OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P2.3 FORCES IN ACTION

SCORE	PERCENTAGE
/167	%

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Question			Answer/Indicative content	Marks	Guidance
1			B	1	
			Total	**1**	
2			D	1	
			Total	**1**	
3			B	1	
			Total	**1**	
4			B	1	
			Total	**1**	
5			B	1	
			Total	**1**	
6	a		A (1) It is the steepest gradient (1)	2	
	b		It has passed its elastic limit **or** it no longer obeys Hooke's Law (1) (The spring is) permanently deformed / distorted **or** (the spring) has undergone plastic deformation (1)	2	
	c	i	$0.5 \times 27 \times (0.25^2)$ (1) 0.84 (J) (1)	2	**ALLOW** 0.25 (1) for conversion of cm to m.
		ii	Record the original length (1) Add a mass (1) Recorded the new length (1) Repeat for increasing masses (1)	4	
		iii	Any two from: Use smaller weights (1) Use a longer ruler (1) Clamp the clampstand to the bench so it will not topple (1)	2	
			Total	**12**	
7			B	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
8	a		Recall weight = mass × gravitational field strength (1) Substitute: 185 × 3.75 (1) 694 to 3 sig.figs (2) N (1)	5	ALLOW 693.75 (1) but no marks for significant figures
	b		'g' is greater on Earth than Mars / weight is bigger as 'g' is greater on Earth (1)	1	
			Total	**6**	
9	a		59 (anomalous result should be left out of calculation) (1)	1	
	b		28 (1)	1	
	c		Green results unreliable / large variation / anomalous result (1) Should have repeated 31 (green) reading / other results (red, blue, white, yellow) are reliable (1) A sensible suggested improvement (1)	3	e.g. use camera to measure bounce heights (1)
	d	i	bounce height / drop height × 100% = 85% useful, therefore 15% wasted. (1) transferred to heat and sound (1)	2	
		ii	If the bounce height was greater then the efficiency would be higher / ORA (1)	1	
			Total	**8**	
10			B	1	
			Total	**1**	
11			C	1	
			Total	**1**	
12			D	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
13			A	1	
			Total	1	
14			D [1]	1	**allow** correct answer circled, ticked or underlined if no answer on the answer line Examiner's Comments Tested the idea of force = rate of change in momentum. About half the candidates answered the question successfully.
			Total	2	
15		i	B [1]	1	**allow** correct answer circled, ticked or underlined if no answer on the answer line
		ii	A [1]	1	**allow** correct answer circled, ticked or underlined if no answer on the answer line Examiner's Comments In this question candidates again confused kinetic and potential energy, with a significant number giving the answers to maximum KE and maximum PE the wrong way round.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
16		i	703 scores (2) **but if answer is incorrect** 185 × 3.8 scores (1)	2	**Examiner's Comments** Most correctly calculated the weight on Mars.
		ii	**any two from:** weight of Rover on Earth is 1850 (N) /AW (1) too heavy on Earth (1) weight too near to safe limits / more likely to break (1)	2	**allow** Rover is 50 (N) more than it can take (2) **allow** heavier / weighs too much (1) e.g. legs / wheels not able to support (1) incorrect statement about mass scores a maximum (1) **Examiner's Comments** Most candidates wrote about the Rover being too heavy or heavier on Earth (often without any reference to the information given). A small number calculated its weight correctly. Many candidates did not use the information in the table to apply to the question but simply compared gravitational field strengths.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
17		i	**lower speed** (than 8000 m/s) then: –centripetal / gravitational force too high (to stay in this orbit) [1] –rocket may fall / move or spiral to Earth [1] **higher speed** (than 8000 m/s) then: –centripetal / gravitational force too low (to stay in this orbit) [1] –rocket may move away from Earth / spiral out of orbit [1] (idea of) higher stable orbits experience lower gravitational force or lower speed / ORA [1]	3	**Eg**. rocket may fall as centripetal / gravitational force is too big [2] **Eg**. rocket may move away as centripetal / gravitational force is too small [2] **allow** any idea that correct speed needed to allow correct angle of re-entry to avoid overheating [1] Examiner's Comments This was an intentionally challenging question, which required both confidence in the physics and some skill in its communication. Few referred correctly in terms of the forces. The idea that lower speeds would cause the satellite to spiral to Earth was reasonably common. Less common was the idea that at higher speeds the satellites would spiral into space.

