OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

M1 ARITHMETIC AND NUMERICAL COMPUTATION

SCORE	PERCENTAGE
/139	%

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Question			Answer/Indicative content	Marks	Guidance
1			C ✓	1 (AO2.2)	
			Total	**1**	
2			D ✓	1 (AO2.1)	Examiner's Comments 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**	
3			B ✓	1 (AO1.2)	
			Total	**1**	
4			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	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,

Question	Answer/Indicative content	Marks	Guidance
	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.*		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 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

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Question	Answer/Indicative content	Marks	Guidance

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 31s however student B and C race resistance was the same 100m and student B did the race in 15s and c did the race in 14s. [0]

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.

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 8.3m/s ~~m~~ This shows that their motion of their Student is very fast. Students B and C ran 100m. However, student B ran 100m in 15 seconds while student C ran 100m in 14 seconds This shows that student B was a slower motion than student C. Student D races 200m in 31 seconds, which is around 6.5m/s. This shows that the motion of student A is slower than the motion of student D. [0]

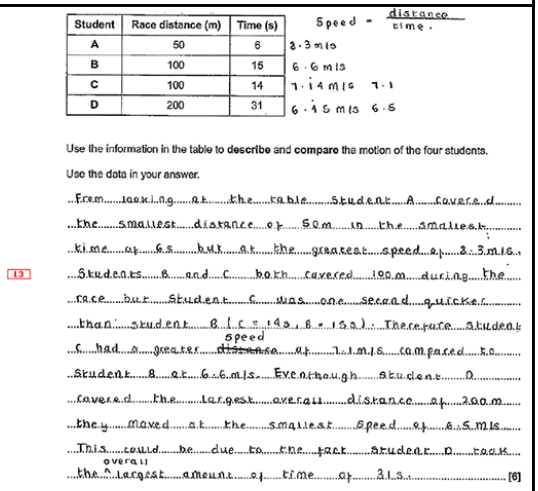
A Level 2 candidate response. They have calculated and compared the speeds of A and D, but only compared the relative motions of B and C. There is a structured line of reasoning and the reporting of data is linked by sentences that offer some interpretation of the facts.

Exemplar 7

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Question			Answer/Indicative content	Marks	Guidance
					 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 three exemplars are similar and demonstrating that a well thought out answer is better than a very long answer.
			Total	6	
5			C ✓	1 (AO1.2)	<u>Examiner's Comments</u> Nearly half of the candidates did get the right answer. However most of the other candidates appeared to have been just guessed which response was correct. **AfL** Standard form is tricky for Foundation Tier candidates. Try using low stakes pop quizzes and starter exercises to embed concepts of standard form and the metric prefixes. See also the Mathematical Skills Handbook <u>http://www.ocr.org.uk/Images/310651-mathematicalskills-handbook.pdf</u>

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Question			Answer/Indicative content	Marks	Guidance
			Total	1	

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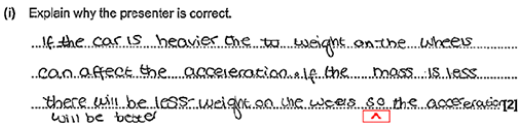
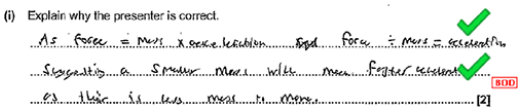
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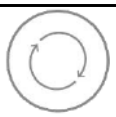
Question			Answer/Indicative content	Marks	Guidance
6		i	TV ✓	1 (AO3.2b)	Examiner's Comments Most candidates multiplied the relevant variables (power and time used) in the data table, and used the units Wh or kWh. This was a good approach for questions of this type.
		ii	Light bulb ✓	1 (AO3.2b)	Examiner's Comments 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.
			Total	2	
7			B ✓	1 (AO2.1)	Examiner's Comments This was the hardest multiple-choice question, with one in six candidates getting it right. Most candidates did not convert cm into m.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
8		i	*F = ma* / force equals mass times acceleration ✓ so reducing mass means the same engine force will cause greater acceleration ✓	2 (AO1.2) (AO2.2)	Must start with Newton II NOT less force for same acceleration <u>Examiner's Comments</u> Few candidates identified that this question was about the implications of the equation F = ma. Candidates did not recognise that the force would be the same for both the heaver and the lighter model of car. Most candidates discussed the effects of friction on the car. For the order of magnitude for changes in mass between different models of a car frictional forces would have no measurable effect on acceleration. Exemplar 12  (i) Explain why the presenter is correct. if the car is heavier the to weight on the wheels can affect the acceleration. if the mass is less there will be less weight on the wheels so the acceleration will be best [2] This answer only considers the marginal changes in friction caused by a very small increase in the contact area of the tyres but ignores the more significant effect that the same force applied to a smaller mass will have on acceleration. Exemplar 13  (i) Explain why the presenter is correct. As force = mass x acceleration and force ÷ mass = acceleration therefore a smaller mass with same force greater acceleration as this is less mass 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**

