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EDEXCEL GCSE PHYSICS: QUESTIONS BY TOPIC

Electromagnetic Induction (13)

GCSE Physics (Higher) Topic 13

8 questions · 93 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Physics 1PH0, Higher Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
1. Q6	Paper 2 June 2025	10	4
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3. Q8 <i>also Topic 8</i>	Paper 2 June 2023	11	11
4. Q9	Paper 2 June 2018	12	15
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QUESTIONS

8 questions · 93 marks · lowest tariff first



10-MARK QUESTIONS

1 question in this booklet



- 6 The battery inside an electric toothbrush is recharged when the toothbrush is placed on its charger.

Figure 9 shows part of the toothbrush and the charger.

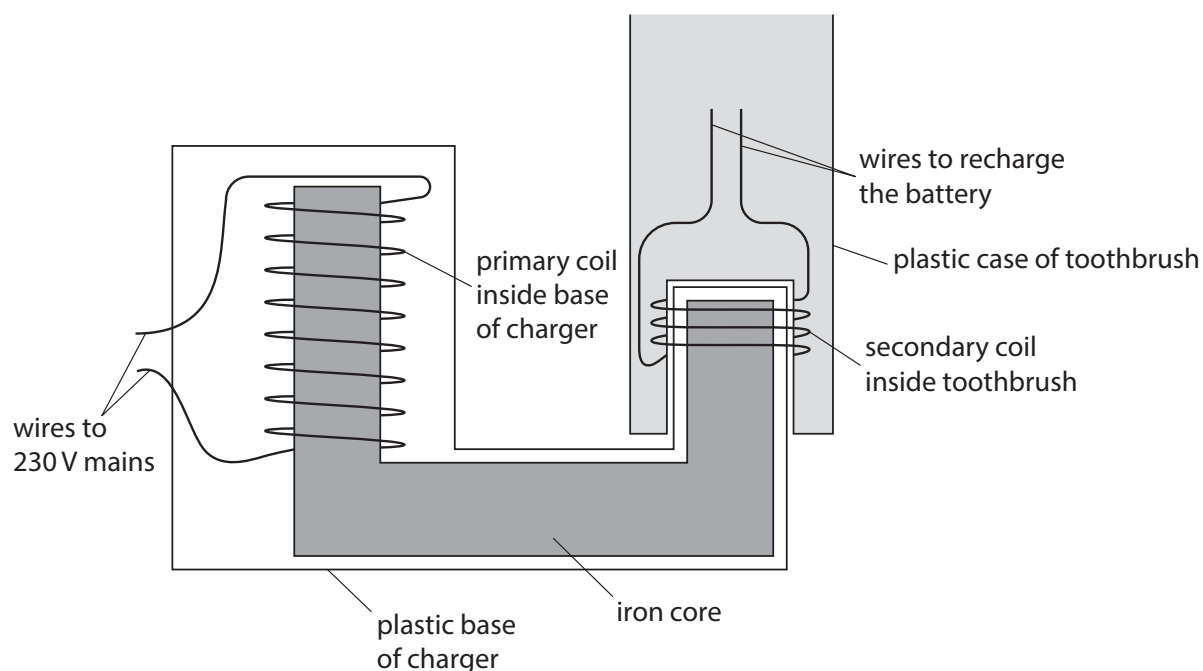


Figure 9

- (a) (i) Explain how the current is produced in the secondary coil of the transformer in Figure 9.

(3)

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(ii) The potential difference across the primary coil is 230V.

The potential difference across the secondary coil is 1.5V.

The primary coil has 1840 turns of wire.

Calculate the number of turns of wire in the secondary coil.

(2)

number of turns = ...

(b) In Figure 9, a diode is connected in series with the rechargeable battery.

Explain why a diode is needed in the toothbrush in this part of the circuit.

(2)

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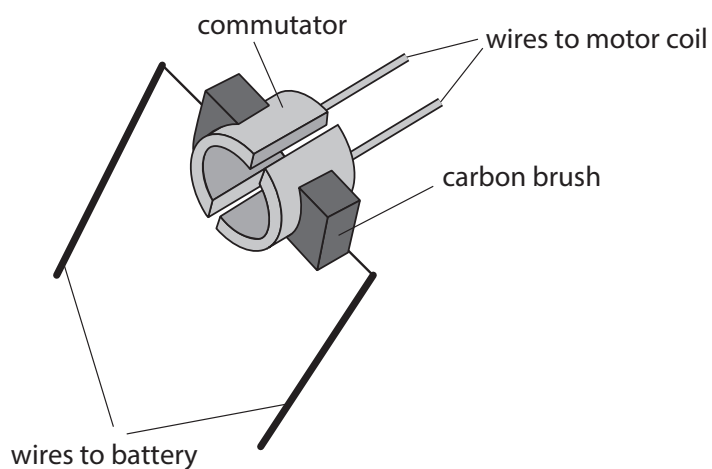
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- (c) Figure 10 shows a simplified diagram of the split ring commutator in a d.c. electric motor.



(Source: gsu.edu)

Figure 10

Explain the function of the commutator in a d.c. electric motor.

(3)

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(Total for Question 6 = 10 marks)

11-MARK QUESTIONS

2 questions in this booklet



7 (a) Figure 15 shows three stages of a magnet moving into and then out of a coil of wire. The coil is connected to a milliammeter.

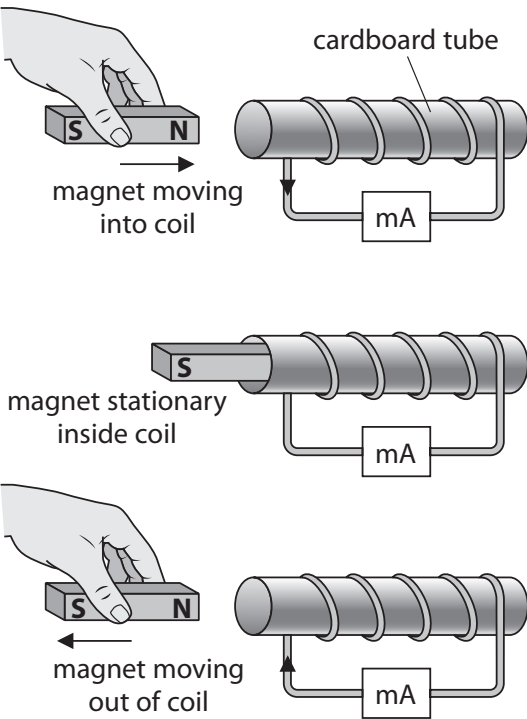


Figure 15

(i) Which row of the table shows the deflection on the milliammeter for the three stages in Figure 15?

