OCR GCSE GATEWAY PHYSICS A · J249

PHYSICS



MARK SCHEME

P4.2 USES OF MAGNETISM

SCORE	PERCENTAGE
/89	%

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Question			Answer/Indicative content	Marks	Guidance
1	a		Fewer coils in the secondary coil (1) Means it induces less potential difference in secondary coil (1) More current induced as power in constant (1)	3	
	b		$\frac{230}{27600} = \frac{12}{X}$ (1) **OR** $\frac{230 \times 12}{27600}$ / **AW** (1) 1 440 (turns) (1)	2	
	c	i	Simple use of P = V × I / idea of ratios using transformer equations (1) Current reduced by 16 times (1)	2	ALLOW current reduced (1)
		ii	Very large decrease in power loss (1) Power loss is related to the square of the current / AW (1)	2	
			Total	9	
2			C	1	
			Total	1	
3			A	1	
			Total	1	
4	a	i	Fleming's left hand rule (1)	1	ALLOW left hand rule / motor rule
		ii	Reference to B, I, L are the largest in the table (1) Some calculation to show the use of F = BIL e.g. one mark point for four correct calculations: A: 0.125 N B: 0.225 N C: 0.225 N D: 1.250 N (1)	2	If no calculations are made pupils can only receive 1 mark

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Question			Answer/Indicative content	Marks	Guidance
	b	i	Wind two coils of wire around an iron core / **AW** (1) Secondary coil has **twice** / **double** the number of primary turns / **ORA** (2) Connect primary coil to an a.c. supply (1)	4	**ALLOW** secondary coil has more turns than the primary coil / **ORA** (1)
		ii	High voltages can be produced / **AW** (1) Any 1 from: Insulate the secondary coil (1) Use very low voltages on the primary coil (1) Keep primary coil voltages low / **AW** (1)	2	**ALLOW** below 6 V
	c		Microphones convert pressure variations in sound waves (1) into variations in current / voltage in electrical circuits / **AW** (1)	2	
			Total	11	

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Question			Answer/Indicative content	Marks	Guidance
5			any one from more turns / AW [1] stronger magnetic field / (soft) iron core / AW [1]	1	Ignore change voltage / resistance / improve brushes for better connection allow idea of greater turns or coils concentration / turns closer together / greater density of turns or coils [1] ignore larger (sized) magnets allow use a radial field or curved magnets / bringing magnets closer together [1] Examiner's Comments As a suggestion of how to increase the speed of the motor most candidates gave a correct answer. Using 'more coils' or a 'stronger magnetic field' was mentioned in approximately equal numbers [1]. Using a soft iron core [1] was also seen from time to time.
			Total	1	
6			C has input and output voltages wrong way round / should be 1000(v) then 50(v) / could be 50(v) then 2.5(v) / ratios incorrect [1] D the ratio is wrong / output should be 200 / input should be 50 / correct ratio of 20:1 [1]	2	If no other marks scored then: EITHER C and D identified OR C is a step-down transformer so output voltage should be lower / AW [1] Examiner's Comments The candidates were asked to look at the data in the table and identify and explain the incorrect rows. Few clearly referred to the incorrect ratios for 2 marks. A mark however, was often gained for stating that the D output should be 200. A compensation mark was sometimes gained for 'C is a step-down' or the identification of C and D being incorrect [1]. B was often incorrectly identified as being incorrect.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
7			**B** and **C** [1] (idea that) the output voltage is higher than the input voltage / ora [1]	1	**both** required in either order **Examiner's Comments** Most candidates could identify errors in a table of step up and step down transformers. Only the lowest ability candidates found this question challenging.
			Total	**2**	
8			(step down) transformer [1]	1	**ignore** type of transformer Examiner's Comments Only about 25% of candidates correctly identified the device that reduces mains voltage as a transformer.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
9			[Level 3] Answer includes one difference in output Voltage AND one similarity AND one difference in construction AND describes a correct use for either A or B Quality of written communication does not impede communication of the science at this level (5 – 6 marks) [Level 2] Answer includes one similarity and one difference in construction AND a correct use for either A or B OR one correct comparison of output voltage Quality of written communication partly impedes communication of the science at this leve (3 – 4 marks) [Level 1] Answer includes two correct statements in terms of construction or output voltage or uses Quality of written communication impedes communication of the science at this level (1 – 2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to C. Indicative scientific points may include: Construction -Similarities • both have an iron core / same material • both have the same input voltage / 20 volts/ AC • both have different numbers of turns on the primary compared to the secondary coils • both isolating transformers • input voltage is connected to the primary coil / output voltage is connected to the secondary coil Construction -Differences • transformer A has less turns on the primary / transformer B has more turns on the primary • transformer A has more turns on the secondary / transformer B has less turns on the secondary Output voltage • both change the output voltage • transformer A is a step-up transformer • transformer B is a step down transformer • the output of transformer A will be 40V or more than 20 V • the output of transformer B will be 10V or less than 20 V Uses • transformer A is used in the National Grid / used in (CRT) TVs • transformer B is used in e.g. mobile phone chargers / radios / laptops / National Grid (to decrease voltage) / any electronic device that is mains powered e.g. halogen lights

