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HIGHER

P7H Magnetism and Electromagnetism: Higher Tier Practice

AQA 8463 · Calculator allowed · about 90 minutes

Total Marks

Name: ________________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 State the magnetic material commonly used to make the core of a high-quality electromagnet that is switched on and off repeatedly.

(Total for Question 1 is 1 mark)

2 A straight wire of length 0.20 m carries a current of 4.0 A. The wire is placed at right angles to a uniform magnetic field of flux density 0.30 T. Use F = B I L to calculate the magnetic force on the wire.

(Total for Question 2 is 2 marks)

3 A particle with charge +2.0 x 10^{-6} C moves horizontally at 3.0 x 10^{5} m/s through a magnetic field of magnitude 0.12 T. The velocity is perpendicular to the magnetic field. Calculate the magnitude of the magnetic force on the particle. Use F = B Q v.

(Total for Question 3 is 3 marks)

4 A current-carrying loop of wire in a uniform magnetic field experiences a turning effect (a couple). Give any two factors from the list below that increase the size of the turning effect on the loop: number of turns, resistance of the wire, area of the loop, frequency of current, magnetic flux density.

(Total for Question 4 is 2 marks)

5 A long solenoid has 800 turns and length 0.50 m. It carries a current of 1.2 A. Calculate the magnetic field strength inside the solenoid using the approximation B = mu0 x (N / L) x I, where mu0 = 4pi x 10^{-7} T m A^{-1}. Give your answer to two significant figures.

(Total for Question 5 is 4 marks)

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6 A straight conductor carries current into the page. Sketch or describe the direction of the magnetic field lines immediately around the conductor and state the rule used to determine this direction.

(Total for Question 6 is 3 marks)

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7 Explain qualitatively why increasing the speed of a magnet moved into a coil increases the induced emf in the coil.

(Total for Question 7 is 2 marks)

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8 A coil has 250 turns. The magnetic flux through each turn changes from 1.2 x 10^{-4} Wb to 4.2 x 10^{-4} Wb in 0.20 s. Calculate the average induced emf in the coil using emf = N x (change in flux) / time. State the sign convention if the flux increases.

(Total for Question 8 is 3 marks)

9 Explain how a step-down transformer changes an alternating potential difference. Your answer should include a description of the components involved and the magnetic and electrical processes that produce a lower output potential difference. Refer to the role of alternating current, magnetic flux in the core and number of turns in each coil.

(Total for Question 9 is 6 marks)

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10 A transformer in a power station steps down the voltage from 12 000 V on the primary to 240 V on the secondary. The primary coil has 4800 turns. The transformer supplies a secondary current of 150 A to a local substation. Assuming an ideal transformer (no losses), calculate:

a) the number of turns on the secondary coil. (2 marks)

b) the current in the primary coil. (4 marks)

Use the relations Vp/Vs = Np/Ns and Ip x Vp = Is x Vs for an ideal transformer. Show substitutions and give units.

(a) Calculate the number of turns on the secondary coil. **(2)**

....

(b) Calculate the current in the primary coil, assuming an ideal transformer. **(4)**

....

(Total for Question 10 is 6 marks)

Mark scheme · P7H Magnetism and Electromagnetism: Higher Tier Practice

Question 1

- **B1** soft iron cao
- **Answer: Soft iron**

Question 2

- **M1** substitutes into F = B I L: F = 0.30 x 4.0 x 0.20
- **A1** 0.24 N cao
- **Answer: 0.24 N**

Question 3

- **M1** substitutes: F = 0.12 x 2.0e-6 x 3.0e5
- **M1** evaluates intermediate product: 2.0e-6 x 3.0e5 = 0.60
- **A1** 0.072 N cao
- **Answer: 0.072 N**

Question 4

- **B1** one correct factor: number of turns, or area of the loop, or magnetic flux density
- **B1** a second, different correct factor from the same list: number of turns, area of the loop, magnetic flux density
- **Answer: Any two of: number of turns, area of the loop, magnetic flux density**

Question 5

- **M1** substitutes values into expression: B = 4pi x 10^{-7} x (800 / 0.50) x 1.2
- **M1** evaluates N/L: 800 / 0.50 = 1600 turns per metre
- **M1** multiplies constants: B = (4pi x 10^{-7}) x 1600 x 1.2 (uses 4pi x 10^{-7} = 1.25663706e-6)
- **A1** 2.4 x 10^{-3} T cao
- **Answer: 2.4 x 10^{-3} T**

Question 6

- **B1** magnetic field lines are concentric circles around the wire
- **B1** direction is clockwise as viewed from the observer (consistent with current into the page) or equivalent description
- **B1** states use of right-hand rule (thumb in direction of current, fingers show field) or named rule
- **Answer: Concentric circular field lines around the wire, clockwise when viewed with current into the page; use the right-hand rule (thumb in direction of current, fingers show field).**

Question 7

- **B1** faster movement changes magnetic flux through the coil more rapidly
- **B1** greater rate of change of flux produces a larger induced emf (Faraday's law), oe
- **Answer: Faster movement causes the magnetic flux through the coil to change more quickly, and a greater rate of change of flux induces a larger emf.**

Question 8

- **M1** computes change in flux per turn: 4.2e-4 - 1.2e-4 = 3.0e-4 Wb
- **M1** substitutes into emf = N x delta φ / t: emf = 250 x 3.0e-4 / 0.20
- **A1** 0.375 V cao
- **Answer: 0.375 V**

Question 9

- **Level 3** (5-6): Detailed explanation: describes alternating current in the primary producing changing magnetic flux in the iron core, explains how the changing flux induces emf in the secondary, links ratio of turns to output potential difference with correct qualitative statement that fewer turns on secondary gives lower p.d., and gives clear causal chain that accounts for step-down action.
- **Level 2** (3-4): Partial explanation: mentions alternating current and induced emf in secondary via changing flux and states that number of turns affects p.d., but explanation lacks full causal linking or some detail about the core or alternating nature.
- **Level 1** (1-2): Basic points: may state that primary produces a magnetic field and secondary gets induced voltage, or simply states fewer turns means lower p.d., with little or no explanation of the process.
- **Indicative content:**
  - Primary coil connected to alternating supply carries alternating current
  - Alternating current produces changing magnetic flux in iron core
  - Changing flux in core passes through secondary coil and induces emf by electromagnetic induction
  - Size of induced emf depends on rate of change of flux and number of turns in secondary
  - Step-down transformer has fewer turns on secondary than primary so induced p.d. is smaller
  - Iron core provides a path to link flux efficiently between coils and increases induced emf

Question 10

- (a) **M1** uses ratio: Ns = Np x Vs / Vp and substitutes: Ns = 4800 x 240 / 12000
- (a) **A1** 96 turns cao
- **(a) Answer: 96 turns**
- (b) **M1** states or uses power equality: Ip x Vp = Is x Vs
- (b) **M1** substitutes values: Ip x 12000 = 150 x 240
- (b) **M1** rearranges: Ip = (150 x 240) / 12000
- (b) **A1** 3.0 A cao
- **(b) Answer: 3.0 A**