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Question			Answer/Indicative content	Marks	Guidance
		ii	(+/?) 4 (m/s^2) scores [3] **but if answer is incorrect then:** $(+/-)\ \frac{(120^2 - 2000^2)}{2 \times 5 \times 10^5}$ [2] **Or if no other marks scored then** evidence of correct substitution into $v^2 = u^2 + 2as$ **or** evidence of **rearranged** formula: $\frac{v^2 - u^2}{2s}$ [1]	3	**allow** 3.99 / 3.9856 (m/s^2) [3] Examiner's Comments The calculation of deceleration was challenging but it discriminated well with about a quarter gaining full marks.
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
18			[Level 3] Describes how KE changes in both sections AND describes how GPE changes in both sections AND calculates the maximum KE or difference in height. Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Describes how KE AND how GPE changes for both sections OR describes correctly how KE changes over both sections and calculates maximum KE OR describes correctly how GPE changes over both sections and calculates maximum KE OR calculates difference in height. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Realises that KE depends on speed and describes changes over part of journey OR describes how GPE changes over part of journey OR attempts to calculate maximum KE / height OR loss in KE = gain in PE (on either section) ORA 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 at grades up to A* Ignore points after C Indicative scientific points at all levels may include: • KE increases from A to B • KE decreases from B to C • GPE decreases from A to B • GPE increases from B to C • loss in GPE = gain in KE • KE = 1/2 mv^2 • maximum KE = 51200J • GPE = mgh • 51200 = mgh = 400 × 10 × h • height = 12.8m Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This six-mark level of response question proved to be the most challenging of the three on the paper. It did involve a data-handling element to the question. The graph, for many looked like a roller coaster track, so about a third of students described the motion along this track. A sizeable minority scored low marks for having the whole thing the wrong way round. Many thought that A to B was climbing and B to C was falling. The more able calculated the height correctly. Again this question discriminated well at the higher grades with approximately 10% scoring five or six marks. About 10% also failed to attempt this question at all.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
19	a		11.25 m (3) **but if incorrect** 56.25 = 5 x h (2) **but if incorrect** KE = ½ x 0.5 x 15 x 15 (1) **or** m g h = ½ m v^2 / PE = KE (1)	3	**allow** 56 = 5h (2) 11.25 (3) **if incorrect** time = 1.5 (seconds) (1) average speed = 7.5 (1) **allow** other correct calculations using equations of motion **Examiner's Comments** Candidates were asked to calculate the distance a rock fell from a cliff. They were given the hint that it gained kinetic energy and lost gravitational potential energy. Despite this hint only about one in five candidates scored on this section.
	b		**any one from** (idea that the) mass cancels out on the equation (1) (idea that without air resistance) both masses have the same acceleration (and so reach the same speed in the same time) (1)	1	**Examiner's Comments** Candidates were asked why a rock of double the mass hit the ground at the same speed. Examiners were looking for the idea that mass cancelled out in the two equations or that all objects fell with the same acceleration due to gravity. Many candidates mistakenly confused mass and weight. This question was about the transfer between kinetic energy and gravitational energy for falling objects. Candidates struggled with both parts of this question.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
20		i	703 (N) scores (2) **but if answer is incorrect** 185 × 3.8 scores (1)	2	**Examiner's Comments** Most correctly calculated the weight on Mars as 703N [2].
		ii	**any two from:** weight of Rover on Earth is 1850 (N) / AW (1) too heavy (on Earth) (1) weight too near to safe limits / more likely to break (1)	2	**allow** Rover is 50 (N) more than it can take (2) **allow** heavier / weighs too much (1) eg. Legs / wheels not able to support (1) incorrect statement about mass scores a maximum of (1) **Examiner's Comments** Most wrote about the Rover being too heavy or above the recommended weight limit on the legs [1]. Others calculated its weight correctly as 1850N [1]. Some concise answers were seen such as 'it is 50N above the weight limit' [2].
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
21			weight - 2500 (N) (1) distance - 2(m) (2) but if final answer is incorrect then look for: d = W / F 5000 / 2500 and award (1)	3	**allow** 5000 divided by incorrect calculated weight Eg weight = 25N (0) 5000 / 25 scores (1) **but** 5000 / 25 = 200 scores (2) 200m without working scores 0 **Examiner's Comments** In this common question targeted at C/D grades many candidates correctly calculated the weight but rather fewer could go further and calculate the height. These weaker candidates could usually get the weight mark but confused mass and weight in the formula for work or simply did not attempt that part.
			Total	**3**	
22			weight – 2500 (N) (1) distance – 2 (m) (2) but if final answer is incorrect then look for: d = W / F 5000 / 2500 and award (1)	3	**allow** 5000 divided by incorrect calculated weight Eg weight = 25N (0) 5000 / 25 scores (1) **but** 5000 / 25 = 200 scores (2) 200m without working scores 0 **Examiner's Comments** About three quarters of candidates were able to calculate the weight of the bar as 2500N but only about one third of these were able to calculate the height that he lifted the bar as 2m. Many found difficulty in rearranging the equation to make distance the subject.
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
23			Y (1) because Y has largest mass / one of the largest masses / AW (1) biggest height / one of the biggest heights / AW (1) **or** all GPE calculations shown V = 2000 / W = 4000 / X = 40000 and Y = 80000 (2)	3	**allow** greatest weight or greatest force **allow** calculations eg 200×40 is the greatest (G) PE / AW (3) **ignore** heaviest if Y is not chosen **allow** for max (1) • greater or big height if W is chosen • greater or larger mass if X is chosen **Examiner's Comments** Candidates can tackle this type of question more confidently. They can look at data and come to sensible conclusions based on their grasp of ideas in physics. The vast majority gained partial or full credit (almost 30% gained all 3 marks). Vague references to 'high' or 'heavy' reduced the potential mark in some responses. Crude calculations (i.e. using the idea of 'mgh' without conversion of mass and / or height to kilograms / metres) were credited since the use of GPE in Item h of Unit P3 is aimed at grade C and above and this question was targeted at grades E, F and G. Answers with calculations therefore did reflect the idea of Y having the greatest GPE by virtue of greatest mass and highest drop height.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
24				3	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.
			Total	3	

