

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.

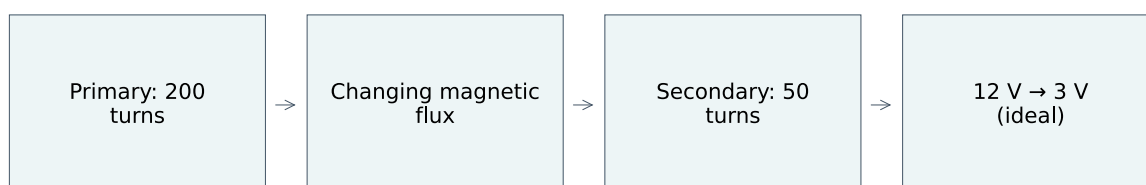
1 Key knowledge and worked examples

■ 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.
-

■ 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]

Solutions

2.1 B 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.

2.2 $V_s = V_p \ N_s/N_p = 20 \times 100/400 = 5 \text{ V}$.

2.3 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.

2.4 induction. induction means Creation of emf by changing flux linkage.

3.1 Power is 6 W; secondary current is $6/5 = 1.2 \text{ A}$. Ideal power conservation exchanges voltage and current. Induction requires changing flux, absent in the steady DC state.