OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

M3 ALGEBRA

SCORE	PERCENTAGE
/232	%

STEMUP

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Question			Answer/Indicative content	Marks	Guidance
1	a		16 / 16.0 / 16.00 (2) If answer incomplete or incorrect then 48 – 15.65 – 16.35 or 48 – 32 scores (1)	2	
	b		220 (cm) (2) If answer is incorrect or incomplete then: Evidence on graph **showing** a line **or** curve scores (1)	2	**Allow** 216 → 224 (2) **BUT** for a reasonable curve extrapolated allow 216 → 230 (2)
	c	i	Time-period is (directly) proportional to the square root of length / AW (1)	1	**Eg.** x and y are proportional (1) **Eg.** 'As square root of length increases in equal steps, the time period increases in equal steps' (1) **Allow** linear relationship **through the origin** (1) **Allow** examples showing this relationship using numbers **Ignore** merely 'positive correlation'
		ii	3.4 (3) But if answer is incorrect or incomplete then: $6.284\sqrt{\frac{3}{10}}$ or 2 x 3.142 x 0.5477 scores (2) $2 \times 3.142\sqrt{\frac{3}{10}}$ scores (1)	3	**Allow** decimal place error: **Eg.** 3.441 (2) **Allow** 34.4 (2) (**for candidate who has used 300 cm instead of 3 m)** Look for correct substitution **AND** some correct processing **Eg.** (π or) 22/7 for 3.142 Look for the correct substitutions Eg. $2 \times \pi\sqrt{\frac{3}{10}}$ scores (1)

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Question			Answer/Indicative content	Marks	Guidance
		iii	0.3 or 0.25 or 0.253..... etc. (2) But if answer is incorrect or incomplete then evidence of correct substitution (in symbols or numbers) scores (1)	2	Eg. $1 = 2 \times 3.14 \times \sqrt{\frac{L}{10}}$ **Allow** π or 22/7 for 3.142
			Total	**10**	
2			**B ✓**	1 (AO2.1)	<u>Examiner's Comments</u> This proved to be the easiest question in Section A, with about 85% of all candidates getting it right. The commonest wrong answer was D.
			Total	**1**	
3			**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**	
4			**C ✓**	1 (AO2.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
5			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 10 000 000 (J) award 4 marks Rearrange to energy = charge × potential difference ✓ 44 000 × 230 ✓ 10 120 000 ✓ 10 000 000 (2 sf) (J) ✓ OR Substitute correctly 44 000 (C) = energy ÷ 230 (V)✓ Rearrange to energy = 44 000 (C) × 230 (V) ✓ = 10 120 000 (J) ✓ = 10 000 000 (2 sf) (J) ✓	4 (AO2.1) (AO2.1) (AO2.1) (AO1.2)	Fourth mark is for correct rounding If answer line has 10 120 000 (J) award 3 marks m.p.2 can include m.p.1 if equation not written m.p.2 can include m.p.1 as above Examiner's Comments There was an erratum with this question to correct the units to joules. The figures in this question were difficult, and many candidates coped well with the large numbers and also the rearrangement of the equation. Some candidates rearranged the equation before substitution and others after. Fewer candidates were able to round 10 120 000 J to two significant figures (e.g. 10 000 000 J). OCR support Mathematical Skills Handbook http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
6			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed description and comparison of the motion of all four students in terms of distance and time relating speed to distance run **AND** Calculates the speed of all four students. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Description and comparison of the motion of three students of distance and time **OR** Calculates the speed of at least three students. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Brief description of the motion of at least three students. **OR** Calculates the speed of at least one student. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6 (AO2 × 1.1) (AO2 × 2.2) (AO1 × 3.1a) (AO1 × 3.2b)	**AO1.1 Demonstrate knowledge and understanding of the correct formulae** • speed = distance ÷ time • v = s ÷ t • evidence of calculation **AO2.2 Apply knowledge and understanding of the motion of the four students** • Race B is a longer distance than race A • Race B and C are the same distance • Students B & C take different amounts of time • Student D takes the longest time • Race D is the longest distance • Race A is the shortest distance • Student A speed = 15÷6 = 8.3m/s • Student B speed = 100÷15 = 6.7m/s • Student C speed = 100÷14 = 7.1m/s • Student D speed = 200÷31 = 6.5m/s **AO3.1a & AO3.2b Analyse information to interpret and draw conclusions about the motion of the four students** • Race B is twice the length of race A, but time is more than twice that of race A • C is faster than B as the time is shorter (for the same distance) • As race length increases, average speed decreases Examiner's Comments There were many excellent answers, with the mean speeds of all four runners calculated with comments about how they had run different races (apart from B and C). Many candidates helped themselves by annotating the calculated speeds next to

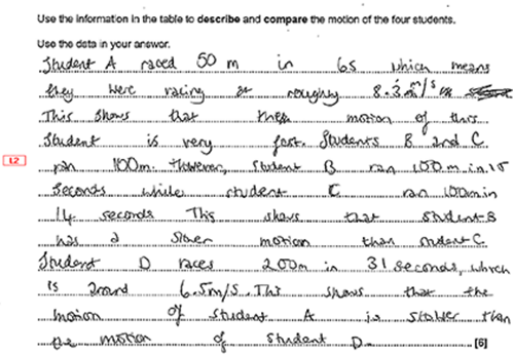
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Question	Answer/Indicative content	Marks	Guidance
			the table). The most able candidates discussed the effect of running a longer race on the mean speed of the runner (see Exemplar 7 below). Less able candidates compared the times of each runner but did not calculate speeds (see Exemplar 5 below). **OCR support** About one in ten candidate did not attempt to answer this question. Level of Response (LoR) questions are designed to open up the potential answers so that candidates at all levels of ability have an opportunity to show their scientific understanding. Every candidate should be encouraged to answer LoR questions as even a weak but relevant answer will be credited. The 'How to answer 6 mark LoR questions' resource can be used to help candidates prepare for this style of question http://www.ocr.org.uk/Images/374902-how-to-answer-6-mark-lor-activity.doc Exemplar 5 Use the information in the table to **describe** and **compare** the motion of the four students. Use the data in your answer. The less motion the student had compleated the race quicker as to student A the race distance is 50m then did the race in 6s about student D the race resistance was 200 and did the race in 8ls however student B and C race resistance was the same 100m and student B did the race in 15s and C did the race in 14s. [6] A Level 1 candidate response. They describe the data in the table with no attempt to process data and calculate the speed of each runner. The information is relevant to the question but there is no real attempt to compare the motion of the four students.

Question	Answer/Indicative content	Marks	Guidance
			Exemplar 6



Use the information in the table to **describe** and **compare** the motion of the four students.

Use the data in your answer.