At **A** all of Susie's energy is GPE.	(✓)
Between **A** and **B** Susie gains **both** GPE and KE.	✗
Between **A** and **B** Susie gains **only** KE.	✓
At **B** her KE is **exactly** half her GPE at **A**.	✗
Just before touching the ground at **C** Susie has her maximum KE.	✓
On the ground at **C** Susie has zero KE.	✓
On the ground at **C** Susie has her maximum GPE.	✗

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Question			Answer/Indicative content	Marks	Guidance
25			**Level 3: 5–6 marks** **Explains fully the changes in KE and GPE between A and B or B and C.** Quality of written communication does not impede communication of science at this level. **Level 2: 3–4 marks** **Gives a partial explanation of the changes in GPE and KE between A and B or B and C** Quality of written communication partly impedes communication of science at this level. **Level 1: 1–2 marks** **Simple statement about KE and GPE.** 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 C** **Indicative scientific points may include (but are not limited to) the following:** <u>KE Statements</u> at **A** kinetic energy is zero / a minimum at **B** kinetic energy is a maximum at **C** kinetic energy is zero / a minimum **allow** correct changes e.g. KE increases from zero to a maximum between **A** and **B** / decreases from maximum to zero between B and C <u>GPE Statements</u> **(allow PE for GPE)** at **A** gravitational potential energy is a maximum at **B** gravitational potential energy is a minimum / zero at **C** gravitational potential energy is a maximum **allow** correct changes e.g. GPE decreases from maximum to minimum between **A** and B / increases from minimum to maximum between B and C **allow** GPE for gravitational potential energy allow just potential energy for GPE as this is in the question **allow** KE for kinetic energy allow PE at C is less than PE at A **simple statements include:** car has KE at B Car has PE at A or C KE depends on speed PE depends on / increases with height
			Total	**6**	
26			**A** ✓	1 (AO1.1)	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
27			C ✓	1 (AO2.2)	
			Total	1	
28			B ✓	1 (AO1.1)	
			Total	1	
29			C ✓	1 (AO1.2)	Examiner's Comments Just over half of all candidates got this correct. The most common wrong answer here was D; candidates need to realise that 'elastic behaviour' for a spring is intended to refer to the straight-line section of the graph.
			Total	1	
30			C ✓	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
31	a	i	moment = force × distance ✓ clockwise moment = 800 (Nm) ✓ anti-clockwise moment = 1000 (Nm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 2 marks (total) if clockwise and anti-clockwise moments are reversed Correct calculation of either moment implies correct equation so gets m.p.1 also Examiner's Comments Some candidates were confused as to the direction of rotation of 'clockwise' and 'anticlockwise', so credit was allowed to those who reversed their sense. Many candidates did not know how to calculate a moment, although this could be deduced from the units provided in the answer line (telling them to multiply the two). The unit Nm is the product of the force (N) and the distance (m) of each child from the pivot point of the seesaw.