Physics 100 - February 9, 2007

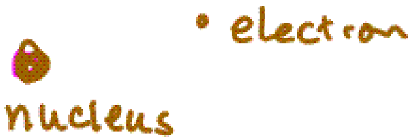
- Exam 1 in 12 days → Feb. 21
  Exam 1 material includes P.S.3, Rec 3
  plus all lectures through this one.
  More on this soon (Q+A session, Review sheet
  notes)
- I'll try to make 1st pass at
  presentation project assignments
  this weekend
- If you have not looked at online lecture notes,
  do so. I think you will find them
  useful

Last Time

Exploring the onion of inner space

layer 1
The ATOM

layer 2
Structure inside The ATOM



Held together by force of Electromagnetism
We are exploring this Force
AND will return briefly
to layer 1 and look again at
atoms later

Then to deeper layers of the onion

between 2 "charged" particles $F = \frac{k q_1 q_2}{r^2}$

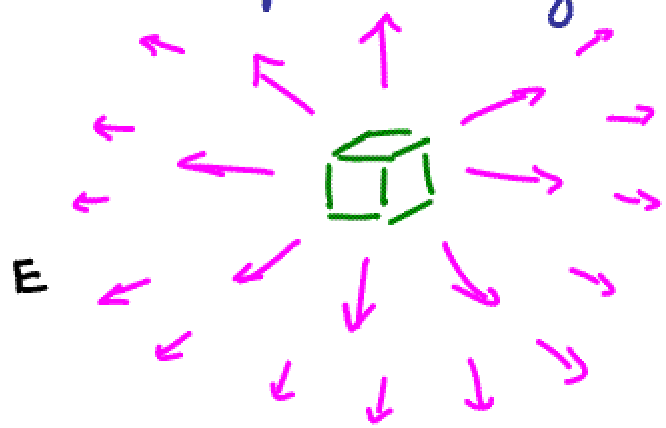
Attractive if $\begin{cases} q_1 = + & q_2 = - \\ q_1 = - & q_2 = + \end{cases}$ opposite signs

Repulsive if $\begin{cases} q_1 = + & q_2 = + \\ q_1 = - & q_2 = - \end{cases}$ same signs

Imagine force conveyed by a "field"

Electric field gives the Magnitude and direction of force on tiny positive "test charge" if placed at that position big conceptual jump.

Can imagine having an electric field in space without having knowledge of what creates it.



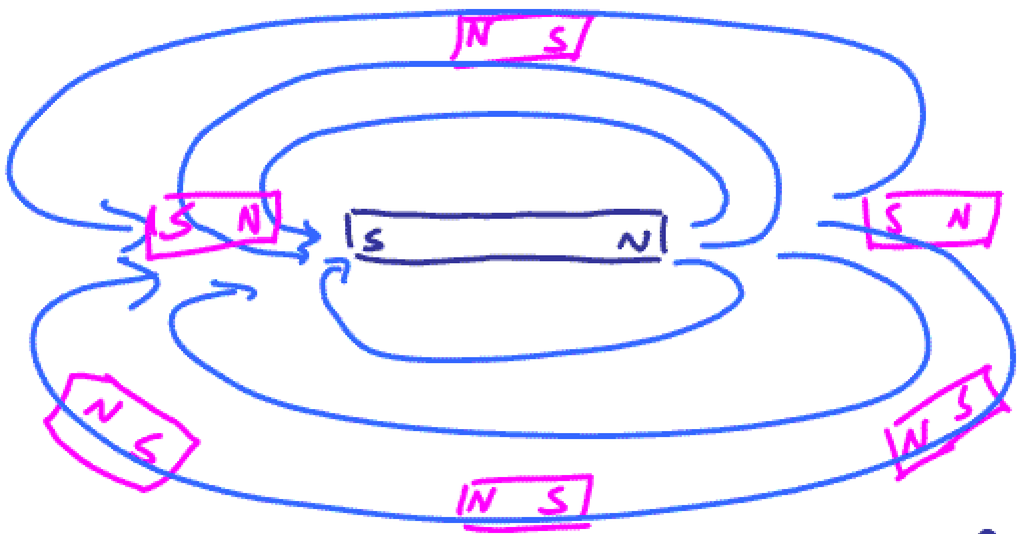
Field is radial

Pretend it has a reality on its own

symbol that represents an electric field is "E"

