3.23 Electromagnetic Induction and Transformers: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 In an alternator, the speed at which the coil rotates can be changed.

(a) State the effect of increasing the speed of rotation of the coil on (i) the frequency of the alternating output, and (ii) the peak potential difference produced. **(2)**

(Total for Question 1 is 2 marks)

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2 An alternator's rotating coil completes 50 full rotations every second, producing an alternating potential difference at UK mains frequency. Use the equation: frequency = 1 / time period (f = 1 / T).

(a) State the frequency of the potential difference produced when the coil rotates 50 times per second. **(1)**

(b) The coil is then slowed so that it rotates 25 times per second. Calculate the new frequency, and state what happens to the period of the output potential difference-time graph. **(2)**

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(Total for Question 2 is 3 marks)

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3 A moving-coil microphone changes sound into a varying electric current using electromagnetic induction.

(a) Describe how the microphone does this. Your answer should refer to: the diaphragm; the coil; the permanent magnet. **(4)**

(Total for Question 3 is 4 marks)

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4 Higher Tier only. A step-up transformer has 300 turns on its primary coil and 1500 turns on its secondary coil. The potential difference across the primary coil is 12 V. Use the Physics Equations Sheet. Use the equation: potential difference across primary coil / potential difference across secondary coil = number of turns on primary coil / number of turns on secondary coil (Vp / Vs = Np / Ns).

(a) Calculate the potential difference across the secondary coil. **(3)**

(Total for Question 4 is 3 marks)

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5 In real transformers, some energy is wasted as heat rather than being usefully transferred from the primary coil to the secondary coil.

(a) State the energy store to which this wasted energy is transferred. **(1)**

(b) Give one reason why energy is wasted as heat in a real transformer. **(1)**

(Total for Question 5 is 2 marks)

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6 The National Grid transmits electrical power across the country using alternating current (a.c.), stepping the potential difference up and down using transformers at different points in the network.

(a) Explain why the National Grid must use alternating current (a.c.), rather than direct current (d.c.), for this system to work. **(3)**

(Total for Question 6 is 3 marks)

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7 An alternator and a dynamo both use the generator effect to generate electricity, but they produce different types of electrical output. Compare how an alternator and a dynamo work, and explain why they produce different types of output. In your answer, refer to: the components used to connect the rotating coil to the circuit; the shape of the potential difference-time graph produced by each generator.

(Total for Question 7 is 6 marks)

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Mark scheme · 3.23 Electromagnetic Induction and Transformers: 30-minute Pack

Question 1

(a) (i) the frequency of the alternating output increases **B1**

(a) (ii) the peak potential difference produced increases **B1**

(a) Answer: Both the frequency of the output and the peak potential difference produced increase.

Question 2

(a) 50 Hz **B1**

(a) Answer: 50 Hz

(b) new frequency = 25 Hz **B1**

(b) the period doubles (increases from 0.02 s to 0.04 s), oe **B1**

(b) Answer: 25 Hz; the period doubles, from 0.02 s to 0.04 s.

Question 3

(a) sound waves cause the diaphragm to vibrate **B1**

(a) the diaphragm is attached to a coil of wire, so the coil vibrates/moves with it **B1**

(a) the coil moves within the magnetic field of a permanent magnet, so it moves relative to the field **B1**

(a) this induces a varying/alternating potential difference (and current) in the coil, by electromagnetic induction, that varies in the same pattern as the sound wave **B1**

(a) Answer: Sound makes the diaphragm vibrate; this moves the attached coil within the magnetic field of a permanent magnet, inducing a varying electrical signal (by electromagnetic induction) that matches the pattern of the sound wave.

Question 4

(a) correct rearrangement: Vs = Vp * (Ns / Np), oe **M1**

(a) correct substitution: Vs = 12 * (1500 / 300), oe **M1**

(a) Vs = 60 V, cao **A1**

(a) Answer: Vs = 60 V

Question 5

(a) the thermal energy store of the surroundings (the transformer and the air around it heat up), oe **B1**

(a) Answer: The thermal energy store of the surroundings.

(b) any one from: resistance in the coils causes heating as current flows through them; eddy currents are induced in the iron core; not all of the magnetic field lines from the primary coil pass through the secondary coil (flux leakage), oe **B1**

(b) Answer: E.g. resistance in the coils causes heating as current flows through them.

Question 6

(a) the National Grid relies on transformers to step the potential difference up (for efficient transmission) and step it back down (for safe use in homes), oe **B1**

(a) transformers only work with an alternating supply, because they rely on a constantly changing magnetic field to induce a potential difference in the secondary coil, oe **B1**

(a) a direct current supply would produce a constant magnetic field, so no potential difference would be induced, and the transformers (and so the whole system) would not work, oe **B1**

(a) Answer: The Grid relies on transformers to step the potential difference up and down; transformers only work with a.c., since they need a constantly changing magnetic field to induce a pd. A d.c. supply gives a constant field, so no pd would be induced and the transformers would not work.

Question 7

Level 0 No relevant content. **0**

Level 1 Basic, isolated statements are made about an alternator and/or a dynamo, with little or no comparison, e.g. simple identification of a.c. or d.c. output only. **1-2**

Level 2 Relevant points are made about both an alternator and a dynamo, showing some comparison, but the description may be incomplete or the link between construction and output may not be clear. **3-4**

Level 3 A clear and detailed comparison is given, correctly linking the construction of each generator (slip rings or split-ring commutator) to the shape of its output potential difference-time graph, with correct use of scientific vocabulary throughout. **5-6**

Indicative content:

- Both an alternator and a dynamo generate a potential difference/current by rotating a coil within a magnetic field, using the generator effect.
- An alternator is connected to the circuit using slip rings (and brushes), which allow the coil to rotate freely while keeping the same connections throughout each rotation.
- Because the connections do not change, the induced pd/current reverses direction every half rotation, producing alternating current (a.c.).
- The output graph of an alternator is a smooth sine wave that alternates between positive and negative values (above and below zero).
- A dynamo is connected to the circuit using a split-ring commutator, which swaps the connections every half rotation.
- This swap keeps the output the same polarity/direction, so a dynamo produces direct current (d.c.).
- The output graph of a dynamo varies in size but stays on one side of zero (it does not go negative), forming a series of humps.
- In both cases, the output pd is greatest when the coil sides are moving at right angles to the magnetic field, and zero when the coil sides are moving parallel to the field.

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