OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

WS1.1 DEVELOPMENT OF SCIENTIFIC THINKING

SCORE	PERCENTAGE
/226	%

STEMUP

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Question			Answer/Indicative content	Marks	Guidance
1		i	**any one from** so to confirm the experiment is • repeatable / reproducible (1) so other scientists can • (idea of) peer review (1) • check the method (1) • check for mistakes (1) • confirm / re-test / verify / prove / validate results (1) • inform other scientists / people (1) • further-development / research (1) • use the data (1)	1	**Allow** 'check it' (1)
		ii	**any one from** scientists have not been able to repeat the claim (1) (seems to) contradict the laws of physics / AW (1) no model that shows that cold fusion is possible (1)	1	**allow** fusion requires high temperatures / high energy (1) **Eg.** it does not produce more energy than amount of energy used (1) **ignore** merely 'no proof' / 'no evidence' / false or fake results
			Total	**2**	
2			**D ✓**	1 (AO2.2)	
			Total	**1**	
3			**C ✓**	1 (AO2.2)	
			Total	**1**	
4			**D ✓**	1 (AO2.1)	<u>Examiner's Comments</u> About two-thirds of the candidates got this question correct: the commonest wrong answer here was A, presumably looking at the symmetry in the bottom part of the diagram.
			Total	**1**	

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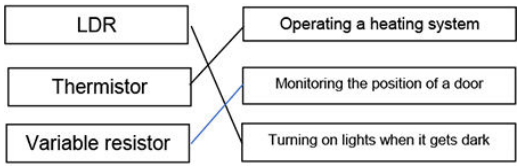
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Question			Answer/Indicative content	Marks	Guidance
5			B ✓	1 (AO2.2)	
			Total	1	
6			C ✓	1 (AO2.1)	
			Total	1	
7			D ✓	1 (AO1.2)	
			Total	1	
8			B ✓	1 (AO1.2)	
			Total	1	
9			C ✓	1 (AO2.1)	
			Total	1	
10			B ✓	1 (AO1.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
11	a	i	TV ✓	1 (AO3.2b)	<u>Examiner's Comments</u> Most candidates multiplied the relevant variables (power and time used) in the data table, and used the units Wh or kWh. This was a good approach for questions of this type.
		ii	Light bulb ✓	1 (AO3.2b)	<u>Examiner's Comments</u> Here the appliance with the lowest power rating (light bulb) was the right answer **Misconception** The most common misconception was just to compare the power ratings of the appliances and chose the toaster as the answer. Doing some quick calculations of work done and jotting vales next to the table helps answering these types of question. If the power and time for the TV and light bulb had been slightly different it would have given a different answer.
	b			2 (AO 2 × 2.1)	1 mark for each correct link <u>Examiner's Comments</u> Most candidates were credited full marks on this question. Virtually no candidates got one mark, perhaps because this required two components to be used for the same purpose. It was encouraging to see how candidates across the ability range were aware of the use of specific electrical components around their homes.

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Question			Answer/Indicative content	Marks	Guidance
	c		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	8	

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Question			Answer/Indicative content	Marks	Guidance
12		i	**Any two from:** The old model has no protons / ORA ✓ The old model has no neutrons / ORA ✓ There is no nucleus in the old model / ORA ✓ The electrons are in fixed positions in the old model / ORA ✓ The positive particles are in a nucleus in the current model ✓ The negative particles/electrons are outside / surround the nucleus in the current model ✓	2 (AO2 × 1.1)	<u>Examiner's Comments</u> **Misconception** It is important to be clear which model/view point/thing the candidate is writing about in these type of question. Candidates will not be credited when they expect the examiner to interpret what their answer implies. It is better to state clearly "the old model." rather than "one of the models …" A number of candidates read the first statement about the old atomic model as implying that atoms had a positive charge. Several candidates did not achieve both marks because they were not clear about which model they were talking about.
		ii	**Any two from:** new evidence ✓ more experiments completed ✓ previous model couldn't explain new observations ✓	2 (AO2 × 1.1)	**ALLOW** mention of Rutherford, Geiger/Marsden <u>Examiner's Comments</u> Most candidates recognised the role of Rutherford/Geiger/Marsden which was expected. Several candidates mentioned Niels Bohr and/or John Dalton, which was unexpected in this context.
			Total	**4**	

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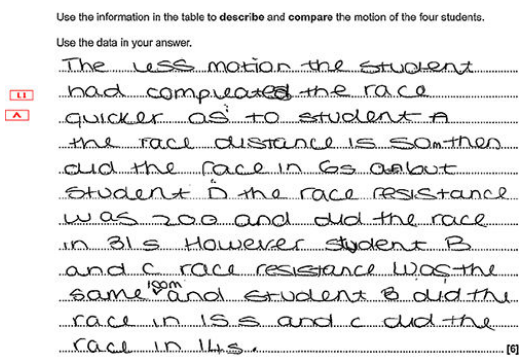
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Question			Answer/Indicative content	Marks	Guidance
13			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed description and comparison of the motion of 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

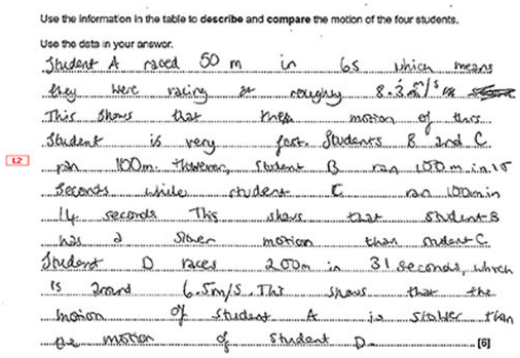
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Question	Answer/Indicative content	Marks	Guidance
			the table). The most able candidates discussed the effect of running a longer race on the mean speed of the runner (see Exemplar 7 below). Less able candidates compared the times of each runner but 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 8.5 however student B and C race resistance was the same 100m and student B did the race in 15.5 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.