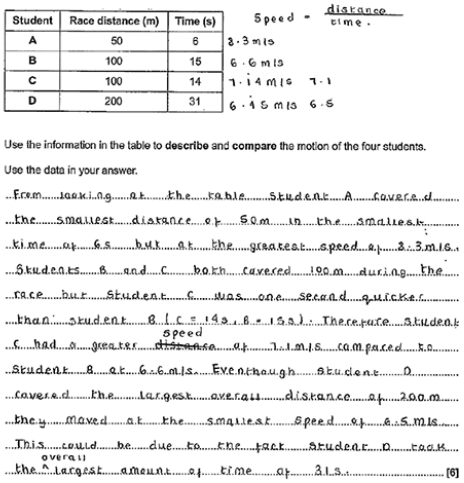
Student A raced 50 m in 6s which means they were racing at roughly 8.3 m/s ~~m~~

This shows that their motion of their Student is very fast. Students B and C ran 100m. However, student B ran 100m in 15 seconds while student C ran 100m in 14 seconds This shows that student B was a slower motion than student C. Student D races 200m in 31 seconds, which is around 6.5m/s. This shows that the motion of student A is faster than the motion of student D. [6]

L2

A Level 2 candidate response. They have calculated and compared the speeds of A and D, but only compared the relative motions of B and C. There is a structured line of reasoning and the reporting of data is linked by sentences that offer some interpretation of the facts.

Exemplar 7



Student	Race distance (m)	Time (s)	Speed = distance / time
A	50	6	8.3 m/s
B	100	15	6.6 m/s
C	100	14	7.14 m/s 7.1
D	200	31	6.45 m/s 6.5

Use the information in the table to **describe** and **compare** the motion of the four students.

Use the data in your answer.

From looking at the table Student A covered the smallest distance of 50m in the smallest time of 6s but at the greatest speed of 8.3m/s. Students B and C both covered 100m during the race but Student C was one second quicker than student B (15 - 14 = 1s). Therefore student C had a greater ~~distance~~ speed of 7.1m/s compared to Student B at 6.6m/s. Even though student D covered the largest overall distance of 200m they moved at the smallest speed of 6.5m/s. This could be due to the fact student D took the overall largest amount of time of 31s. [6]

L3

A Level 3 candidate response. They first calculated the speed of each student and then annotated the data table. This allowed them to be more focused and precise in their response. They have offered some explanation of the relative motions of the students. This answer is logical and all the content is relevant. The word counts for all

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Question			Answer/Indicative content	Marks	Guidance
					three exemplars are similar and demonstrating that a well thought out answer is better than a very long answer.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
7	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	
8		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 × 16 ✓ 4 (V) ✓	2 (AO2.1) (AO2.1)	Examiner's Comments Most candidates were successfully completed the calculation.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks P = IV ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ OR P = I^2R ✓ P = 0.25^2 × 16 ✓ P = 1 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci Examiner's Comments A quarter of all candidates calculated the correct answer here. Very few of the other candidates recognised that (c)(i) and (c)(ii) were a developing story and so did not multiply the answer to the first part of the question (4 V) by 0.25 A to calculate the answer to the second part.
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
9			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	
10			D ✓	1 (AO2.2)	Examiner's Comments This calculation was answered successfully by about three quarters of the candidates stating D.
			Total	1	
11			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	
12			C ✓	1 (AO2.1)	Examiner's Comments About two thirds of candidates gave the correct answer C.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
13		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4 (V) award 2 marks 0.25 × 16 ✓ 4 (V) ✓	2 (AO2.1) (AO2.1)	Examiner's Comments This standard demand Ohm's law calculation was very well answered by almost all candidates. As, on this occasion, the formula was given in the question then the mark total was limited to 2 marks.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1 (W) award 3 marks P = IV ✓ P = 0.25 × 4 ✓ P = 1 (W) ✓ OR P = I^2R ✓ P = 0.25^2 × 16 ✓ P = 1 (W) ✓	3 (AO1.2) (AO2.1) (AO2.1) (AO1.2) (AO2.1) (AO2.1)	ALLOW e.c.f. from part ci Examiner's Comments About two thirds of candidates gained all 3 marks here for the calculation on power.
			Total	5	

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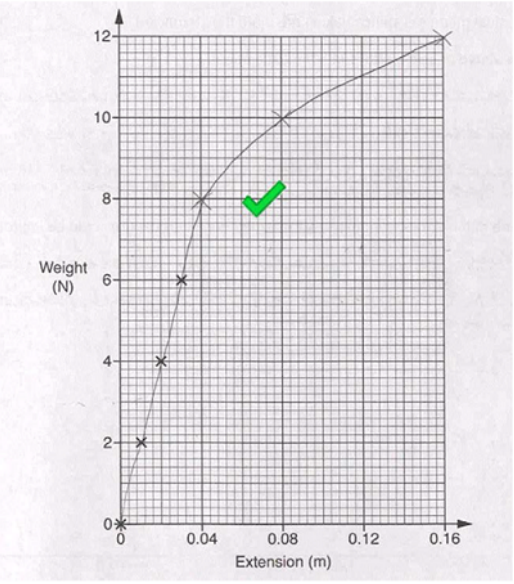
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Question			Answer/Indicative content	Marks	Guidance
14		i	potential difference ✓ closed or complete circuit ✓	2 (AO2 × 1.1)	IGNORE ions / charge ALLOW voltage ALLOW higher level answers eg. must have delocalised electrons / electrons that are free to move Examiner's Comments Only about 10% here gained both marks. Delocalised electrons was a common correct answer for 1 mark. Less often seen were a potential difference [1] and a complete circuit [1].
		ii	FIRST CHECK THE ANSWERON ANSWER LINE If answer = 1500 (C) award 4 marks Q = It ✓ t = 5 × 60 = 300 (s) ✓ Q = 5 × 300 ✓ Q = 1500 (C) ✓	4 (AO1.1) (AO2.1) (AO2.1) (AO2.1)	Examiner's Comments This was reasonably well answered and about two thirds of candidates gained 3 marks for 1500. Some forgot to convert minutes to seconds but were credited some reward for their working.
			Total	6	

