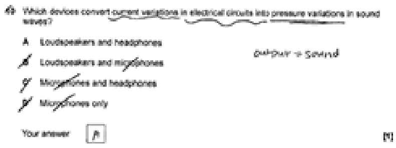
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		Any **two** from: Current (in the coil) causes a magnetic field ✓ magnetic field of the current-carrying wire <u>interacts</u> with magnetic field of the magnets **AND** causes a <u>force</u> (to act on the wire) ✓ the forces on either side of the coil are opposite / one side of the coil the force is up and the other is downwards / (idea that) these two forces work together to cause rotation around the axle ✓	2 (AO 1.2 x2)	**IGNORE** statement of Fleming's left-hand rule **<u>Examiner's Comments</u>** Candidates found this question challenging, and there were many vague responses. Some referred to the motor effect without explaining what was meant by the motor effect. Many candidates did not discuss the magnetic field due to the current in the coil, and that it is the interaction of the magnetic field due to the current and the magnetic field due to the magnets that results in a force. Few candidates explained that the forces would act in opposite directions on the sides of the coil to cause the rotation.
	b	i	Similarities: Both rotate a coil in a magnetic field / between magnets ✓ Both induce a (variable) pd / current when rotated ✓ Differences: Alternator <u>generates</u> ac / dynamo <u>generates</u> dc ✓ Dynamo uses split ring commutator / alternator uses slip rings ✓	4 (AO 2.1 x4)	**ALLOW** voltage for pd **DO NOT ALLOW** both use electromagnetism **DO NOT ALLOW** reference to a.c. and/or d.c **ALLOW** induces / creates / produces for generates **<u>Examiner's Comments</u>** The question required candidates to compare 'how the devices work.' Few candidates scored marks for the similarities, often stating that the similarities were 'they both have magnets' and 'they both have coils.' Few candidates stated that the coils were rotated in a magnetic field.

					For the differences, many incorrectly stated that the alternator 'used' a.c. and the dynamo 'used' d.c. ? **Misconception** Many candidates did not appear to understand that the dynamo and alternator are generators and produce an electromotive force (emf) or current. For a generator, movement (or rotation) of coils in a magnetic field produces an emf. A current in a coil in a magnetic field is the motor effect.
		ii	Any **one** from: Spin the coil faster ✓ More turns on the coil ✓ Increase the strength of magnetic field / use stronger magnets ✓	1 (AO 1.2)	**IGNORE** bigger magnet, longer coil **ALLOW** more coils **ALLOW** flux density for field **<u>Examiner's Comments</u>** Many candidates gave the answer of "increase the current"not realising that both the alternator and dynamo are generators. ? **Misconception** Many candidates did not realise that both the alternator and dynamo are generators and work on the principle of the relative movement of magnets, or that coils produce an induced electromotive force (emf) or current.
	c		**First check the answer on the answer line** **If answer = 0.45 (m) award 3 marks** (F = BIL) L = F / (IB) ✓ L = 0.81 / (1.2 x 1.5) ✓ L = 0.45 (m) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** two marks for 9/20 **ALLOW** 1 mark for correct substitution into unrearranged equation **<u>Examiner's Comments</u>**

					The majority of the candidates correctly selected the equation, rearranged it and substituted in the data to obtain the correct answer.
			Total	**10**	
2			A	1 (AO 1.1)	**Examiner's Comments** This question was well answered. Option B was a common incorrect response, where candidates perhaps did not fully understand what the question was asking. Some candidates, when answering multiple-choicequestions, benefit from underlining key terms in the question. Exemplar 1  Which devices convert current variations in electrical circuits into pressure variations in sound waves? A Loudspeakers and headphones B Loudspeakers and microphones C Microphones and headphones D Microphones only Your answer A [1] In this example the candidate has underlined the key parts of the question and sensibly used the white space surrounding the question with the comment 'output = sound.' The candidate has also then reviewed each of the options ruling out incorrect answers by placing a single line through the incorrect word and then through the letter. The advantage of using a single line is that the candidate can still see what is written in case there is a change of mind.
			Total	**1**	
3	a		<u>Similarities</u> **Any two from:** Both have alternating / changing current / p.d. / voltage ✓ Both use coil / magnets / magnetic field ✓ Both have (moving) diaphragms ✓ The frequency of the sound equals the frequency of the current ✓	4 (4 ×AO 1.1)	**IGNORE** reference to energy (as it is not relevant to the operation of the transducers) **ALLOW** a.c. for alternating current **ALLOW** cone for diaphragm **ALLOW** in a microphone the cone /