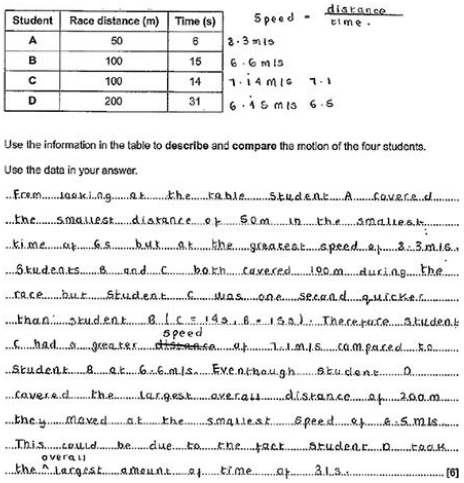
Use the data in your answer.

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

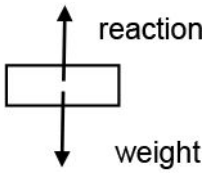
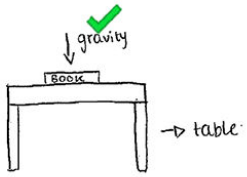
A Level 3 candidate response. They first calculated the speed of each student and then annotated the data table. This allowed them to be more focused and precise in their response. They have offered some explanation of the relative motions of the students. This answer is logical and all the content is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

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	

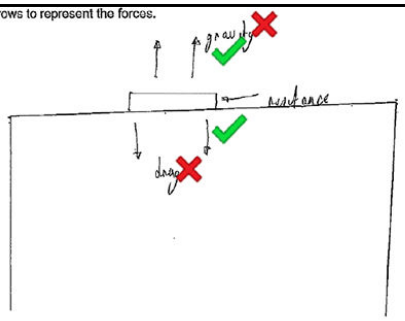
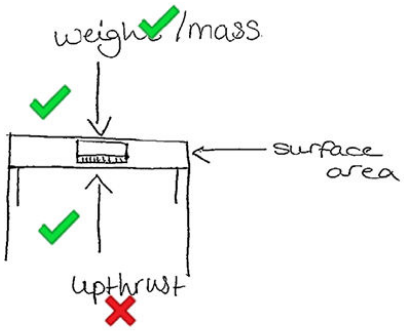
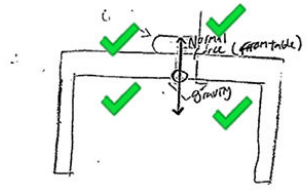
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Question			Answer/Indicative content	Marks	Guidance
14	a		Two arrows drawn of equal length ✓ One up and one down ✓ The downwards arrow labelled weight/gravity ✓ The upwards arrow labelled contact/reaction force ✓	4 (AO4 × 2.1)	e.g.  Examiner's Comments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

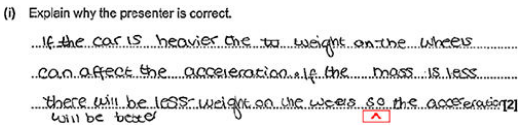
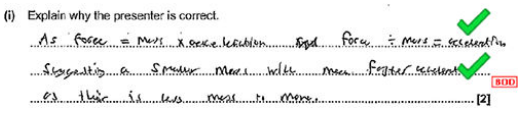
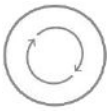
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Question			Answer/Indicative content	Marks	Guidance
					Use arrows to represent the forces.  [4] Exemplar 10  [4] Exemplar 11  [4]
	b	i	*F = ma* / force equals mass times acceleration ✓ so reducing mass means the same engine force will cause greater acceleration ✓	2 (AO1.2) (AO2.2)	Must start with Newton II NOT less force for same acceleration <u>Examiner's Comments</u> Few candidates identified that this question was about the implications of the equation F = ma. Candidates did not recognise that the force would be the same for both the heaver and the lighter model of car. Most candidates discussed the effects of friction

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Question	Answer/Indicative content	Marks	Guidance
			on the car. For the order of magnitude for changes in mass between different models of a car frictional forces would have no measurable effect on acceleration. Exemplar 12  (i) Explain why the presenter is correct. If the car is heavier the to weight on the wheels can affect the acceleration. If the mass is less there will be less weight on the wheels so the acceleration will be beter [2] This answer only considers the marginal changes in friction caused by a very small increase in the contact area of the tyres but ignores the more significant effect that the same force applied to a smaller mass will have on acceleration. Exemplar 13  (i) Explain why the presenter is correct. As force = mass x acceleration and force ÷ mass = acceleration Therefore a greater mass will require greater acceleration as this is less work to move [2] This candidate's answer shows very clearly why using a more mathematical approach in physics saves time and increases understanding. They have identified the appropriate equation (F=ma), changed the subject to acceleration and then drawn the correct conclusion. Using this approach their answer was shorter, clearer and more relevant than exemplar 12.  **AfL** As a starter exercise show students the question and ask them to select the equation that will answer the question. Helping students to be more comfortable using equations will help them overcome their reluctance to answer physics questions using maths.

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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 (m/s^2) award 3 marks change in speed = 25–5 = 20 (m/s) ✓ acceleration = 20 ÷ 4 (m/s^2) ✓ = 5 (m/s^2) ✓	3 (AO2.1) (AO2.1) (AO2.1)	e.c.f. incorrect change in speed if subtraction attempted <u>Examiner's Comments</u> This calculation was well done with most candidates being credited with all three marks.
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
15		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.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
16		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)	<u>Examiner's Comments</u> 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 <u>Examiner's Comments</u> 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
17		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 × A* to calculate the pressure as 1 Pa.
		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	4	
18			always points to North / South ✓✓ OR Points to (magnetic) North / South ✓ line up with the magnetic field lines of the Earth ✓ OR Compass needle shows (an angle of) dip ✓ Dip (angle) changes (from equator) ✓	2 (AO2 ×1.1)	ALLOW Points North/South wherever you are ✓✓ Examiner's Comments This was a challenging question for candidates. This question asks about a quite separate behaviour of a magnetic compass in the Earth's magnetic field. Wherever you might happen to be on the surface of the Earth a magnetic (dipping) compass will always point north (or south). There were very few candidates who referred to the angle of dip in the direction of the north (or south) magnetic pole. Or that at the magnetic poles a dipping compass dips vertically downward towards the core of the Earth.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
19			C ✓	1 (AO1.1)	Examiner's Comments The great majority of candidates gave the correct answer C.
			Total	1	
20			A ✓	1 (AO2.1)	Examiner's Comments About 80% of candidates gave the correct answer A. Common incorrect answers were randomly selected form the other distractors.
			Total	1	
21			D ✓	1 (AO1.2)	Examiner's Comments About two thirds of candidates gave the correct answer D. A common incorrect response was 'C'.
			Total	1	
22			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	
23			D ✓	1 (AO1.1)	Examiner's Comments This was well known by nearly all candidates who gave D as their answer.
			Total	1	
24			A ✓	1 (AO2.1)	Examiner's Comments About 40% of the candidature gave the right answer A. The common incorrect response was usually 'D'.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
25			D ✓	1 (AO2.2)	Examiner's Comments This calculation was answered successfully by about three quarters of the candidates stating D.
			Total	1	
26			C ✓	1 (AO2.2)	Examiner's Comments About half of the candidates could correctly calculate the distance travelled from the graph (by area or calculation) and gave C as the answer. Working out was often seen on this question and answer D was a frequently chosen distractor (velocity × time, 8 × 5 = 40m).
			Total	1	
27			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	
28			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
29		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	
30			always points to North / South ✓✓ OR Points to (magnetic) North / South ✓ line up with the magnetic field lines of the Earth ✓ OR Compass needle shows (an angle of) dip ✓ Dip (angle) changes (from equator) ✓	2 (AO2 ×1.1)	ALLOW Points North / South wherever you are ✓✓ Examiner's Comments Most candidates gained 1 mark for the idea of pointing north. Better answers (about a third) stated that the compass always pointed north and gained both marks. There were very few answers referring to the angle of dip.
			Total	2	

