / AW ✓ there is (slight) deceleration due to air resistance ✓	2 (AO2 × 1.2)	<u>Examiner's Comments</u> Many candidates did not seem to know what an air-track glider was and as a result there answers showed limited understanding of the practical activity. Other candidates had seen an air-track glider and discussed the (relatively) unhindered movement of the glider and the action of air resistance. The most able candidates gained credit for discussing the motion of the glider during the initial push given by the teacher.
	d	i	*F = ma* / force equals mass times acceleration ✓ so reducing mass means the same engine force will cause greater acceleration ✓	2 (AO1.2) (AO2.2)	Must start with Newton II NOT less force for same acceleration <u>Examiner's Comments</u> Few candidates identified that this question was about the implications of the equation F = ma. Candidates did not recognise that the force would be the same for both the heaver and the lighter model of car. Most candidates discussed the effects of friction on the car. For the order of magnitude for changes in mass between different models of a car frictional forces would have no measurable effect on acceleration. Exemplar 12  (i) Explain why the presenter is correct. If the car is heavier the to weight on the wheels can affect the acceleration i.e. the mass is less there will be less weight on the wheels so the acceleration will be less [2] This answer only considers the marginal changes in friction caused by a very small increase in the contact area of the tyres but ignores the more significant effect that the same force applied to a smaller mass will have on acceleration. Exemplar 13  (i) Explain why the presenter is correct. As force = mass x acceleration and force ÷ mass = acceleration Therefore a smaller mass will have greater acceleration as this is less mass it more. [2]

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
					This candidate's answer shows very clearly why using a more mathematical approach in physics saves time and increases understanding. They have identified the appropriate equation (F=ma), changed the subject to acceleration and then drawn the correct conclusion. Using this approach their answer was shorter, clearer and more relevant than exemplar 12.  **AfL** As a starter exercise show students the question and ask them to select the equation that will answer the question. Helping students to be more comfortable using equations will help them overcome their reluctance to answer physics questions using maths.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 (m/s^2) award 3 marks change in speed = 25–5 = 20 (m/s) ✓ acceleration = 20 ÷ 4 (m/s^2) ✓ = 5 (m/s^2) ✓	3 (AO2.1) (AO2.1) (AO2.1)	e.c.f. incorrect change in speed if subtraction attempted <u>Examiner's Comments</u> This calculation was well done with most candidates being credited with all three marks.
			Total	12	
40			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> This question about F = ma was answered well with about 80% of candidates getting it correct with the answer B. All other responses were seen with A being the most common incorrect answer given.
			Total	1	

© OCR 2022. You may photocopy this page.

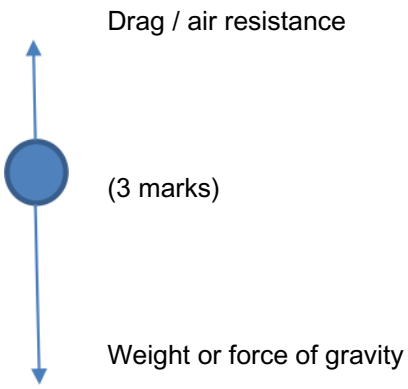
Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
41	a		momentum ✓ kinetic energy or KE ✓	2 (AO 2 × 1.1)	IGNORE mass conserved If more than two answers mark the first two answers (unless one of them is mass). Eg 'KE, mass, momentum ✓✓ Eg. PE, KE, momentum ✓ Examiner's Comments Kinetic energy and momentum were the answers here. Full marks (in 10% of cases) were attained by more able candidates only. Just less than a half gained 1 mark only. 'Energy' or 'potential energy' (rather than kinetic energy) was often seen along with mass, velocity.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINES If answers = 8.4 (kgm/s) and 6.75 / 6.8 (kgm/s) award 3 marks 2 × 4.2 2.5 × 2.7 ✓ A: 8.4 (kgm/s) ✓ B: 6.75/6.8 (kgm/s) ✓	3 (AO 1.2) (AO 2.2) (AO 2.2)	8.4 and 6.7 scores ✓✓ (incorrect rounding of one of the values) Examiner's Comments The great majority calculated both values of momentum correctly and gained 3 marks.