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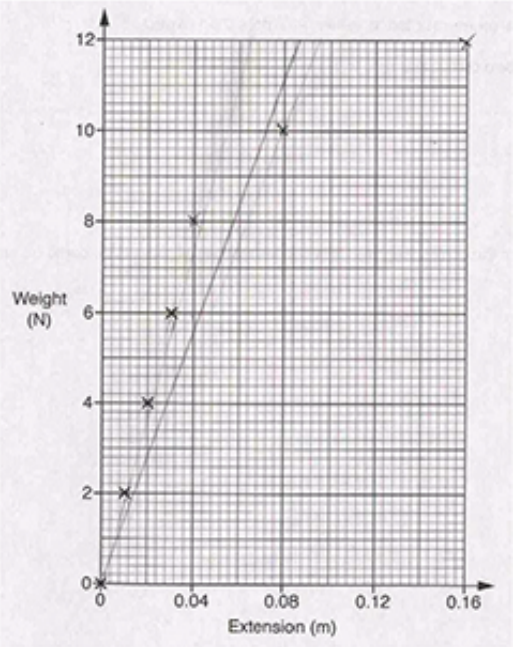
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Question			Answer/Indicative content	Marks	Guidance
15	a	i	All three points correctly plotted ✓✓ **OR** two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / – ½ square or less (by eye) **Examiner's Comments** All the points were usually 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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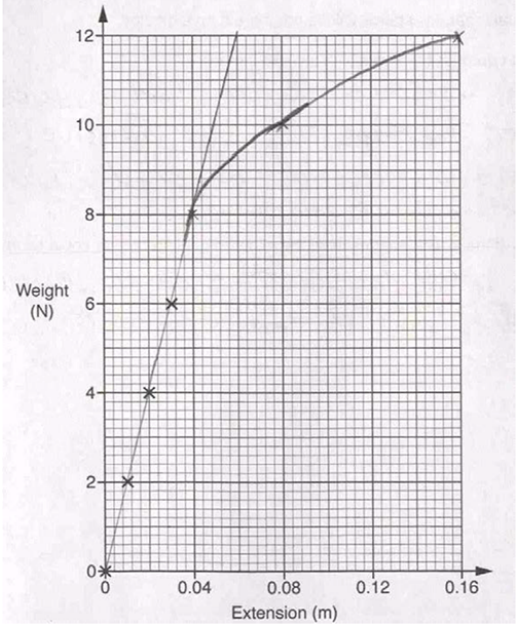
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Question	Answer/Indicative content	Marks	Guidance
			the question and produces a straight line graph in part ii that becomes curved after 8N. Although the line does slightly miss the point at 8N, the line and curve are reasonable. Exemplar 2  This was a common error with points plotted accurately but a straight line drawn so this was credited 0 marks. Exemplar 3

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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 k = F ÷ x ✓ k = 6 ÷ 0.03 ✓ (or equivalent correct expression from 0 to 6N) k = 200 (N/m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**IGNORE** F=kx Substitution into correctly rearranged formula ✓✓ 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 E = 0.5 × 200 × 0.04^2 ✓ E = 0.16 (J) ✓	2 (AO 1.2) (AO 2.1)	**ALLOW** ecf from part b **ALLOW** area under graph method: 0.5 × 8 × 0.04 ✓ **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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Question			Answer/Indicative content	Marks	Guidance
16			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 380 000 (J) award 3 marks	3	
			SLH = E ÷ m ✓	(AO 1.2)	Rearranging equation 95 ÷ 250 or 0.38 scores ✓ (evidence of rearranged formula)
			= 95000 ÷ 0.25 ✓	(AO 2.1)	95 000 ÷ 250 = 380 scores ✓✓ Or 95 ÷ 0.25 = 380 ✓✓ Or 380 ✓✓
			= 380000 (J/kg) ✓	(AO 2.1)	<u>Examiner's Comments</u> Slightly over a half gained all 3 marks for this calculation. Some gained fewer marks because of power of 10 errors in conversions for example 360 [2] rather than 360 000 [3]. Others gained [1] for the correct rearrangement of the formula.
			Total	3	

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17	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.

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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.4 (m/s) award 3 marks	3	
			(8.4 + 6.75) × 4.5 ✓	(AO 2.2)	ECF for momentum values eg. (A + B) ÷ 4.5
			3.37 / 3.366666667 (m) ✓	(AO 2.2)	
			3.4 (rounding to 2 sf) ✓	(AO 1.2)	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	

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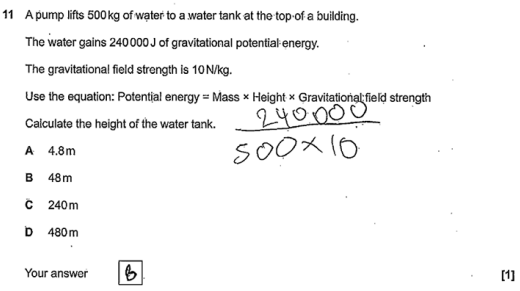
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Question			Answer/Indicative content	Marks	Guidance
18		i	initial speed is zero **and** • either acceleration due to gravity = 10 • or g = 10 ✓ use a = (v-u) ÷ t to find the final speed / v ✓ use $v^2 - u^2 = 2as$ to find s ✓	3 (AO 3 × 1.1)	IGNORE the idea of echoes and speed of sound ALLOW answers using g = 9.8 or 9.81 ALLOW v = u + at ✓ ALLOW credit for higher level answers: Eg. three marks for answer in terms of $s = ut + ½at^2$ <u>Examiner's Comments</u> This was an intentionally challenging question where less than 10% did not score at all. Most of these wrote about g = 10 and the initial velocity was 0 and gained 1 mark. Very few successfully continued further.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 22 (m/s) award 2 marks** 10 = v (- 0) / 2.2 OR uses idea that stone gains 10m/s each second ✓ V = 22 (m/s) ✓	2 (AO 2 × 2.1)	ALLOW 21.56 or 21.58 or 21.6 (if g=9.8 or 9.81) ✓✓ <u>Examiner's Comments</u> Again this challenging calculation saw about $1/5^{th}$ gaining both marks with 22 (m/s). A few correctly used g = 9.8 or 9.81 and still scored full marks. Many used speed = distance ÷ time and did not score.
			Total	5	
19			D ✓	1 (AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
20			B ✓	1 (AO2.2)	Examiner's Comments Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below. Exemplar 1  11 A pump lifts 500 kg of water to a water tank at the top of a building. The water gains 240 000 J of gravitational potential energy. The gravitational field strength is 10 N/kg. Use the equation: Potential energy = Mass × Height × Gravitational field strength Calculate the height of the water tank. 240000 / 500×10 A 4.8 m B 48 m C 240 m D 480 m Your answer b [1]
			Total	1	
21			B ✓	1 (AO1.2)	Examiner's Comments Higher ability candidates were able to correctly apply their knowledge of refraction through a prism (option B). Most lower ability candidates chose one of the distractors and were unable to explain why violet light is refracted more than red light.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
22		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO1.2)	ALLOW equation in any form
			11 x 11 x 23 or 11^2 x 23 or 121 x 23 ✓	(AO2.1)	
			= 2783 ✓	(AO2.1)	
			Conversion to kW = 2.8 ✓	(AO2.1)	ALLOW ECF candidates answer to 3rd marking point converted to kW Examiner's Comments This question required candidates to recall the equation: *power = current² x resistance* before converting their answers into kW. Out of the candidates who gained credit, most were credited with all four marks. A few candidates were only credited with one mark for converting the power output in W into kW. A significant number of candidates used an incorrect equation for power, most commonly using *current* rather than *current²* AfL When a physics question requires candidates to apply their mathematical skills they should always write down how they are answering the question. Using brief notes is and writing down intermediate calculations helps the examiner to see what the candidate is doing. A single finger error will result in many candidates receiving no credit because they only write down their final answer. Marks may be available for each stage of the process, using the correct equation, rearranging the equation, substituting in correct values. Choosing to access