(1)

	magnet moving into coil	magnet stationary inside coil	magnet moving out of coil
☐ A			
☐ B			
☐ C			
☐ D			

Figure 16

(ii) Give **two** ways of increasing the deflections on the milliammeter shown in Figure 16.

(2)

1.....

2.....

(b) Figure 17 is a diagram representing a loudspeaker.

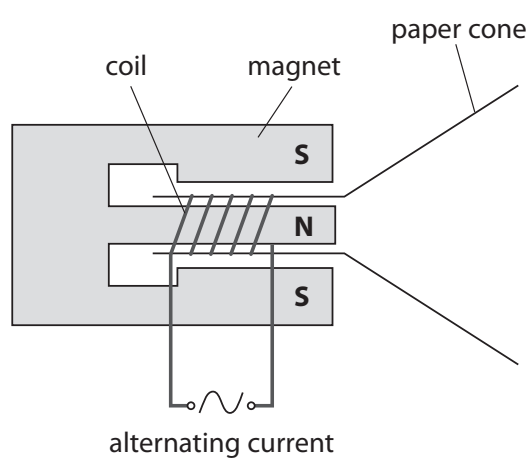


Figure 17

Explain how sound is produced when an alternating current is supplied to the coil of the loudspeaker.

(4)

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(c) Figure 18 shows a transformer.

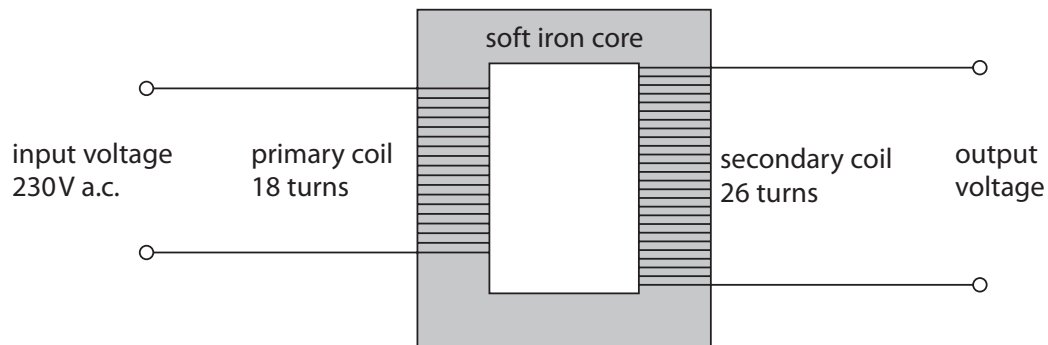


Figure 18

(i) State the purpose of the transformer shown in Figure 18.

(1)

(ii) Calculate the output voltage of the secondary coil.

Use an equation selected from the list of equations at the end of this paper.

(3)

output voltage = ... V

(Total for Question 7 = 11 marks)

- 8** (a) An electric car is travelling at a speed of 16.0 m/s .

The total mass of the car is 1200 kg .

- (i) Calculate the kinetic energy, in kJ , of the car.

(2)

kinetic energy = ... kJ

- (ii) On a journey, the car transfers energy from the battery at an average rate of 17.5 kW .

The battery in the car transfers a total of 126 MJ of energy before it becomes discharged.

Calculate the time taken for the battery to become discharged on this journey.

Give your answer in hours.

(2)

time taken = ... hours



- (iii) Figure 20 shows an electrical device connected to the wheels of an electric car.

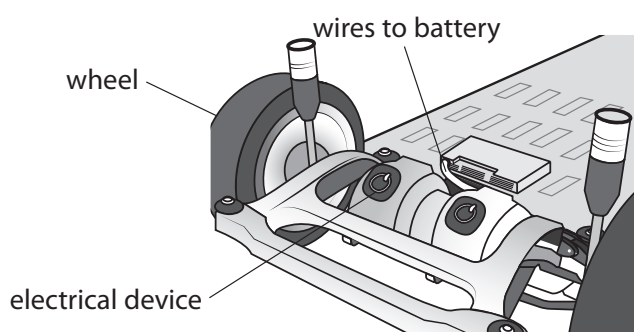


Figure 20

The electrical device is used as a motor when the car accelerates and as a dynamo when the car decelerates.

Explain how using the device can help to increase the time that the car can be driven before the battery becomes discharged.

(2)

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- (b) The battery can be recharged at a charging point.

The charging point provides an average current of 15.0 A to the battery, at a potential difference (voltage) of 400 V.

It is claimed that 126 MJ of energy can be transferred to the battery in less than 6 hours.

- (i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V} \quad (3)$$

- (ii) Calculate the total charge that moves into the battery while it is being recharged.

Use the equation

$$E = Q \times V \quad (2)$$

charge = ... C

(Total for Question 8 = 11 marks)

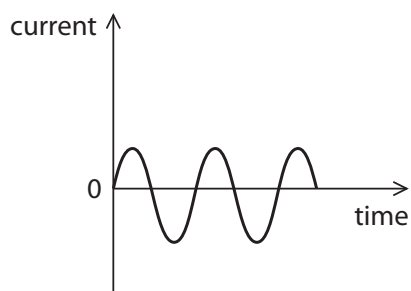
12-MARK QUESTIONS

4 questions in this booklet

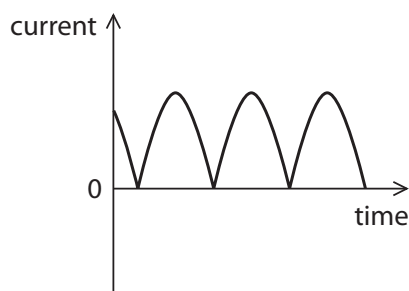


9 (a) Which of these could be the output for a dynamo?

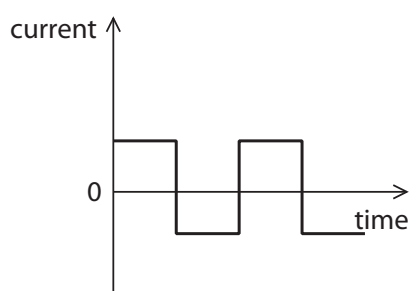
(1)



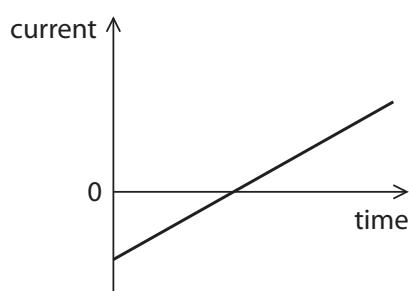
☐ A



☐ B



☐ C



☐ D

(b) (i) Figure 17 shows the output from a battery.