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.4 (m/s) award 3 marks (8.4 + 6.75) × 4.5 ✓ 3.37 / 3.366666667 (m) ✓ 3.4 (rounding to 2 sf) ✓	3 (AO 2.2) (AO 2.2) (AO 1.2)	ECF for momentum values eg. (A + B) ÷ 4.5 Wrong answer but evidence of correct rounding ✓ Eg. 6.75 to 6.8 ✓ <u>Examiner's Comments</u> Just under a half of candidates calculated this correctly to two significant figures. About a third did gain any credit at all and gave attempts of calculations that were incorrect or difficult to follow.
			Total	8	
42			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> Only about a third of candidates gave the correct answer 'B'. A common incorrect response was 'A' although the other distractors were also seen on occasions.
			Total	1	

Question			Answer/Indicative content	Marks	Guidance
43			**only** 2 arrows drawn or directions of the two forces described – one upwards and one downwards ✓ Correctly names weight **and** air resistance / drag ✓ downward arrow longer than upward arrow / forces are unbalanced / resultant / net / overall force downwards ✓ so object accelerates / gets faster / increases velocity or speed ✓	4 (AO 2.1) (AO 1.1) (AO 2.1) (AO 1.1)	Award marks for answer points given in diagrams or prose. **ALLOW** force of gravity or mg or gravitational pull for weight **BUT DO NOT ALLOW** merely 'gravity' **IGNORE** upthrust for this marking point only  Examiner's Comments There were some good answers here. A common error was to state 'gravity' rather than weight or force of gravity. The relative sizes of the arrows were often correct. Upthrust was often unsuccessfully substituted for air resistance. The question discriminated well with about a third gaining full marks.
			Total	**4**	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
44		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 60 000 (J) award 2 marks 48 000 + 12 000 ✓ = 60 000 (J) ✓	2 (AO 2.2) (AO 2.2)	Check table <u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		ii	C ✓	1 (AO 3.2b)	<u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.
		iii	B ✓	1 (AO 3.2b)	<u>Examiner's Comments</u> Part was answered well by most candidates. Many candidates showed workings and completed the table which helped them in answering. However, around one in five candidates gave incorrect responses. Most of these candidates had nether completed the table nor shown any workings.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
		iv	Heat / sound / KE of particles passed to other particles / AW ✓	1 (AO 1.1)	ALLOW (energy) transferred to surroundings / by friction Examiner's Comments A large number of candidates correctly stated that the motor would produce heat and/or sound or indicated that the energy was 'wasted' through friction. Some candidates wrote out all the energy transfers in an electric motor (e.g. "heat, sound and kinetic energy") which could not gain credit as it did not describe how energy is 'wasted'. Credit was given when it was clear that the 'waste' resulted from the transfer of the kinetic energy store of particles passed on to other particles or to the surroundings but not a vague transfer of 'kinetic energy to the atmosphere'.
		v	Lubrication / oil ✓	1 (AO 2.1)	ALLOW reduce friction Examiner's Comments Candidates found this question extremely challenging. There were very few suggestions of specific improvements to the electric motor such as lubricating it or applying oil to the moving parts. Many candidates suggested general energy efficiency tips such as switching it off when it not in use, running the motor at a slower speed or putting insulation around the motor.
			Total	6	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
45			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 800 (kg) award 3 marks Recall: force = mass × acceleration ✓ 4000 ÷ 5 ✓ 800 (kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 0.8 for two marks Examiner's Comments Some candidates divided their calculated answer by 1000 so that there answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.
			Total	3	
46			D ✓	1 (AO2.1)	Examiner's Comments This was a straightforward question to begin section A. Almost all the candidates correctly substituted the numbers into the given equation. Some candidates wrote their working in the space around the question. The advantages of this method are that there is a smaller chance of making a mistake by using the wrong numbers and it is easier to check the answer later.
			Total	1	
47			B ✓	1 (AO1.1)	Examiner's Comments This question was generally well answered. Candidates should be encouraged to use the space around the question for their working.
			Total	1	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
48			C ✓	1 (AO2.1)	Examiner's Comments This question was well answered. Candidates should be encouraged to consider each letter of the diagram, adding a small cross to the ones that are eliminated.
			Total	1	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
49			A downwards arrow labelled weight/load ✓ An upwards arrow labelled tension ✓ <u>Two</u> equal length arrows (by eye), one vertically up and one vertically down ✓	3 (AO3x 2.2)	**DO NOT ALLOW** labels pointing to apparatus **ALLOW** gravity/gravitational force **DO NOT ALLOW** mass **ALLOW** force from spring **NOTE** this mark may not be scored if more than two arrows are drawn <u>Examiner's Comments</u> A small majority of candidates gained at least two marks for this question. Most of these candidates drew two arrows of equal length and labelled correctly the weight or gravitational force. Few candidates labelled the upwards arrow "tension" or "force from spring". A common misconception was the use of the term "upthrust". When representing vectors by straight lines, candidates should be encouraged to use a ruler with a millimetre scale. Ideally candidates should refer to the gravitational force as "weight" or "force due to gravity" rather than "gravity". A few candidates did not understand a "free body force diagram" and drew the apparatus and labelled the apparatus. Other errors were the drawing of many arrows on the diagram in varying directions. **Exemplar 3**  This candidate has drawn a "free body force diagram" with two arrows of the same length – the candidate confirms that the arrows are the same length. Force of load was allowed for one of the label marks.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
			Total	3	
50			A ✓	1 (AO1.1)	
			Total	1	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
51	a	i	Bar C drawn to the correct height of 12s ✓	1 (AO1.2)	Examiner's Comments Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (s) award 2 marks 14 + 10 + 12 = 36 / (14 + 10 + 12)/3 without the 36 ✓ 36 ÷ 3 = 12 (s) ✓	2 (AO3.1a) (AO1.2)	ECF from (a)(i) ECF from mp1 above Examiner's Comments Most candidates drew the correct bar in (a)(i) and then went on to carry out an accurate calculation of the mean time.
		iii	Lift B ✓ Takes the least time (power is work done ÷ time taken)/AW ✓	2 (AO3.1b) (AO1.2)	If A chosen and correct explanation (for B) given, award mp2 but not mp1 Examiner's Comments Many candidates identified lift B uses the most power correctly but did not provide an explanation of why it use the most power for the second mark. Some candidates clearly thought the highest bar in the bar chart indicated a greater height reached by the lift and so chose lift A.