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.6 (m) award 3 marks (anti-clockwise moment) 500 (N)×distance = 800 (N m) ✓ distance = 800 ÷ 500 ✓ = 1.6 (m) ✓	3 (AO1.2) (AO2.2) (AO2.2)	E.c.f. clockwise moment from (a)(i) for 800 (N m) If child B chosen, giving 1000 ÷ 400 = 2.5 (m), award 2 marks (loses m.p.1) Examiner's Comments Many candidates did not identify that the command word "calculate" was asking them to provide a mathematical solution rather than a qualitative descriptive of where child A should sit. Several candidates did calculate the correct answer and showed their workings in the space provided.
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (Pa) award 3 marks pressure = force ÷ area ✓ = 10 ÷ 0.1 ✓ = 100 (Pa)✓	3 (AO1.2) (AO2.1) (AO2.1)	Examiner's Comments Many candidates were not able to recall the equation $P = F/A$. Some candidates did recall the equation and correctly calculated the pressure in the fluid as 100 Pa. A common misconception was using the equation $P = F \times A$ to calculate the pressure as 1 Pa.

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Question			Answer/Indicative content	Marks	Guidance
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	ALLOW to the left opposite to the force from the plunger Examiner's Comments Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	10	
32			B	1 (AO2.1)	Examiner's Comments This was the first calculation on the paper and about 80% gave the correct answer B. A common incorrect response was 'A', presumably due to confusion over clockwise and anticlockwise.
			Total	1	
33			A ✓	1 (AO2.1)	Examiner's Comments In this calculation about a third of candidates gave the correct answer A. The other distractors were randomly selected.
			Total	1	

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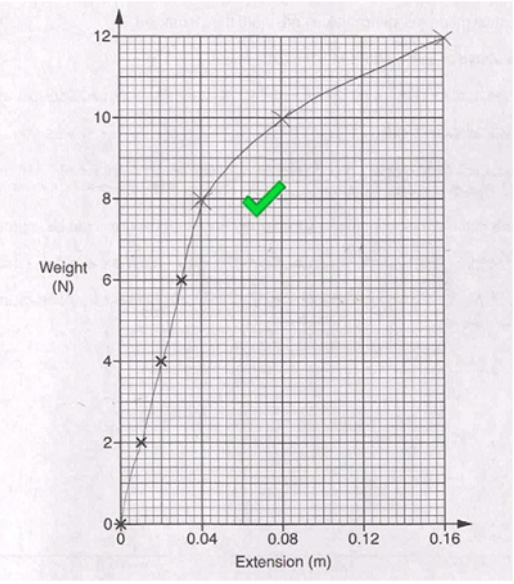
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Question			Answer/Indicative content	Marks	Guidance
34			Rod **attracts** water ✓ • Opposite charges attract ✓ • water has both + and – charges / idea of polarisation / AW ✓	3 (AO3 × 1.2)	**IGNORE** positive electrons / movement of protons / ions for this answer. **ALLOW** Water bends or moves towards rod **OR** for candidates that have misinterpreted the diagram as repulsion of water then **ALLOW** Rod **repels** water / water bends or moves away from rod ✓ • Like charges repel ✓ • water has both + and – charges / idea of polarisation / AW ✓ Examiner's Comments The diagram was interpreted differently by candidates. Some thought it attracted (ideal scenario) and others thought it repelled. However marks were made available for both lines of thought as both interpretations were valid from the diagram. It gave a full range of marks and discriminated well with about 10% gaining full marks by including the idea of polarisation. The ideas of repulsion of water and opposite charges repelling were credited 2 marks.
			Total	3	