			<u>Differences</u> A microphone converts sound (waves) into current / p.d. / electrical signal ✓ A speaker converts current / p.d. / electrical signal into sound (waves) ✓		diaphragm / magnet moves to produce a current **ALLOW** in a speaker a current makes a cone / diaphragm / magnet move **<u>Examiner's Comments</u>** A large number of candidates correctly stated that both a microphone and a loudspeaker use coils and/or magnets. Some candidates' responses were vague with a similarity being that a microphone and a loudspeaker both have a current rather than being more specific and discussing a changing or alternating current. In describing differences, high scoring candidates discussed the transfer of sound waves to an electrical signal for a microphone and the transfer of an electrical signal to sound waves for a loudspeaker. A common response that did not gain credit was that the loudspeaker used the motor effect and the microphone used the dynamo effect – a more detailed response was expected.
	b		The (current in the wire) produces a magnetic field ✓ The magnetic field of the magnet and the magnetic field of the wire interact (to exert a force on each other) ✓ The wire experiences a force / moves <u>downwards</u> ✓	3 (AO 2.2) (AO 2.2) (AO 2.2) (AO 3.2a)	**<u>Examiner's Comments</u>** This question required candidates to logically explain that the wire would move downwards. High scoring candidates stated that the current in the wire has a circular magnetic field around the wire which interacts with the magnetic field due to the poles of the magnet.
	c		**First check the answer on answer line** **If answer = 1.1 (N) award 3 marks** (F = BIL) F = 0.30 × 5.0 × 0.75 ✓ F = 1.125 (N) ✓ F = 1.1 (N) 2 SF ✓	3 (AO 2.1) (AO 2.1) (AO 1.2)	**<u>Examiner's Comments</u>** This question was well answered. A small minority of candidates did not score the last mark as they rounded their final value to 1.13 (2 decimal places, where they were asked for 2 significant figures).
			Total	**10**	

4			**B**	1 (AO 1.2)	**Examiner's Comments** This question tested the basic understanding of Fleming's left hand rule. A range of responses was seen from the small minority of candidates who did not choose B.
			Total	**1**	
5			**D**	1 (AO 2.1)	**Examiner's Comments** The majority of the candidates realised that the type of transformer was step-up. A large minority of candidates perhaps misread the question and assumed that the primary coil was on the left.
			Total	**1**	
6	a		**Any four from:** Wrap coil(s) around a (soft iron) rod ✓ Connect a voltmeter across secondary coil / measure p.d. across secondary coil ✓ Connect (a.c. power) supply to primary coil ✓ Change the number of turns in the secondary coil ✓ Keep p.d. of the a.c. supply/primary p.d. constant ✓ Keep number of turns in the primary coil constant ✓	4 (4 × AO 3.3a)	**ALLOW** marks awarded from a clear diagram **ALLOW** coils side by side or on top of one another **ALLOW** dependent variable is p.d. across secondary coil **DO NOT ALLOW** d.c. power supply or cell/battery in diagram **ALLOW** independent variable is number of turns **ALLOW** p.d. of a.c. supply/primary p.d. is a control variable **ALLOW** control variable is number of turns in primary coil **Examiner's Comments** It was evident that most candidates found this question the most challenging on the paper, with usually only the highest achieving candidates gaining more than 1 mark. The question assessed AO3. It required candidates to describe how to use the equipment provided to make a transformer to investigate the relationship between the p.d. across the secondary coil and the number of

					turns on this coil. Some candidates confused the transformer with an electromagnet and many did not mention primary and secondary coils, this allowed access to the first marking point only. Many drew diagrams where the primary coil and the secondary coil were joined together in a circuit. A few students described bending the iron rod into a square shape like a conventional transformer, and usually these candidates then gained the most marks, because they went on to label the two coils and connected the power supply and voltmeter in the correct places. Most candidates were not specific about which coil they were referring to when writing about the power supply, voltmeter and changing the number of turns.
	b	i	**First check the answer on answer line** **If answer = 19.5 (V) award 3 marks** Rearrangement: (V_s =) V_p × (N_s ÷ N_p) ✓ (V_s =) 230 × (300 ÷ 3540) ✓ (V_s =) 19.5 (V) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** 19 (V) or 19.49 (V) **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 / V_s = 3540 / 300
		ii	**First check the answer on answer line** **If answer = 0.39 (A) award 3 marks** Rearrangement: (I_p =) (I_s × V_s)÷ V_p ✓ (I_p =) 4.62 × 19.5 ÷ 230 ✓ (I_p =) 0.39 (A) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	**ALLOW** ECF from **(c)(i)** **ALLOW** (I_p =) (I_s × N_s)÷ N_p **ALLOW** (I_p =) 4.62 × 300 ÷ 3540 **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 × I_p = 4.62 × 19.5 **OR** 3540 × I_p = 4.62 × 300 **<u>Examiner's Comments</u>** The calculations in Questions 21 (b) (i) and (b) (ii) were generally