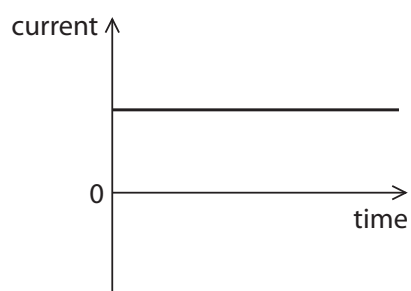


Figure 17

Explain why a transformer will not work with the input current as shown in Figure 17.

(2)

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(ii) A transformer has 30 turns on the primary coil and 150 turns on the secondary coil.

A potential difference of 25V is applied across the primary coil.

Calculate the potential difference across the secondary coil.

Use an equation selected from the list of equations at the end of this paper.

(3)

potential difference = ... V



*(c) High voltage transmission cables and transformers are used in the national grid.

Explain how using high voltage transmission cables and transformers allows the distribution of electrical power around the United Kingdom to be as efficient as possible.

Refer to the following equations in your answer.

$$P = I^2 \times R$$

$$V_p \times I_p = V_s \times I_s$$

(6)

(Total for Question 9 = 12 marks)



- 9 (a) There is an alternating current of 3 A in the primary coil of a transformer.

There is an alternating current of 6 A in the secondary coil of the transformer.

The transformer is 100% efficient.

- (i) The size of the potential difference (voltage) across the secondary coil is

(1)

- ☐ A twice the size of the current in the primary coil
- ☐ B half the size of the current in the primary coil
- ☐ C twice the size of the voltage across the primary coil
- ☐ D half the size of the voltage across the primary coil

- (ii) Explain how an alternating current in the primary coil causes an alternating current in the secondary coil of the transformer.

(3)

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(b) The primary coil of a different transformer is connected to the 230V mains supply.

The voltage across the secondary coil is 15V.

The primary coil has 600 turns.

Calculate the number of turns on the secondary coil.

Use an equation selected from the list of equations at the end of the paper.

(2)

number of turns = ...



*(c) Figure 19 shows a coil of wire that is being rotated between the poles of a magnet.

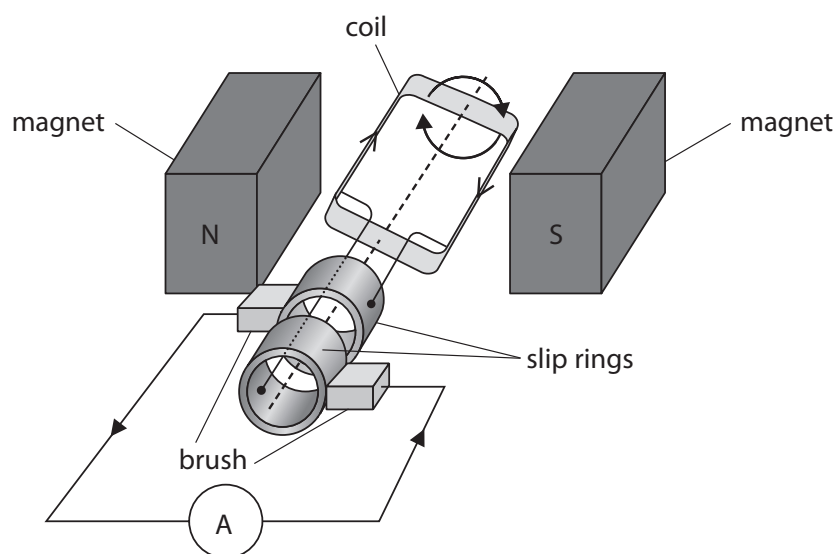


Figure 19

Figure 20 shows how the current in the coil changes during **one** complete rotation of the coil.

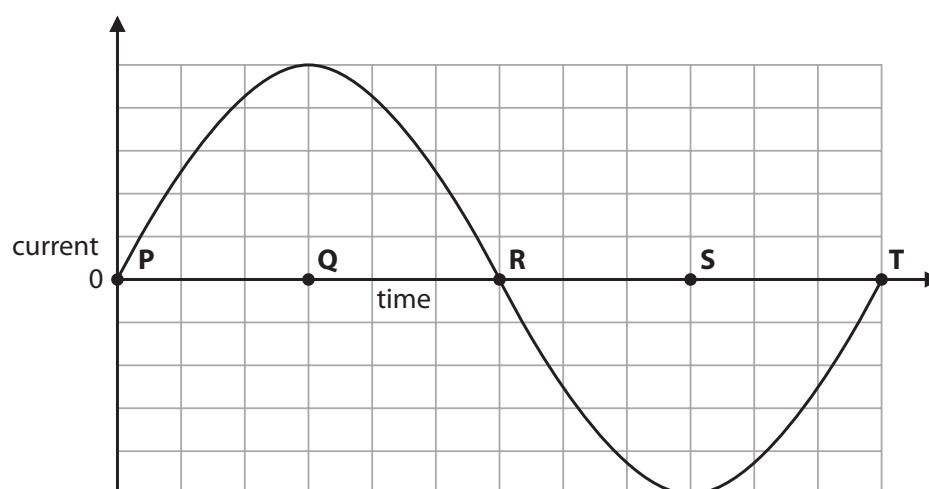


Figure 20

Explain why the current changes in the way shown by the graph in Figure 20.

Your answer should include details of the position of the coil relative to the magnet at each of the times labelled P, Q, R, S and T.

You may use diagrams to help your answer.

(6)

(Total for Question 9 = 12 marks)



10 (a) Figure 20 shows a magnet and a coil.

The coil is connected to a sensitive centre-zero ammeter.