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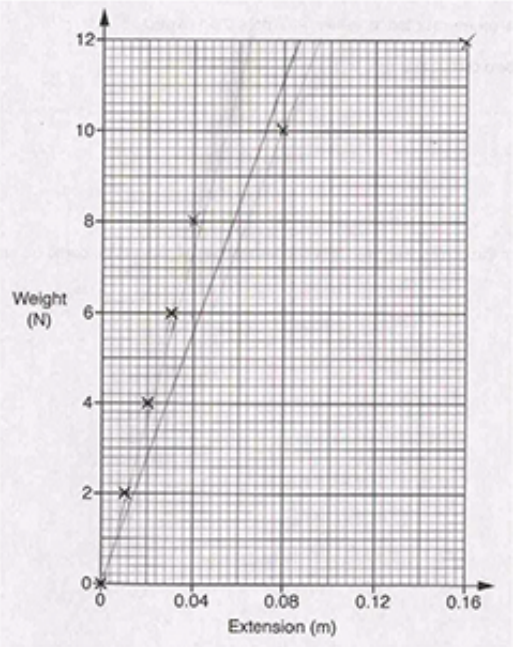
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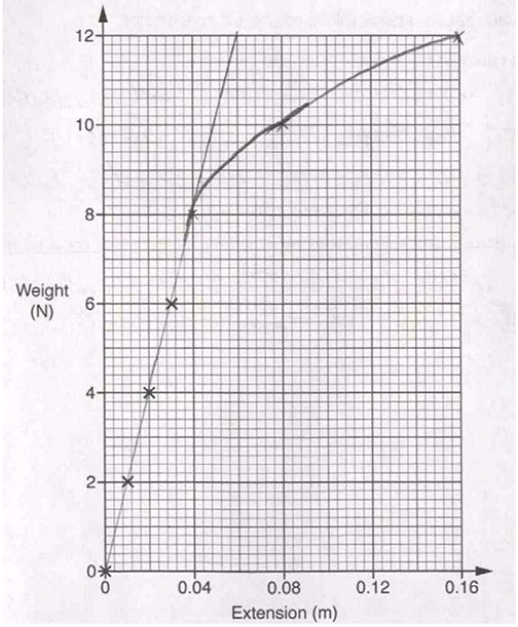
Question			Answer/Indicative content	Marks	Guidance
35	a	i	All three points correctly plotted ✓✓ **OR** two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / – ½ square or less (by eye) **Examiner's Comments** All the points were usually plotted correctly.
		ii	straight line up to 0.04, 8 **and** curved line consistent with points plotted past this point ✓	1 (AO 3.1a)	**ALLOW ecf from part ai for misplotted points** **ALLOW** straight part of graph drawn without ruler. **DO NOT ALLOW** dot-to-dot for curve **Single** line should be **thin** (less than ½ square thick) and **continuous** to gain the mark. **Examiner's Comments** Just over half of answers gained the one mark here. Common mistakes were double lines, lines too thick (larger than half a square) and straight line of best fit with no curve. Exemplar 1  This gets full marks for both parts as the answer shows accurate plotting for part i of

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Question	Answer/Indicative content	Marks	Guidance
			the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable. Exemplar 2  This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks. Exemplar 3