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Question			Answer/Indicative content	Marks	Guidance
					Use the L1, L2, L3 annotations in scoris. Do not use ticks Examiner's Comments This 6 mark level of response question on transformers was targeted up to grade C. For level 1, examiners were seeking to award marks for a description of the observed similarities in the construction of two transformers. For level 2, most candidates gained a partial match for a correct description in similarities and differences in construction. Some candidates went on to compare the output voltages arising from the different turns ratios of the transformers. However, very few candidates reached a secure level 3 which required a comparison of the applications of a step up or step down transformer.
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
10	a		Clockwise anticlockwise clockwise [1]	1	**allow** appropriately drawn curly arrows **Examiner's Comments** About a third of answers were correct.
	b	i	(idea of using) variable resistor [1] (idea of using) more or less or changing the: voltages / pd / current / power (input) [1]	1	 **ignore** stronger current **ignore** changes to coils **ignore** changes to field / magnets **Examiner's Comments** Suggestions for changing the speed of this motor often referred inappropriately to fieldstrength, magnets or the number of turns. Better answers referred to using a variable resistor (rarely seen) [1] or either changing voltage or current [1].
		ii	**any two from:** when switched on the motor's speed increases [1] when switched off the motor's speed decreases [1] the motor doesn't stop spinning [1]	2	**Allow** high voltage for 'switched on' **Allow** low voltage for 'switched off' Ignore reference to constant speed If no mark scored **allow** one mark for 'speed varies' **Examiner's Comments** Most stated that the speed fluctuated [1] and some linked switching on as high speed and off (or low) as lower speed [2].
		iii	**any one from:** (idea of) smoother speed / less jerky [1] (idea that) **variation** in motor speed will be less [1]	1	**Examiner's Comments** Some answers described the speed as having less variation [1].
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
11			<table><tr><th>step up</th><th>step down</th><th>isolating</th></tr><tr><td>(✓)</td><td></td><td></td></tr><tr><td></td><td>✓</td><td></td></tr><tr><td></td><td></td><td>✓</td></tr><tr><td></td><td>✓</td><td></td></tr><tr><td>✓</td><td></td><td></td></tr></table> (2)	2	**all** correct (2) 2 or 3 correct (1) **Examiner's Comments** Most candidates showed a good grasp of the structure of different types of transformer to gain both marks.
			Total	2	

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Question			Answer/Indicative content	Marks	Guidance
12	a		coil is rotated / moves (in a magnetic field) to produce current in the coil [1] induction / (current or voltage) induced [1] slip rings / brushes keep circuit complete or make sure the current continues to flow (in the external circuit) [1] brushes make good / continuous contact (between the coil and the external circuit) [1]	2	If motor is described award a maximum of [1] available for last two marking points **Eg.** coils break magnetic field lines to produce current [1] **Eg.** magnets make coil spin and a current is induced [0] **BUT** magnets make coil spin and a current is induced and the slip rings pass current into the circuit [1] **Eg.** coil spins and induces current [2] **Eg.** Slip rings keep current flowing [1] **Ignore** Slip rings prevent wires tangling **Eg.** brushes / slip rings carry / pass on current to (external) circuit [1] Examiner's Comments In explaining the generator many candidates mistakenly described a motor, stating that the coil was forced or made to rotate. Marks were available for the coils turning in the magnetic field producing a current [1]. Also the brushes passing on current to the external circuit gained one mark. Motor explanations were limited to the second of these marking points at best (maximum one mark).