Question			Answer/Indicative content	Marks	Guidance
					 As a starter exercise show students the question and ask them to select the equation that will answer the question. Helping students to be more comfortable using equations will help them overcome their reluctance to answer physics questions using maths.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5 (m/s^2) award 3 marks change in speed = 25–5 = 20 (m/s) ✓ acceleration = 20 ÷ 4 (m/s^2) ✓ = 5 (m/s^2) ✓	3 (AO2.1) (AO2.1) (AO2.1)	e.c.f. incorrect change in speed if subtraction attempted <u>Examiner's Comments</u> This calculation was well done with most candidates being credited with all three marks.
			Total	5	

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

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Question			Answer/Indicative content	Marks	Guidance
		ii	at right angles/perpendicular/90° (to the plunger)	1 (AO1.1)	ALLOW to the left opposite to the force from the plunger Examiner's Comments Many answers here bore no relationship to the diagram: Any clear indication of direction including 'left' or 'at right angles' or 'perpendicular/90° to the plunger' were accepted. Ambiguous and inappropriate directions such as 'to the east' were not credited.
			Total	10	
10			D ✓	1 (AO2.2)	Examiner's Comments This calculation was answered successfully by about three quarters of the candidates stating D.
			Total	1	

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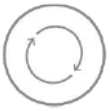
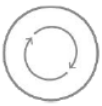
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Question			Answer/Indicative content	Marks	Guidance
11		i	potential difference ✓ closed or complete circuit ✓	2 (AO2 × 1.1)	IGNORE ions / charge ALLOW voltage ALLOW higher level answers eg. must have delocalised electrons / electrons that are free 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
12			C ✓	1 (AO2.2)	Examiner's Comments  Many candidates struggled to estimate the force of the brakes, often incorrectly choosing distractor B. Those candidates who correctly choose distractor C were often seen to write down their estimated values of the mass and acceleration.  AfL Candidates would benefit from being provided with opportunities to estimate, the speed, accelerations and forces involved for everyday road transport.
			Total	1	

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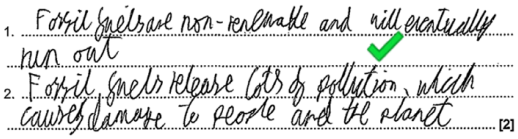
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Question			Answer/Indicative content	Marks	Guidance
13	a	i	5.2 (billion tonnes oil equivalent) ✓	1 (AO3.1a)	ALLOW answers between 5.0 and 5.5 IGNORE wrong units
		ii	Oil ✓	1 (AO3.1a)	Examiner's Comments Part (a)(i) and (ii) assessed AO3 and required candidates to use estimated values from the graph. The majority of candidates were able to do this successfully.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 78 (%) award 2 marks 8.3 / 10.6 (x 100) ✓ =78 (%) ✓	2 (AO 2 × 3.1a)	ALLOW answers that round between 77(%) and 80(%) ✓✓ ALLOW 8.2 / 10.6 (x 100) OR 8.4 / 10.6 (x 100) OR 8.5 / 10.6 (x 100) OR answers that round between 0.77 and 0.80 Examiner's Comments This question required candidates to use estimated values from the graph to work out the amount of energy use due to fossil fuels and then convert their answer into a percentage of the total energy use. The question discriminated well as the lower ability candidates struggled to identify the proportion due to fossil fuel use. Many did not take into account all three of the fossil fuels which resulted in percentages that were much smaller than the expected answer. The higher ability candidates, who did identify the amount of energy use due to fossil fuels, were able to calculate the percentage correctly.

