OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

WS1.4 SCIENTIFIC VOCABULARY, QUANTITIES, UNITS, SYMBOLS AND NOMENCLATURE

SCORE	PERCENTAGE
/137	%

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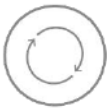
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Question			Answer/Indicative content	Marks	Guidance
1			B ✓	1 (AO2.1)	Examiner's Comments This was the hardest multiple-choice question, with one in six candidates getting it right. Most candidates did not convert cm into m.
			Total	1	
2			C ✓	1 (AO1.2)	Examiner's Comments 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 http://www.ocr.org.uk/Images/310651-mathematicalskills-handbook.pdf
			Total	1	

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

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Question			Answer/Indicative content	Marks	Guidance
4		i	variable resistor ✓	1 (AO1.2)	ALLOW rheostat IGNORE potentiometer Examiner's Comments Q22 is an overlap question with J249/03. Very few candidates recognised that this was a variable resistor. Many thought it was a thermistor.
		ii	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1 (AO1.2)	DO NOT ALLOW merely 'changes the voltage or changes p.d.' BUT ALLOW: changes the potential difference or voltage across (component) X ✓ Examiner's Comments Candidates who misidentified the variable resistor in Q22(a)(i) were not able to answer this question.
			Total	2	
5			B ✓	1 (AO1.1)	Examiner's Comments This question about F = ma was answered well with about 80% of candidates getting it correct with the answer B. All other responses were seen with A being the most common incorrect answer given.
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
6		i	variable resistor ✓	1 (AO1.2)	ALLOW rheostat IGNORE potentiometer Examiner's Comments Most named this correctly as a variable resistor for 1 mark. 'LDR' or 'resistor' and 'thermistor' were common incorrect answers.
		ii	Control / change / vary / increase / decrease / AW the resistance / current in the circuit ✓	1 (AO1.2)	DO NOT ALLOW merely 'changes the voltage or changes p.d.' BUT ALLOW: changes the potential difference or voltage across (component) X Examiner's Comments About half of candidates referred correctly to changing, varying or controlling the current or resistance for 1 mark. Incorrect answers varied but frequently seen were a device to measure current or resistance.
			Total	2	

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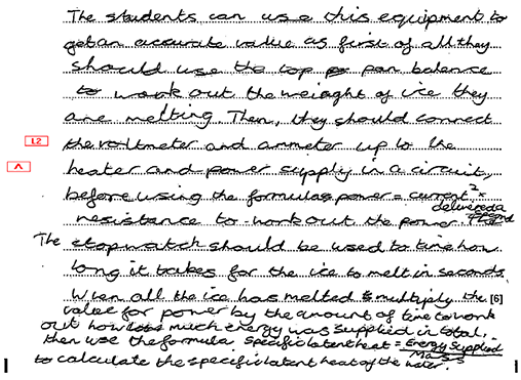
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Question			Answer/Indicative content	Marks	Guidance
7			Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) A detailed explanation of experimental procedure AND detailed discussion about accuracy *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) EITHER a detailed explanation of the experimental procedure OR detailed discussion about accuracy OR a brief explanation of the experimental procedure and simple discussion about accuracy *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 explanation of the experimental procedure OR simple comment about accuracy *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 × 2.2) (AO 2 × 3.3a) (AO 2 × 1.2)	AO1.2 and AO2.2 Applies knowledge and understanding of how to use the equipment to find specific latent heat of water. For example: • Measure the initial mass / weight of beaker • Turn on the heater • Start timing • Use the voltmeter, ammeter and stopclock to calculate the energy supplied (E=VIt) • Turn off the heater • Stop timing • Use a balance to measure the mass of the beaker and melted ice • Subtract the original mass of the beaker to find the mass / weight of the melted ice / calculate mass / weight of melted ice • Calculate specific latent heat by dividing energy by mass AO3.3a Analyses information and ideas to develop experimental procedures and consider accuracy of the experiment. For example: • Make sure that the heater is always covered with ice • Insulate / put lid on the funnel to reduce heat losses • Make sure that the mass of water produced is sufficiently large – run the experiment for long enough • Repeat the experiment to minimise (random) errors <u>Examiner's Comments</u> This six mark level of response question is the only one on this paper. It gave the full range of marks and discriminated well at higher grade demand with about 10% giving level 3 answers and gaining 5 or 6 marks. The procedure was explained quite well with many gaining level 2 scores. A few were very brief with the description (level1) and did a little more than relate the equipment given in the question. Most got the idea of measuring the ice melted,