Here field is uniform to right

Magnetic field, B

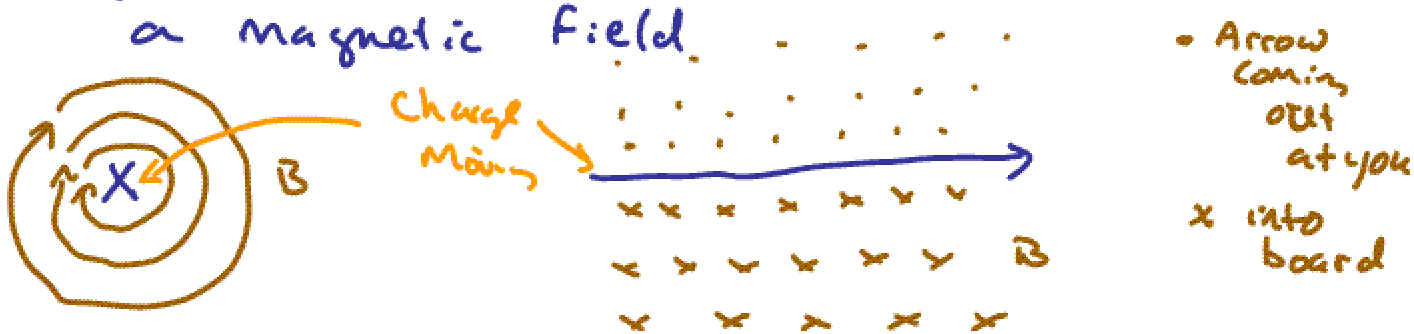


Visualizing lines along which little test bar magnet would align

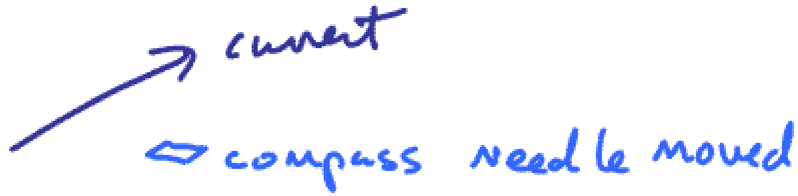
Force that rotates and pulls on test bar magnet falls off as $1/r^2$

E, B are NOT independent

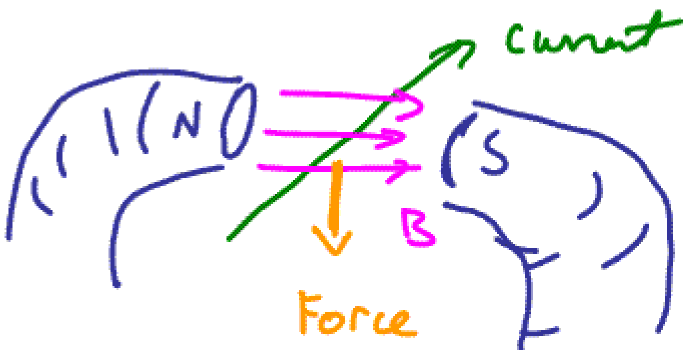
moving electric charge = "current" creates a magnetic field



We saw this with demo



Also magnetic field causes force on moving charged particles



Saw this in demo with current-carrying wire in strong magnetic field

Maxwell's Equations

1873

James Clerk Maxwell

1831 - 1879 (Edinburgh)

$$\oint_s \vec{E} \bullet d\vec{a} = \frac{Q_{encl}}{\varepsilon_o}$$

$$\oint_s \vec{B} \bullet d\vec{a} = 0$$

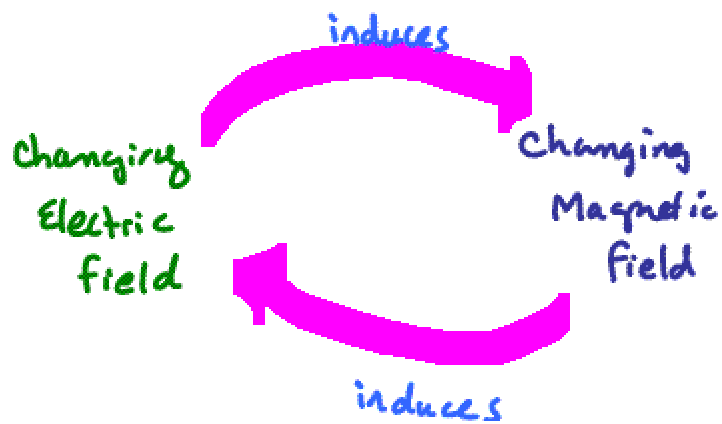
$$\oint_c \vec{E} \bullet d\vec{l} = -\frac{d\int_s B \bullet d\vec{a}}{dt}$$

$$\oint_c \vec{B} \bullet d\vec{l} = \mu_o I_{encl} + \mu_o \varepsilon_o \frac{d\int_s \vec{E} \bullet d\vec{a}}{dt}$$