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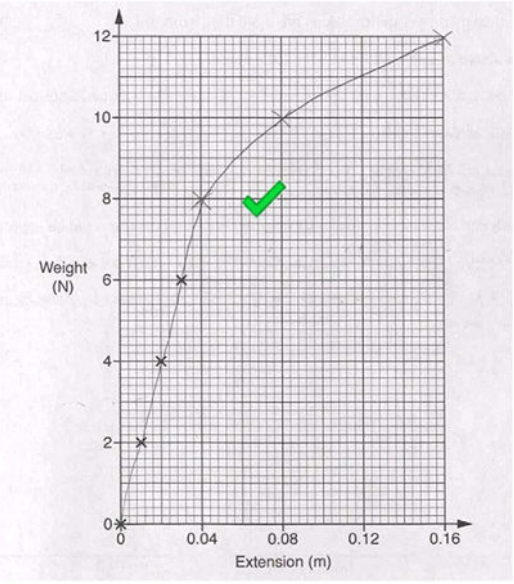
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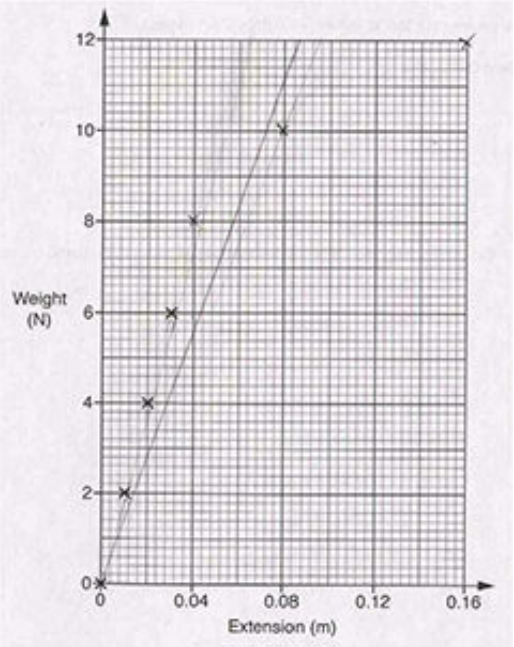
Question			Answer/Indicative content	Marks	Guidance
31		i	potential difference ✓ closed or complete circuit ✓	2 (AO2 × 1.1)	IGNORE ions / charge ALLOW voltage ALLOW higher level answers eg. must have delocalised electrons / electrons that are free to move Examiner's Comments Only about 10% here gained 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	

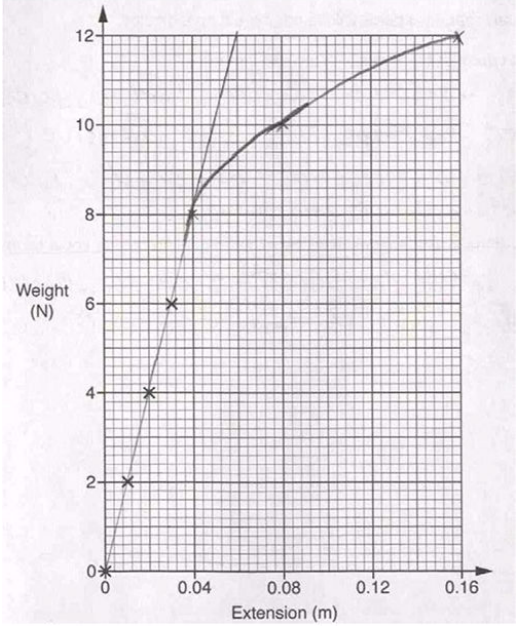
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Question			Answer/Indicative content	Marks	Guidance
32	a	i	All three points correctly plotted ✓✓ **OR** two points correctly plotted ✓	2 (AO 2 × 2.2)	Points should be + / – ½ square or less (by eye) **Examiner's Comments** All the points were usually 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

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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Question			Answer/Indicative content	Marks	Guidance
33			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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Question			Answer/Indicative content	Marks	Guidance
34	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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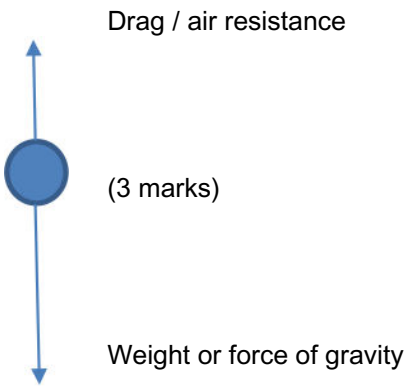
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Question			Answer/Indicative content	Marks	Guidance
35	a	i	initial speed is zero **and** • either acceleration due to gravity = 10 • or g = 10 ✓ use a = (v-u) ÷ t to find the final speed / v ✓ use $v^2 - u^2 = 2as$ to find s ✓	3 (AO 3 × 1.1)	IGNORE 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.