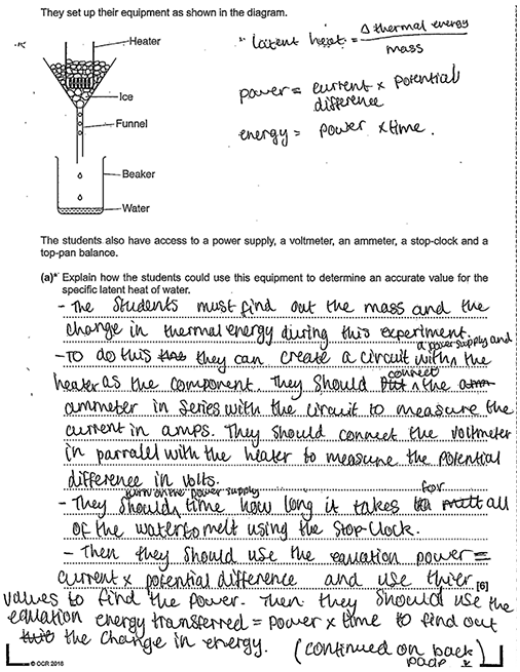
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Question	Answer/Indicative content	Marks	Guidance
			measuring the voltage and current (and multiplying them to get power). Many showed how to calculate the energy and then use this to calculate the specific latent heat (SLH). Very few wrote about accuracy and therefore did not get level 3 rewards at all. A few misread the question and wrote about specific heat capacity (SHC) rather than SLH. As in previous qualifications candidates highlighted key words in the question. This helped them focus their attention on structuring their answers in a clear and concise manner thus gaining marks along the way. Exemplar 4  The students can use this equipment to get an accurate value as first of all they should use the top pan balance to work out the weight of ice they are melting. Then, they should connect the voltmeter and ammeter up to the heater and power supply in a circuit. Before using the formula power = current² × resistance to work out the power. The stopwatch should be used to time how long it takes for the ice to melt in seconds. When all the ice has melted & multiply the value for power by the amount of time to work out how much energy was supplied in total. Then use the formula specific latent heat = Energy Supplied / Mass to calculate the specific latent heat of the ice. L2 A [6] This answer has some idea of the method but often restates the information in the diagram. For example connects the ammeter and voltmeter to the heater – rather than connects the voltmeter in parallel and the ammeter in series. The formula suggested seems a little insecure for a full level 2 answer so the candidate is credited 3 marks.

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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 5  They set up their equipment as shown in the diagram. Heater Ice Funnel Beaker Water * latent heat = Δ thermal energy / mass power = current × potential difference energy = power × time. The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance. (a)* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water. - The students must find out the mass and the change in thermal energy during this experiment. - TO do this they can create a circuit with the heater as the component. They should connect a power supply and ammeter in series with the circuit to measure the current in amps. They should connect the voltmeter in parallel with the heater to measure the potential difference in volts. - They should time how long it takes for all of the water to melt using the stop-clock. - Then they should use the equation power = current × potential difference and use their values to find the power. Then they should use the equation energy transferred = power × time to find out the change in energy. [6] (continued on page 4) © OCR 2016 This answer clearly explains the method in some detail. It describes the measurements taken and the calculations and formulae needed. It does not attempt to describe anything about accuracy so it is limited to level 2 and is credited 4 marks.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
8	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.

