3.23 Electromagnetic Induction and Transformers: Test Pack

Total Marks

AQA 8464 · Calculator allowed · about 25 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Electromagnetic induction (the generator effect) can be demonstrated using a bar magnet and a coil of wire connected to a centre-zero galvanometer.

(a) State what is meant by the term electromagnetic induction. **(2)**

(Total for Question 1 is 2 marks)

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2 A transformer is supplied with 500 W of electrical power at its primary coil. The useful power output at its secondary coil is 460 W. Use the equation: efficiency = useful output power / total input power.

(a) Calculate the efficiency of the transformer, giving your answer as a percentage. **(2)**

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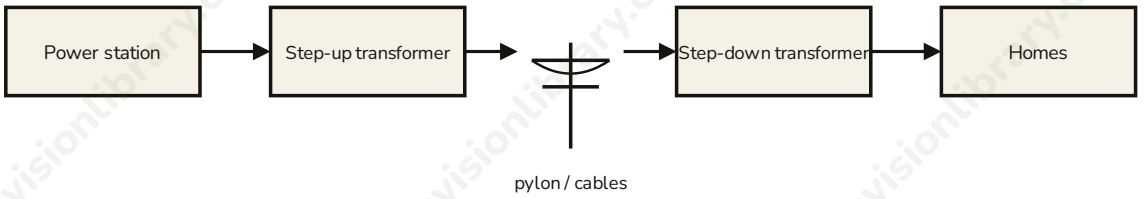
(b) Calculate the power wasted as heat by the transformer. **(1)**

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(Total for Question 2 is 3 marks)

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3 Electricity generated at a power station is transmitted across the country using the National Grid. At the power station, a step-up transformer increases the potential difference from 25,000 V (25 kV) to 400,000 V (400 kV) before transmission. The current leaving the power station (the primary current) is 800 A. Assume the transformer is 100% efficient. Use the Physics Equations Sheet. Use the equations: potential difference across primary coil * current in primary coil = potential difference across secondary coil * current in secondary coil (Vp * Ip = Vs * Is); power = potential difference * current (P = V * I).



(a) Calculate the current in the transmission cables (the secondary current, Is). **(3)**

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(b) Calculate the power transmitted through the cables. Give your answer in megawatts (MW). **(3)**

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(c) Explain why transmitting electricity at a high potential difference and low current (rather than a low potential difference and high current) reduces the energy wasted as heat in the transmission cables. **(3)**

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(Total for Question 3 is 9 marks)

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4 Higher Tier only. A company claims that a new transformer core material will improve efficiency to over 100%, so that the transformer 'creates extra electrical energy from nothing'.

(a) Evaluate this claim, using your knowledge of the conservation of energy. **(4)**

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(Total for Question 4 is 4 marks)

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Mark scheme · 3.23 Electromagnetic Induction and Transformers: Test Pack

Question 1

(a) a potential difference (and current, if the circuit is complete) is induced across the ends of a conductor, oe **B1**

(a) when there is relative motion between the conductor and a magnetic field, or when the magnetic field through the conductor changes, oe **B1**

(a) Answer: A potential difference (and current, in a complete circuit) is induced across a conductor when there is relative motion between the conductor and a magnetic field, or when the magnetic field through it changes.

Question 2

(a) efficiency = (460 / 500) * 100, oe **M1**

(a) 92%, cao (allow awrt 92%) **A1**

(a) Answer: 92%

(b) 40 W (= 500 - 460), cao **B1**

(b) Answer: 40 W

Question 3

(a) correct rearrangement: Is = (Vp * Ip) / Vs, oe **M1**

(a) correct substitution: Is = (25000 * 800) / 400000, oe **M1**

(a) Is = 50 A, cao **A1**

(a) Answer: Is = 50 A

(b) uses P = V * I with a matching pair of primary or secondary values, oe **M1**

(b) correct substitution, e.g. P = 25000 * 800 (or 400000 * 50), oe **M1**

(b) P = 20,000,000 W = 20 MW, cao (allow awrt 20 MW) **A1**

(b) Answer: P = 20 MW (20,000,000 W)

(c) the power wasted as heat in the cables is given by $P = I^2 * R$, for a fixed cable resistance R, oe **B1**

(c) transmitting at a high pd means a much smaller current is needed to transmit the same power, since P = V * I, oe **B1**

(c) because power loss depends on current squared, a smaller current greatly reduces the power/energy wasted as heat, making transmission more efficient, oe **B1**

(c) Answer: Power wasted as heat is $P = I^2 * R$ for a fixed cable resistance. A high pd needs a much smaller current to transmit the same power (P = V * I); since power loss depends on the current squared, a smaller current greatly reduces the energy wasted.

Question 4

(a) the claim is not possible / is incorrect **B1**

(a) the law of conservation of energy states that energy cannot be created or destroyed, only transferred from one store to another, oe **B1**

(a) a transformer can only transfer the electrical energy supplied to its primary coil; the useful output energy at the secondary coil can never be greater than the input energy, oe **B1**

(a) in reality, some energy is always wasted (e.g. as heat, due to resistance in the coils or eddy currents in the core), so a real transformer is always less than 100% efficient, never more, oe **B1**

(a) Answer: The claim is not possible. By the conservation of energy, energy cannot be created; a transformer can only transfer the input energy, so useful output can never exceed input. In reality some energy is always wasted as heat, so efficiency is always below 100%.

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