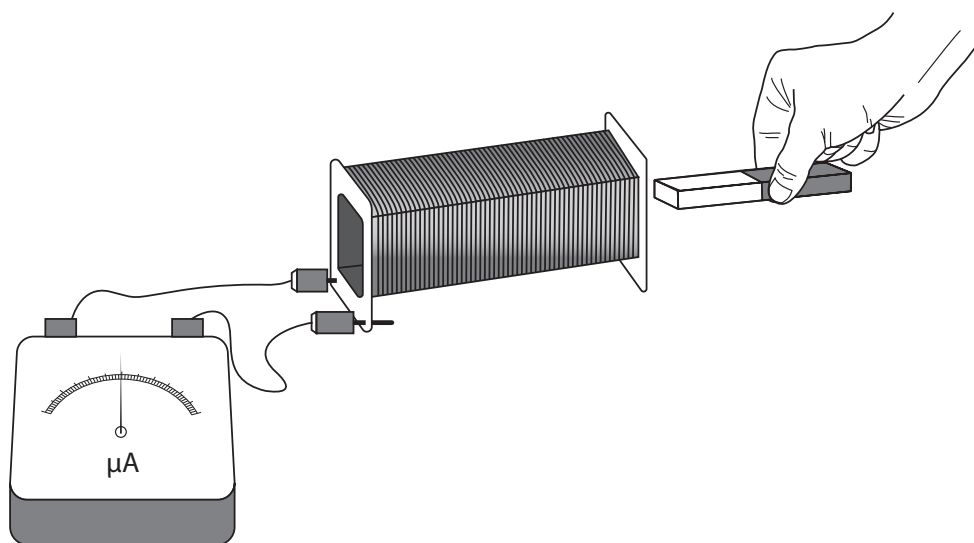


Figure 20

Explain what will be observed on the meter when the magnet is pushed in and pulled out of the coil, repeatedly.

(3)

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(b) This question is about a transformer.

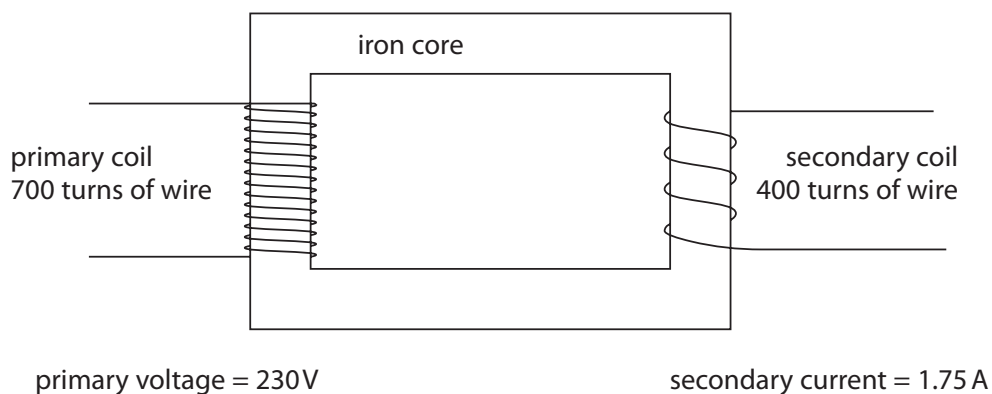


Figure 21

Calculate the current in the primary coil.

Use the information given in Figure 21 and equations selected from the list of equations at the end of this paper.

The transformer is 100% efficient.

(3)

current in the primary coil = ... A

*(c) Figure 22 shows how electricity is delivered efficiently from a power station (P) to homes (T).

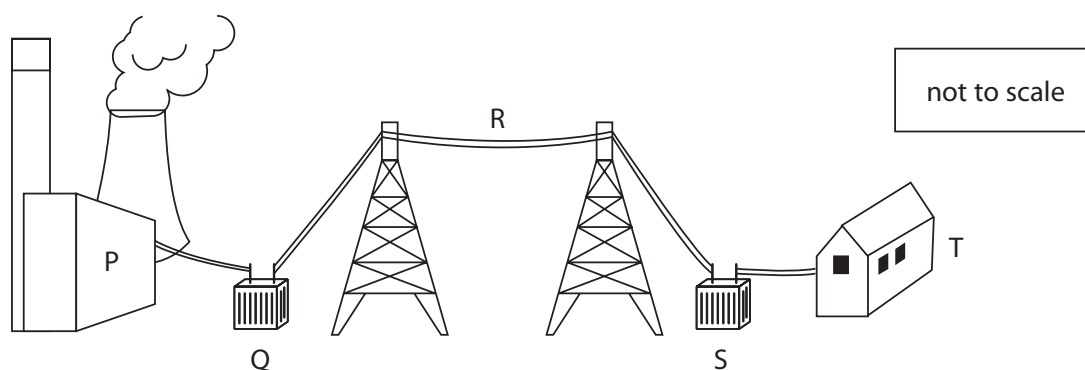


Figure 22

Using Figure 22, explain the stages in the process of delivering electricity efficiently from P to T.

Your answer should include details of the effects that Q, R and S have on efficiency.

(6)

(Total for Question 10 = 12 marks)

10 (a) Figure 23 shows a model dynamo.

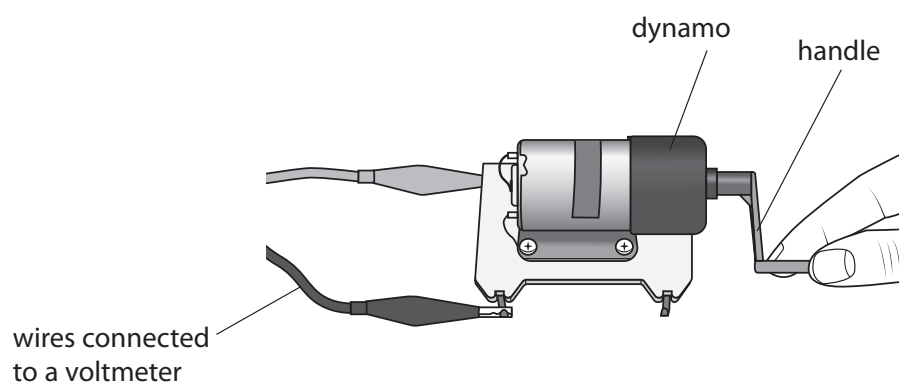


Figure 23

The dynamo contains a coil of wire that can spin inside a permanent magnet.

The dynamo produces a D.C. output.

A teacher connects a voltmeter to the terminals of the dynamo.

The teacher rotates the handle to make the coil spin inside the magnet.

Figure 24(a) shows the reading on the voltmeter.

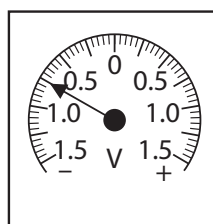


Figure 24(a)

The teacher then rotates the handle differently.