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Question			Answer/Indicative content	Marks	Guidance
					these compensatory marks by showing workings is good examination technique.
		ii	Wind speed varies / AW ✓	1 (AO2.1)	**ALLOW** it depends on the strength of the wind / how windy it is / AW **IGNORE** there might not be any wind / wind changes direction / AW
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO2.1)	**ALLOW** (it) may not generate enough power / energy / AW Examiner's Comments Most candidates gained full credit for Q16(d)(ii) and (d)(iii). Those who did not gain credit often provided non-specific generalised reasons about the weather or the wind turbine 'breaking'.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
23		i	(Wave speed =) frequency x wavelength ✓	2 (AO1.1)	ALLOW correct symbol equation eg (v =) f × λ ALLOW equation in any form ALLOW any frequency and corresponding wavelength from the table substituted into this equation IGNORE units for this marking point only
			$30 \times 10^9 \times 0.01$ or $30 \times 10^9 \times 1 \times 10^{-2}$ ✓	(AO3.2b)	ALLOW 30 000 000 000 × 0.01 or 30 000 000 000 × 1 × 10^{-2} ALLOW reverse arguments using speed and wavelength or speed and frequency Examiner's Comments This question assessed AO1 and AO3 and required candidates to recall and use the equation: *wave speed = frequency x wavelength* as well as convert 30 GHz into Hertz and 1 cm into metres. Most candidates struggled with the meaning of the prefixes and converting the units. Because many of these candidates did not write down the equation or their workings they could not be credited for any of the compensatory marks available in the mark scheme. A number of candidates used data from the table for radio or infra-red waves. Although they could not gain full marks they were credited with 1 mark for correct use of the equation.

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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 (nm) award 3 marks	3	
			(Wavelength =) velocity ÷ frequency ✓	(AO1.2)	ALLOW (λ =) v ÷ f IGNORE v = f × λ and f = v / λ or words ALLOW 3×10^8 divided by any frequency from the table
			$\frac{3 \times 10^8}{3000 \times 10^{12}}$ or 1×10^{-7} ✓	(AO2.1)	IGNORE units for this marking point only
			= 100 (nm) ✓	(AO2.1)	Examiner's Comments This question required candidates to convert the prefix Tera into a power of ten, recall and rearrange the equation: *wave speed = frequency x wavelength* to calculate the wavelength of ultra-violet, and then convert their answer into nanometres. Only the higher ability candidates gained full credit. The majority of candidates did not score any marks. Those candidates, who did gain credit, were credited with a one mark for correctly rearranged equation or for the correct application of the equation (i.e. 3×10^8 divided by any frequency from the table). OCR support Candidates would benefit from greater familiarity with the standard metric prefixes (WS1.4d). The Mathematical Skills Handbook provides additional support on the use of prefixes and powers of ten for orders of magnitude: http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	5	

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Question			Answer/Indicative content	Marks	Guidance
24	a		E ✓ FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.6 (s) award 2 marks 5 ÷ 8 ✓ = 0.6 (s) ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 0.625 or 0.63 (s) <u>Examiner's Comments</u> Most candidates were able to identify that driver E had the quickest reaction time. Only the higher ability candidates were then able to correctly calculate the reaction time. Calculations were sometimes shown and a common error made by candidates when calculating the reaction time was to use (*thinking distance + braking distance) ÷ speed*.
	b	i	AWARD ALL CANDIDATES 2 MARKS	2 (AO1 × 2.1) (AO1 × 1.2)	<u>Examiner's Comments</u> We have adjusted the mark scheme to allow for a typo within this question.
		ii	KE transferred to thermal energy / heat in brakes / surroundings / AW ✓✓ OR (KE of car) is reduced / transferred ✓ Brakes gain / absorb thermal energy / heat ✓	2 (AO1.1) (AO1.2)	ALLOW surroundings gain thermal energy / heat dissipated to surroundings IGNORE just brakes get hot <u>Examiner's Comments</u> The majority of candidates knew that the kinetic energy store would decrease or be transferred and so were credited with one mark. Fewer candidates gained the second mark as although they referred to heat or thermal energy they did not specify that the energy was transferred to the brakes or surroundings (i.e. into a thermal energy store).
		iii	AWARD ALL CANDIDATES 3 MARKS	3 (AO2 × 2.1) (AO1.2)	
			Total	10	

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Question			Answer/Indicative content	Marks	Guidance
25			D ✓	1 (AO 2.1)	Examiner's Comments Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	1	
26			C ✓	1 (AO 2.2)	Examiner's Comments Candidates were required to carry out a simple substitution into a given equation were generally answered well. The most common error was not squaring the speed and choosing distractor B.
			Total	1	

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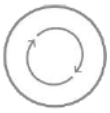
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Question			Answer/Indicative content	Marks	Guidance
27		i	3.5 (cm) ✓	1 (AO 1.1)	ALLOW 3.4 to 3.6 Examiner's Comments One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response was 9 cm.
		ii	2.4 (cm) ✓	1 (AO 1.1)	Examiner's Comments Many candidates read the vertical axis incorrectly and gave values that were around 2.4 cm but not that specific value (for example 2.5 cm).  Misconception A common incorrect answer was 4.8 cm, where candidates confused the peak to peak value with amplitude. Other candidates confused amplitude with the wavelength.

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Question			Answer/Indicative content	Marks	Guidance
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.5 (m/s) award 2 marks 2 × 25 OR 2 × 0.25✓ 0.5 (m/s) ✓	2 (AO 2 x 2.1)	ALLOW 50 <u>Examiner's Comments</u> Most candidates were credited with one mark for multiplying 2 by 25 to give an answer of 50. Fewer candidates appreciated that this was 50 cm/s while the unit on the answer line was m/s.  AfL Encourage candidates to check the unit used on the answer line. This additional information can help them to understand the question and the equations they should use.
			Total	4	

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Question			Answer/Indicative content	Marks	Guidance
28	a	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.

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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.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 89 (%) award 3 marks	3	
			48 000 ÷ 54 000 (× 100) ✓	(AO 2.1)	
			= 88.88888….etc ✓	(AO 2.1)	
			= 89(%) (2 sig figs) ✓	(AO 1.2)	ALLOW two marks for 0.89 or 88(%) ALLOW one mark for 0.88 Examiner's Comments Two thirds of candidates were credited with some marks for this question. Candidates needed to use the equation provided and give their final answer as a percentage. Many candidates did not show any working so could only be credited with any marks if their final answer was correctly given as a percentage. There was a compensatory mark for showing 48000 divided by 54000 in a candidate's workings which almost every candidate could have accessed. OCR support The answer to two significant figures is 89%. Many candidates gave their final answer to two significant figures as 0.8/ 80% or 0.9/90% or 0.88 /88%. .The Mathematical Skills Handbook provides support on the use of significant figures and other required mathematical skills. http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
29			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.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
30	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (m/s) award 2 marks Rearrange formula - 4 × 3 ✓ 12 (m/s) ✓	2 (AO 2.1) (AO 2.1)	<u>Examiner's Comments</u> Higher ability candidates wrote out in a recognisable form that *change in velocity = acceleration × time = 3 × 4 = 12 (m/s)*. A common misconception was to divide the acceleration by time taken (i.e. 3 × 4 = 0.75). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.
	b		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 <u>Examiner's Comments</u> 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	5	