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4166.7 (W) award 4 marks	4	
			P = *E* ÷ *t* / power = work done ÷ time taken ✓	(AO1.2)	**ALLOW** energy (transferred) ÷ time taken
			P = 50000 ÷ 12 ✓	(AO2.1)	
			P = 4166.666667 (W) ✓	(AO2.1)	**ALLOW** 4166.7 for 2 marks if more dp not given
			P = 4166.7 (W) (1dp)✓	(AO1.2)	**ECF** own calculated power to 1 dp Examiner's Comments Part (i): required candidates to round their answer to one decimal place. Many candidates did the calculation well and gained 4/4, or 3/4 with incorrect rounding. Any calculation error in finding the power of the lift could still earn the candidate the last mark if their result was rounded correctly. Part (ii) was done correctly by the majority of candidates. The stem of the question contained some data that they did not need to complete the calculation, which made this a more challenging task than it may appear to be.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3000 (J) award 3 marks ✓	3	
			Work done = force × distance ✓	(AO1.2)	
			W = 750 x 4 ✓	(AO2.1)	
			W = 3000 (J) ✓	(AO2.1)	
			Total	12	
52			C ✓	1 (AO2.1)	Examiner's Comments This question was answered well with candidates being able to recall the equation relating acceleration, force and mass.
			Total	1	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
53			B ✓	1 (AO2.1)	Examiner's Comments This question was very well answered. Candidates correctly squared the speed. Again, higher ability candidates used the space around the question for their working.
			Total	1	
54			B	1 (AO2.1)	
			Total	1	
55			D	1 (AO1.1)	
			Total	1	
56			C	1 (AO2.1)	
			Total	1	
57			D	1 (AO2.1)	
			Total	1	
58		i	Gravitational (potential energy store) to kinetic (energy store) ✓	1 (AO2.1)	**ALLOW** kinetic (energy store) to thermal (energy store) / gravitational (potential energy) to thermal (energy) **ALLOW** KE for kinetic energy / GPE for gravitational (potential) energy / heat for thermal **IGNORE** just potential energy / PE
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.6 (J) award 4 marks** 86cm = 0.86 m ✓ (Work done =) 3(.0) x 0.86 ✓ (Work done =) 2.58 (J) ✓ (Work done =) 2.6 (J) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	**ALLOW** ecf for missing or incorrect unit conversion e.g. 260 (J) for 3 marks, 258 (J) for 2 marks
			Total	5	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK

Question			Answer/Indicative content	Marks	Guidance
59			B	1 (AO2.1)	
			Total	1	
60	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (N) award 2 marks 5 x 4 ✓ = 20 (N) ✓	2 (AO2.1) (AO2.1)	
		ii	Any one from: Not all energy is transferred to motion ✓ (Air) resistance ✓ Drag ✓ Friction ✓	1 (AO3.2a)	ALLOW Energy losses
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1500 (J) award 2 marks 30 x 50 ✓ = 1500 (J) ✓	2 (AO2.1) (AO2.1)	
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 20 (W) award 3 marks work done ÷ time ✓ 1500 ÷ 75 ✓ = 20 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf from (i) ALLOW P = WD ÷ t
			Total	8	

© OCR 2022. You may photocopy this page.

Created in ExamBuilder

STEMUP.CO.UK