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Question			Answer/Indicative content	Marks	Guidance
	b	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  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.
			Total	**8**	

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Question			Answer/Indicative content	Marks	Guidance
14		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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Question			Answer/Indicative content	Marks	Guidance
15	a		(The **thinking** distance will) **stay the same** (The **braking** distance will) **decrease** (The **stopping** distance will) **decrease** **All three** correct ✓✓ **Two** correct ✓	2 (AO3.2b) (AO3.2b)	<u>Examiner's Comments</u> Higher ability candidates generally were credited with full marks for this question. However a third of the candidates did not provide any creditable response. . **AfL** These 'thought experiment' type questions can be used as short starter activities to help students develop the habit of thinking about science. Candidates can also be encouraged to quickly sketch out the question. This can help candidates to visualise how the forces acting on the car have changed from moving along the flat road to moving uphill at a constant speed.
	b		Any two from: A, C or D ✓ Thinking distance / reaction time is proportional to speed / AW ✓	2 (AO3.2b) (AO3.2b)	**ALLOW** as speed doubles, thinking distance doubles / ratio of speed:distance or distance:speed is the same / both have reaction time of 0.75 (s) <u>Examiner's Comments</u> This question required candidates to identify two drivers from A, C and D and explain why their reaction times are the same. Over half of the candidates correctly identified two of the drivers. Most of these candidates proceeded to explain why, usually by calculating the reaction time of 0.75 s. A significant number of candidates did not gain any credit. A common error candidates made was to choose drivers A and E or B and D due to their braking distances being almost the same.

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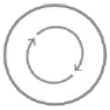
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Question			Answer/Indicative content	Marks	Guidance
			Total	4	
16			D ✓	1 (AO 2.1)	Examiner's Comments Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
17	a		Thinking distance doubles ✓	1 (AO1.1)	ALLOW higher level answer: thinking distance is (directly) proportional to speed Examiner's Comments Around half the candidates stated that thinking distance also doubled and used data from the table to demonstrate their answer. Many of the candidates who did not gain credit stated that the thinking distance increases but without using the information from the question of the speed doubling. Other candidates did not answer the question set but explained factors that could affect thinking distance. A few candidates referred to the 'thinking time' doubling.  AfL When investigating stopping distances, candidates should be encouraged to understand fully the terms thinking distance, braking distance, thinking time, braking time. Encourage candidates to underline the important parts of the question – in this case thinking distance (which was already emboldened) and speed doubles.

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Question			Answer/Indicative content	Marks	Guidance
	b		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	4	

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Question			Answer/Indicative content	Marks	Guidance
18	a	i	5.2 (billion tonnes oil equivalent) ✓	1 (AO 3.1a)	ALLOW answers between 5.0 and 5.5 IGNORE wrong units Examiner's Comments Many candidates found it difficult to interrogate the stacked line graph and many candidates stated the total energy use in 1971 rather than the increase from 1971 to 2003. As the vertical scale on the graph was only marked at 1 billion tonne increments candidates were allowed to give an answer between 5.0 and 5.5 billion tonnes (oil equivalent).
		ii	Oil ✓	1 (AO 3.1a)	Examiner's Comments Most candidates correctly identified oil as the greatest use. Other candidates suggested coal or renewables.
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 78 (%) award 2 marks 8.3 / 10.6 (× 100) ✓ =78 (%) ✓	2 (AO 2 x 3.1a)	ALLOW answers that round between 77(%) and 80(%) ✓✓ ALLOW 8.2 / 10.6 (× 100) OR 8.4 / 10.6 (× 100) OR 8.5 / 10.6 (× 100) OR answers that round between 0.77 and 0.80 Examiner's Comments Only around 10% of candidates were able to answer this question fully and most other candidates were not credited with any marks. Many candidates struggled to identify coal, oil and gas as fossil fuels. Those less able candidates that attempted to show their working were could be credited with a compensatory mark.