Question			Answer/Indicative content	Marks	Guidance
					 This shows two lines, one curved and one straight. The marker cannot give credit as they are unsure which one to mark. In any case the curved line would have been too thick to award the mark as it is thicker than half a square.
		iii	Initially the **extension** increases steadily / linearly / uniformly / (directly) proportionally / elastically / AW ✓ (then the) wire reaches its **elastic limit** ✓ the extension increases plastically / by more for each (2N) weight added (past this point) / AW ✓	3 (AO 3.1a) (AO 1.2) (AO 3.1a)	**ALLOW** gradient is steady up to 8N **ALLOW** initially obeys Hooke's law **IGNORE** limit of proportionality (as this is an AO3 answer for an AO1 question) **ALLOW** Hooke's law not obeyed after 8N <u>Examiner's Comments</u> This gave a good range of marks with most describing the first stage as extension is linear or proportional. Some clearly referred to elastic limit [1 mark] although vague answers such as 'limit of proportionality' was frequently seen [0 mark]. Some were successful in describing the extension after the limit is reached.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 200 (N/m) award 3 marks	3	
			k = F ÷ x ✓	(AO 1.2)	IGNORE F=kx
			k = 6 ÷ 0.03 ✓ (or equivalent correct expression from 0 to 6N)	(AO 2.1)	Substitution into correctly rearranged formula ✓✓
			k = 200 (N/m) ✓	(AO 2.1)	Examiner's Comments This calculation, like many on the paper was answered well. Here about third quarters of answers gained all three marks. For unsuccessful calculations however, 1 mark was given for the correct rearrangement of the formula k = F ÷ x.
	c		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.16 (J) award 2 marks	2	ALLOW ecf from part b
			E = 0.5 × 200 × 0.04^2 ✓	(AO 1.2)	ALLOW area under graph method: 0.5 × 8 × 0.04 ✓
			E = 0.16 (J) ✓	(AO 2.1)	BUT area under graph method used to calculate 0.16 scores ✓✓ Examiner's Comments Most candidates incorrectly used 'work done = force × distance' giving the answer 0.32 (J). Better answers used E = 0.5 × 200 × 0.4^2 to successfully get 0.16 (J) and gained full marks.
			Total	11	

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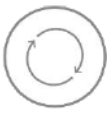
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Question			Answer/Indicative content	Marks	Guidance
36	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 120 (N/cm^2) award 3 marks	3	
			Recall: pressure = force ÷ area ✓	(AO 1.2)	
			12000 ÷ 100 OR 40000÷ 25 ✓	(AO 2.1)	ALLOW 12000÷25 for one mark
			= 120 (N/cm^2)	(AO 2.1)	ALLOW for two marks 480 (N/cm^2) Examiner's Comments Candidates are advised to start their response to this type of question by writing down the appropriate equation. They should then substitute the numbers from the stem of the question into the equation before they calculate the answer. Making sure to write down each stage of the process. A common error was candidates who had not allowed for the four tyres and gave a final answer of 480 N/cm^2.

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Question			Answer/Indicative content	Marks	Guidance
	b	i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1 (AO 1.1)	<u>Examiner's Comments</u> Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.  AfL The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	1 (AO 1.1)	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop <u>Examiner's Comments</u> Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.

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Question			Answer/Indicative content	Marks	Guidance
			Total	5	
37			B ✓	1 (AO1.1)	Examiner's Comments Most candidates understood that a moment is required to cause a rotation.
			Total	1	
38			Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2 (AO 2.1) (AO 1.1)	ALLOW weight of child is lower/child is smaller Examiner's Comments Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
			Total	2	
39			A ✓	1 (AO2.1)	Examiner's Comments This question was generally answered well. Candidates should be encouraged to consider the units. In the units in each answer is given as N / kg, then 16 N should be divided by 10 kg giving an answer of 1.6 N / kg.
			Total	1	
40			C ✓	1 (AO2.1)	Examiner's Comments The majority of candidates realised that the mass ($\times g$) $\times$ distance above the ground was needed. For this type of question, it is good to calculate the potential energy for each option.
			Total	1	

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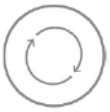
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Question			Answer/Indicative content	Marks	Guidance
41			A ✓	1 (AO1.1)	Examiner's Comments This question was generally answered well. For the cogs shown since the reverse must also be true, response A was straightforward. Candidates who did not gain this mark often chose response B.
			Total	1	
42			A ✓	1 (AO2.1)	Examiner's Comments This was well answered by higher ability candidates. Often the half or the change of unit (cm to m) was missing. Higher ability candidates wrote the equation from the data sheet, then substituted the numbers into the equation and then carried out the calculation.
			Total	1	

