

Fri: Review for Test 2

Mon: Test 2 covers Energy, Electricity + Magnetism

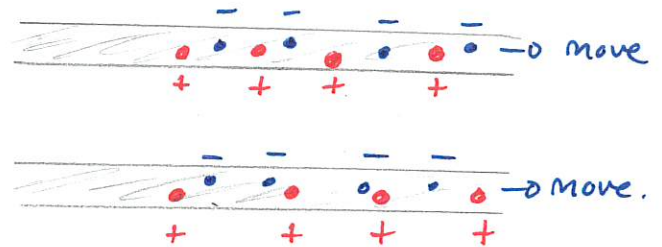
2021 Test 2 Q1 → 5, 7, 8

2022 Test 2 Q1 → 9, 11-13

Forces between currents

We could place two current-carrying wires near to each other and consider the force that one exerts on the other. The wires are electrically neutral and so they will not exert the usual electric forces on each other.

However, we will observe that one wire does exert a force on the other



DEMO: Uof Minn Parallel Wires

The observed forces depend on the directions of the currents. This requires a rule for the direction of current that depends on the type of charge that is flowing and its direction of motion. Observations show that

parallel currents attract
opposite currents repel

Discovered by Ampère 1820

Quiz 1 95%

Such forces cannot be explained through electric forces. The ultimate explanation will involve magnetism.

Effects of a current on a magnet

The first clue about a connection between electricity and magnetism arrived from an accidental discovery by Oersted in 1819-1820. He observed:

An electric current can exert a force on a magnet.

Show: Oersted Image

Demo: Oersted compass needle

Demo: Current Loop Board

If a current could exert a force on a magnet then by Newton's Third Law a magnet should exert a force on a current.

Demo: U of Iowa Jumping wires

Demo: Rail gun.

This is actually observed. So we can conclude that

Currents have magnetic properties

Magnetic fields

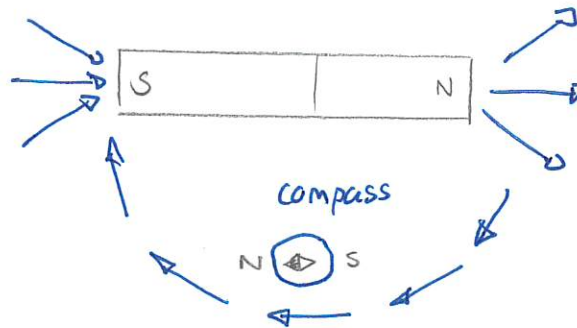
The magnetic effects of magnets and currents can be explained via magnetic fields.

A magnetic field is a collection of arrows, one at each location in space

Demo: Magnet and Needle Board

Demo: PhET magnets + electromagnets.

At any location the magnetic field direction corresponds to the direction in which a compass needle will settle when placed at that location.



In general magnets like bar magnets have two poles - a North and a South pole. These obey the rules:

like poles repel

unlike " attract

A compass is really just a small bar magnet with a N and S pole.

Quiz 2 70%

The theory of electromagnetism provides:

- 1) a method for calculating the magnetic field produced by any current.
- 2) the force that a magnetic field exerts on any current.

Demo: Show Solenoid

Quiz 3 70%

Quiz 4 70%

Generating currents with magnetic fields

It is possible to generate a current with a time varying magnetic field.

Demo: Faraday's Law U. Iowa video

This is the basis for how electricity is produced

- * a magnet and a coil move relative to each other
- * a current is generated in the coil.

Demo: Faraday's Lab

Demo: Tube / magnet