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Question			Answer/Indicative content	Marks	Guidance
	b	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.
			Total	8	

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Question			Answer/Indicative content	Marks	Guidance
19			A ✓	1 (AO1.1)	Examiner's Comments This question was generally answered well. For the cogs shown since the reverse must also be true, response A was straightforward. Candidates who did not gain this mark often chose response B.
			Total	**1**	
20			**B ✓**	1 (AO1.1)	
			Total	**1**	
21			**C ✓**	1 (AO1.2)	
			Total	**1**	
22			**B ✓**	1 (AO2.1)	
			Total	**1**	
23			**C ✓**	1 (AO2.1)	
			Total	**1**	
24			B	1 (AO2.1)	
			Total	**1**	
25			B	1 (AO2.1)	
			Total	**1**	
26			A	1 (AO2.1)	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
27	a	i	(Ruler has) equal numbers of protons and electrons / ORA ✓ So (effects of positive charges and negative charges) cancel out / AW / ORA ✓	2 (AO2 x 1.1)	**ALLOW** equal numbers of positive and negative charges/opposite charges / ORA **ALLOW** ruler has not lost/gained electrons / ORA **ALLOW** ruler is/atoms are neutral unless there is a loss/gain of electrons / ORA **ALLOW** if the ruler had been charged, movement of electrons (to/from the air) would discharge it **ALLOW** overall/net charge is zero/neutral / ORA **IGNORE** just charge is neutral
		ii	Electrons are transferred (from/to the ruler or from/to the cloth) / ORA ✓ **And any one from:** Charges are no longer equal / AW ✓ Different numbers of protons and electrons / AW ✓ Effects no longer cancel out / AW ✓	2 (AO2 × 1.1)	**ALLOW** electrons are lost/gained **DO NOT ALLOW** protons/positive charges move **ALLOW** ruler becomes negative/positive with correct movement of electrons ✓✓
	b	i	They must be opposite/unlike charges / one is positive and one is negative / one is a proton and one is an electron ✓ **And any two from:** They are being attracted ✓ The arrows show a force on the positive (charge)/(charge) B ✓ Forces/field (lines) go from positive to negative ✓ (Charge) A is negative AND (charge) B is positive ✓	3 (AO3 x 1.2)	**ALLOW** A is positive and B is negative for this mark only **ALLOW** forces/field (lines) go from B to A **ALLOW** maximum of 1 mark if described as opposite poles / positive and negative poles

