

Tutorial Foundations Week 10

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1 Magnetism

Electrons in a wire

- a) Electrons move through a straight thin piece of wire at a rate of 4×10^{20} per second.
 - i) Draw a clear diagram.
 - ii) Calculate the electric current in the wire.
 - iii) Calculate the magnetic field 1mm, 1cm, and 1m from the wire, and clearly mark on your diagram the direction and magnitude of the magnetic field.
 - iv) The single wire is replaced by five identical pieces of current-carrying wire. If the wire is roughly 1mm thick, how do your answers to part iii) change?
- b) The single wire is now bent to make a circular current loop.
 - i) Draw a clear diagram.
 - ii) Calculate the magnetic field at the centre of the loop, and clearly mark on your diagram the direction and magnitude of the magnetic field.
 - iii) The single wire is replaced by five identical pieces of current-carrying wire. If the wire is roughly 1mm thick, how do your answers to part ii) change?
- c) A square loop with side length 10cm and 10 turns is placed in an external magnetic field of $B = 10$ T.
 - i) Draw three clear diagram with the angle between the loop and the magnetic as 0° , 45° , and 90° .
 - ii) Clearly draw the area vector in each diagram. What is it's direction? What is it's magnitude?
 - iii) Calculate the magnetic flux Φ (Phi) in each case.
 - iv) Discuss Lenz's Law with the person next to you.
 - v) Determine the EMF generated in the loop.
 - vi) What kind of current is generated?
 - vii) If a quarter-turn lasts 0.2 seconds, what is the average EMF over this period?