Magnetism — Part 2

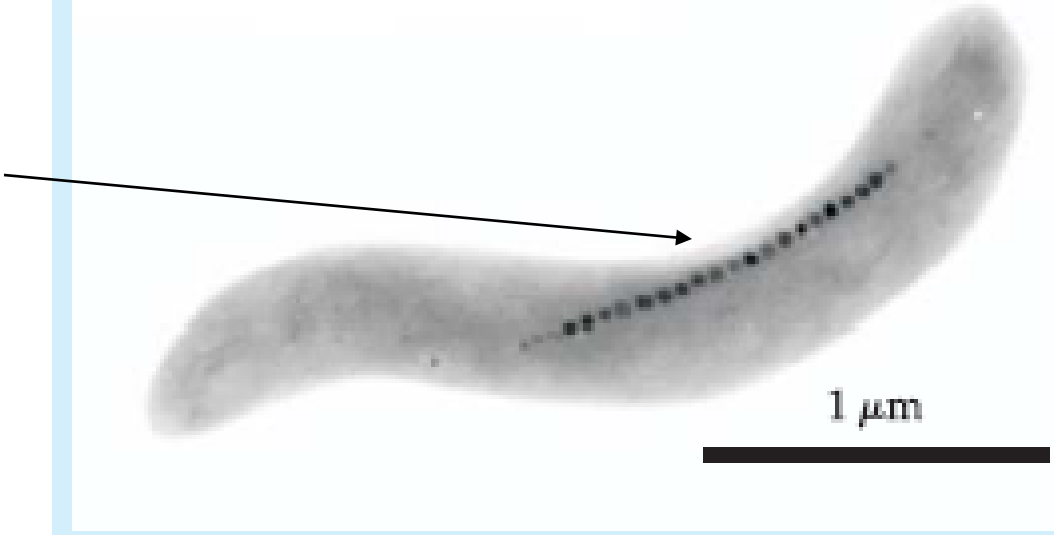
Magnetism in Nature –

MAGNETITE **(Fe_3O_4) is the most magnetic of naturally occurring minerals on earth.**

Many animals navigate by means of magnetoreceptors. There is a chain of magentite in the bacterium *Magnetospirillum magnetotacticum*.

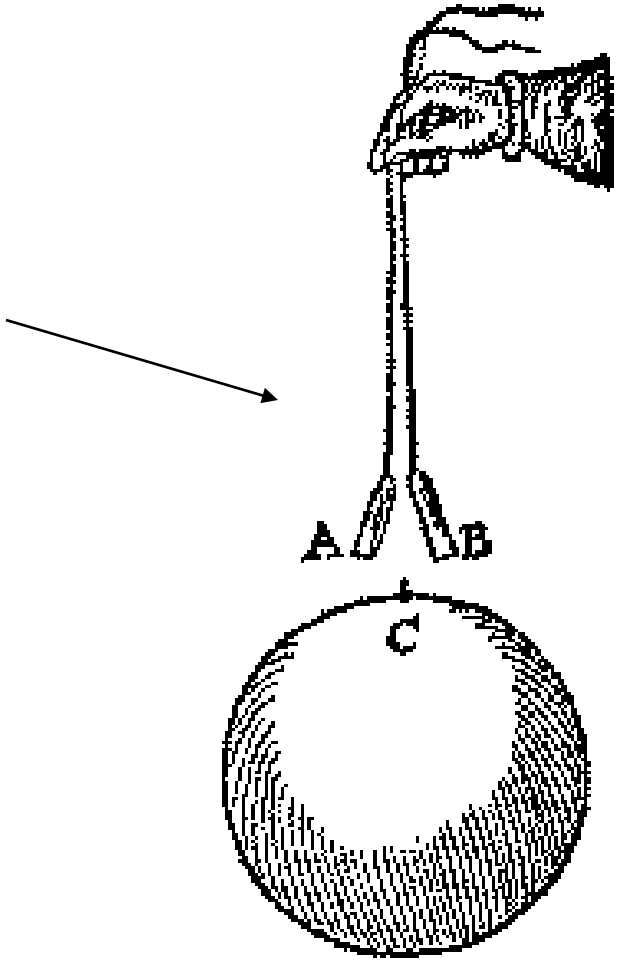
It uses it to locate to sense which way is "down" and find deeper, less oxygenated mud.