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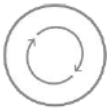
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Question			Answer/Indicative content	Marks	Guidance
31		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO 1.2)	ALLOW equation in any form
			11 × 11 × 23 or 112 × 23 or 121 × 23 ✓	(AO 2.1)	
			= 2783 ✓	(AO 2.1)	
			Conversion to kW = 2.8 (kW) ✓	(AO 2.1)	ALLOW ecf candidates answer to 3rd marking point converted to kW Examiner's Comments Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11 × 23 or 23 ÷ 11, rather than 112 × 23 = 2.78kW. .
		ii	Wind speed varies / AW ✓	1 (AO 2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW Examiner's Comments Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

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Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	
32			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	

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Question			Answer/Indicative content	Marks	Guidance
33			D ✓	1 (AO2.1)	Examiner's Comments Most candidates correctly substituted the numbers into the given equation.
			Total	1	
34			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	
35			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	
36			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	

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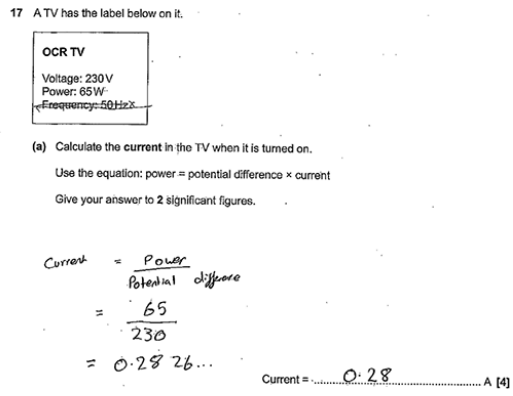
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Question			Answer/Indicative content	Marks	Guidance
37			A ✓	1 (AO2.1)	Examiner's Comments This was well answered by higher ability candidates. Often the half or the change of unit (cm to m) was missing. Higher ability candidates wrote the equation from the data sheet, then substituted the numbers into the equation and then carried out the calculation.
			Total	1	

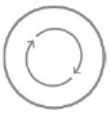
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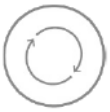
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Question			Answer/Indicative content	Marks	Guidance
38	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓ I = 65 ÷ 230 ✓ I = 0.2826086 ✓ I = 0.28 (A) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE If answer not to 2 sig figs max 3 marks ALLOW one mark for any calculated answer to 2sf <u>Examiner's Comments</u> Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.2826 before rounding the answer as 0.28 (two significant figures). A number of candidates wrote their answer exactly from the calculator as 0.28 which was not acceptable for two significant figures. Exemplar 1  17 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the **current** in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to **2** significant figures. Current = Power / Potential difference = 65 / 230 = 0.28 26... Current = 0.28 A [4] This candidate has clearly rearranged the equation and then substituted the correct numbers from the data box. It is then clear that the candidate has then calculated the correct answer before rounding it correctly to two significant figures.

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Question			Answer/Indicative content	Marks	Guidance
					The candidate has perhaps helpfully crossed out the frequency as this is not needed for this part. Candidates need to be careful about crossing out quantities as the crossed out quantities might be needed in later parts. Underlining the quantities needed is probably a better method.  AfL For calculations, candidates should show their working. The following steps are useful: 1 Recall equation or select the appropriate equation from the data sheet (if not given in the question) 2 rearrange equation, if necessary 3 substitute the numbers into the equation 4 calculate the answer 5 consider significant figures or decimal places.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	ALLOW ECF from (a) E = Q x V or I x t x V E = 0.28 ×1800 × 230 ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) E = 116000 (J) ✓ <u>Examiner's Comments</u> Candidates did not always know which equation to use. Many recalled correctly the equation relating energy, power and

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Question			Answer/Indicative content	Marks	Guidance
					time but did not always remember that the energy needed to be measured in seconds. Higher ability candidates clearly showed their working including the conversion of 30 minutes to 1800 seconds. Some candidates recalled that E = Q × V and Q = I × t or E = I × t × V and used the answer from 17(a). This was correct physics and thus gained full credit.  AfL When carrying out calculations, candidates should consider units. Normally time is measured in second. Candidates should be aware of exceptions to the normal units, e.g. when energy transferred is measured in kW h, then the power is measured in kilowatt, kW and time in hour h. Similarly, if a speed is measured in measured in km / h, then the distance should be measured in kilometre, km and the time in hour, h.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
39	a	i	LED / cells connected the wrong way around OR ✓ Voltmeter is across the battery/cells OR voltmeter should be across the LED ✓	2 (AO2x3 .2a)	ALLOW diode IGNORE voltmeter in wrong place Examiner's Comments The majority of the candidates gained at least one mark. Vague answers such as "voltmeter is in the wrong place" did not gain credit. Higher ability candidates stated for one of the errors that the LED (or cells) were connected the wrong way around or the LED (or cells) needed to be reversed. For the other error, it was expected that the candidates would indicate that the voltmeter was not measuring the potential difference across just the LED, but across the battery. Candidates gained a mark for this error by suggesting connecting the voltmeter across the LED. Incorrect answers given by many candidates included the ammeter being in the wrong place or the variable resistor being in the wrong place. Often candidates incorrectly suggested that the order of the components mattered.
		ii	Any one from: Control/change/alter the current (in the circuit) ✓ Control/change/alter the potential difference/voltage (across the LED) ✓	1 (AO1.2)	DO NOT ALLOW to vary the resistan Examiner's Comments A large number of candidates answered this question by stating that the component was a variable resistor or to vary the resistance of the circuit. Few candidates answered the question in term of the purpose of the variable resistor was to vary the potential difference across the LED or vary the current through the LED (by varying the resistance in the circuit).

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Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 100 (Ω) award 3 marks** Resistance = potential difference ÷ current / R = V ÷ I ✓ R = 3.0 ÷ 0.03 ✓ R = 100 (Ω) ✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner's Comments</u> The majority of the candidates were able to rearrange the given equation and substitute into the rearranged equation the correct values to give an answer of 100 Ω. A very small minority of candidates used 0.3 A rather than 0.03 A. Candidates often underline the quantities in the question, which was good practice.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 4.5 (C) award 4 marks** Charge flow = current × time / Q = I × t ✓ t = 2.5 minutes = 150 seconds ✓ Q = 0.03 x 150 ✓ Q = 4.5 (C) ✓	4 (AO1.2) (AO1.2) (AO2.1) (AO2.1)	**ALLOW** 3 marks for an answer of 0.075 (C) (time not converted to seconds) ✓✓✓ <u>Examiner's Comments</u> In this question, higher ability candidates who did not obtain the correct answer, but showed their working, could still gain marks from their working. In this case, the equation for charge flow needed to be recalled and the time of 2.5 minutes needs to be changed to 150 seconds, before the answer could be calculated.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 13.5 (J) award 2 marks** E = 4.5 x 3.0 ✓ E = 13.5 (J) ✓	2 (AO2.1) (AO2.1)	**ECF** from **(ii)** **ALLOW** 14(J) <u>Examiner's Comments</u> Most candidates were able to multiply their answer to (ii) by 3.0 to gain the correct answer.
			Total	**12**	

