kshop on Fields: Omar Clay, omar@physics.ucsd.edu

line:
1. Brief history
2. Defining Characteristics
3. Explorations & Demonstrations
4. Homework

Brief history

a. Early 1600's
  William Gilbert (1544-1603): author of De Magnete; basics of B fields
  Demo: dividing bar magnet => 2 magnets, dipolar
  Des Cartes (1596-1650): Cartesian coordinate system, momentum, dualism
  Galilleo (1564-1642): Momentum conservation, discuss energy
   Demo: 5 colliding pendula
b. Late 1600's
  Newton (1642-1727): Force, Gravitational Force Law: $F_g = G m_1 m_2 / r^2$
  Problem of Action at a Distance,
c. 1700's
  Ben Franklin (1706-1790) Electric Charge
  Demo: PVC pipe
  Augustin Coulomb (~1785) Static Electric Force Law: $F_e = k q_1 q_2 / r^2$
d. 1800's
  Hans Oersted: interaction between E and B
  Ohm
  Marie Ampere: $B = u_o/2*pi (I/r)$
   Demos: Current => B use coil and compass/ gauss meter
   Right hand rules for linear wires and coils
e. Michael Faraday (1791-1867): $V_{coil} = -A dB/dt$
  Member of lower class in England, little/no formal ed., talented
  experimentalist, worked for Royal Society, "I cannot afford to get rich"
  Proposed the concept of a Field to understand Action at a Distance problem-
  originally scorned. Demo: Drop a magnet through a coil and
  watchvoltage/current on a meter

 Fields:
   a. Types: Gravitational
  Electric
  Magnetic (actually intimately linked to electric fields)
  Atomic/ Nuclear
b. Properties:
  1. Transmit Force/ Momentum Demo: magnetic chaos spinner
  2. Vector Nature Demo: magnetic probe, iron filings, ferrofluid
  3. Store Energy Demo: magnetic elevation
  4. Preferred Media/material Demo: iron chips allow magnet to be picked up
c. Representations & Intuition

1. source/ termination points "charges" outline sources, equations, qualitatively discuss curl and divergence of fields
2. interactions b/n field lines

d. Interactions b/n B and E, briefly discuss how moving relative to a static B/E field transforms in part to a E/B field, Special Relativity
e. Eventually E& M waves

xplorations/ Demonstratons

a. Use probes to map out field lines around disc magnets
b. Hypothesize and test why magnets feel forces perpendicular to their poles
c. Play w/ other demos
d. induction in copper tube

Homework Questions

a. In several sentences explain what is a vector field
1. it represents a potential force
2. acts on charged objects
3. strength and direction

b. Why was the concept introduced?
1. action at a distance

c. What types of fundamental forces are there?
d. Mention what preferred media is about.
e. What are the sources of Fields?
f. given the formula for B due to a wire and the right hand rule;
1. will parallel wires w/ current running in the same direction attract, repel, or have no effect on each other?
2. For the wires to feel 1/4 of the force they do at a distance r, what distance from each other should they be placed at? A: 4 times farther away.

g. Given that the force between two dipoles (on axis) falls off w/ 1/r^3 how much farther away should two dipoles be placed to be 1/8 of the force they feel when r away from one another? A: twice the distance.