Figure 24(b) shows the new reading on the voltmeter.

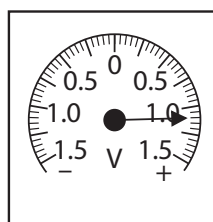


Figure 24(b)

- (i) Which row of the table shows how the rotation of the handle has changed between (a) and (b)?

(1)

	speed of rotation	direction of rotation
☐ A	(a) faster than (b)	(a) opposite to (b)
☐ B	(a) faster than (b)	(a) same as (b)
☐ C	(a) slower than (b)	(a) opposite to (b)
☐ D	(a) slower than (b)	(a) same as (b)

- (ii) The teacher connects the dynamo to a lamp.

It is now more difficult for the teacher to rotate the handle.

Explain why it is more difficult to turn the dynamo when it is connected to a lamp.

(2)

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(b) Figure 25 shows a transformer.

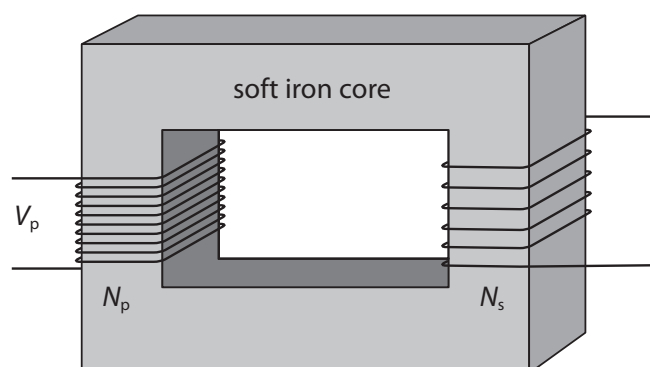


Figure 25

The number of turns on the primary coil, $N_p = 800$

The potential difference across the primary coil, $V_p = 230\text{ V}$

The number of turns on the secondary coil, $N_s = 18$

Calculate the potential difference across the secondary coil.

Use an equation selected from the list of equations at the end of the paper.

(3)

potential difference across the secondary coil = ... V

*(c) Figure 26 shows a picture of an electrical device and a simplified drawing of the important parts.

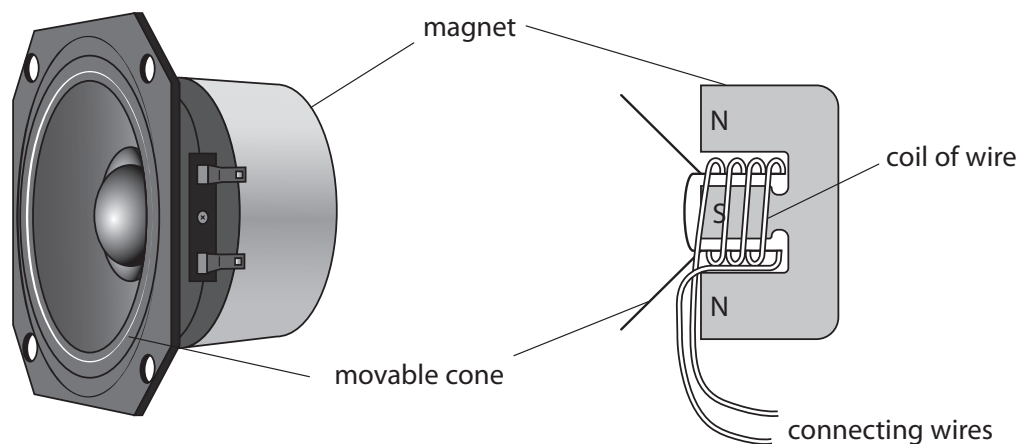


Figure 26

The device can be used as a loudspeaker or it can be used as a microphone.

Compare how the device operates when used as a loudspeaker with how the device operates when used as a microphone.

(6)

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(Total for Question 10 = 12 marks)

13-MARK QUESTIONS

1 question in this booklet



10 (a) Figure 23 shows a magnet being dropped through a coil.

The coil is connected to a sensitive voltmeter.

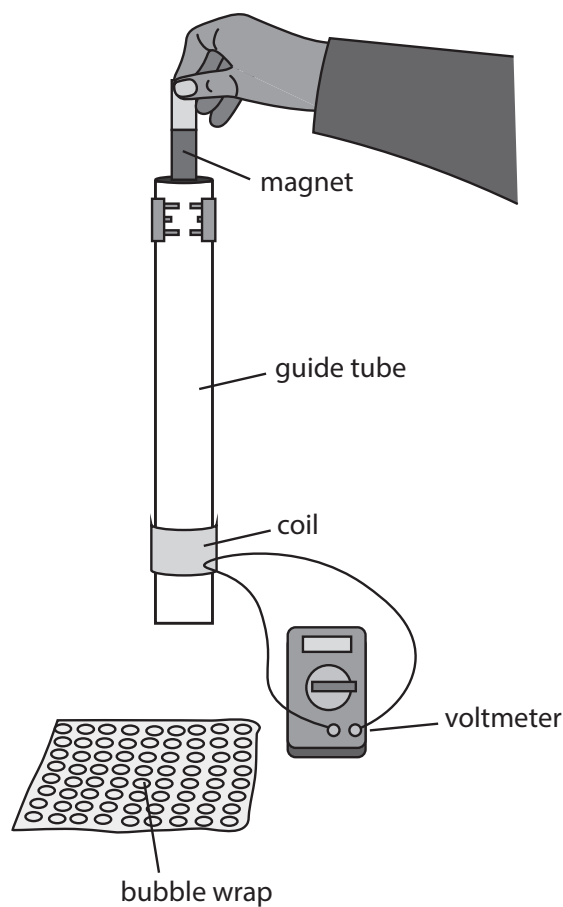


Figure 23

- (i) Explain why the voltmeter shows a reading as the magnet passes through the coil.

(3)

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- (ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.

Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4)



*(b) A transformer converts a voltage of 11 000 V to 230 V.

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V.

Your answer should include

- details of the structure of a transformer
- how a transformer works, using ideas of electromagnetic induction
- how the design of this transformer enables this exact voltage of 230 V to be obtained.

You may draw a diagram to help your answer.

