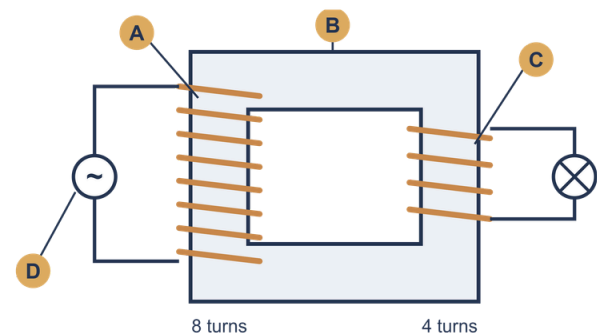


Transformers *Combined Paper 1 · Triple Paper 2*

1 · The structure of a transformer

step-down: 8 turns → 4 turns



A _____ B _____
C _____ D _____

(a) Label parts A–D. [4] (b) Describe the structure of a transformer. [2]

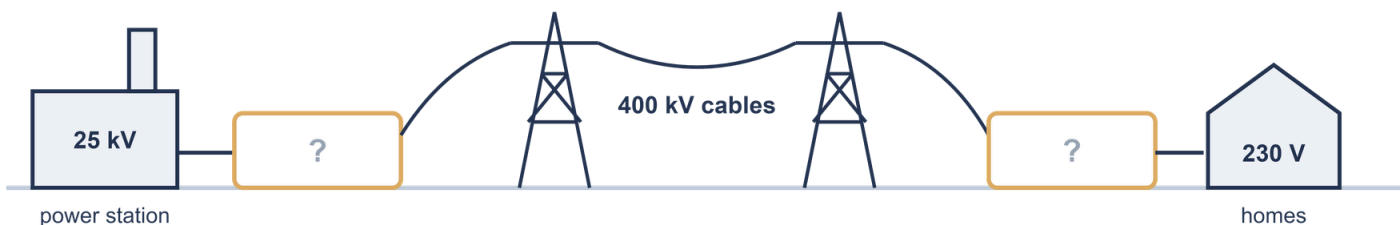
(c) Explain how a step-down transformer works. [4]

HOW IT WORKS — TICK AS YOU WRITE

- ☐ An **alternating current** in the primary coil creates a **changing magnetic field**
- ☐ The **iron core** becomes an **induced magnet** and creates a **magnetic field**
- ☐ The **changing magnetic field induces** an **alternating voltage**
- ☐ **Fewer** turns on the secondary → a **lower** voltage (step-down); **more** turns → higher (step-up)

2 · Step-up and step-down transformers in the National Grid

name the two transformers



STEP-UP — AT THE POWER STATION

- ☐ The **step-up** transformer **increases the voltage** and **decreases the current**
- ☐ Power in = power out, so the same power is **transferred** with a **smaller current**
- ☐ A smaller current means **less heating** of the cables
- ☐ So **less energy is wasted** to the surroundings: it is **more efficient**

STEP-DOWN — NEAR HOMES

- ☐ The **step-down** transformer **decreases the voltage** to **230 V**
- ☐ This is **safer** to use in **homes**

Why change the voltage twice? At 25 kV the current in the cables would be huge and waste lots of energy. At 400 kV it would be far too dangerous to use at home.

3 · Exam-style question

6 marks

Electricity is generated at 25 kV. It is sent across the country through the National Grid at 400 kV, and used in homes at 230 V.

Explain why step-up and step-down transformers are used in the National Grid. You may draw a diagram. [6]

Transformer Calculations *Triple only*

1 · The two transformer equations

know and use both

VOLTAGES AND TURNS

$$\frac{\text{input (primary) voltage}}{\text{output (secondary) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

In symbols:

Use it when the question gives the **number of turns**.

POWER IN = POWER OUT (100% EFFICIENT)

$$\text{input power} = \text{output power}$$

In symbols:

Use it when the question gives a **current**.

2 · Worked example

we'll do this one together

A laptop charger contains a transformer. The mains input is **230 V** and the output is **20 V**. The primary coil has **1150 turns**.

(a) Calculate the number of turns on the secondary coil. [3]

1 WRITE THE EQUATION

2 SUBSTITUTE

3 REARRANGE

4 ANSWER + UNIT

(b) The laptop draws 3.0 A from the secondary coil. Calculate the current in the primary coil. [3]

1 WRITE THE EQUATION

2 SUBSTITUTE

3 REARRANGE

4 ANSWER + UNIT

3 · Your turn

same four steps

A power station generates electricity at **25 kV**. A transformer increases this to **400 kV** for the cables. The primary coil has **800 turns**.

(a) Calculate the number of turns on the secondary coil. [3]

1 WRITE THE EQUATION

2 SUBSTITUTE

3 REARRANGE

4 ANSWER + UNIT

(b) The current in the primary coil is 2000 A. Calculate the current in the cables. [3]

1 WRITE THE EQUATION

2 SUBSTITUTE

3 REARRANGE

4 ANSWER + UNIT

For the turns equation the two voltages just need the **same unit** (both kV is fine). For power, use **volts**: 25 kV = 25 000 V.

4 · Quick fire: find the missing value

show your working beside the table

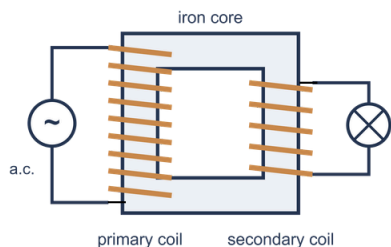
	V_p	V_s	n_p	n_s	I_p	I_s	step-up or step-down?
1	230 V	_____	2300	120	—	—	_____
2	12 V	240 V	50	_____	—	—	_____
3	_____	6.0 V	400	20	—	—	_____
4	230 V	46 V	—	—	0.50 A	_____	_____

Transformers: Exam Questions *Triple only*

Question 1 · How a transformer works

6 marks

The diagram shows a transformer.



(a) Explain how the transformer produces a potential difference across the secondary coil. [4]

(b) Explain why a transformer does not work with a direct current (d.c.) supply. [2]

Question 2 · A phone charger

7 marks

A phone charger contains a transformer. The input p.d. is **230 V**. The primary coil has **4600 turns** and the secondary coil has **100 turns**.

Equations: $V_p \div V_s = n_p \div n_s$ and, if 100% efficient, $V_s \times I_s = V_p \times I_p$

(a) Calculate the output p.d. [3]

output p.d. = _____ V

(b) Is this a step-up or a step-down transformer? Give a reason. [1]

(c) The output current is 2.0 A. The transformer is 100% efficient. Calculate the current in the primary coil. [3]

current = _____ A

Question 3 · The National Grid

10 marks

A power station generates electricity at **25 000 V**. A step-up transformer increases this to **400 000 V** for the transmission cables.

(a) The primary coil has 2000 turns. Calculate the number of turns on the secondary coil. [3]

turns = _____

(b) The power transmitted is 100 MW. Calculate the current in the cables. Use $P = VI$. [3]

current = _____ A

(c) Explain why transmitting electricity at a high potential difference makes the National Grid more efficient. [4]
