Phys 112 2019

Lecture 14

Tues: Discussion / quiz

Supp. 49, 50, 52

Ch 23 Q 9

Ch 23 Prob 5, 69

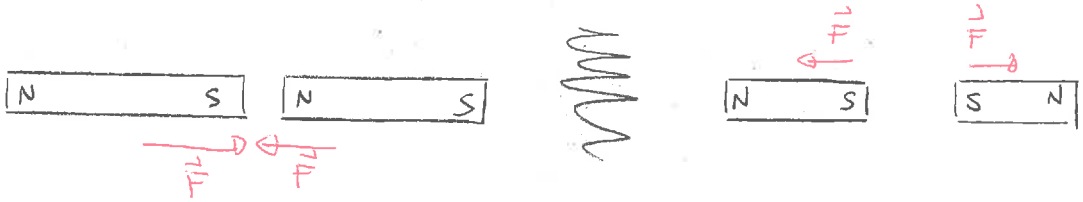
Magnetic Fields

We can perform various simple observations using bar magnets (page 839) and these show:

1) any magnet will exert a force on any other magnet
2) the force exerted by one magnet on another depends on the relative orientation of the magnets
3) any magnet exerts forces on some metallic objects.

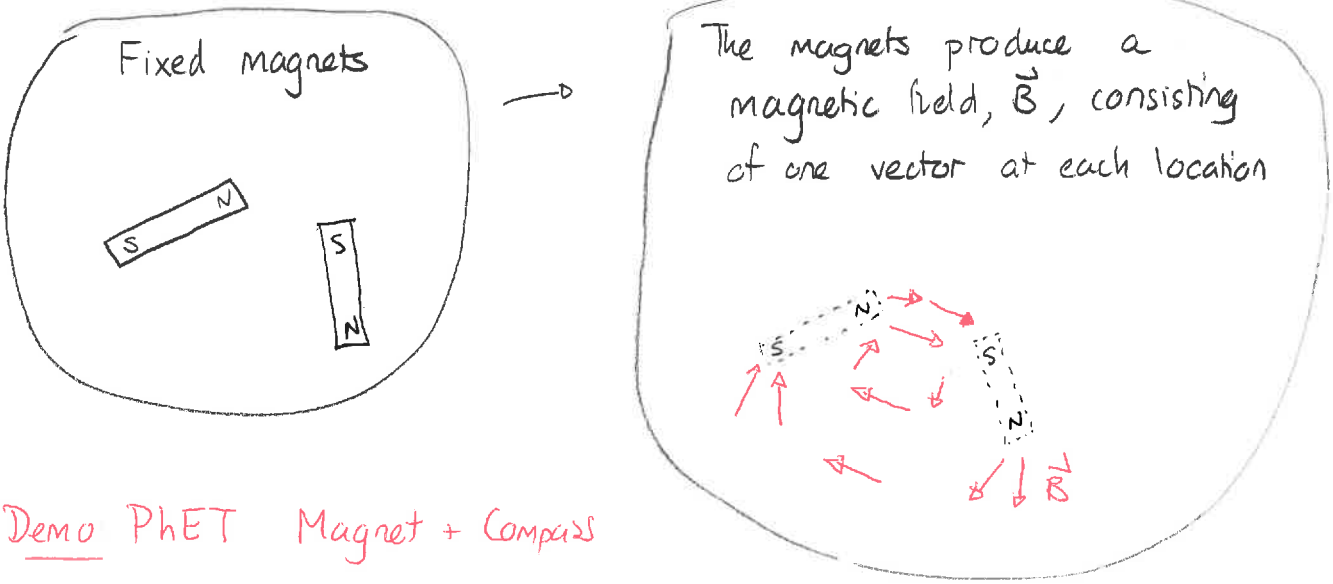
We can describe the forces that magnets exert on each other in terms of poles. Every magnet has two poles (North and South) and

> Like poles repel, Opposite poles attract



We will explain such forces and magnetism in terms of magnetic fields.

