

Electromagnetic Induction and Transformers

Total marks:18

Q1.

Figure 18 shows a transformer.

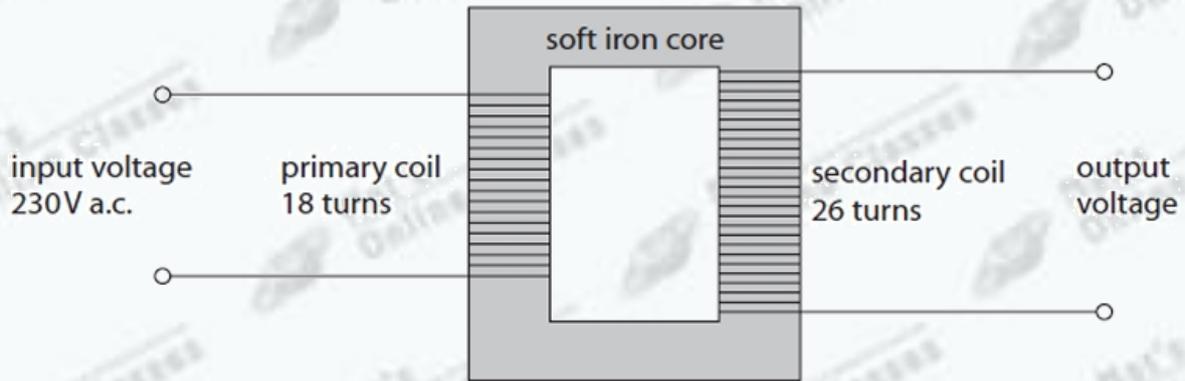


Figure 18

(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 = 4 marks)

Q2.

This question is about using the mains electricity supply.

A transformer is used to connect a laptop computer to the mains electricity supply.

The input voltage to the transformer is 230 V.

The output current from the transformer is 2.37 A.

The transformer has an output voltage of 19.0 V.

The transformer used is 100% efficient.

Calculate the input current to the transformer.

Use the equation

$$\text{input current} \times \text{input voltage} = \text{output current} \times \text{output voltage}$$

(3)

$$\text{input current} = \dots\dots\dots \text{ A}$$

(Total for question = 3 marks)

Q3.

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

The voltage across the secondary coil is 15 V.

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)

$$\text{number of turns} = \dots\dots\dots$$

(Total for question = 2 marks)

Q4.

