

Magnets, motors, generators and transformers

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train the key ideas of magnets, electromagnets, the motor effect $F = B I L$, induction and transformers. You will predict directions with Fleming's left-hand rule, read graphs and tables, and work through turns-ratio and power calculations.

Level 1 problems use one idea, level 2 combine two or three steps, and level 3 asks for reasoning and multi-part calculations. They suit GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high-school physics.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS2-5, GCSE P7

Problem 1 Attract or repel? (easy)

Amara in Abuja tests bar magnets on a table. Predict whether each pair attracts or repels.

1. A north pole facing a south pole.
2. A north pole facing a north pole.
3. A south pole facing a south pole.
4. A north pole facing an unmagnetised iron nail.

Problem 2 Field line facts (easy)

Zainab in Karachi maps the field of a bar magnet with plotting compasses.

1. State the direction of the field lines outside a magnet.
2. State where the field is strongest and how the lines show this.
3. Describe what a compass needle does when placed in the field.
4. State the unit of magnetic field strength.

Problem 3 Force on a wire (easy)

Haruto in Osaka places a 0.10 m wire at right angles to a field of 0.50 T. The current is 2.0 A.

1. Calculate the force on the wire.
2. State the force if the wire is turned parallel to the field.
3. Calculate the force if the current is doubled.

Problem 4 Unit conversions (easy)

Convert each value into the unit in brackets.

1. 25 cm (m)

2. 250 mT (T)
3. 40 mA (A)
4. The period of 50 Hz alternating current (ms)

Problem 5 Stronger electromagnet (easy)

Sizwe in Cape Town builds an electromagnet from a nail and insulated wire.

1. State three ways to make it stronger.
2. Explain why the core is soft iron and not steel.
3. Give one advantage of an electromagnet over a permanent magnet.

Problem 6 Transformer output (easy)

A transformer has 1000 turns on the primary coil and 50 turns on the secondary. The primary is connected to 230 V a.c.

1. Calculate the secondary voltage.
2. State whether it is step-up or step-down.
3. Calculate the number of secondary turns needed for 46 V.

Problem 7 Making more voltage (easy)

Nia in Wellington fits a dynamo to her bicycle.

1. State three ways to increase the voltage the dynamo induces.
2. Explain why the output is alternating.
3. State what is induced when the magnet is held still inside the coil.

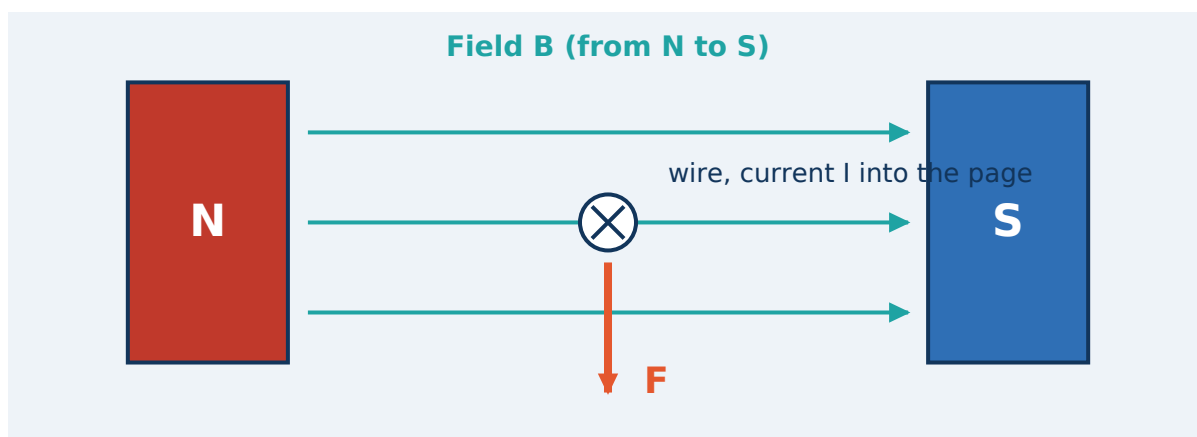
Problem 8 Finding the current (medium)

A teacher in Mombasa shows a wire jumping in a field of 0.30 T. A 0.20 m length of wire feels a force of 0.36 N.

