# 6.2 Induction and transformers

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

## Objective

Build the skills to answer exam questions on **electromagnetic induction** : inducing a voltage, factors that change its size and direction, generators, and transformers with $V_p/V_s = n_p/n_s$ and $V_pI_p = V_sI_s$.

**You must be able to:**

- describe how a voltage is induced in a wire or coil
- explain how a generator and a transformer work
- use $V_p/V_s = n_p/n_s$ and $V_pI_p = V_sI_s$
- explain why electricity is transmitted at high voltage

## 1 Key knowledge and worked examples

### Induction

| idea | equation or rule |
|---|---|
| induction | a voltage is induced when a wire cuts a magnetic field, or the field through a coil changes |
| bigger voltage | move faster, use a stronger magnet, or use more turns |
| direction | reversing the motion or the field reverses the voltage |
| transformer turns | $V_p \div V_s = n_p \div n_s$ |
| transformer power | $V_p \times I_p = V_s \times I_s$ (if 100% efficient) |
| transmission | high voltage means low current, so less energy is wasted heating the cables |

**Worked example 1: turns ratio.** A transformer has 200 primary turns and 50 secondary turns. The input is 240 V. Find the output.

1. Known: $n_p = 200$; $n_s = 50$; $V_p = 240$ V.
2. Rule: $V_s = V_p \times n_s \div n_p$.
3. Numbers: $240 \times 50 \div 200$.
4. Result: 60 **V**.



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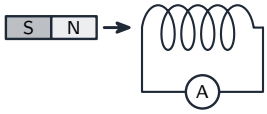
**Worked example 2: current.** That transformer gives 2.0 A at 60 V. Find the primary current.

1. Known: $V_s = 60$ V; $I_s = 2.0$ A; $V_p = 240$ V.
2. Rule: $V_p I_p = V_s I_s$.
3. Numbers: $I_p = 60 \times 2.0 \div 240$.
4. Result: 0.50 **A**.

**Answer shapes:** a transformer works only with a.c., because only a changing current makes a changing field.

## 2 Practice

**2.1** A magnet is pushed into a coil connected to a meter. The needle moves to the right. Describe what happens when the magnet is held still, and when it is pulled out. [2]




**2.2** Give **two** ways to induce a bigger voltage when the magnet is moved. [2]

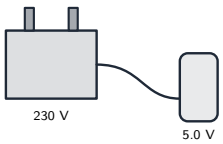



**2.3** Explain why a transformer does not work with a steady d.c. supply. [2]




## 3 Exam-style questions

**3.1** A phone charger has a transformer that changes 230 V to 5.0 V. Its primary coil has 1840 turns. Calculate the number of turns on the secondary coil. [3]

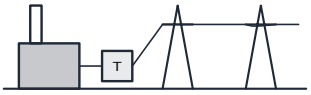





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**3.2** A power station gives 500 kW. A step-up transformer raises the voltage from 25 000 V to 400 000 V for the National Grid.

(a) Calculate the current in the cables at 400 000 V. [2]




(b) Calculate the current at 25 000 V, and how many times smaller the current is at 400 000 V. [3]



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(c) Explain why the grid uses a very high voltage, and why a step-down transformer is needed near homes. [3]

(d) Describe how a transformer changes the voltage. Refer to the coils, the iron core and the magnetic field. [6]



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