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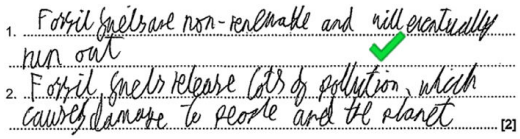
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Question			Answer/Indicative content	Marks	Guidance
	b		**only** 2 arrows drawn or directions of the two forces described – one upwards and one downwards ✓ Correctly names weight **and** air resistance / drag ✓ downward arrow longer than upward arrow / forces are unbalanced / resultant / net / overall force downwards ✓ so object accelerates / gets faster / increases velocity or speed ✓	4 (AO 2.1) (AO 1.1) (AO 2.1) (AO 1.1)	Award marks for answer points given in diagrams or prose. **ALLOW** force of gravity or mg or gravitational pull for weight **BUT DO NOT ALLOW** merely 'gravity' **IGNORE** upthrust for this marking point only  Examiner's Comments There were some good answers here. A common error was to state 'gravity' rather than weight or force of gravity. The relative sizes of the arrows were often correct. Upthrust was often unsuccessfully substituted for air resistance. The question discriminated well with about a third gaining full marks.
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
36	a	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO3.1b) (AO3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO2 / carbon emissions IGNORE just pollution or bad for the environment / more CFCs <u>Examiner's Comments</u> This question assessed AO3 and the majority of candidates gained at least 1 mark, usually for the idea that fossil fuels are not renewable. A significant number of candidates did not gain the second mark as their responses included statements about pollution that were too vague e.g. 'harmful emissions' or 'bad for the environment'. Exemplar 2  1. Fossil fuels are non-renewable and will eventually run out 2. Fossil fuels release lots of pollution, which causes damage to people and the planet [2] This response was credited with 1 mark for stating that fossil fuels are renewable. The second mark was not achieved as the candidate's statement that 'fossil fuels release lots of pollution' is not specific enough. To gain the second mark, the candidate should have referred to an appropriate scientific reason, for example more CO2 or more greenhouse gases.

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Question			Answer/Indicative content	Marks	Guidance
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less **named** damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	**2** (AO1.2) (AO1.2)	**ALLOW** will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) **ALLOW** less polluting gases / carbon emissions / ice caps melting / droughts and storms **IGNORE** just less pollution or just better for the environment / less CFCs <u>Examiner's Comments</u> Although many candidates achieved 1 or 2 marks, a significant proportion did not gain any credit. Some candidates had the misconception that nuclear power is renewable. Others gave vague suggestions about 'damage to the environment'. Only the highest ability candidates usually gained full credit. **AfL** Candidates should be aware that in a Physics exam what they write will be assessed as a specific scientific response. Where candidates use unnamed, vague statements about 'pollution' or 'damage to the environment' these are unlikely to gain credit. For example graffiti, fly tipping and loud music are examples of pollution that are unlikely to be caused a power station.
	b	i	Step-up transformer ✓	**1** (AO1.1)	<u>Examiner's Comments</u> The majority of candidates correctly identified a step-up transformer. However, many lower ability candidates had less secure knowledge and suggested an inappropriate electrical device such as a voltmeter.

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Reduce** energy wastage / loss ✓	1 (AO1.1)	**ALLOW** less heat loss / reduce current / reduce power loss / more useful power out / more efficient / less heating of wires **DO NOT ALLOW** no energy losses / prevent energy loss / AW Examiner's Comments This question is a direct assessment of on specification knowledge (P8.2d and P8.2e) that is in both separate Physics and Combined Science. However candidates across the ability range found it challenging and a minority of candidates correctly answered this lower demand question. **Misconception** Candidates have many misconceptions about transformers and why the voltage needs be increased. They referred to many incorrect ideas such as to make the energy move faster / further, to transfer enough power to homes and to reduce the resistance. Some candidates suggested that high voltages are used in the National Grid as this reduces energy losses during transmission to zero. **OCR support** There is a KS3–KS4 Transition Guide (J249) and a KS4–KS5 Transition Guide (H557) that offer support on teaching about generation of and distribution of the domestic electrical supply: http://www.ocr.org.uk/Images/324646-electricity-ks3-ks4-transition-guide.pdf http://www.ocr.org.uk/Images/309732-generating-electricity-transition-guide.pdf

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Question			Answer/Indicative content	Marks	Guidance
		iii	d.c – (current / voltage / charge flow / it) has one direction or polarity ✓ a.c.- (current / voltage / charge flow / it) (continually) changes direction or polarity ✓	2 (AO1.1) (AO1.1)	ALLOW dc only positive / only negative IGNORE electricity ALLOW current / voltage alternates OR positive and negative Examiner's Comments Most candidates gained at least 1 mark, usually for identifying a.c. as alternating current. Common misconceptions for d.c. included 'd.c. is constant' or 'd.c. goes straight to the device'.
	c	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks (P =) $I^2 \times R$ ✓ 11 x 11 x 23 or 11^2 x 23 or 121 x 23 ✓ = 2783 ✓ Conversion to kW = 2.8 ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO2.1)	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓ ALLOW equation in any form ALLOW ECF candidates answer to 3rd marking point converted to kW Examiner's Comments This question required candidates to recall the equation: *power = current^2 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 *current^2* 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

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Question			Answer/Indicative content	Marks	Guidance
					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 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	14	

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Question			Answer/Indicative content	Marks	Guidance
37		i	2 ½ or 2.5 ✓	1 (AO1.2)	Examiner's Comments Most candidates were able to calculate the number of waves produced. The most common error made was to divide the time by the frequency instead of multiplying the time by the frequency.
		ii	**Speed** is unchanged / stays the same ✓ **Wavelength** reduces ✓	2 (AO2.1) (AO2.1)	Answer **must** indicate idea of speed Answer **must** indicate idea of wavelength **IGNORE** answers that merely state 'no change and reduces' Examiner's Comments Most candidates correctly stated that the wavelength would decrease. The majority of candidates stating that wave speed would also increase while only the highest ability candidates knew that that wave speed would be unchanged.
		iii	Any two from: Water / particles move up and down / oscillate vertically ✓ Water / particles move at 90° / perpendicular to the direction of wave (travel) / AW ✓ Energy moves in direction of the wave (travel) / AW ✓	2 (AO2 × 2.1)	**IGNORE** any statements that are just repeated from the question. **IGNORE** water waves move up and down **ALLOW** energy moves at 90° to wave vibrations / movement ✓✓ Examiner's Comments Candidates found this question very challenging and many misinterpreted what they were being asked to do. Most candidates did not identify that the second and third statements about water wave were incorrect and many merely rewrote the student's original statement. The most common mark gained was for the idea of the water moving perpendicular to the direction of the wave motion. Only the highest ability candidates gained full credit.