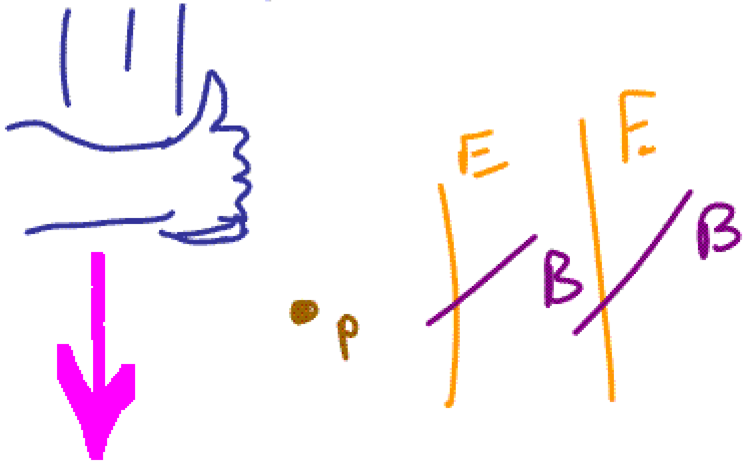
Maxwell tied it all together

- Electric and Magnetic forces unified
  → electromagnetism

- Also finds



Fist full of Electric charge → creates changing E which induces changing B which induces changing E ...



Propagates outward at speed of light

⤳ it is light

observer very far Away

end of material for Exam 1

Maxwell's eqns also tell us that E, B satisfy wave equations

Waves are a well-known mechanical phenomenon

Wave pulse traveling on a string

other examples:

Sound waves traveling in air

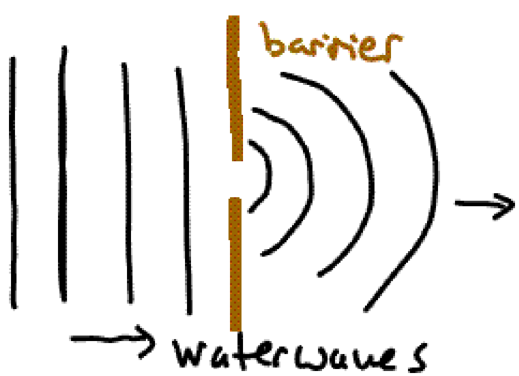
Water waves traveling on the surface of lake or ocean

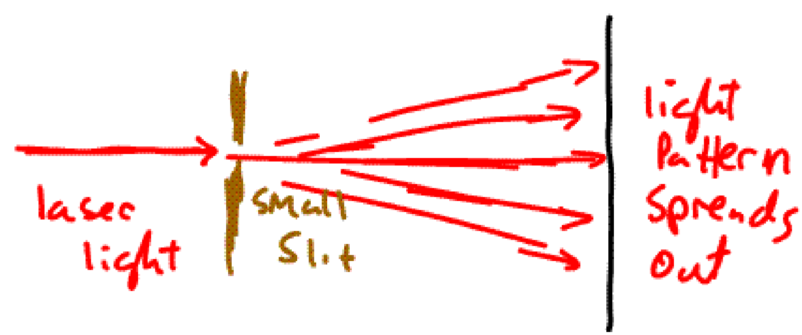
When I say E, B satisfy wave equations — it means Maxwell's equations can be written in a form similar to other equations whose solutions yield waves.

Light is a wave!

This is important because all waves share many basic properties ...

