

19.1 Fields, motors and induction

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS induction • transformer

Objective

Fields, motors and induction. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

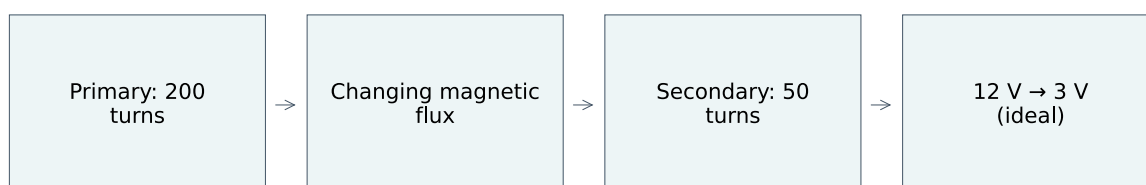
1 Key knowledge and worked examples

■ What would explain this observation?

- A magnet beside a wire does not always produce a current. An induced electromotive force depends on changing magnetic flux linkage.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- A field describes a force effect at positions in space. A current-carrying conductor in a magnetic field can experience a force. Electromagnetic **induction** occurs when magnetic flux linkage changes.
- induction: Creation of emf by changing flux linkage; **transformer** : A device transferring energy between coils through changing flux.



■ Choose evidence that can test it

- Changing field strength, coil area, orientation or relative motion can change flux linkage. Lenz law describes an induced effect opposing the change producing it, consistent with energy conservation.
 - Use a coil and sensitive meter to compare magnet motion in each direction. Record that a stationary arrangement gives no induced signal. Use approved low-voltage supplies for motor demonstrations.
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■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a transformer has 200 primary turns, 50 secondary turns and 12 V primary voltage. For an ideal transformer, $V_s/V_p = N_s/N_p$. $V_s = V_p N_s/N_p = 12 \times 50/200 = 3.0$ V. Real transformers also dissipate energy.

Example:

An ideal transformer has $N_p=400$, $N_s=100$ and $V_p=20$ V. Find V_s . Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- A transformer needs changing magnetic flux; a steady DC input does not provide continuous transformer action. Magnetic field direction is not automatically the direction of force.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A steady DC input produces continuous ideal transformer action. This claim is false: A transformer needs changing magnetic flux; a steady DC input does not provide continuous transformer action. Magnetic field direction is not automatically the direction of force.

Key:

Fields, motors and induction: Changing field strength, coil area, orientation or relative motion can change flux linkage. Lenz law describes an induced effect opposing the change producing it, consistent with energy conservation.

2 Practice

2.1 Which gives a continuing emf in a coil? Choose one answer.

- **A** A constant unchanging flux
- **B** A changing flux linkage
- **C** A nearby stationary magnet in every situation

[1]

2.2 An ideal transformer has $N_p=400$, $N_s=100$ and $V_p=20$ V. Find V_s . Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: A steady DC input produces continuous ideal transformer action.

[2]

2.4 Creation of emf by changing flux linkage: write the technical term.

[1]

3 Exam-style questions

3.1 An ideal transformer reduces 20 V to 5 V with primary current 0.30 A. Find secondary current and power. Why does steady DC not fit the model? [4]