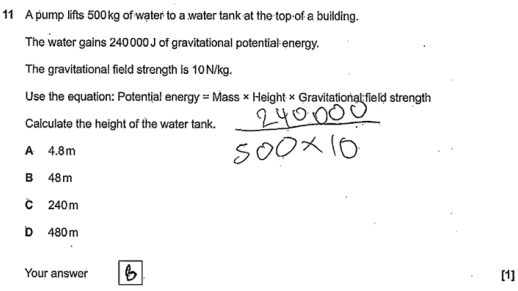
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Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.4 (m/s) award 3 marks (8.4 + 6.75) × 4.5 ✓ 3.37 / 3.366666667 (m) ✓ 3.4 (rounding to 2 sf) ✓	3 (AO 2.2) (AO 2.2) (AO 1.2)	 ECF for momentum values eg. (A + B) ÷ 4.5 Wrong answer but evidence of correct rounding ✓ Eg. 6.75 to 6.8 ✓ <u>Examiner's Comments</u> Just under a half of candidates calculated this correctly to two significant figures. About a third did gain any credit at all and gave attempts of calculations that were incorrect or difficult to follow.
			Total	8	
9			A ✓	1 (AO1.1)	
			Total	1	
10			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> Most candidates successfully applied their knowledge of ionisation to identify what happens to the atom for it to become a positive ion.
			Total	1	
11			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> This question required candidates to recall and apply the equation: *acceleration = change in velocity ÷ time* as well as use the relationship provided to convert m/s into mph. Most candidates were able to do this successfully.
			Total	1	
12			D ✓	1 (AO2.2)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
13			B ✓	1 (AO2.2)	Examiner's Comments Q10 and Q11 required candidates to rearrange the equations provided to calculate the useful output energy transfer per minute, or the height of the water tank. Almost every candidate wrote out their workings by the side of the question stem and then selected the correct answer. See Exemplar 1 below. Exemplar 1  11 A pump lifts 500 kg of water to a water tank at the top of a building. The water gains 240 000 J of gravitational potential energy. The gravitational field strength is 10 N/kg. Use the equation: Potential energy = Mass × Height × Gravitational field strength Calculate the height of the water tank. 240000 500×10 A 4.8 m B 48 m C 240 m D 480 m Your answer b [1]
			Total	1	
14			C ✓	1 (AO2.1)	Examiner's Comments Most candidates demonstrated a good knowledge about the orbits of artificial satellites at different heights (P8.3f and P8.3g). Most other candidates correctly identified that the force of gravity would be less when the satellite is moved to a higher orbit, but also predicted that the speed would increase (distractor D).
			Total	1	
15			C ✓	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
16	a	i	Step-up transformer ✓	1 (AO1.1)	Examiner's Comments 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'.
	b	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	10	

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Question			Answer/Indicative content	Marks	Guidance
17	a	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
	b		**Any 3 from:** Outer ear (pinna) / auditory canal transfers sound to ear drum ✓ Ear drum vibrates ✓ Ossicles / small bones / anvil, hammer or stirrup vibrate ✓ Ossicles / small bones / anvil, hammer or stirrup amplify vibration ✓ Liquid in cochlea transmits movement (to small hairs) ✓ Small hairs / cilia vibrate ✓	**3** (AO1.1) (AO2 × 2.1)	**ALLOW** ear drum moves in and out <u>Examiner's Comments</u> Most candidates gained at least 1 mark for either the eardrum, ossicles or cilia vibrating. Good responses were able to mention all 3 of these vibrations. Candidates who achieved zero or 1 mark, did not use the word 'vibrate', merely listing the parts of the ear that the sound travelled through.
			Total	**8**	