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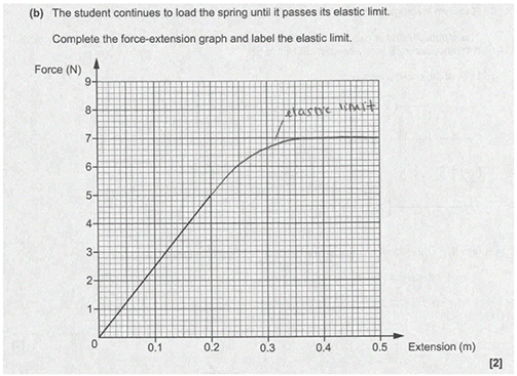
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Question			Answer/Indicative content	Marks	Guidance
43	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 25 (N/m) award 3 marks	3	
			Recall and rearrange: spring constant = force exerted by a spring ÷ extension ✓	(AO1.2)	
			= 5 ÷ 0.2 ✓	(AO2.1)	ALLOW any other correct pair of points from the graph – points to be read to ±½ a small square
			= 25 (N/m) ✓	(AO2.1)	Final answer between 24 and 26 (N/m) scores three marks Examiner's Comments The majority of candidates scored highly on this question. Higher ability candidates stated either the equation for spring constant or stated that the spring constant was the gradient of the graph. It was then expected that candidates would substitute into their equation appropriate values from the graph. A small but significant minority of candidates tried to use the same equation from the data sheet which had been used to determine the energy transferred and substituted in a force for the energy. This approach was not creditworthy.  AfL Candidates should be able to read information from graphs and determine a gradient.

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Question			Answer/Indicative content	Marks	Guidance
	b		Line curves and gradient decreases ✓ Point at the end of the linear section of the line labelled 'elastic limit' ✓	2 (AO2x 1.2)	IGNORE poorly drawn curves/thick lines DO NOT ALLOW curve with negative gradient at any point Examiner's Comments This question required candidates to demonstrate that they understood how a spring stretched with an increasing force and the term "elastic limit". For marks to be given the straight line section (if any) should be drawn with a ruler and the curve should be smooth. Sometimes the labelling of the elastic limit was vague. Higher ability candidates added a small cross at the elastic limit and then labelled the cross. Exemplar 2  This candidate has clearly extended a straight line and then drawn a curve with decreasing gradient which gains the first mark. The labelling of the elastic limit is vague and incorrect. It would have been helpful if this candidate had indicated precisely on the line with a dot or cross where the elastic limit is located and then added a label.
	c		A downwards arrow labelled weight/load ✓	3 (AO3x 2.2)	DO NOT ALLOW labels pointing to apparatus ALLOW gravity/gravitational force

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Question			Answer/Indicative content	Marks	Guidance
			An upwards arrow labelled tension ✓ <u>Two</u> equal length arrows (by eye), one vertically up and one vertically down ✓		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.
			Total	8	

Question			Answer/Indicative content	Marks	Guidance
44			B ✓	1 (AO2.2)	
			Total	1	
45			C ✓	1 (AO2.1)	
			Total	1	
46			B ✓	1 (AO1.1)	
			Total	1	
47			B ✓	1 (AO1.1)	Option B was the correct answer. Option D was a common misconception, probably because the phrase 'see-saw' suggested rotation to many candidates. Examiner's Comments  AfL Rather than focus on a single word like 'see-saw' in the stem of a question, it can be helpful for candidates to try and visualise each of the operations described. At the pivot a see-saw does not move. The book is moving down in A and up in C. However the door is rotating on its hinges.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
48	a		**Any three from:** Measure original length (using the ruler) ✓ Add the 2N weight ✓ Measure the extended length and use Extension = extended length – original length ✓ Use $k = F \div x$ to determine k ✓	3 (AO1.2 x3)	**ALLOW** measure the extension/how far it stretched **Examiner's Comments** Only a few candidates stated how the spring constant should be calculated by referring to *spring constant = force exerted by the spring ÷ extension*. However as the mark scheme allowed for any of the four marking points to count towards the total many candidates gained all 3 marks without reference to the spring constant equation. Exemplar 3 was a typical response and gained two marks. This candidate did realise a calculation was needed but decided it should be $E = ½ k x^2$. This energy equation (which was on the data sheet) was given in more candidate answers than the expected force = *extension x spring constant* **Exemplar 3** 18 A student has a spring, a ruler and a 2.0 N weight. (a) Describe how the student can use this equipment to determine the **spring constant** of the spring. the student can attach the spring to a stand and a clip, then put the weight on the end of the spring, measuring how far it extends. Then use the equation energy transferred in stretching = 0.5 × spring constant × (extension)² [3]
	b		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 400 (Pa) award 2 marks** $P = 2 \div 0.005$ ✓ $P = 400$ (Pa) ✓	2 (AO2.1) (AO2.1)	**Examiner's Comments** Relatively few candidates had problems with dividing by 0.005.