(6)



(Total for Question 10 = 13 marks)

MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Additional guidance	Mark
6(a)(i)	an explanation linking alternating current in the primary coil (1) changing magnetic field (in the iron core) (1) <u>induces</u> an (alternating) p.d. (across the secondary coil) (1)	mains is alternating / a.c. <u>induces</u> (alternating) current (in the secondary coil) ignore step-up/step-down	(3) AO1

Question number	Answer	Additional guidance	Mark
6(a)(ii)	substitution into $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ (1) $\frac{230}{1.5} = \frac{1840}{N_s}$ rearrangement and evaluation (1) ($N_s =$) 12 OR ALTERNATIVE METHOD rearrangement (1) ($N_s =$) $\frac{V_s \times N_p}{V_p}$ substitution and evaluation (1) ($N_s =$) 12	($N_s =$) $\frac{1840 \times 1.5}{230}$ award full marks for correct answer without working.	(2) AO2

Question number	Answer	Additional guidance	Mark
6(b)	an explanation linking a battery supplies d.c. (1) (diode) only allows current/charge flow in one direction (1)	a battery requires d.c. (to recharge) battery would be discharged (by a.c) a.c. (from secondary) unsuitable for battery diode rectifies / converts a.c. to d.c.	(2) AO1

Question number	Answer	Additional guidance	Mark
6(c)	an explanation linking (commutator) carries current from (battery) wires to coil (1) direction of current in coil(s) changes each half turn (1) to keep force between coil(s) and magnet in the same direction (1)	mark points may be seen as candidate's annotation(s) on Figure 10 allow motor for coil throughout current enters copper conductor(s) via (carbon) brush(es) (commutator) connects coil to battery reverses current (in coil) / swaps connections (to the coil) keep coil(s) turning in the same direction keep coil continuously turning	(3) AO1

Total for Question 6 = 10 marks



Question number	Answer	Mark
7(a)(i)	C  A and B are incorrect because there is no current when the magnet is stationary in the coil. D is incorrect because there is always a current when the magnet is moving in the coil	(1)

Question number	Answer	Additional guidance	Mark
7(a)(ii)	any two from moving the magnet faster (1) using a stronger magnet (1) more turns/rotations on the coil (1)	do not allow increase size of coil	(2)

Question number	Answer	Additional guidance	Mark
7(b)	an explanation linking in a logical order any four of the following:- (alternating) current produces (changing) magnetic field (around coil)(1) the coil is in a magnetic field (of fixed magnets) (1) (varying current in magnetic field) produces a force (1) the force on the coil /cone (continuously) changes direction (1) the paper cone /coil vibrates/ moves to and fro (1)	magnetic fields interact making the air molecules (in the cone) vibrate	(4)

Question number	Answer	Additional guidance	Mark
7 (c)(i)	{step up/increase}(output) voltage or {stepdown/ decrease}(output) current		(1)

Question number	Answer	Additional guidance	Mark
7(c)(ii)	substitution (1) $\frac{230}{V_s} = \frac{18}{26}$ rearrangement (1) $(V_s =) \frac{230 \times 26}{18}$ evaluation (1) 330(V)	substitution and re-arrangement in either order allow 332 (.2) (V) allow answers between 322 (V) and 333 (V) where candidates have truncated an intermediate calculation 159.2 (V), 160 (V) gains 1 mark award full marks for the correct answer without working	(3)

Total marks for question 7 = 11



Question number	Answer	Additional guidance	Mark
8 (a) (i)	selection and substitution (1) (KE =) $\frac{1}{2} \times 1200 \times 16(.0)^2$ evaluation in kJ (1) (KE =) 150 (kJ)	(KE =) $\frac{1}{2} \times 1200 \times 16(.0)^2 \times 10^{-3}$ accept any value that rounds to 150 e.g. 153.6 award full marks for correct answer without working. award 1 mark for 153.6 or 150 to any other power of ten	(2) AO2

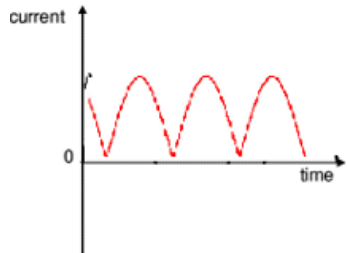
Question number	Answer	Additional guidance	Mark
8 (a) (ii)	selection and substitution (1) $17.5 (x 10^3) = \frac{126 (x 10^6)}{t}$ re-arrangement and evaluation (1) (t=) 2(.0) (h)	alternative method selection and rearrangement (1) (t =) $\frac{E(nergy)}{P(ower)}$ or (t=) $\frac{126 (x 10^6)}{17.5 (x 10^3)}$ (substitution and) evaluation (1) (t=) 2(.0) (h) award full marks for correct answer without working. allow 1 mark for 7(.2) to any power of ten (incorrect time conversion) allow 1 mark for 2(.0) to any power of 10 (POT error)	(2) AO2

Question number	Answer	Additional guidance	Mark
8 (a) (iii)	an explanation linking (energy transfers when the car is decelerating) (from) kinetic energy (store) (1) (to) chemical energy (store) (1)	idea of energy that would be otherwise wasted uses an electrical pathway {electric current / electricity / emf} produced allow mechanical for kinetic in this context recharges battery increases available energy store of battery more useful energy available	(2) AO2

Question number	Answer	Additional guidance	Mark
8 (b) (i)	either calculation of time: substitution (1) $(t =) \frac{126 \times 10^6}{15 \times 400 \times 3600}$ evaluation (1) (t=) 5.8(3) (h) conclusion (1) claim is justified as the time is less (than 6 hours) or calculation of energy: substitution (1) $6 \times 3600 = \frac{E}{15 \times 400}$ rearrangement and evaluation (1) E = 130 MJ conclusion (1) claim is justified as energy (in 6 hours) is more than (126 MJ) required.	accept correct time conversion e.g. 5h 50 min 350 min 21 000 s award 2 marks for correct answer without working. award 1 mark for answer of either 2.1 or 5.8(3) to any other power of ten allow relevant comment based on incorrectly calculated time (independent mark) accept 129.6 MJ accept 129 600 000 J allow relevant comment based on incorrectly calculated energy (independent mark)	(3) AO3

Question number	Answer	Additional guidance	Mark
8 (b) (ii)	substitution (1) $126 (\times 10^6) = Q \times 400$ re-arrangement and evaluation (1) $(Q =) 315\,000 \text{ (coulombs)}$	alternative method re-arrangement (1) $(Q =) \frac{E}{V}$ or $(Q =) \frac{126 (\times 10^6)}{400}$ (substitution and) evaluation (1) $(Q =) 315\,000 \text{ (coulombs)}$ accept answers rounding to 320 000 (coulombs) allow one mark for answers rounding to 3.2 to any other power of ten award two marks for correct answer without working.	(2) AO2