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

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

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Question			Answer/Indicative content	Marks	Guidance
	b		(skin) cancer / (skin) aging ✓	1 (AO1.1)	ALLOW sunburn / blisters / wrinkles / mutates cells / ionises cells IGNORE kills cells / damages cells / just burns Examiner's Comments The majority of candidates achieved 1 mark. Of those candidates who did not gain credit, most had stated that ultra-violet waves cause 'burns' rather than cause sunburn.
			Total	6	
19			Contamination occurs when radioactive **source / material** is on or in the body / object ✓ Irradiation occurs when object is exposed to radiation (from outside of the body / object) ✓	2 (AO1.1) (AO1.1)	ALLOW material becomes radioactive / becomes a source of radiation Examiner's Comments Only a small number of candidates were unable to explain the difference between irradiation and contamination. A common misconception was candidates that confused the terms 'radiation' and 'radioactive source' in their explanation.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
20		i	AWARD **ALL** CANDIDATES 2 MARKS	**2** (AO1 × 2.1) (AO1 × 1.2)	<u>Examiner's Comments</u> We have adjusted the mark scheme to allow for a typo within this question.
		ii	KE transferred to thermal energy / heat in brakes / surroundings / AW ✓✓ OR (KE of car) is reduced / transferred ✓ Brakes gain / absorb thermal energy / heat ✓	**2** (AO1.1) (AO1.2)	**ALLOW** surroundings gain thermal energy / heat dissipated to surroundings **IGNORE** just brakes get hot <u>Examiner's Comments</u> The majority of candidates knew that the kinetic energy store would decrease or be transferred and so were credited with one mark. Fewer candidates gained the second mark as although they referred to heat or thermal energy they did not specify that the energy was transferred to the brakes or surroundings (i.e. into a thermal energy store).
		iii	AWARD **ALL** CANDIDATES 3 MARKS	**3** (AO2 × 2.1) (AO1.2)	
			Total	**7**	
21			**D** ✓	**1 (AO 1.1)**	<u>Examiner's Comments</u> Most candidates answered this question although a common misconception was that the nucleus was uncharged (option D).
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
22			D ✓	1 (AO 2.2)	Examiner's Comments Candidates found this question difficult with only about a third of the candidates choosing the correct answer D. Candidates should know that electromagnetic waves are transverse and travel through space with the same velocity. The other three options were regularly chosen by the candidates. Candidates should practice answering this type of questions which often test basic knowledge and understanding. One way of answering these questions is to look at one of the column headings for example transmission and rule out with small crosses A and B, then look at the next column and rule out A and C, which then means the correct answer should be D. In this question the third column could be used to check that D would still work again by placing a cross next to A and B.
			Total	1	
23			C ✓	1 (AO 2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
24			A ✓	1 (AO 2.2)	Examiner's Comments This was the most challenging question in Section A. The most common response was distractor D, where candidates multiplied the numbers together rather than dividing wave speed by wavelength. AfL For these type of questions candidates should be encouraged to insert the numbers into the equation. When they do this they will see that the equation needs to be rearranged. Alternatively, candidates could rearrange the equation so that the unknown quantity is on the left-hand side of the equal sign.
			Total	1	
25			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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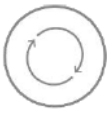
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Question			Answer/Indicative content	Marks	Guidance
26		i	3.5 (cm) ✓	1 (AO 1.1)	ALLOW 3.4 to 3.6 Examiner's Comments One in five candidates answered this question correctly. Some candidate confused wavelength with the amplitude. Another common response was 9 cm.
		ii	2.4 (cm) ✓	1 (AO 1.1)	Examiner's Comments Many candidates read the vertical axis incorrectly and gave values that were around 2.4 cm but not that specific value (for example 2.5 cm).  Misconception A common incorrect answer was 4.8 cm, where candidates confused the peak to peak value with amplitude. Other candidates confused amplitude with the wavelength.

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

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Question			Answer/Indicative content	Marks	Guidance
27		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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Question			Answer/Indicative content	Marks	Guidance
			Total	4	
28			B ✓	1 (AO1.1)	Examiner's Comments The majority of the candidates correctly recalled the diameter of the atom. A small but significant number of candidates incorrectly chose response A.
			Total	1	

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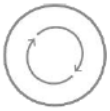
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Question			Answer/Indicative content	Marks	Guidance
29		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks	4	ALLOW 2.78 kW or 2.783 kW ✓✓✓✓
			(P =) $I^2 \times R$ ✓	(AO 1.2)	ALLOW equation in any form
			11 × 11 × 23 or 112 × 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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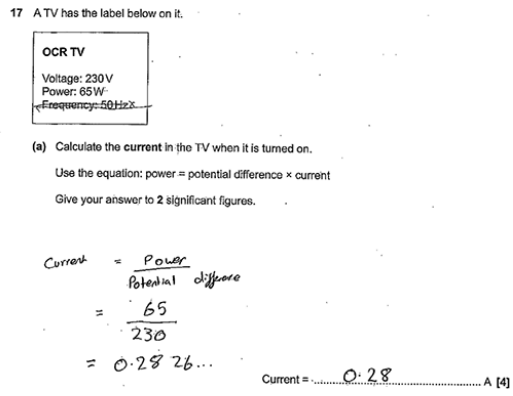
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Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW Examiner's Comments Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	

