

Induction

International Baccalaureate · IB Diploma · Physics · HL

Scope and prerequisites

This handout covers selected HL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

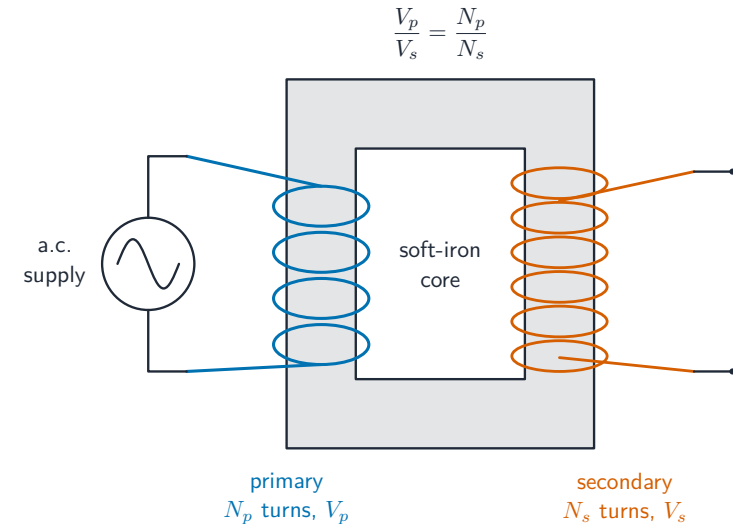
Fields, motors and induction

■ 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.



$$V_s/V_p = N_s/N_p: 200 \text{ turns to } 50 \text{ turns steps } 12 \text{ V down to } 3 \text{ V (ideal)}$$

■ 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, $V_s/V_p = N_s/N_p$.
- $V_s = V_p N_s/N_p = 12 \times 50/200 = 3.0 \text{ V}$.
- Real transformers also dissipate energy.

Your turn: An ideal transformer has $N_p=400$, $N_s=100$ and $V_p=20 \text{ V}$. Find V_s .

■ 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.

■ Write from a Faraday doubling

- A coil's flux linkage doubles, either by doubling B or turning the coil to face the field.
- Induced emf depends on the RATE OF CHANGE of linkage – a doubled but then steady flux induces nothing after the change.

■ Write from a Lenz direction

- A magnet's north pole approaches a coil.
- The near face becomes north, repelling the approach – Lenz's law is energy conservation wearing a sign convention.