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Question			Answer/Indicative content	Marks	Guidance
		ii	**Any one from:** North and South (poles) (replace positive and negative charges) ✓ The arrows/field lines go from North to South (as opposed to positive to negative) ✓ They have similar shape field (patterns) ✓ Closeness of field lines represents strength of field (in each case) ✓ Opposite <u>poles</u> (and opposite charges) attract ✓ Both show direction of field (lines)/forces ✓	1 (AO1.1)	
	c		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5(.00) (C) award 3 marks** (Rearrange equation) (charge =) energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ (charge =) 5 (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	**11**	
28			**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1260 or 1300 (Nm) award 4 marks** (Force = 70 x 10 =) 700 (N) ✓ (Moment =) force x distance ✓ (Moment =) 700 x 1.8 ✓ (Moment =) 1260 (Nm) ✓	4 (AO2.1) (AO1.2) (AO2.1) (AO2.1)	**ALLOW** ecf for using mass not weight e.g. 3 marks for an answer of 126 (Nm), 2 marks for 70 x 1.8 **ALLOW** ecf for incorrect calculation of force **ALLOW** ecf for converting 1.8m to 180cm e.g. 3 marks for 126 000 (Nm)
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
29		i	Gravitational (potential energy store) to kinetic (energy store) ✓	1 (AO2.1)	**ALLOW** kinetic (energy store) to thermal (energy store) / gravitational (potential energy) to thermal (energy) **ALLOW** KE for kinetic energy / GPE for gravitational (potential) energy / heat for thermal **IGNORE** just potential energy / PE
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.6 (J) award 4 marks** 86cm = 0.86 m ✓ (Work done =) 3(.0) x 0.86 ✓ (Work done =) 2.58 (J) ✓ (Work done =) 2.6 (J) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	**ALLOW** ecf for missing or incorrect unit conversion e.g. 260 (J) for 3 marks, 258 (J) for 2 marks
			Total	**5**	
30		i	(From) <u>Chemical</u> energy (store) ✓ (To) <u>Thermal</u> energy (store of the water in the kettle) ✓	2 (AO2 × 2.1)	**ALLOW** chemical energy store decreases **ALLOW** thermal energy store increases **ALLOW** heat / internal energy for thermal **IGNORE** sound/electrical energy **IGNORE** intermediate energy transfers/stores and any energy transfers/stores after thermal (store of the water)
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 138 000 (J) award 4 marks** (Recall: energy transferred =) power x time ✓ (Power = 5.0 x 230 =) 1150✓ (Time = 2 x 60 =) 120✓ (Energy transferred =) 1150 × 120 = 138 000 (J) ✓	4 (AO1.2) (AO2.1) (AO2.1) (AO2.1)	**ALLOW** equation in any form **ALLOW** ecf for incorrect power calculated **ALLOW** ecf for incorrect/no conversion of time
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
31	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	
32			B	1 (AO2.1)	
			Total	1	
33			B	1 (AO2.1)	
			Total	1	
34			A	1 (AO2.1)	
			Total	1	
35			A	1 (AO2.1)	
			Total	1	
36			D	1 (AO1.1)	
			Total	1	
37			C	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
38		i	FIRST CHECK THE ANSWER ON ANSWER LINE **If answer = 997 (kg/m^3) award 2 marks** 9970 ÷ 10 ✓ = 997 (kg/m^3) ✓	2 (AO 2.1) (AO 2.1)	
		ii	C B A	1 (AO1.1)	Correct order only
		iii	**Any one from:** C has more/the most particles (for the same volume) ✓ A has fewer/the least particles (for the same volume) ✓	1 (AO 1.1)	**ALLOW** C has particles closest together/least spread out/most tightly packed **ALLOW** A has particles furthest apart/most spread out/least tightly packed **ALLOW** correct identification of C = solid, (B = liquid,) A = gas
			Total	**4**	
39			Any one set of readings from the graph multiplied together to give a correct number ✓ Any second set of readings from the graph multiplied together to give the same constant ✓	2 (AO3.1b x 2)	e.g. 5×500 = 10×250 = 20×125 = 25× 100 = 2500
			Total	**2**	

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

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Question			Answer/Indicative content	Marks	Guidance
41	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.8 (J) award 2 marks ½ x 40 x 0.2^2 ✓ = 0.8 (J) ✓	2 (AO2.1) (AO2.1)	ALLOW 3.8 (J)
	b	i	(moment of 2N weight) = 80 (N cm) ✓ (moment of 3N weight) = 150 (N cm) ✓	2 (AO2.1) (AO2.1)	ALLOW 1 mark if answers are reversed
		ii	Anti-clockwise (as anti-clockwise moment is larger than the clockwise moment) / left hand side goes down / AW✓	1 (AO3.1b)	ALLOW indication of rotation by an arrow on the diagram
			Total	5	
42			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 5(.00) (C) award 3 marks (Rearrange equation) Charge = energy transferred / potential difference ✓ (charge =) 200 / 40 ✓ = 5 (C) ✓	3 (AO1.2) (AO2.1) (AO2.1)	
			Total	3	

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