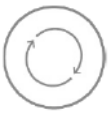
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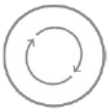
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Question			Answer/Indicative content	Marks	Guidance
30	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓ I = 65 ÷ 230 ✓ I = 0.2826086 ✓ I = 0.28 (A) ✓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

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

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Question			Answer/Indicative content	Marks	Guidance
					time but did not always remember that the energy needed to be measured in seconds. Higher ability candidates clearly showed their working including the conversion of 30 minutes to 1800 seconds. Some candidates recalled that E = Q × V and Q = I × t or E = I × t × V and used the answer from 17(a). This was correct physics and thus gained full credit.  AfL When carrying out calculations, candidates should consider units. Normally time is measured in second. Candidates should be aware of exceptions to the normal units, e.g. when energy transferred is measured in kW h, then the power is measured in kilowatt, kW and time in hour h. Similarly, if a speed is measured in measured in km / h, then the distance should be measured in kilometre, km and the time in hour, h.
			Total	8	
31			B ✓	1 (AO1.2)	Examiner's Comments This involves two different unit conversions, km to m and h to s. Many successful candidates used the space to set out step-by-step intermediate calculations..
			Total	1	

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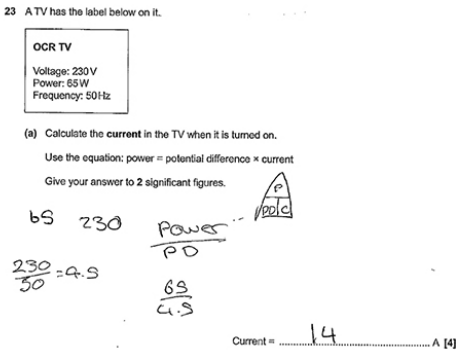
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Question			Answer/Indicative content	Marks	Guidance
32	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.28 (A) award 4 marks	4	
			Rearrange equation current = power ÷ potential difference/ I = P ÷ V ✓	(A1.2)	
			I = 65 ÷ 230 ✓	(A2.1)	
			I =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

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Question			Answer/Indicative content	Marks	Guidance
					Exemplar 9  23 A TV has the label below on it. OCR TV Voltage: 230 V Power: 65 W Frequency: 50 Hz (a) Calculate the **current** in the TV when it is turned on. Use the equation: power = potential difference × current Give your answer to **2** significant figures. 65 230 Power / PD 230/50 = 4.6 65/4.6 Current = 14 A [4]
	b		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 117000 (or 116000) (J) award 4 marks E = P x t ✓ Unit conversion 30 minutes = 1800 seconds ✓ E = 65 x 1800 ✓ E = 117000 (J) ✓	4 (A1.2) (A1.2) (A2.1) (A2.1)	ALLOW ECF from (a) E = Q x V or I x t x V E = 0.28 x 1800 x 230 ALLOW ECF for incorrect time conversion ALLOW three marks for 1950 (J) E = 116000 (J) ✓ <u>Examiner's Comments</u> This calculation, the last on the paper, required recall of the energy/power/time relationship and conversion of minutes to seconds, resulting in a large value answer. One candidate did calculate 117000 J correctly and then wrote 'Wrong!' next to it: However, the examiner ignored this comment and the candidate was credited with full marks for the question.
			Total	8	
33			C ✓	1 (AO2.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
34			D ✓	1 (AO1.2)	
			Total	1	
35			C ✓	1 (AO1.2)	
			Total	1	
36			A	1 (AO1.1)	
			Total	1	