1. Calculate the current.
2. Calculate the field strength needed to produce the same force with a current of 3.0 A.

Problem 9 Direction of the force (medium)

The wire in the figure carries a current into the page.



A wire carrying current into the page between two poles feels a downward force.

1. State the direction of the force on the wire.
2. State the direction of the force if the current is reversed.
3. State the direction of the force if both the current and the field are reversed.
4. Name the rule used to decide.

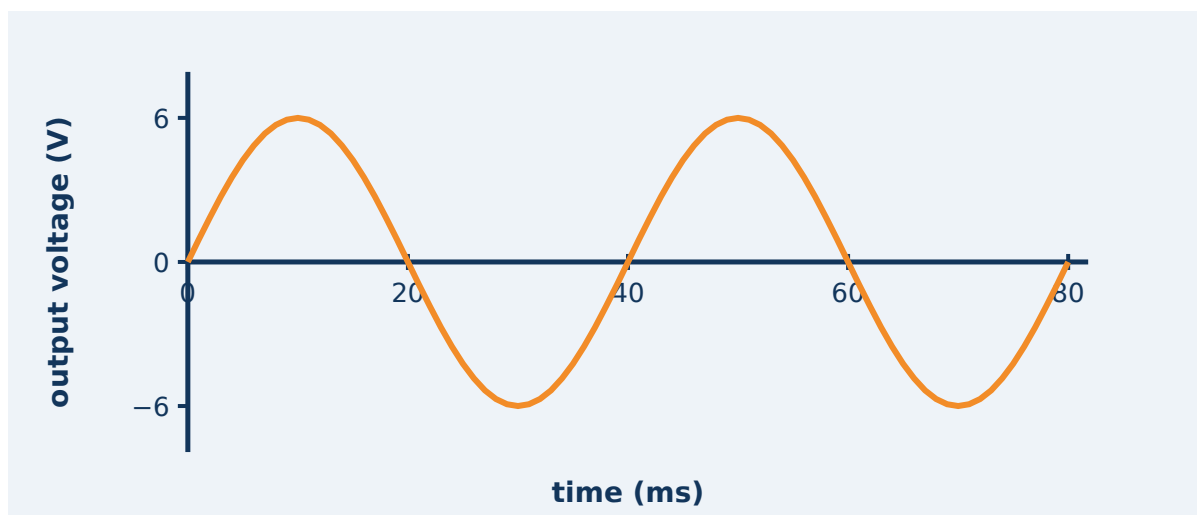
Problem 10 Phone charger transformer (medium)

A charger has 2300 primary turns and is plugged into 230 V mains. Its output is 9.0 V.

1. Calculate the number of secondary turns.
2. The output current is 1.5 A. Calculate the output power.
3. Assuming the transformer is ideal, calculate the primary current.

Problem 11 Reading a dynamo graph (medium)

Lucas in Quito records the output of a bicycle dynamo.



Output voltage of a small bicycle dynamo against time.

1. State the peak voltage.
2. Find the period and calculate the frequency.
3. State the voltage at $t = 10$ ms.
4. Describe how the graph changes if the wheel turns twice as fast and the peak voltage

doubles with speed.

Problem 12 Why alternating? (medium)

Ravi in Hyderabad connects a transformer to a 6 V battery and finds the secondary voltmeter reads zero after a flick at the start.

1. Explain why the reading stays at zero.
2. Explain what the voltmeter flick shows.
3. State the purpose of the iron core.

Problem 13 Electromagnet data (medium)

A pupil counts the paper clips lifted by an electromagnet.

Turns of wire	10	20	30	40
Clips lifted	4	9	13	18

1. Describe the pattern.
2. Predict the number of clips for 50 turns.
3. Name two variables the pupil must keep constant.

Problem 14 How much can the force lift? (medium)

A horizontal wire of length 12 cm in a field of 0.080 T carries 3.5 A at right angles to the field. The force acts upwards. Use $g = 9.8 \text{ N/kg}$.

1. Calculate the force.
2. Calculate the greatest mass it could support, in grams.
3. Calculate the greatest mass if the current is doubled.