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Question			Answer/Indicative content	Marks	Guidance
40			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed explanation about how a transformer works. **AND** A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Simple explanation of how a transformer works. **AND** A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. **OR** Detailed explanation about how a transformer works. **AND** A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Simple explanation of how a transformer works. **OR** A quantitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. **OR**	6 (AO1.1x3) (AO3.1ax2) (AO3.2ax1)	**AO1.1 Demonstrates knowledge and understanding of scientific ideas to give an explanation of how a transformer works** For example: • Alternating current / ac / voltage / potential difference • (induces) (alternating) pd / current in secondary • Linking different numbers of coils to changing potential differences (or currents) • More secondary coils = bigger output potential difference • Alternating current in primary coil induces alternating magnetic field in the iron core • Alternating magnetic field in the iron core induces alternating potential difference in the secondary coil • An alternating current flows if the output is connected to a circuit • Ratio of potential differences depends on ratio of coils • Step up transformers increase potential difference and have more secondary coils ORA **AO3.1a Analyse information and ideas to interpret – quantitative** • Correct equation selected from data sheet • Data from table processed • For A and C expect secondary pd of 24 V • For B and D expect secondary pd of 6 V **AO3.1a Analyse information and ideas to interpret - qualitative** For example: • Double the number of secondary coils (compared to primary) and the output potential difference is doubled (compared to input) • Halve the number of secondary coils (compared to primary) and the output potential difference is halved

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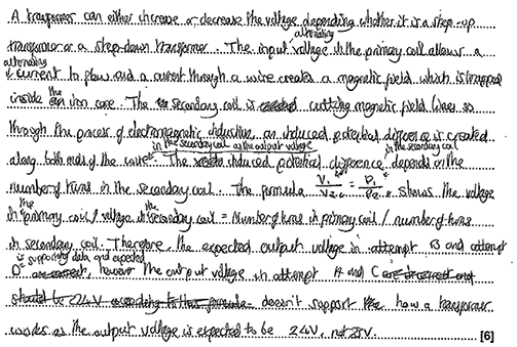
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Question	Answer/Indicative content	Marks	Guidance
	A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* 0 marks *No response or no response worthy of credit.*		(compared to input) • In transformer A the number of coils increases by 100% and the voltage increases by almost 100%/AW • In transformer B the number of coils decreases by 50% and the voltage decreases by 50%/AW • In transformer C the number of coils increases by 100% and the voltage increases by almost 100%/AW • In transformer D the number of coils decreases by 50% and the voltage decreases by 50%/AW AO3.2a Analyses information and ideas to make judgements • Data supports the expected output voltages • Energy losses in A and C • B and D are efficient ALLOW voltage for potential difference and vice versa Examiner's Comments This question gave candidates the opportunity to apply their knowledge and understanding of the operational of a transformer and to demonstrate that they are able to use the equation linking number of turns and potential difference given on the data sheet. The question is open ended so that candidates have the opportunity of demonstrating their knowledge as well as having the opportunity to structure their answers logically. The question required candidates to explain the operation of the transformer. Most candidates were able to select an appropriate equation from the data sheet and discuss the meaning of step-up and step-down transformers in terms of the turns ration and the p.d. ratio. Few candidates mentioned that transformers worked on a.c. or clearly

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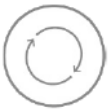
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Question	Answer/Indicative content	Marks	Guidance
			explained the alternating magnetic field in the iron core of the transformer inducing an alternating p.d. across the secondary coil. For the highest marks, it was expected that clear calculations for each of the four transformers would be shown with a comment as to whether they supported the theoretical predictions. Many candidates did not show any working. There was also the opportunity to discuss energy losses in transformers particularly about transformer A and transformer C. Exemplar 4  A transformer can either increase or decrease the voltage depending whether it's a step-up transformer or a step-down transformer. The input voltage in the primary coil allows a alternating current to flow and a current through a wire creates a magnetic field which is stronger inside the iron core. The secondary coil is cutting magnetic field lines so through the process of electromagnetic induction, an induced potential difference is created in the secondary coil as the output voltage along both ends of the wire. The size of induced potential difference depends on the number of turns in the secondary coil. The formula $\frac{V_s}{V_p} = \frac{n_s}{n_p}$ shows the voltage in the primary coil / voltage in the secondary coil = number of turns in primary coil / number of turns in secondary coil. Therefore, the expected output voltage in attempt 1 and attempt 2 are correct, however the output voltage in attempt 3 and 4 are incorrect and supporting data as expected should be 24V according to the formula. doesn't support the how a transformer works as the output voltage is expected to be 24V, not 2V. [6] This candidate has written a plan of how they intend to answer the question. The initial part of the plan explains how the transformer works. The candidate includes the alternating current, the alternating magnetic field in the iron core and the alternating p.d. induced across the secondary coil. The candidate then discusses step-up and step-down transformers. Before using the data, an equation is given with each of the symbols defined. Working is then shown for the four transformers with a reason why the step-up transformers do not agree with the predicted data. This candidate's response demonstrates a detailed explanation of how the transformer works and there is a quantitative line between the coils and potential difference

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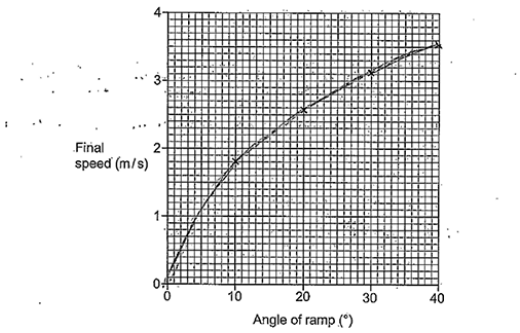
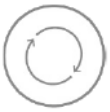
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Question			Answer/Indicative content	Marks	Guidance
					ratios in relation to the expected output voltages. This is a Level 3 response. The response has a well-developed line of reasoning which is clear and logically structured and the information is relevant so this candidate is given six marks.  AfL Candidates should practice explaining physics concepts.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
41	a	i	Both points correctly plotted ✓ Smooth curve correctly drawn ✓	2 (AO1.2)	**ALLOW** within ½ small square for plotting **DO NOT ALLOW** straight lines between data points **IGNORE** any line drawn for <10° <u>Examiner's Comments</u> Candidates needed to plot the last two data points before drawing the best fit line. Many candidates incorrectly drew a straight line through plots that appeared to lie on a curved trend. Other candidates did not draw smooth curves, or had many lines. **Exemplar 5**  This candidate has clearly indicated the correct positions of the two missing plots using two small crosses. The smooth line was not considered good enough in that there appeared to be more than one line in several places. This candidate has correctly assumed that the graph starts from the origin.  **AfL** Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. It may help candidates to draw smooth curves by rotating the paper so that the

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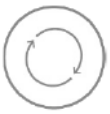
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Question			Answer/Indicative content	Marks	Guidance
					curve can be drawn naturally with the arc of the candidates' arm. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.