Schematically



Demo PhET Magnet + Compass

* Show bar magnet with no compass

A partial qualitative understanding of the magnetic field involves a compass, which is itself a small bar magnet. Then:

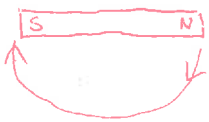
> The direction of the magnetic field is the same as the direction in which a compass needle (with clamping) will eventually settle.

Demo: Compass near bar magnet

Demo: PhET Compass magnet

Demo: Magnet / needle board

Warm Up!



Quiz!

Electric Currents and Magnetic Fields

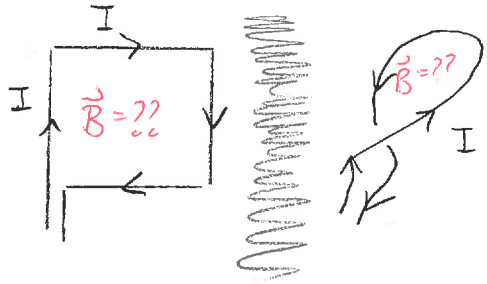
An accidental discovery by Oersted (mid 1800s) demonstrated that electrical currents affect nearby compasses. Therefore

> Any electric current produces a magnetic field.

Demo: Current board with ~~magnets~~ loops

The magnetic field depends on

1) the current strength
2) the geometrical configuration / arrangement of the current

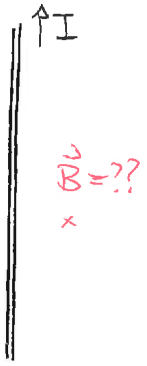


Eventually during the 19th century, a general framework for determining the field produced by any current become available. The calculations that this demands can be very complicated and we will present the results for a few important special cases

Magnetic field produced by a straight current

Consider a straight section of wire. Suppose that a constant current passes along the wire. In order to describe the magnetic field produced by the wire we need to provide

1) a direction at each location
2) a magnitude at each location

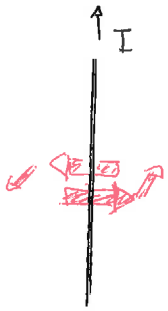


We can do the direction part for a general current. However, we will only give the magnitude for a current which is infinitely long.

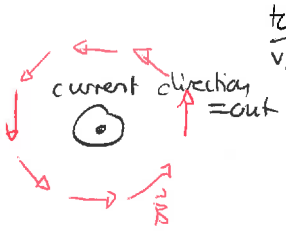
The direction is given by the following:

* the magnetic field vectors circle the current

* the sense in which the magnetic field vectors circle is determined by the following right hand rule



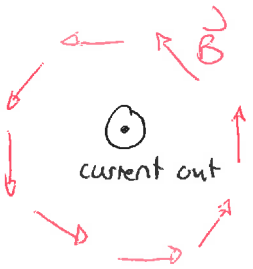
front view

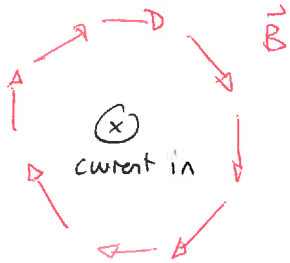


top view

1) Hold the wire with the right hand so that the thumb points along the current direction

2) The fingers indicate the sense in which the current circles.



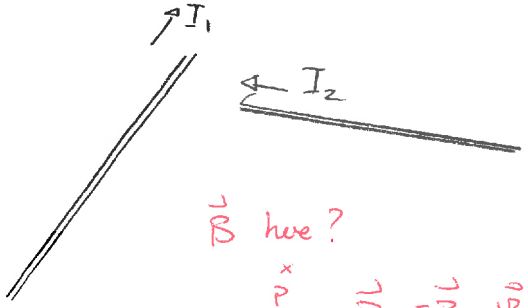


Warm Up 2

Superposition of fields

Suppose that there are multiple straight sections of wire. What is the net magnetic field produced by these? The general rule is:

The magnetic field produced by multiple straight currents is the vector sum of the fields produced by the individual currents.



The net magnetic field will determine the direction in which a compass points.

$\vec{B}$ here?

P

$\vec{B} = \vec{B}_1 + \vec{B}_2$

$\vec{B}_1$ at P, $\vec{B}_2$ at P

Quiz 2 30% – 80%

Quiz 3 60% – 90%