Total 11 marks

Question Number:	Answer	Mark
9(a)	 B The only correct answer is B <i>A is incorrect because it shows an alternating current which is produced by an alternator and not by a dynamo</i> <i>C is incorrect because it shows a square waveform which is not produced by a dynamo</i> <i>D is incorrect because it shows current linearly increasing with time and this is not produced by a dynamo</i>	(1) AO 3 2b

Question Number:	Answer	Additional Guidance	Mark
9(b)(i)	an explanation linking: (p.d. / current is only induced by a) changing magnetic field (1) a changing current (is needed to create a changing magnetic field) (1)	alternating magnetic field the voltage/current (as shown) is not changing	(2) AO 1 1

Question Number:	Answer	Additional Guidance	Mark
9(b)(ii)	substitution into $\frac{V_P}{V_S} = \frac{N_P}{N_S} \quad (1)$ $\frac{25}{V_S} = \frac{30}{150}$ rearrangement (1) $V_S = \frac{25 \times 150}{30}$ evaluation (1) ($V_S =$) 130 (V)	substitution and rearrangement in either order $\frac{V_S}{25} = \frac{150}{30}$ allow 120 or 125 award full marks for correct answer without working	(3) AO 2 1

Question Number	Answer	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1(6 marks) Understanding of physics • (long) transmission wires have resistance • reduced p.d. at the destination • (thermal) energy is dissipated in the transmission wires • this creates a power loss (refers to $P=I^2R$) • transformers are used to step up to a high voltage for transmission • this means a low current (refers to $V_P I_P = V_S I_S$) • so power loss is small(er) • transformers used to step down to a safer voltage for consumers • consumer wires are shorter and so power loss is less of an issue	(6) AO 1 1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) - Presents an explanation that is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	- An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) - Presents an explanation of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	- An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

(Total for Question 9 = 12 marks)



Question number	Answer	Additional guidance	Mark
9ai	D half the size of the voltage across the primary coil A and B are incorrect because the voltage will not necessarily be twice or half the value of the current C is incorrect because the voltage across secondary coil will be less than that across the primary coil		(1) AO2

Question number	Answer	Additional guidance	Mark
9 aii	an explanation linking three of magnetic field in primary / secondary coil / core (due to current) (1) magnetic field is alternating (1) (this magnetic) field cuts/links secondary coil (1) <u>induces</u> an alternating voltage (across secondary coil) (1)		(3) AO1

Question number	Answer	Additional guidance	Mark
9b	substitution into $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ (1) $\frac{230}{15} = \frac{600}{N_s}$ Rearrangement and evaluation (1) $(N_s =) \frac{600 \times 15}{230}$ $= 39$	allow substitution and rearrangement in either order accept values that round to 39 e.g. 39.13 award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers of that round to 0.026 (eg 0.255) (substitution mark)	(2) AO2

Question number	Indicative content	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • coil moving/cuts through magnetic field • coil experiences changing magnetic field • induces a voltage/current in the coil • size of voltage/current depends on rate of change of magnetic field • rate of change depends on angle between direction of movement and direction of field. • greatest (rate of) change when coil moving perpendicular to field. • maximum current at Q and S • coil is horizontal at Q and S • coil moving vertically up at Q and down at S • direction of current at Q opposite to S. • no change when coil moving parallel to field. • zero current at P, R and T • coil vertical at P, R, and T Credit can be given for correctly labelled diagrams	(6) AO2 and AO3

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)



Question number	Answer	Additional guidance	Mark
10 (a)	an explanation linking three from: needle oscillates (1) either side of (centre) zero (1) (in response to) pole entering and pole leaving (end of coil) (1) (producing) {p.d. / voltage / emf} <u>induced</u> (via changing magnetic field) (1) (producing) an <u>alternating</u> current (1)	needle vibrates / moves side to side positive and negative accept N / north / S / south for pole do not accept magnet accept current produced / induced accept (induce) an <u>alternating</u> emf / voltage	(3) A01.2

Question number	Answer	Additional guidance	Mark
10(b)	selecting, rearranging and substituting (1) $(V_s = \frac{N_s}{N_p} \times V_p)$ $= \frac{400}{700} \times 230$ selecting, rearranging and substituting (1) $(I_p = \frac{V_s}{V_p} \times I_s)$ $= \frac{131(.429)}{230} \times 1.75$ evaluation (1) 1(.00) (A)	accept correct alternative calculation routes 1 mark for any voltage rounding to 130 V $\frac{130 \times 1.75}{230}$ 0.989 (A) using 130 award full marks for the correct answer without working	(3) A02.1

SSQ NO:	CS NO:	Answer	Mark
10(c)*		Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 strand 1 (6 marks) • Q is a step-up transformer • step up V causes I to be lower • voltage increases (25 kV to 400 kV) • R is a transmission line / (national) grid / cable • smaller currents in transmission lines • less energy lost though heating those wires • $V = I \times R$ • smaller voltage drop across the transmission line • S is a step-down transformer reducing voltage to 230V • ready for use in homes T • detail of transformers – iron core + coils • transformers are not 100% efficient • idea of power as $V \times I$ or $P = I^2 R$	(6) AO1.1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which may be inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
	0	No rewardable material.	Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
Level 1	1–2	<u>Additional guidance</u> isolated ideas e.g. identifying two of Q, S and R	<u>Possible candidate responses</u> Q and S are transformers R is a wire / cable
Level 2	3–4	<u>Additional guidance</u> more detail about the process of what at least two of Q, R and S do / achieve	<u>Possible candidate responses</u> Q is a step-up transformer - voltage increases R is a high voltage transmission line / cable / part of the National Grid S is a step-down transformer → idea of reducing voltage to 230V
Level 3	5–6	<u>Additional guidance</u> understanding is detailed and fully developed. includes detail about functions and efficiency explanation	<u>Possible candidate responses</u> need for step up and step-down functions via transformers to transfer energy at high voltages (voltage may be specified e.g. 400kV) transformers are not 100% efficient smaller currents in transmission lines so less energy lost though heating those wires: makes system more efficient

Total 12 marks

Question number	Answer	Additional guidance	Mark
10 (a) (i)	C (a) slower than (b) and (a) opposite to (b) B and D are incorrect because the direction of the readings are opposite and so the rotations must be opposite A is incorrect because the value in (a) is less than the value in (b) and so the rotation cannot be faster		(1) AO1