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Question			Answer/Indicative content	Marks	Guidance
			Total	5	

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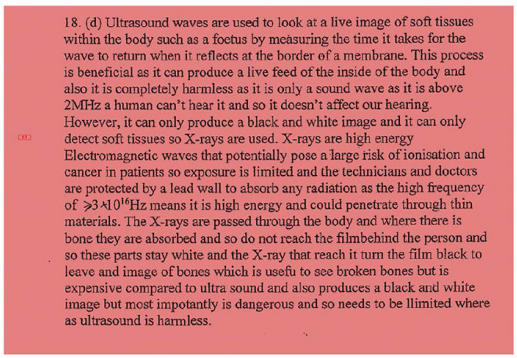
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Question			Answer/Indicative content	Marks	Guidance
38			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) A detailed explanation of how ultrasound and X-rays are used. AND A detailed evaluation of the risks / benefits of using the two different waves to scan patients in hospital, which may include use of information from the table. *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) An explanation of how ultrasound and X-rays are used. AND An evaluation of the risks / benefits of using the two different waves to scan patients in hospital. *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) EITHER An explanation of how ultrasound and X-rays are used. OR An evaluation of the risks / benefits of using the two different waves to scan patients in hospital. OR An explanation of ultrasound or X-rays AND an evaluation of the risks / benefits of ultrasound or X-rays. *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 worthy of credit.*	6 (AO2 × 1.2) (AO1 × 2.2) (AO1 × 3.1b) (AO2 × 3.2a)	AO1.2 Demonstrate knowledge and understanding of X-rays and ultrasound • X-rays show bone • Ultrasound shows eg soft tissue / kidneys/ blood flow / prenatal scan AO2.2 Applies knowledge and understanding of X-rays and ultrasounds • X-rays damage / ionise living cells / causes cancer / damage foetus • Ultrasound is harmless AO3.1b Analyses information to evaluate the differences in X-rays and ultrasound • X-rays are absorbed by bone but do not show up soft tissues • Ultrasound is (partially) reflected for soft tissues only AO3.2a Analyses information to make judgements about the risks and benefits: • Ultrasound always safe **and** useful for soft tissue scanning • X-rays can cause cancer **but** save lives with identifying bone problems • X-rays have a frequency greater than 3 × 10^{16} Hz / (very small) wavelengths less than 10 nm to penetrate the body <u>Examiner's Comments</u> This Level of Response question assessed all three Assessment Objectives and provided an opportunity for candidates to demonstrate Grade 9 performance. Most candidates gained some credit for their written responses. The majority demonstrated a good knowledge of X-rays in particular and two thirds of the candidates demonstrated Level 2 or Level 3 performance. Many excellent responses at Level 3 included detailed explanations of absorption of X-rays by bones, reflection of ultrasound for soft tissues, and a detailed

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Question			Answer/Indicative content	Marks	Guidance
					evaluation of the risks and benefits of the two different waves. Most responses successfully identified the risks / benefits of X-rays but a common misconception was that ultrasound could also cause cell mutations or harm (to the baby). **Misconception** Most candidates successfully identified the risks and benefits of X-rays but a significant number of candidates mistakenly believed that ultrasound could also cause cell mutations or harm to the baby. **Exemplar 4**  18. (d) Ultrasound waves are used to look at a live image of soft tissues within the body such as a foetus by measuring the time it takes for the wave to return when it reflects at the border of a membrane. This process is beneficial as it can produce a live feed of the inside of the body and also it is completely harmless as it is only a sound wave as it is above 2MHz a human can't hear it and so it doesn't affect our hearing. However, it can only produce a black and white image and it can only detect soft tissues so X-rays are used. X-rays are high energy Electromagnetic waves that potentially pose a large risk of ionisation and cancer in patients so exposure is limited and the technicians and doctors are protected by a lead wall to absorb any radiation as the high frequency of $\geqslant 3\times10^{16}$Hz means it is high energy and could penetrate through thin materials. The X-rays are passed through the body and where there is bone they are absorbed and so do not reach the filmbehind the person and so these parts stay white and the X-ray that reach it turn the film black to leave and image of bones which is usefu to see broken bones but is expensive compared to ultra sound and also produces a black and white image but most impotantly is dangerous and so needs to be llimited where as ultrasound is harmless. This is a six mark, Level 3 answer. The candidate included a detailed explanation of how both X-rays and ultrasound are used to scan patients. There is also a detailed evaluation of risks / benefits of both waves, which includes the use of some data from the table.
			Total	6	

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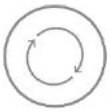
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Question			Answer/Indicative content	Marks	Guidance
39	a	i	(Radioactive nuclei) are unstable ✓	1 (AO1.1)	ALLOW (nuclei have) too many neutrons Examiner's Comments Just over half of the candidates correctly explained that some isotopes are radioactive because the nuclei are unstable or have too many neutrons. Common incorrect responses referred to 'more neutrons' or ideas about numbers of electrons or protons.
		ii	Different numbers of neutrons ✓	1 (AO1.1)	Examiner's Comments The majority of candidates successfully stated that there are a different number of neutrons in carbon-12 and carbon-14.
	b	i	226 ✓ Th 90 ✓	2 (AO2.2) (AO2.2)	
		ii	0 ✓ β –1 ✓	2 (AO2.2) (AO2.2)	
		iii	$^{235}_{92}U \rightarrow \gamma = {}^{U}$ ✓	2 (AO2.2) (AO2.2)	Examiner's Comments Almost all candidates were able to complete all three decay equations. Of the small number who could not complete the equation the most common error was stating the atomic number of beta as +1 rather than -1.
			Total	8	
40			D ✓	1 (AO 1.1)	Examiner's Comments This question was generally answered well. The common incorrect answer was B, where candidates thought that ultrasound was an electromagnetic wave.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
41			B ✓	1 (AO 1.1)	Examiner's Comments This question was generally answered well. Some candidate incorrectly selected either A the normal or C.  AfL With ray diagrams, candidates should always identify the normal, before working out further positions of the rays.
			Total	1	
42			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	