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

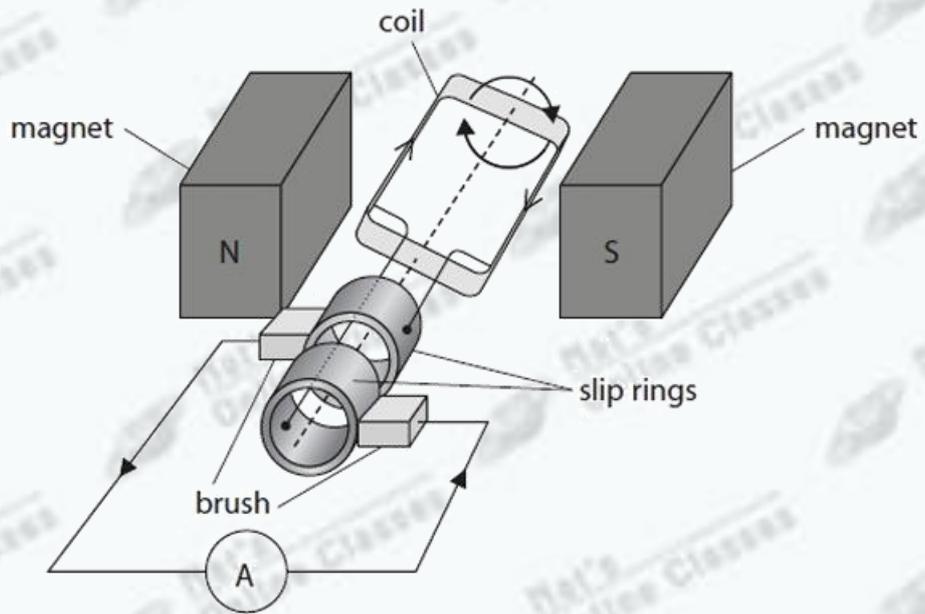


Figure 19

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

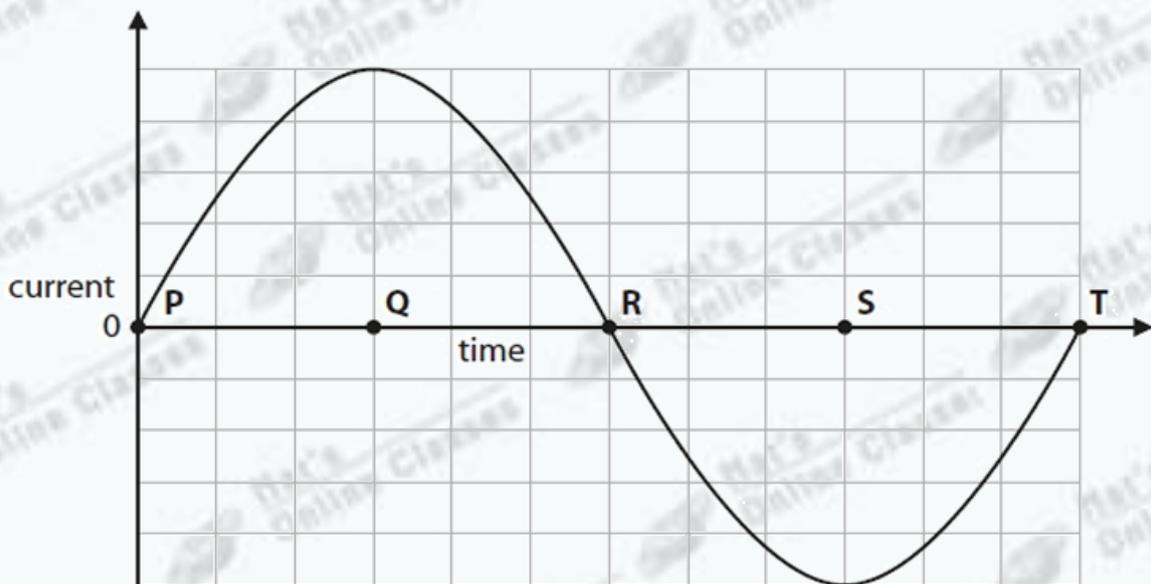


Figure 20

Q5.

Complete the following sentences using one of the phrases from the box below.

efficiency is reduced
the national grid
a power station
heat loss is reduced
a transformer

(i) Electrical power is generated at

(1)

.....

(ii) Electricity is transmitted over long distances by transmission lines that are part of

(1)

.....

(iii) Electricity is transmitted at high voltages so that

(1)

.....

(Total for question = 3 marks)

Mark scheme:

Q1.

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

Question number	Answer	Additional guidance	Mark
(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)

Q2.

Question number	Answer	Additional guidance	Mark
	<p>substitution (1) $(I_p) \times 230 = 19 \times 2.37$</p> <p>rearrangement (1) $(I_p) = (19.0 \times 2.37) \div 230$</p> <p>evaluation (1) input current = 0.196 (A)</p>	<p>rearrangement and substitution in either order</p> <p>allow numerical values written above equation</p> <p><i>input voltage = (output voltage × output current) ÷ input voltage</i></p> <p>award full marks for any answer that rounds to 0.2(00) (A)</p> <p>award 1 mark for 5.1(07) (substitution with upside down rearrangement)</p> <p>award full marks for correct answer without working</p>	<p>(3) AO2</p>

Q3.

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

Q4.

Question number	Indicative content	Mark
*	<p>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.</p> <p>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.</p> <ul style="list-style-type: none"> • 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 <p>Credit can be given for correctly labelled diagrams</p>	<p>(6) AO2 and AO3</p>

Level	Mark	Descriptor
	0	<ul style="list-style-type: none"> • No awardable content
Level 1	1–2	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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)

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> isolated facts about interaction of electric current and magnetic fields or one salient feature of the graph	<u>Possible candidate responses</u> the coil experiences a changing magnetic field as it rotates. Size of the (induced) current varies.
Level 2	3–4	<u>Additional guidance</u> simple description of why current changes (either in direction or magnitude) and reference to at least one relevant point on the graph.	<u>Possible candidate responses</u> at position R the (plane of the) coil is parallel to the field and there is no current Or at position Q the coil is moving quickly through the field and the current is large.
Level 3	5–6	<u>Additional guidance</u> Full description of why current changes in magnitude or direction and reference to at least two relevant points on the graph	<u>Possible candidate responses</u> At Q, the coil is horizontal and moving most quickly across the field so the current is at its greatest. At R the coils is vertical and moving parallel to the field so there is no current.

Q5.

Question Number:	Answer	Mark
(i)	a power station	(1) AO 1 1

Question Number:	Answer	Mark
(ii)	the national grid	(1) AO 1 1

Question Number:	Answer	Mark
(iii)	heat loss is reduced	(1) AO 1 1