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Question			Answer/Indicative content	Marks	Guidance
	c		Two (or more) forces (are needed) ✓ Acting in different directions ✓	2 (AO1.1) (AO1.1)	Multiple forces are implied by the use of certain verbs e.g. squash, twist, squeeze **ALLOW** the marking points shown on a diagram Idea of second force can be implied by fixing one end/part of the material **ALLOW** clear use of tension or compression for both marks <u>Examiner's Comments</u> The key factors which were needed here were that more than once force is necessary, and that those forces must act in different directions. The 'multiple forces' idea was accepted to be implied by the use of some verbs, for example squash, twist, squeeze and crush. The 'opposite directions' mark could be gained by setting up a situation where the opposition was obvious, for example by. putting the object on a table and pushing down from above
	d		Plastic – stays deformed (when force is removed) ✓ Elastic – returns to original shape (when force removed) ✓	2 (AO1.1) (AO1.1)	**ALLOW** permanently changed <u>Examiner's Comments</u> Around half of all candidates described plastic deformation and this almost always led on to a description of elastic deformation, or vice versa (a description elastic deformation leading into plastic deformation). Very few candidates only described one form of deformation.
			Total	**9**	
49			**D** ✓	1 (AO2.1)	
			Total	**1**	
50			D	1 (AO2.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
51			B	1 (AO1.2)	
			Total	**1**	
52			A	1 (AO2.1)	
			Total	**1**	
53			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1260 or 1300 (Nm) award 4 marks** (Force = 70 x 10 =) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700 x 1.8 ✓ (Moment =) 1260 (Nm) ✓	4 (AO2.1) (AO1.2) (AO2.1) (AO2.1)	**ALLOW** ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70 x 1.8 **ALLOW** ecf for incorrect calculation of force **ALLOW** ecf for converting 1.8m to 180cm e.g. 3 marks for 126 000 (Nm)
			Total	**4**	
54			D	1 (AO1.1)	
			Total	**1**	
55			B	1 (AO2.1)	
			Total	**1**	
56			A	1 (AO2.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
57	a	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (N/cm) award 3 marks (Spring constant =) force ÷ extension ✓ 2.0 ÷ 4.0 ✓ = 0.5 (N / cm) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW 3 marks for 50 N/m Needs algebraic or arithmetic rearrangement for this m.p. Choice of *F, ext* for wrong data point loses mp2 but can get mp3 for evaluation ecf.
		ii	Any two from: Repeat readings and calculate a mean/average ✓ Use more forces ✓ Plot data on a graph (and use a line of best fit) ✓ Use equipment with a higher resolution✓ Repeat experiment with different equipment (and compare results) ✓	2 (AO3.3b x 2)	
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (J) award 2 marks ½ x 40 x 0.2^2 ✓ = 0.8 (J) ✓	2 (AO2.1) (AO2.1)	ALLOW 3.8 (J)
	c	i	(moment of 2N weight) = 80 (N cm) ✓ (moment of 3N weight) = 150 (N cm) ✓	2 (AO2.1) (AO2.1)	ALLOW 1 mark if answers are reversed
		ii	Anti-clockwise (as anti-clockwise moment is larger than the clockwise moment) / left hand side goes down / AW✓	1 (AO3.1b)	ALLOW indication of rotation by an arrow on the diagram
			Total	10	

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