Problem 15 Motor against generator (medium)

Compare a simple motor with a simple generator.

1. State the energy transfer in each.
2. State one way they are similar in construction.
3. State which uses a split-ring commutator and which uses slip rings, and why.

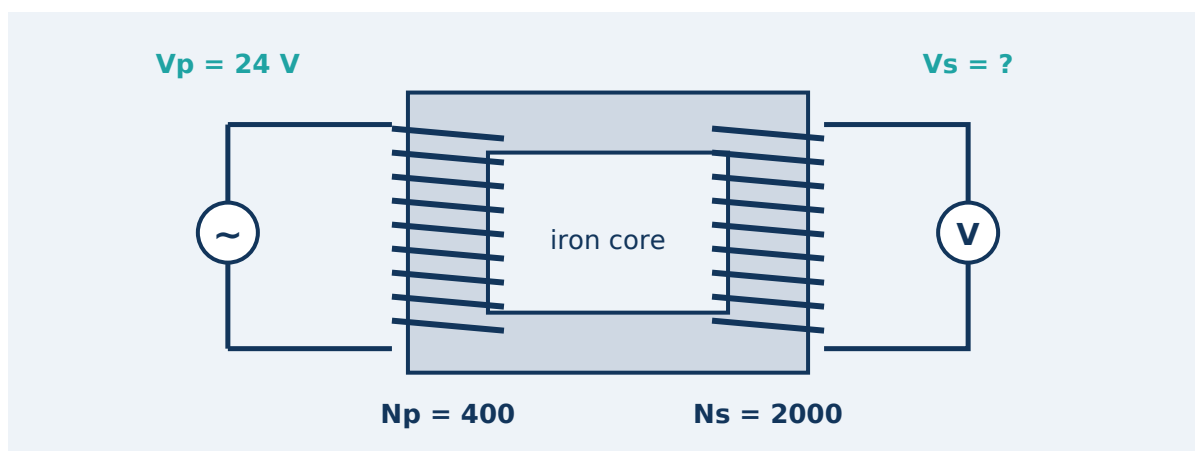
Problem 16 Transformer efficiency (hard)

A step-up transformer changes 12 V to 240 V. It delivers 60 W to a load and is 92 % efficient.

1. Calculate the turns ratio $N_s \div N_p$.
2. Calculate the secondary current.
3. Calculate the input power.
4. Calculate the primary current.
5. Suggest where the lost energy goes.

Problem 17 Lamp on a transformer (hard)

An ideal transformer in the figure has a 400-turn primary and a 2000-turn secondary. The primary is connected to 24 V a.c. and the secondary supplies a 60 W lamp.



Transformer: two coils on a laminated iron core. The primary coil is on the left, the secondary on the right.

1. Calculate the secondary voltage.
2. State the type of transformer.
3. Calculate the secondary current.
4. Calculate the primary current.
5. Show that $I_p \div I_s$ equals $N_s \div N_p$.

Problem 18 Spot the errors (hard)

Mateo in Quito wrote three statements. Say why each is wrong and give the correct statement.

1. "A step-up transformer gives more power at the output than at the input."
2. "A magnet at rest inside a coil induces a steady voltage."
3. "A wire lying parallel to a magnetic field feels the biggest force."

Problem 19 Turning effect of a coil (hard)

A motor coil has 50 turns. Each side in the field is 0.060 m long. The field is 0.40 T and the current is 1.2 A. The two sides are 0.040 m apart.

1. Calculate the force on one side of the coil.
2. State the direction of the force on the opposite side.
3. Calculate the turning effect (moment) when the coil is parallel to the field.
4. State the turning effect when the coil is at right angles to the field.
5. Explain why a commutator is needed.

Problem 20 Magnet in a copper tube (hard)

Mei in Singapore drops a 40 g magnet down a vertical copper tube 0.50 m long. It leaves the tube after falling at a steady 0.25 m/s. Use $g = 9.8\text{ N/kg}$.

1. Calculate how long a free fall of 0.50 m would take.
2. Calculate the time in the tube.
3. Explain, using induction, why the fall is slower.
4. Calculate the gravitational energy lost by the magnet.
5. Calculate the average power transferred to the tube.