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Question			Answer/Indicative content	Marks	Guidance
43		i	(Particles move) up and down / oscillate/vibrate vertically/at right angles to the direction of the wave ✓	1 (AO 1.1)	
		ii	(Particles move) forwards and backwards / oscillate/vibrate parallel to the direction of the wave / AW ✓	1 (AO 1.1)	Examiner's Comments Very few candidates were able to express a clear understanding of the motion of particles caused by the progress of a transverse water wave, or a longitudinal sound wave. A number of candidates stated used ambiguous descriptions such as 'the particles would move side to side', which could apply to both transverse and longitudinal waves. OCR support The Waves in Matter transition guide (from KS3 to KS4) provides guidance on the teaching about waves. http://www.ocr.org.uk/Images/318139-waves-in-matter-transition-guide.pdf
			Total	2	
44			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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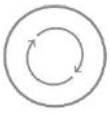
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Question			Answer/Indicative content	Marks	Guidance
45	a	i	3.5 (cm) ✓	1 (AO 1.1)	ALLOW 3.4 to 3.6 Examiner's Comments One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response 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.
	b	i	Radio / infra-red / microwave ✓	1 (AO 1.1)	
		ii	Ultra-violet / X-rays / gamma-rays ✓	1 (AO 1.1)	

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Question			Answer/Indicative content	Marks	Guidance
		iii	Any two from: Radiotherapy / killing cancer cells ✓ Irradiating food / sterilisation of instruments✓ Tracer / medical imaging✓ Scanning metals / non-destructive testing (NDT) ✓	4 (AO2.1)	 ALLOW tumours / treatment of cancer ALLOW killing bacteria / (harmful) microorganisms / sterilising food <u>Examiner's Comments</u> Candidates had a sounder understanding of the trend in frequency in the electromagnetic spectrum (part ii) than that for wavelength (part i). The most common misconception was by candidates who gave visible light as their response to both part i and part ii. Around half of the candidates knew that gamma-rays are used in the treatment of cancer but other uses, such as the irradiation of food or medical equipment, were known by far fewer. To gain credit, candidates need to ensure that their answers are specific. A number of candidates stated that gamma-rays were used in chemotherapy. Some candidates stated that gamma-rays were used in scans, often with an implication of unborn babies. It was hoped that candidates would understand the use of gamma radiation as a tracer and for sterilising instruments.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
46	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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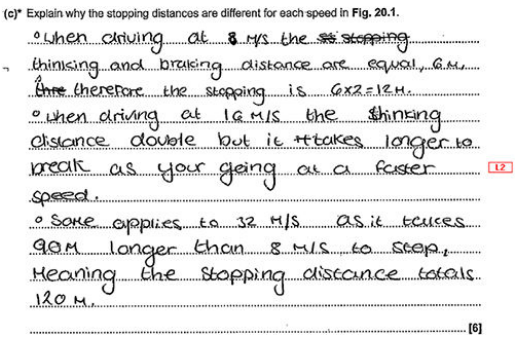
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Question			Answer/Indicative content	Marks	Guidance
47			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Explains quantitatively why the stopping distances are different for each speed in the table in terms of braking distance and thinking distance. *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) Explains qualitatively why the stopping distances are different for each speed in the table in terms of braking distance or thinking distance increasing with speed from the table *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) States basic ideas about thinking distance / braking distance / stopping distance OR identifies variation of thinking distance / braking distance / stopping distance with speed *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 (AO 2 x 1.1) (AO 2 x 2.1) (AO 2 x 3.2b)	AO1.1a Demonstrates knowledge and understanding of thinking, braking and stopping distance • Thinking distance is the distance the car travels while the driver reacts • Braking distance is the distance travelled while the brakes are applied • Stopping distance is thinking distance + braking distance AO2.1 Applies knowledge and understanding of thinking, braking and stopping distance in relation to the details in the table • Increasing the speed, increases the thinking distance • Increasing the speed, increases the braking distance • Increasing the speed, increases the stopping distance AO3.2b Analyses information to make judgements and draw detailed conclusions from table • Thinking distance is directly proportional to the speed • When speed doubles, thinking distance doubles • Braking distance is proportional to speed2 • When speed doubles, braking distance quadruples <u>Examiner's Comments</u> This question gave candidates the opportunity to apply their knowledge and understanding of stopping distances. The question is deliberately set to be open ended so that candidates had the opportunity of structuring their answers logically. Higher ability candidates explained that the stopping distance was equal to the sum of

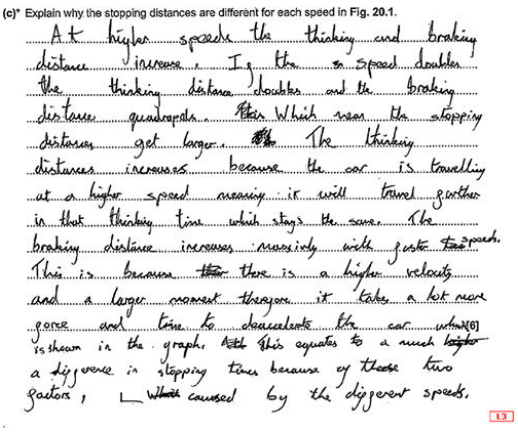
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Question	Answer/Indicative content	Marks	Guidance
			the thinking distance and braking distance before stating that the stopping distances increased with speed. Often candidates demonstrated the change in stopping distance using the data from the table. For the highest marks, candidates were expected to analyse the data quantitatively from the table. A few candidates used part (a) and stated that thinking distance doubled with speed and carried out a similar analysis for braking distance, stating that as speed doubled, braking distance quadrupled. Common misconceptions included thinking time increasing with speed, drivers being under greater pressure at high speed, braking forces increasing with speed. Other candidates discussed factors that affected thinking distance and braking distance rather than using the data in the table. **Exemplar 2**  (c)* Explain why the stopping distances are different for each speed in Fig. 20.1. • When driving at 8 m/s the ~~ss~~ stopping thinking and braking distance are equal, 6 m, ~~then~~ therefore the stopping is 6x2=12 m. • When driving at 16 m/s the thinking distance double but it takes longer to break as your going at a faster speed. • Some applies to 32 m/s as it takes 90 m longer than 8 m/s to stop, Meaning the stopping distance totals 120 m. [6] This is a four mark, Level 2 response. The candidate has calculated the stopping distance for each speed and provided a limited analysis. They have made good use of mathematical expressions to show that stopping distance is equal to the product of thinking and breaking distance. The information presented is relevant, however there are limited links made between the bullet points. To progress to a Level 3 response the candidate could have added a short introduction and a final bullet point linking the analysis at each speed together