Diffraction — waves spread out passing thru small hole

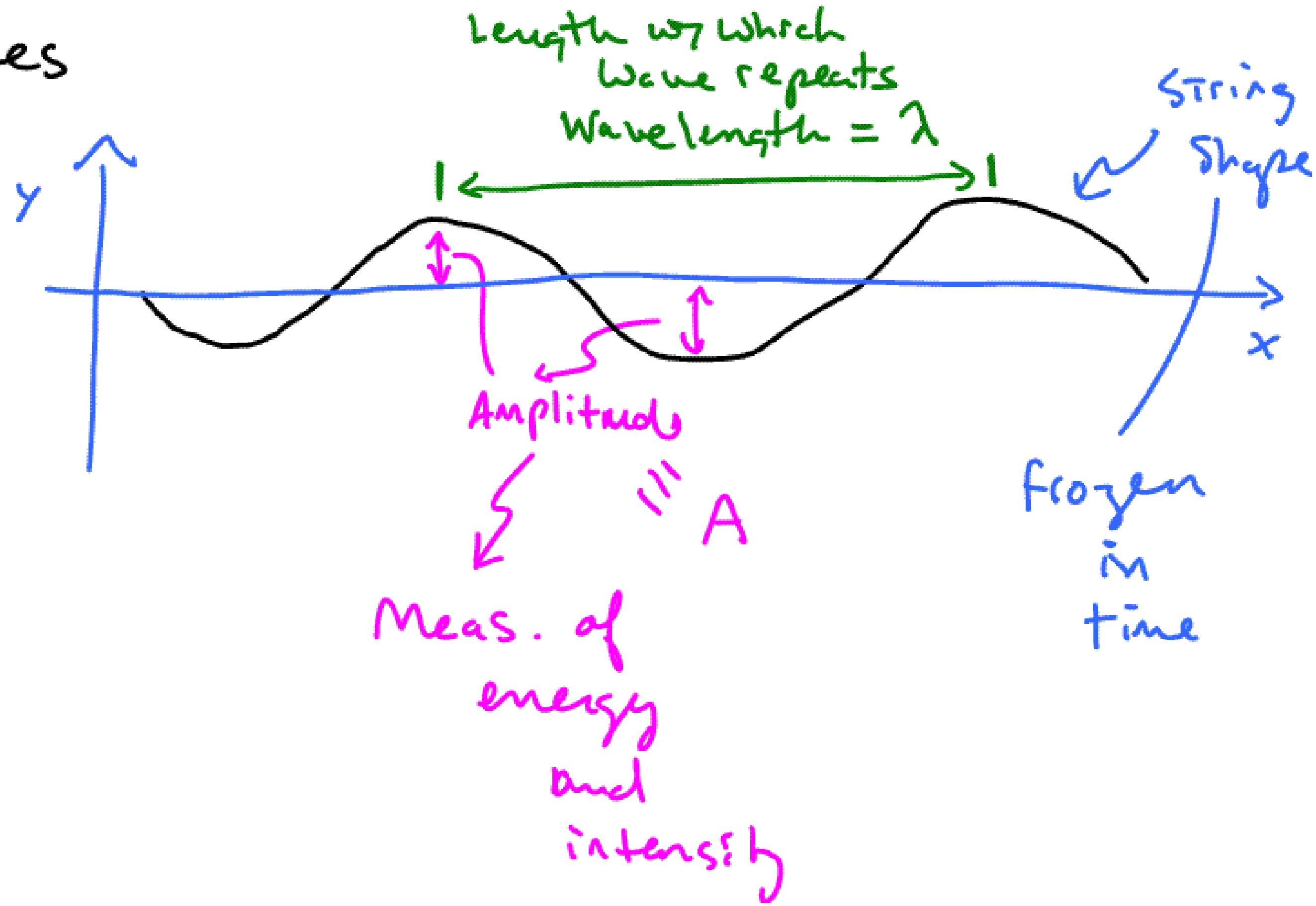


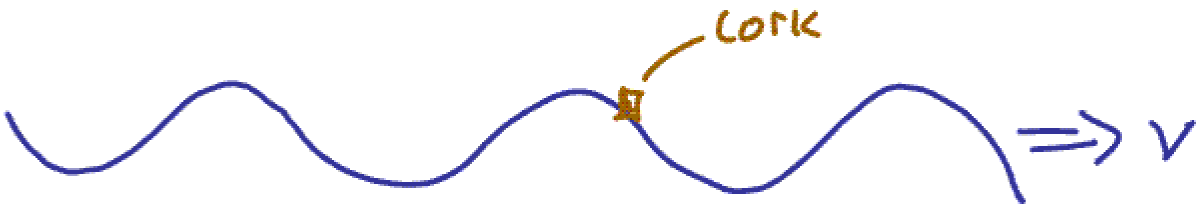


Other properties waves share

interference } will discuss next class
Refraction }

waves





imagine wave traveling on surface of water
with cork floating on surface

As wave moves past, the cork bobs up and down
without moving to the right or left.
The amount of time it takes the cork to bob through
one full cycle of its up and down motion is called
a <u>period</u>. The symbol for the period of a wave is T.
T is measured in seconds.

The period is the amount of time it takes a wave
to move a distance of one <u>wavelength</u>.

$$\text{frequency of wave} = \frac{1}{T} = \frac{1}{\text{seconds}} \equiv \text{Hertz} \quad (\text{Hz})$$

Sound waves at high frequency → you perceive as having high pitch

low frequency → low pitch

frequency corresponds to pitch in sound waves.

light waves ~ high frequency more blue

low frequency more red

frequency corresponds to color in light waves