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Question			Answer/Indicative content	Marks	Guidance
	b		increase the speed / frequency of rotation of the coils (1) **and any one from** decrease the number / area of coils (1) reduce the magnetic field strength / AW (1)	2	**Allow** weaker / less powerful magnet [1] **Allow** move magnets apart [1] **ignore** size of magnet Examiner's Comments In this question about a different generator output, common answers were the reverse of those required. Some candidates did gain a mark for faster coil rotation but also said stronger field or more coils. Only the highest ability candidates gained two marks here.
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
13	a		magnet coil brush slip ring (1)	1	all four required Examiner's Comments ??The vast majority could match the labels to the parts of an ac generator.
	b		moving the magnet(s) (1)	1	**allow** move magnet and coil (1) Examiner's Comments ??Only higher ability candidates could describe the movement of the magnets as a way to generate electricity. In part this may have been due to them trying to look at how it could be done with the generator shown in the diagram rather than another generator as this has been a focus in previous years.
	c		(supply) voltage of **B** is lower / ORA (1) frequency of **B** is higher / ORA (1)	2	Examiner's Comments This part-question discriminated particularly well across the ability range. A significant number struggled to communicate the comparison of the two features for the two supplies and hence did not gain credit.
			Total	**4**	
14			(Transformers are devices that work with) **AC**. (Phone chargers use) **step-down** (transformers.) (Bathroom shaver sockets use) **isolating** (transformers.)	2	3 correct = 2 marks 1 or 2 correct = 1 mark Examiner's Comments ??Most achieved at least one mark for knowing that transformers work with AC or that phone charges had strep down transformers. Most did not know about the use of isolating transformers in a shaver socket and so very few scored two marks.
			Total	**2**	

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Question			Answer/Indicative content	Marks	Guidance
15			[Level 3] Describes the construction of the transformer AND performs a calculation to determine the turns ratio or output current AND explains the process of electromagnetic induction. Quality of written communication does not impede communication of the science at this level. (5–6 marks) [Level 2] Describes the construction of this transformer AND EITHER performs a simple calculation OR gives a partial explanation of electromagnetic induction. Quality of written communication partly impedes communication of the science at this level. (3–4 marks) [Level 1] Describes two features of the basic construction of a transformer. Quality of written communication does impedes communication of the science at this level. (1–2 marks) [Level 0] Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	This question is targeted at grades up to A. Level 3 relevant points: • two coils wrapped around core made of iron secondary less turns than primary • 46 × more turns on primary or calculate current = 2300mA • varying magnetic field in primary and varying magnetic field in secondary inducing an emf. Level 2 diagram or description of transformer construction: • two coils wrapped around (iron) core with secondary less turns than primary • ratio 230:5 or 2% or sensibly attempted calculation using transformer equation. Level 1 diagram or description of transformer construction: • two coils of wire • wrapped on (iron) core • step down transformer Use the L1, L2, L3 annotations in Scoris. Do not use ticks. Examiner's Comments This was a challenging 6 mark question on transformers targeted up to A* grade. About a third of candidates failed to score any marks here. Some made no attempt at all whilst others wrote of potential dividers or relays. Two thirds of candidates, however made valiant attempts at the question and produced a wide spread of marks enabling differentiation and discrimination to happen. Most described the transformer correctly and this was often seen as a diagram. Better answers then described the relative turns and performed a simple calculation

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Question			Answer/Indicative content	Marks	Guidance
					[4]. Higher grade answers also did this but in addition explained the induction process in clear detail to gain [6].
			Total	6	
16	a	i	step-down transformer (1) more turns or coils in primary / LHS / first side / input coil / ORA (1)	2	**Allow** output voltage lower than input voltage (1) If no marks scored then different numbers of turns on each side (1)
		ii	5 000 (V) (2) **but if answer is incorrect or incomplete then:** $\frac{20\,000}{x} = \frac{400}{100}$ (1)	2	**allow** any manipulation of this equation (1)
	b		no change in voltage (1) appliance or socket is not live / no direct connection between live (to primary coil) and output (from secondary coil) (1)	2	**ignore** references to current **allow** isolates from mains (supply) / high voltage (for safety) (1) **Allow** less chance of an electric shock. **Allow** can't get a shock (1)
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
17			**Level 3: (5–6 marks)** **similarity OR difference** **AND** **detailed description of how the size of the voltage can be changed.** Quality of written communication does not impede communication of science at this level. **Level 2: (3–4 marks)** **similarity OR difference** **AND** **simple description of how the size of the voltage** **can be changed.** Quality of written communication partly impedes communication of science at this level. **Level 1: (1–2 marks)** **similarity** **OR** **difference** **OR** **simple description of how the size of the voltage can be changed.** Quality of written communication impedes the communication of science at this level **Level 0: (0 marks)** Insufficient or irrelevant science. Not worthy of credit.	6	This question is targeted up to grade C Indicative scientific points may include (but are not limited to) the following: **similarities** • generate electricity • work in an opposite way to a motor • both have moving parts • movement of coil of wire relative to magnet / ORA **differences** • simple generator has coil inside the magnet / generator in power station has magnet inside coil • simple generator has coil of wire moving / spinning • generator in power station has magnet moving / spinning **changes to size of voltage** • change speed of rotation of coil (in the simple generator) • change speed of rotation of magnet (in the generator in the power station) • change number of coils (in both generators) • change the strength of the magnet
			Total	6	