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Question			Answer/Indicative content	Marks	Guidance
					in a summary sentence. Exemplar 3  (c)* Explain why the stopping distances are different for each speed in Fig. 20.1. At higher speeds the thinking and braking distance increase. I.e. the a speed doubles the thinking distance doubles and the breaking distance quadrupals. Which mean the stopping distances get larger. The thinking distances increases because the car is travelling at a higher speed meaning it will travel further in that thinking time which stays the same. The breaking distance increases massively with greater the speed. This is because there is a higher velocity and a larger moment therefore it takes a lot more force and time to decelerate the car which is shown in the graph. This equates to a much larger a difference in stopping times because of these two factors, which caused by the different speeds. [3] This is a six mark Level 3 response. This is very clear analysis of the data in the table that is linked together in a clear logical structured way. Although the candidate has not annotated their script (except in their response to (a) it is clear that they have processed the data in the table. They have described the complex mathematical relationships (for example 'if the speed doubles the thinking distance doubles and the breaking distance quadruples') although it would have been easier to present this conclusion numerically.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
48	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	
49	a		Distance (between source and observer) ✓ Time (for sound to travel between source and observer) ✓	2 (AO 2 x 1.1)	**Do not accept** distance / time the ball travels **Do not accept** metres / seconds Examiner's Comments Some candidates wrote a list of quantities that could be measured with no description: speed, distance, time, frequency and wavelength. These candidates could not be credited with any marks as they had not answered the question. Candidates were expected to describe how the distance that the sound would travel and the time for the sound to travel were needed to calculate the speed. Many candidates ignored the context for the question and referred to measuring the distance the ball travels.
	b		Speed = distance ÷ time ✓	1 (AO 1.1)	**ALLOW** distance ÷ time Examiner's Comments This question was answered well by candidates. Some candidates quoted the wave equation which was not appropriate to the experiment. A significant number of candidates incorrectly gave the correct equation as *speed = distance × time*..
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
50			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.75 (s) award 3 marks Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 or 12÷16 or 24÷32 ✓ = 0.75 (s) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE correct substitutions if NOT rearranged Examiner's Comments 10% of candidates recalled the speed equation and rearrange it as *reaction time = thinking distance ÷ speed*. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.
			Total	3	
51			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	

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Question			Answer/Indicative content	Marks	Guidance
52	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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Question			Answer/Indicative content	Marks	Guidance
53	a	i	Fossil fuel may run out / is non-renewable / be in short supply / become very costly ✓ Named damage to environment: Eg (increased) greenhouse gases / global warming / sea levels rise / carbon dioxide / climate change / acid rain ✓	2 (AO 3.1b) (AO 3.1b)	ALLOW being used faster than being produced / finite resource ALLOW ice caps melting / droughts and storms / more polluting gases / other named polluting gases e.g. SO_2 / carbon emissions IGNORE just pollution or bad for the environment / more CFCs Examiner's Comments Most candidates recognised that fossil fuels may run out or be in short supply or stating that they are non-renewable. However, fewer candidates went on to give specific scientific reasons for scientists concerns that were creditable. Most candidates gave generalised responses about fossil fuels damaging the environment or causing 'pollution'.
		ii	To meet demand for electricity / not enough energy from renewable resources ✓ Less named damage to environment: (decreased) greenhouse gases / global warming / sea levels may fall / carbon dioxide / climate change / acid rain / ORA for coal ✓	2 (AO 1.2) (AO 1.2)	ALLOW will not run out as fast (as coal) / to preserve fossil fuels / produces more energy (per kg than coal) ALLOW less polluting gases / carbon emissions / ice caps melting / droughts and storms IGNORE just less pollution or just better for the environment / less CFCs Examiner's Comments Higher ability candidates said that there were not enough renewable energy resources and nuclear power stations would assist in meeting the demand for electricity, or help in preserving fossil fuels. Answers which gave detail about less damage to the environment were also credited, although a number of candidates thought that nuclear power stations would not cause any potential damage to the environment.

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Question			Answer/Indicative content	Marks	Guidance
	b	i	Step-up transformer ✓	1 (AO 1.1)	Examiner's Comments One in six candidates did mention transformers. Step-up and step-down transformers are on specification knowledge (P8.2d) and candidates should know the difference that step-up transformers are used to increase the voltage distributed by power line.
		ii	**Reduce** energy wastage / loss ✓	1 (AO 1.1)	**ALLOW** less heat loss / reduce current / reduce power loss / more useful power out / more efficient / less heating of wires **DO NOT ALLOW** no energy losses / prevent energy loss / AW Examiner's Comments This question required candidates to apply their understanding of the National Grid from P8.2e. Only the most able candidates recalled that the higher voltage reduces energy losses but does not eliminate them. Some candidates stated that higher voltages allowed more power to be produced.
		iii	d.c – (current / voltage / charge flow / it) has one direction or polarity ✓ a.c.- (current / voltage / charge flow / it) (continually) changes direction or polarity ✓	2 (AO 1.1) (AO 1.1)	**ALLOW** dc only positive / only negative **IGNORE** electricity **ALLOW** current / voltage alternates OR positive and negative Examiner's Comments Only the most able candidates were able to answer this question explaining both the differences in the direction of the current flow and the polarity of the voltage. Misconception Most candidates' knowledge and understanding of a.c. and d.c. electrical supply is quite vague, and often only understood in terms of 'different directions' but not how this relates to the flow of current nor to the polarity of the voltage.