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Question			Answer/Indicative content	Marks	Guidance
37			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 why speed and velocity are different from each other **AND** Calculations of speed **and** velocity completed and are correct *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)** Detailed explanation about why speed and velocity are different from each other **AND** Calculation of speed **OR** velocity completed and is correct **OR** both equations stated/implied **OR** Explanation about why speed and velocity are different from each other **AND** Calculations of speed **and** velocity completed and are correct *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)** Explanation about why speed and velocity are different from each other. **OR** Calculation of speed **or** velocity completed and is correct **OR** Both equations stated/implied *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*	6 (AO1.1x4) (AO2.1x2)	**AO1.1 Demonstrate knowledge and understanding of the difference between speed and velocity** For example: • speed is a scalar • velocity is a vector • speed has magnitude only • velocity has magnitude and direction • speed depends on distance • velocity depends on displacement • speed is rate of change of distance • velocity is rate of change of displacement **AO1.2 Recall of speed and velocity equations** • speed = distance / time • velocity = displacement / time **AO2.1 Apply knowledge and understanding of calculating speed and velocity** For example: • speed = 3.0 / (0.5x60) • speed = 0.10 (m/s) • velocity = 0.6 / (0.5x60) • velocity = 0.02 (m/s)

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Question			Answer/Indicative content	Marks	Guidance
			0 marks No response or no response worthy of credit.		
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
38		i	Point correctly plotted at (5.7 m/s^2, 4N) within ½ a small square ✓	1 (AO2.2)	
		ii	Force is (directly) proportional to acceleration ✓✓ OR Maximum of one mark from: Linear relationship (through the origin)✓ As force increases, acceleration increases / ORA ✓	2 (AO2x3.1 a)	ALLOW (directly) proportional to each other / they are (directly) proportional ALLOW y = mx + c, c = 0 so y = mx IGNORE positive correlation
		iii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.7, 0.71 or 0.72 (kg) award 2 marks Change in y / change in x or 5(.0)/7(.0) ✓ (mass =) 0.7(0) / 0.71 / 0.72 (kg) ✓	2 (AO2.2) (AO2.2)	ALLOW eg 4.3/6.0, 4.0/5.6 etc. to within +/- ½ small square ALLOW other answers between 0.65 and 0.75 only if workings shown using correct values read from the graph to within +/- ½ small square ✓✓
		iv	Any two from: Not all of the energy is transferred to the trolley / energy is transferred/lost to other stores It assumes all of the force on the trolley is equal to the weight added on the string ✓ Friction on the pulley / between the wheels and the surface ✓ Mass of the string/card is ignored ✓ The card on the trolley was not measured properly✓ The card on the trolley did not pass through the light gates vertically/at 90° ✓	2 (AO2x3.2 a)	ALLOW energy is transferred/lost to the surroundings/due to friction/air resistance ✓ ALLOW table is not smooth / friction in the wheels

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Question			Answer/Indicative content	Marks	Guidance
		v	**Any two from:** Compensate for/reduce friction, e.g. by raising the ramp / use a linear air-track / oil/grease pulley ✓ Repeat the experiment and calculate the mean ✓ Measure the acceleration between two points which are further apart ✓ Use different equipment (to check if it produces similar results) ✓ Use equipment with higher resolution/precision ✓ Use string/card with less mass/weight ✓	2 (AO2x3.3 b)	**ALLOW** repeat to remove/identify anomalies **ALLOW** use lighter string/card / subtract mass of card/string (from measurements) **ALLOW** use a pulley with less mass to reduce energy wasted when turning pulley / AW
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
39	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 x 10^{17} (s) **ALLOW** equation in any form
			Total	**11**	
40			D	1 (AO1.1)	
			Total	**1**	
41			**Any two from:** As temperature increases, pressure increases / AW✓ Linear /straight line relationship ✓ Higher temperature means more (frequent) collisions (between particles and container) / AW✓	2 (AO1.1.x 2)	**ALLOW** higher temperature means bigger pressure **DO NOT ALLOW** *T* & *P* in wrong order **DO NOT ALLOW** (directly) proportional relationship **ALLOW** pressure goes up at the same rate as temperature **IGNORE** idea of more collisions with other particles
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
42			**Any two from:** Speed is a scalar ✓ Velocity is a vector ✓ Speed does not take direction into account / AW ✓ Velocity does take direction into account / AW ✓ Speed is calculated using distance ✓ Velocity is calculated using displacement ✓ Displacement depends on direction from start point / displacement takes into account direction ✓ Distance does not depend on direction from start point / distance does not take into account direction ✓	2 (AO1.1 x 2)	
			Total	2	

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