19.1 Fields, motors and induction

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS induction • transformer

Objective

Fields, motors and induction. Original classroom practice for IB HL; not an official IB paper.

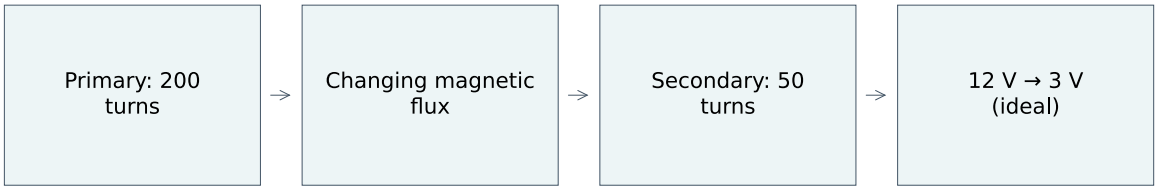
1 Key knowledge and worked examples

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.

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.

In the lab: 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

- Known: a transformer has 200 primary turns, 50 secondary turns and 12 V primary voltage.
- For an ideal transformer, Vs/Vp = Ns/Np.
- Vs = Vp Ns/Np = 12×50/200 = 3.0 V.
- Real transformers also dissipate energy.

Your turn: An ideal transformer has Np=400, Ns=100 and Vp=20 V. Find Vs.

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.

Not true: A steady DC input produces continuous ideal transformer action. A transformer works by electromagnetic induction, which requires changing flux. Steady DC produces constant flux, so after the brief switch-on change there is no induced emf and no continuous transformer action.

Key:

- A field describes a force effect at positions in space.
- Changing field strength, coil area, orientation or relative motion can change flux linkage.
- Watch for: A transformer needs changing magnetic flux; a steady DC input does not provide continuous transformer action.

Write from a secondary voltage of 8 V

- An ideal transformer has 250 primary turns, 100 secondary turns and a primary voltage of 20 V.
- Find the secondary voltage. A steady DC input does not keep an ideal transformer working.

2 Practice

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

- **A** A nearby stationary magnet in every situation
- **B** A constant unchanging flux
- **C** A changing flux linkage [1]

2.2 An ideal transformer has Np=400, Ns=100 and Vp=20 V. Find Vs. 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 C Electromagnetic induction needs CHANGE: an emf is induced only while the flux linkage through the coil is changing. A constant flux, however large, induces nothing, and a stationary magnet beside a stationary coil changes no flux.

2.2 Vs=Vp Ns/Np=20×100/400=5 V.

2.3 False. A transformer works by electromagnetic induction, which requires changing flux. Steady DC produces constant flux, so after the brief switch-on change there is no induced emf and no continuous transformer action.

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 A. Ideal power conservation exchanges voltage and current. Induction requires changing flux, absent in the steady DC state.