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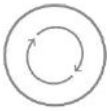
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Question			Answer/Indicative content	Marks	Guidance
	c	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO 1.2)	ALLOW equation in any form
			11 × 11 × 23 or 112 × 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	14	

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Question			Answer/Indicative content	Marks	Guidance
54	a		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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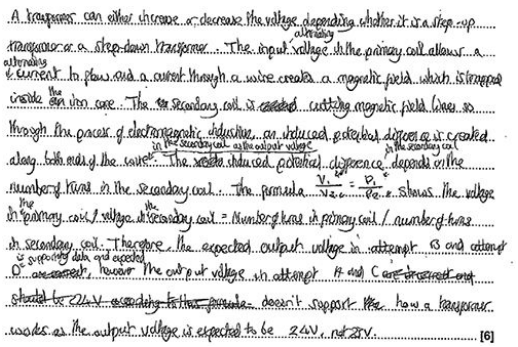
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Question			Answer/Indicative content	Marks	Guidance
			A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. *There is an attempt at a logical structure with a line 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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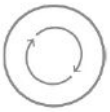
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Question	Answer/Indicative content	Marks	Guidance
			explained the alternating magnetic field in the iron core of the transformer inducing an alternating p.d. across the secondary coil. For the highest marks, it was expected that clear calculations 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 an iron core. The the secondary coil is cutted cutting magnetic field lines so through the power of electromagnetic induction, an induced potential difference is created along both ends of the wire. The voltage 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 primary coil / voltage in secondary coil = number of turns in primary coil / number of turns in secondary coil. Therefore, the expected output voltage in attempt 1 3 and attempt 2 are correct, however the output voltage in attempt 4 and 5 are incorrect and 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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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.

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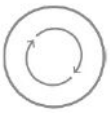
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Question			Answer/Indicative content	Marks	Guidance
	b	i	Incorrect word (A) **resistance** (is induced across the ends of the wire) ✓ Corrected sentence (A) potential difference/voltage (is induced across the ends of the wire) ✓ OR Incorrect word (A microphone is similar to a) **motor** ✓ Corrected sentence (A microphone is similar to a) generator ✓	2 (AO2.1 x2)	**ALLOW** current is induced **ALLOW** dynamo <u>Examiner's Comments</u> A large number of candidates correctly identified that "resistance" was incorrect. Many realised that a potential difference is induced across the ends of the wire. The Examiners on this occasion also allowed a current is induced across the end of the wire. Other candidates identified "motor" as incorrect and substituted "generator" in the sentence A significant number of candidates stated that pressure was incorrect and re-wrote the sentence with longitudinal. A few candidates replaced "similar" with "not similar" which did not gain credit.
		ii	Loudspeaker/speaker/headphones ✓	1 (AO1.1)	**IGNORE** phone <u>Examiner's Comments</u> Most candidates stated speaker(s). It is important that candidates stated a relevant device as opposed to an appliance such as a phone.
			Total	9	

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Question			Answer/Indicative content	Marks	Guidance
55			For an increase in temperature / heating of gas: gas particles / molecules / atoms have a higher (average) speed / more (kinetic) energy ORA✓ They collide more frequently / often with the walls (of container) / container AW✓ Bigger force (over same area) equals greater pressure ✓	3 (AO3 x1.1)	**Direction of temperature change must be clear** **ALLOW** move faster for higher (average) speed **ALLOW** linked to increase/decrease of KE if temperature change not explicit **ALLOW** bigger change in momentum Examiner's Comments There were a range of marks in this question. Candidates needed to be able to explain either how an increase in temperature affects the gas pressure or a decrease in temperature affects the gas pressure. The direction of the temperature change needed to be clear. Most candidates realised that an increase in temperature resulted in the gas molecules having more kinetic energy and thus a higher average speed. Candidates were then expected to state that the molecules collided more frequently with the walls of the container. Often, "frequently" was omitted from candidates' answers. The final mark was for stating that the more frequent collisions resulted in a large force over the same area which causes a greater pressure. Some candidates correctly explained the larger force in a greater rate of change of momentum.  **AfL** Candidates should be encouraged to practise explaining physics concepts in terms of the effect of increasing a quantity on another quantity.
			Total	3	

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Question			Answer/Indicative content	Marks	Guidance
56	a		(All galaxies) showed <u>red-shift</u> ✓ (Hubble measured the) wavelength/frequency of <u>light</u> (from the galaxy) ✓	2 (AO2 × 1.1)	**ALLOW** (all galaxies) showed <u>light</u> with a longer wavelength/lower frequency for 2 marks
	b	i	Readings of speed taken for two different values of distance ✓ Working to show that the factor increase in speed is the same as distance ✓	2 (AO2 × 3.1a)	**ALLOW** +/- ½ a small square **ALLOW** a statement for the second mark e.g. as the distance doubles so does the speed. <u>Example:</u> At 20 Mpc, speed = 1400 km/s At 40 Mpc, speed = 2800 km/s 40/20 = 2 = 2800/1400 **ALLOW** 1 mark maximum for it is a (straight) line of best fit through the origin (therefore it is proportional)
		ii	**Any one from:** The more distant galaxies are travelling faster ✓ The evidence suggests the universe is expanding ✓ The universe was smaller in the past ✓	1 (AO1.1)	**ALLOW** galaxies are moving away from each other
	c		To ensure results are reproducible / check the work is of high enough quality / claims are not false / for new theories to be accepted / to develop theories / AW ✓	1 (AO1.1)	**ALLOW** check validity / for mistakes/anomalies / AW **ALLOW** check that it's not biased / AW
	d	i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5 800 000 (m/s) award 2 marks** (Reads off speed from graph =) 5800 (km/s) ✓ Speed = 5800 × 1000 = 5 800 000 (m/s) ✓	2 (AO2.2) (AO1.2)	**ALLOW** 5.8×10^6 (m/s) **ALLOW** ecf for their speed from graph x 1000

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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 4.36×10^{17} (s) award 3 marks time = distance / speed ✓ (time =) 2.53×10^{24} / 5 800 000 ✓ (time =) 4.36×10^{17} (s) ✓	3 (AO1.2) (AO2.1) (AO2.1)	ALLOW ecf from (i) ALLOW 4.4×10^{17} (s) ALLOW equation in any form
			Total	11	

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