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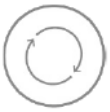
Question			Answer/Indicative content	Marks	Guidance
		ii	Increase in angle of ramp increases speed (at bottom ramp) ORA✓ Increase is not linear/doubling angle does not double final speed / AW ✓ Reference to quantitative data for two calculations, for example, increase from 10˚ to 20˚ the speed increases by 0.76 whilst 20˚ to 30˚ the speed increases by 0.54 ✓	3 (AO3.1a) (AO3.1a) (AO3.1b)	IGNORE correlation ALLOW Not directly proportional / Not constant increase **NOTE comparison of two increases required** **NOTE** Speed increase from 0˚ to 10˚ is 1.81 and speed increase from 30˚ to 40˚ is 0.40 Examiner's Comments Most candidates correctly stated that the as the angle of the ramp increased the speed increased. It was essential that candidates included a comparison between the angle of the ramp and the speed. The next two marks were more challenging and required candidates to state that the angle of the ramp and the speed were not directly proportional or linear since there was not a constant increase in speed for the same increase in angle. Candidates were expected to demonstrate this by carrying out two calculations using data from the table or graph.  AfL Understand how to test from a graph whether two quantities are directly proportional. 1 Take the quantity on the x-axis and double it and read off the y-axis values and see whether they double as well 2 See whether there is a straight line through the origin.

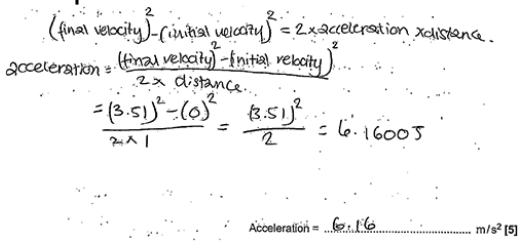
Question			Answer/Indicative content	Marks	Guidance
		iii	(Increase in angle) increases potential energy of the trolley/more work is done raising trolley to that point on the ramp ✓ This **increases** the / **more** kinetic energy at the bottom of the ramp ✓	2 (AO1.1 x2)	**ALLOW more** PE is transferred to KE Examiner's Comments Most candidates found this question challenging to gain two marks due to some vague answers relating to the transfer energy from the PE store to the KE store without specifically referring to the greater energy in the PE store being transferred so that there more energy in the KE store.
		iv	Attempt 1 at 30˚ (is only recorded to 1 decimal place)/ 3.1 ✓ Student should record data to a consistent number of decimal places or 2 dp / the reading should by recorded as 3.10 / AW ✓	2 (AO3.3a) (AO3.3b)	**ALLOW** only recorded to 2 significant figures **ALLOW** should be recorded to 3 significant figures **NOT** same accuracy Examiner's Comments Many candidates correctly identified that the first attempt (3.1) at an angle of 30° was only recorded to one decimal place. Most candidates then suggested that that the raw data should have been recorded to the same number of decimal places and the reading should have been recorded as 3.10. Some candidates referred to significant figures, which was allowed this year. Candidates need to understand that raw data should be recorded to the same number of decimal places while calculated data is recorded to a number of significant figures which is dependent on the number of significant figures in the raw data.

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Question			Answer/Indicative content	Marks	Guidance
		v	**Any two from:** Reproducible means that the results can be reproduced by someone else ✓ Only one student has collected this data ✓ The experiment is repeatable (as the repeated readings are close together) ✓	2 (AO2.2 x2)	**NOT** experiment can be repeated Examiner's Comments Most candidates discussed apparatus details such as not indicating what sort of surface was used, etc. Few candidates realised that reproducible results would need to be reproduced by someone else. A few candidates did state that the experiment is repeatable since the repeated reading are close to each other.  AfL Understand the terms used in the language of measurement. See the Glossary of terms on the OCR website at: https://www.ocr.org.uk/Images/467774-glossary-of-terms.doc
	b	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 6.16 (m/s^2) award 5 marks** $v^2 - u^2 = 2as$ (no mark – on formula sheet) u = 0 ✓ a = $v^2 \div 2s$ ✓ a = $3.51^2 \div (2x1.0)$ ✓ a = 6.16005 (m/s^2) ✓ a = 6.16 (m/s^2) (2 decimal places) ✓	5 (AO2.1) (AO1.2) (AO2.1) (AO2.1) (AO1.2)	NOTE must be rearranged **ALLOW** Any number which rounds to 6.16 **ALLOW** one mark for any calculated answer to 2dp Examiner's Comments About half the candidates gained full marks for this question. It was expected that candidates would

Question			Answer/Indicative content	Marks	Guidance
					select an appropriate equation from the data sheet, rearrange the equation and substitute in the numbers from the question before calculating the answer. It was expected that the initial speed of zero would be shown in any calculation. Many candidates who did not gain full marks attempted to gain the answer by using the definition of acceleration and the equation linking average speed with distance and time without realising the importance of the word “average”. Candidates using this method often arrived with an incorrect answer of 12.32 m / s^2. **Exemplar 6**  This candidate has correctly selected the equation from data sheet. The candidate has then rearranged the equation before substituting in the values form the question. Helpfully the candidate has indicated that the initial velocity was zero. The candidate then correctly calculates the answer as 6.16005 before correctly rounding the answer to two decimal places.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 9 (J) award 3 marks** kinetic energy (J) = 0.5 x mass (kg) x (speed (m/s))^2 / KE = ½ mv^2 / KE = 0.5mv^2 ✓ KE = 0.5 x 2.0 x 3.0^2 ✓ KE = 9 (J) ✓	3 (AO1.2) (AO2.1) (AO2.1)	<u>Examiner’s Comments</u> Candidates who were able to recall the equation for kinetic energy scored well on this question. Candidates should be encouraged to show their working.
			Total	**19**	

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Question			Answer/Indicative content	Marks	Guidance
42	a		Pressure is inversely proportional to volume OR ρV = constant for a particular gas OR for any of the gases calculation of p x V ✓	3 (AO3.2b)	
			For gas B: 10 x 0.4 = 4 and for gas C: 20 x 0.2 =4 OR Pressure of C is double the pressure of B and volume of C is half the volume of B ✓	(AO3.1a)	**NOTE** could be written next to table Examiner's Comments
			B and C ✓	(AO3.2b)	This question required candidates to use the data in the table which was generally well answered by all candidates. Higher ability candidates clearly stated that pressure is inversely proportional to volume and then went on to state that pressure × volume = constant. Most candidates then calculated for each gas pressure × volume before stating that B and C were the same. A few candidates demonstrated that doubling the pressure halved the volume and gained full credit with the appropriate conclusion.
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5500 (Pa) award 3 marks pressure due to a column of liquid (Pa) = height of column (m) x density of liquid (kg/m3) x g (N/kg) / P = hρg (no mark – on formula sheet)	3	**ALLOW** three marks for 5390 Pa if g=9.8 N/kg or 5395.5 Pa if g=9.81 N/kg is used
			g = 10 (N/kg) ✓	(AO1.1)	**ALLOW** 9.8(1) N/kg
			P = 0.5 x 1100 x 10 ✓	(AO2.1)	Examiner's Comments
			P = 5500 (Pa) ✓	(AO2.1)	Most of the candidates correctly selected an equation from the data sheet and used an appropriate value for *g*. Candidates who did not gain credit for this question, tended to just multiply 0.5 by 1100. By understanding that the unit of pressure is Pa or N / m^2, candidates should be able to reason that m × kg / m^3 is not valid.