This magnetite chain is about 42 nm long.



Many materials (e.g. iron, steel) can be magnetized by contact or just by being in the vicinity of a magnet.

Look at Gilbert's experiment (late 1500s) on induced magnetism.



Are magnet poles charged?

Is a “north” pole positive?

Is a “south” pole negative?

Make some observations (work sheet page 1).

How does an electric field affect a moving charge?

$$F = qE$$

Look at an example –
oscilloscope – electron trajectory.

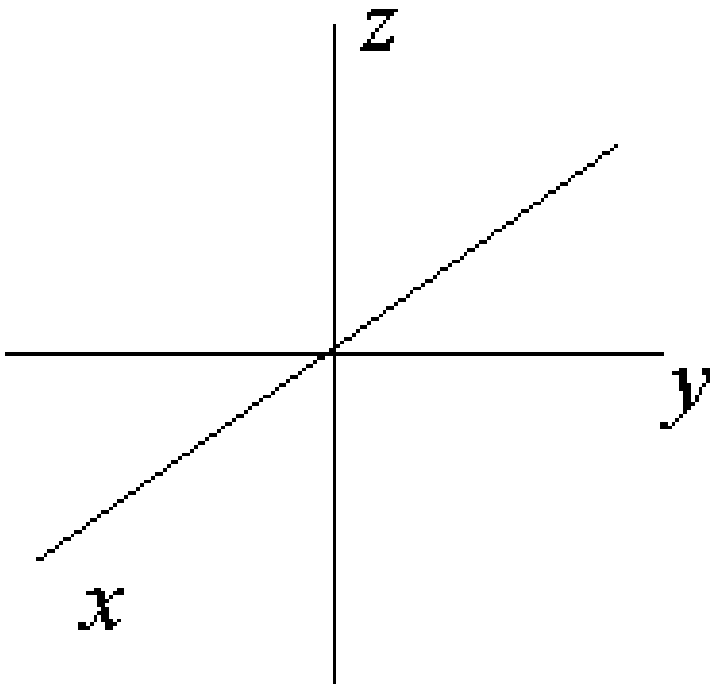
Look at this applet:

http://www.lon-capa.org/~mmp/kap18/RR4460app.htm

How does a magnetic field affect a moving charge?

Oscilloscope – electron beam deflection.

Coordinate system:



What is observed?

Symbol for magnetic field: *B*

For a field of a given strength:

$F \propto q$ direction depends on sign of charge

$F \propto \upsilon$

$F \propto \sin\theta$ (θ is the angle between $\vec{\upsilon}$ and $\vec{B}$)

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This *defines* magnetic field strength:

$$B \equiv \frac{F}{q\upsilon\sin\theta}$$

The SI unit for magnetic field

$q\upsilon$ has units: $\mathrm{C}\cdot\dfrac{\mathrm{m}}{\mathrm{s}}=\dfrac{\mathrm{C}}{\mathrm{s}}\cdot\mathrm{m}=\mathrm{A}\cdot\mathrm{m}$

Unit for B is

$$\frac{\text{newton}}{\text{ampere-meter}}=\text{tesla}\rightarrow 1\ \frac{\mathrm{N}}{\mathrm{A}\cdot\mathrm{m}}=1\ \mathrm{T}\left(\text{also}\ \frac{\text{Weber}\quad \mathrm{Wb}}{\mathrm{m}^2}\right)$$

Another older unit: gauss (G) $\quad 1\ \mathrm{T}=10^4\ \mathrm{G}$

A Few Typical *B* Values

Conventional laboratory magnets

25000 G or 2.5 T

Superconducting magnets

300000 G or 30 T

Earth's magnetic field

0.5 G or 5×10^{-5} T

Finding the Direction of Magnetic Force

Experiments show that the magnetic force is always perpendicular to the plane of $\vec{v}$ and $\vec{B}$.

Apply *right hand rule #1* (for positive charge).

Two versions – use either one.
Reverse force for a negative charge.