Question number	Answer	Additional guidance	Mark
10 (a) (ii)	either an answer in terms of magnetic fields and forces: current in the (dynamo) coil generates a magnetic field (1) (interaction of) fields cause force (that opposes motion) (1) OR an answer in terms of output energy and input work: energy is being transferred to the lamp (1) additional work is being done (by teacher) / additional energy is necessary (1)	accept lamp uses (thermal / heat / light) energy (to light up) ignore reference to greater (electrical) resistance	(2) AO1



Question number	Answer	Additional guidance	Mark
10 (b)	substitution into $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ (1) $\frac{230}{V_s} = \frac{800}{18}$ rearrangement (1) $(V_s =) \frac{18 \times 230}{800}$ evaluation (1) (Vs =) 5.2 (V)	alternative method re-arrangement (1) $(V_s =) \frac{V_p \times N_s}{N_p}$ substitution (1) $(V_s =) \frac{18 \times 230}{800}$ evaluation (1) (Vs =) 5.2 (V) allow values that round to 5.2 (e.g. 5.175) award 1 mark for answers that round to 10 000 (e.g. 10 222) award full marks for correct answer without working.	(3) AO2

Question number	Indicative content	Mark
*10(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Basic facts • Sound is vibrations (of air) • Loudspeaker emits / gives out sound • Loudspeaker is an output device • Microphone accepts / takes in sound • Microphone is an input device Principles of operation • Alternating current or (electrical) signal sent into a loudspeaker • Loudspeaker cone / coil vibrates (air) • Motor effect in loudspeaker • Microphone cone / coil is vibrated by air/sound • Alternating current / (electrical) signal is produced by microphone • Electromagnetic induction in microphone Details of operation of loudspeaker • Alternating current or (electrical) signal in coil produces changing magnetic field • (changing) Force between magnetic field of coil and magnet. • Frequency / amplitude of sound depends on frequency / amplitude of alternating current Details of operation of microphone • Coil oscillates in a magnetic field • Generates an alternating p.d. (across the wires) / alternating current / signal • Frequency / amplitude of alternating p.d. / current depends on amplitude / frequency of the sound	(6) AO2

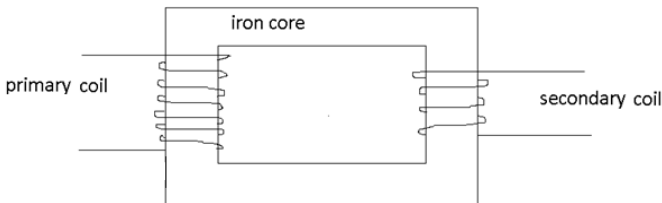
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	- The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. - Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	- The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. - Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	- The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. - Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
	0	No rewardable material.	e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
Level 1	1-2	<u>Additional guidance</u> Basic facts	<u>Possible candidate responses</u> A loudspeaker vibrates to make sound.
Level 2	3-4	<u>Additional guidance</u> Principles of operation supported by basic facts. Facts may be implied by principles.	<u>Possible candidate responses</u> Sound vibrates the coil in the microphone. This makes a signal. OR A loudspeaker uses the motor effect to vibrate the cone and make a sound.
Level 3	5-6	<u>Additional guidance</u> Principles and details of operation. Principles may be implied by details. One device may be more developed than the other but both devices must be referenced.	<u>Possible candidate responses</u> Alternating current in the loudspeaker coil makes the coil move inside the magnet. This forces the cone to vibrate and produce sound. The microphone makes an alternating current.

Total 12 marks

Question number	Answer	Additional guidance	Mark
10 a i	an explanation linking any three from (magnetic) field lines cut / intercepted by coil (1) induces a voltage / current (in the coil) (1) voltmeter measures (induced) voltage / potential difference (1) electrons (in the wire) experience a force / move in response to (a changing) field (1) (induced) voltage / current changes magnitude / direction as magnet passes through (1)	(magnetic) field lines interact with coil / act on coil coil experiences changing (magnetic) field / flux (linkage) produces magnetism or magnetic poles in the coil voltmeter reads / shows current voltmeter measures induced voltage scores 2	(3) AO2.2

Question number	Answer	Additional guidance	Mark
10 a ii	practical suggestions to include any four from drop magnet from different heights (1) use of metre rule (1) change height in steps (e.g. of 5 cm) (1) record (maximum) meter reading / voltage (1) repeat readings for each drop and take an average (1) set the digital voltmeter on a.c. (1) plot an appropriate graph – e.g. voltmeter reading against height (1)	move the coil to different positions use different length tubes allow ruler / tape measure	(4) exp AO3.3

SSQ NO:	CS NO :	Answer	Mark
10(b)*		Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 strand 1 (6 marks) Elements of physics understanding included in explaining the design: details of structure  credit diagram for construction as part of the explanation • (closed) iron core • primary and secondary coils • primary coils number (considerably) different from secondary coils number how a transformer works • a.c. in primary • causes changing magnetic field in (iron) core • induces a.c. voltage in secondary coil	(6) Exp AO1.1

		- stepping down or reducing the voltage / more turns on primary than secondary how 230V is obtained - achieved by same ratios of $\frac{V_p}{V_s}$ and $\frac{N_p}{N_s}$ - ratio 11 000:230 i.e. $\approx 48:1$	
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Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- Demonstrates elements of physics understanding, some of which may be inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	- Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	- Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> basic ideas about construction OR how transformer works OR use of ratio equation	<u>Possible candidate responses</u> use of primary and secondary coils on iron core use of a.c. / iron core and (changing) magnetic field step down transformer with smaller number of turns for secondary
Level 2	3–4	<u>Additional guidance</u> more developed ideas about construction AND how transformer works OR use of ratio idea	<u>Possible candidate responses</u> use of different sized primary and secondary coils and iron core use of a.c. in primary which causes changing magnetic field in (iron) core use of $\frac{V_p}{V_s} = \frac{N_p}{N_s}$
Level 3	5–6	<u>Additional guidance</u> understanding is detailed and fully developed. includes detail about construction AND how transformer works AND use of ratio idea for transformers one aspect of the three treated weakly may be tolerated	<u>Possible candidate responses</u> use of primary and secondary coils and iron core with primary coils number (considerably) bigger than secondary coils number AND (alternating) current in primary coil produces changing magnetic field in (iron) core inducing an a.c. voltage in the secondary coil AND ratio is 11000 / 230 or 48:1

Summary for guidance**Total question 10 = 13 marks**