					answered well, with a significant number of candidates gaining full credit. Other candidates struggled with rearranging the equations, but still gained marks for substituting the given information into an unrearranged equation. **Assessment for learning** Candidates could benefit from short activities where they practise rearranging the transformer equations with four terms.
			Total	**10**	
7	a	i	(1.12 ÷ 0.44) = 2.5 ✓	1 (AO2.1)	**ALLOW ECF** from (a)(i) **ALLOW** any number which rounds to 2.5 **ALLOW** 2.55 **<u>Examiner's Comments</u>** Most candidates scored marks for this question. Some candidates inverted the answer.
		ii	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.7 award 4 marks** (Mean) speed = distance / time ✓ = 1.2 / 0.44 ✓ = 2.73 s = 2.7✓	4 (AO1.2) (AO2.1) (AO2.1) (AO1.2)	**ALLOW ECF** for use of time = 1.12 s **ALLOW** 1.07 for two marks **ALLOW** 1.1 for three marks Correct re-arrangement **ALLOW** 1.2 / 0.444 or 1.2 / 0.4444 **ALLOW** 2.702 or 2.7002 or $2.\dot{7}$ or $2.\dot{7}\dot{2}$ or 2.72 **DO NOT ALLOW** $2.\dot{7}$ **<u>Examiner's Comments</u>** This question was well answered. Some candidates used the wrong mean. Useful advice is to underline the quantities in the question.
	b		**Any three from:** falling magnet produces a changing magnetic field ✓	3 (3 × AO1.2)	**IGNORE** copper becomes a magnet **<u>Examiner's Comments</u>**

			magnetic field / ✓ magnet induces a potential difference / current (in the copper / tube) ✓ magnetic field due to current in copper is produceds ✓ this magnetic field due to the current opposes the original magnetic field of the magnet✓		Many candidates discussed the magnet being attracted to the copper. Some high scoring candidates realised that the falling magnet produced a changing magnetic field which induced a current in the copper tube. To gain further marks, candidates needed to state that the induced current in the copper created a magnetic field that opposed the motion of the magnet. **Misconception** Many candidates stated that the magnet was attracted to copper. Many candidates did not understand electromagnetic induction.
			Total	**8**	
8	a	i	force (exerted) on the wire / coil ✓ **or** interaction between the magnetic field around the wire and the (permanent) magnet / AW ✓	1 (AO1.1)	**<u>Examiner's Comments</u>** Answers to this question were often vague. There was little reference to the magnetic field of the coil interacting with the magnetic field due to the current in the coil causing opposite forces to act on the coil.
		ii	clockwise ✓ (Fleming's) left hand rule ✓	2 (AO2.2) (AO1.2)	**ALLOW** <u>left</u> hand side up / <u>right</u> hand side down **<u>Examiner's Comments</u>** For the direction, it was expected that the candidates would state clockwise. Many candidates gave vague answers such as up, sideways. It was expected that Fleming's left-hand rule would be quoted.
	b		**Any two from:** increase the current (in the coil) ✓ increase the number of coils ✓ increase the length of the coil (in the magnetic field) ✓ increase the strength of the magnet / magnetic field ✓	2 (2 × AO1.2)	**ALLOW** increase potential difference / p.d. / voltage **IGNORE** size of magnet **IGNORE** (soft) iron core **<u>Examiner's Comments</u>** Most of the candidates stated two out

					of increasing the current, increasing the number of coils and increasing the strength of the magnetic field. Examiners did not allow larger magnets since larger magnets does not necessarily mean a stronger magnetic field. Some candidates stated increasing the potential difference – this was allowed as an alternative to increasing the current.
			Total	**5**	