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Question			Answer/Indicative content	Marks	Guidance
			Total	6	
43			C ✓	1 (AO2.1)	
			Total	1	
44			B ✓	1 (AO1.2)	Examiner's Comments This involves two different unit conversions, km to m and h to s. Many successful candidates used the space to set out step-by-step intermediate calculations..
			Total	1	
45			B ✓	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
46	a		FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 200 Ω award 4 marks** Unit conversion 20(mA) = 0.02(A)/20x10^{-3} (A) ✓	4 (AO1.2)	If final unit is kΩ or V/mA, this unit conversion is not needed so mp1 is subsumed into mp2
			R = 4.0 ÷ 0.02 ✓	(AO2.1)	**ECF** incorrect or absent conversion of mA to A e.g. a bald answer of 0.2 gains mp2 & mp3 unless the unit is kΩ or V/mA, when all 4 marks are awarded.
			R = 200 ✓	(AO2.1)	
			Ω ✓	(AO1.2)	Mark unit independently **ALLOW** ohm(s) or V/A or V/mA if consistent with working <u>Examiner's Comments</u> In this question the unit mark was free-standing and so any valid unit combination was allowed. Both 0.20 kΩ and 0.2 mA/V are examples of responses which gained 4/4. Because of the application of error-carried-forward, candidates losing the first mark by not converting mA to A did not lose subsequent marks, so for example 0.2 Ω with suitable workings could gain three of the four marks.

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Question			Answer/Indicative content	Marks	Guidance
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 75 (C) award 3 marks Charge flow = current × time / $Q = It$ ✓ Q = 2.5 x 30 ✓ Q = 75 (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	Mp1 can be assumed if correct substitution follows No **ECF** from incorrect equation <u>Examiner's Comments</u> Although the concept of electrical charge is difficult for many GCSE candidates, and they were required to recall the equation the majority of candidates were credited with full marks here.
			Total	7	
47			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 400 (Pa) award 2 marks P = 2 ÷ 0.005 ✓ P = 400 (Pa) ✓	2 (AO2.1) (AO2.1)	<u>Examiner's Comments</u> Relatively few candidates had problems with dividing by 0.005.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
48	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.

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Question			Answer/Indicative content	Marks	Guidance
	b	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4166.7 (W) award 4 marks	4	
			$P = E \div t$ / 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	

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Question			Answer/Indicative content	Marks	Guidance
49			EITHER $v^2 - u^2 = 2as$ (no mark – on formula sheet) $u = 0$ ✓ $a = v^2 \div 2s$ ✓ $a = 2^2 \div (2 \times 2.0)$ ✓ $a = 1.0/1$ (m/s^2) ✓ OR mean v = ½ (0 + 2 m/s) = 1 m/s ✓ $t = s$/mean v = 2 m / 1 m/s = 2 s ✓ $a = \Delta v/t$ ✓ = (2 m/s - 0)/2 s = 1 (m/s^2) ✓	4 (AO2.1) (AO2.1) (AO2.1) (AO2.1)	If no working shown and answer = 1 (m/s^2), award all 4 marks. If wrong physics used, then award marks as appropriate for either approach. <u>Examiner's Comments</u> There were different possible approaches to the calculation: use of $v^2 = u^2 + 2as$ or finding the mean speed and hence t and using a = (v-u)/t. Both were seen. Many candidates just randomly multiplied or divided the numbers given, and two of these operations gave a response of 1 m/s^2. Where candidates used incorrect physics in their response (e.g. acceleration = speed/distance = 2/2 = 1) then they only gained marks for those parts of their workings that were appropriate. For fairness candidates who only wrote '1' on the answer line with no workings shown were given the benefit of the doubt and awarded all 4 marks.
			Total	4	

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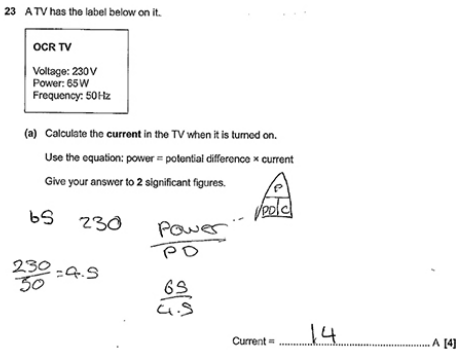
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Question			Answer/Indicative content	Marks	Guidance
50	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks	4	
			Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓	(A1.2)	
			I = 65 ÷ 230 ✓	(A2.1)	
			I = 0.2826086 ✓	(A2.1)	NOTE If answer not to 2 sig figs max 3 marks
			I = 0.28 (A) ✓	(A1.2)	ALLOW one mark for any calculated answer to 2sf Examiner's Comments In their response to this question candidates earned a marks for the correct rearrangement of the given equation, a mark for substitution of the appropriate values, a mark for evaluation, and a mark for expressing the evaluated result to 2 significant figures. Error-carried-forward applied here, as shown in Exemplar 9. The first mark was earned by the power/p.d. quotient; it would have been cleared if they had included a subject to make it into a clear equation). There was no obvious logic to their other workings, but the final expression written is 65/4.5 = 14.4444 which (expressed to 2 s.f.) is 14, so earned second mark was given. Examiners are expected to mark positively and although the candidate has not set their workings out sensibly the examiner has assumed 65/4.5 and 14 to be the candidate's final decision.

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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 9  23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the **current** in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to **2** significant figures. 65 230 Power / PD 230/50 = 4.9 65/4.9 Current = 14 A [4]
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	4 (A1.2) (A1.2) (A2.1) (A2.1)	ALLOW ECF from (a) E = Q x V or I x t x V E = 0.28 x 1800 x 230 ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) E = 116000 (J) ✓ <u>Examiner's Comments</u> This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
51			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 8 (m/s) award 4 marks u = 0 or $v^2 = (u^2 +) 2as$ ✓ $v^2 = 2 \times 10 \times 3.2$ or $v = \sqrt{(2 \times 10 \times 3.2)}$ ✓ $v^2 = 64$ ✓ v = 8 (m/s) ✓ OR alternative method: $mgh = ½ mv^2$ ✓ $(70 x) 10 \times 3.2 = ½ (x 70) \times v^2$ ✓ $64 = v^2$ ✓ v = 8 (m/s) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO2.1)	$v^2 - u^2 = 2as$ does not score a mark
			Total	4	
52			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.9 (A) award 2 marks (Rearrangement: $I_p =) I_s \times V_s / V_p$ ✓ OR $(I_p =) 12 \times 9.0 / 120$ ✓ $(I_p =)$ 0.9 (A) ✓	2 (AO1.2) (AO2.1)	
			Total	2	

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