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Question			Answer/Indicative content	Marks	Guidance
18	a		isolating (1) **and any one from** shaver not connected directly to mains / shaver isolated from mains (1) reduces risk of electrocution (1) current cannot reach user (1)	2	**allow** idea that voltage is unchanged / primary coils = secondary coils (1) **allow** no risk of electrocution / no risk of (electric) shock (1) **allow** blocks current from one circuit to another / decouples one circuit from the other (1)
	b		Step-down transformers are used in mobile phone chargers. ✓ Step-up transformers are used in laptops. ☐ Transformers change AC to DC. ☐ Transformers only work with AC. ✓ Transformers only work with DC. ☐ **(2)**	2	each correct tick = 1 mark three ticks, with one or two correct = 1 mark four ticks = 0 marks
			Total	4	
19			A ✓	1 (AO2.1)	<u>Examiner's Comments</u> About 40% of the candidature gave the right answer A. The common incorrect response was usually 'D'.
			Total	1	
20			D ✓	1 (AO2.2)	<u>Examiner's Comments</u> This calculation was answered successfully by about three quarters of the candidates stating D.
			Total	1	

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

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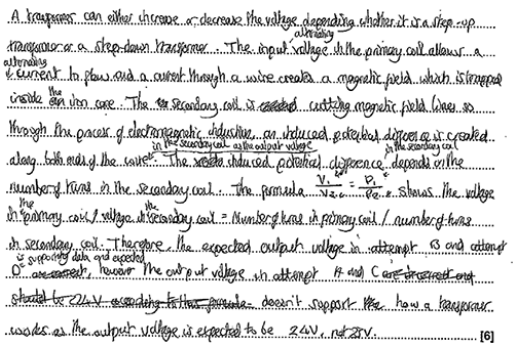
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Question	Answer/Indicative content	Marks	Guidance
	A qualitative link between coil and potential difference ratios to inform judgement that the data supports the expected output voltages. *There is an attempt at a logical structure with a line of reasoning.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

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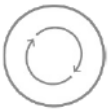
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Question	Answer/Indicative content	Marks	Guidance
			explained the alternating magnetic field in the iron core of the transformer inducing an alternating p.d. across the secondary coil. For the highest marks, it was expected that clear calculations for each of the four transformers would be shown with a comment as to whether they supported the theoretical predictions. Many candidates did not show any working. There was also the opportunity to discuss energy losses in transformers particularly about transformer A and transformer C. Exemplar 4  A transformer can either increase or decrease the voltage depending whether it's a step-up transformer or a step-down transformer. The input voltage in the primary coil allows a alternating current to flow and a current through a wire creates a magnetic field which is stronger inside the iron core. The secondary coil is cutting magnetic field lines so through the power of electromagnetic induction, an induced potential difference is created along both ends of the wire. The induced potential difference depends on the number of turns in the secondary coil. The formula $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ 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 is correct 6 and attempt 2 supporting data and expected 0 are correct, however the output voltage in attempt 1 and 3 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.
			Total	6	
22			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
23		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	3	

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Question			Answer/Indicative content	Marks	Guidance
24			C ✓	1 (AO1.1)	
			Total	1	
25			C	1 (AO1.1)	
			Total	1	
26			B	1 (AO2.1)	
			Total	1	
27			A	1 (AO2.1)	
			Total	1	

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