

# On electromagnetism

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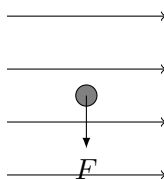
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## Warm-up problems

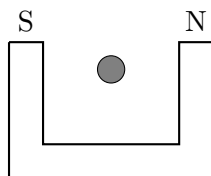
1. Draw a diagram to show Fleming's left hand rule to determine the direction of the force on a current carrying wire, making it clear what each digit (fingers and thumb) represents. What factors might increase the force on the wire?
2. State carefully in words how a voltage can be electromagnetically induced across the ends of a conductive bar of copper (*do not draw a diagram for this*).
3. Draw a labelled diagram of a transformer and explain how it works.

## Regular problems

4. In the following diagram, a uniform magnetic field is directed toward the right, and a wire lies perpendicular to the plane of the paper (shown in cross section) carrying electric current. The force on the wire is also shown. What is the direction of the current?

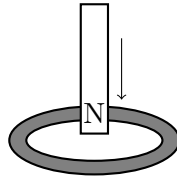


5. The diagram shows a horseshoe magnet with its north and south poles marked. Between the poles is the cross section of a wire, carrying electric current towards us out of the plane of the paper.



- (a) Add to the diagram a few magnetic field lines showing the direction of the magnetic field (due to the magnet) near the wire.
- (b) Show the direction of the force acting on the wire under these circumstances and describe how you worked this out.
- (c) Does the magnet experience a force? If so, in what direction? If not, why not?
- (d) Suppose the wire is rotated so that it lies in the plane of the paper, with the current going from left to right. What would be the direction of the force on the wire now?

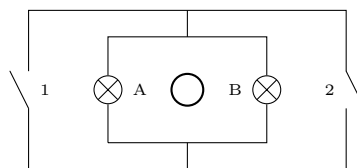
- (e) Suppose that you were told that a wire carrying a current into the plane of the paper experiences an upward force. What would you infer must be the direction of the magnetic field?
6. The north pole of a magnet is thrust downward into a horizontally oriented copper ring as shown.



- (a) Does the ring experience a force under these circumstances? If so, in what direction? Explain your reasoning.
- (b) Does the magnet experience a force? If so, in what direction? Explain your reasoning.
7. A transformer is needed to provide 30 W of power at 28 V to a fridge from the mains electricity supply. If there are 1250 turns on the primary coil,
- (a) How many turns will there be on the secondary coil?
- (b) What current will there be in the fridge motor?
- (c) What fuse should be installed in the plug (*where the electricity is drawn from the mains*)?
8. Explain the advantages of switch mode power supplies over transformers alone in providing a voltage to charge the battery on a laptop computer.

## Extension problems

9. Find out how a coil of wire and a permanent magnet can be used to create a simple loudspeaker, draw a diagram of the arrangement and explain how this works.
10. A long coil of wire, axis perpendicular to the paper, carries a steadily increasing current, so there is a steadily changing magnetic field in the coil. With both switches open, a resulting current flows in the loop of wire surrounding the coil and the two identical bulbs shown light up:



- (a) What happens to the brightness of bulb B if bulb A is unscrewed from its socket whilst the current in the magnetic field is still increasing? Explain your answer.
- (b) Suppose now that with both bulbs in their sockets, switch 1 is closed and switch 2 is left open. What happens to the brightness of each bulb?
- (c) Suppose that now switch 1 is opened and switch 2 is closed. What happens to the brightness of each bulb?



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