ELECTRIC FIELD AND SIMPLE CHARGE DISTRIBUTIONS

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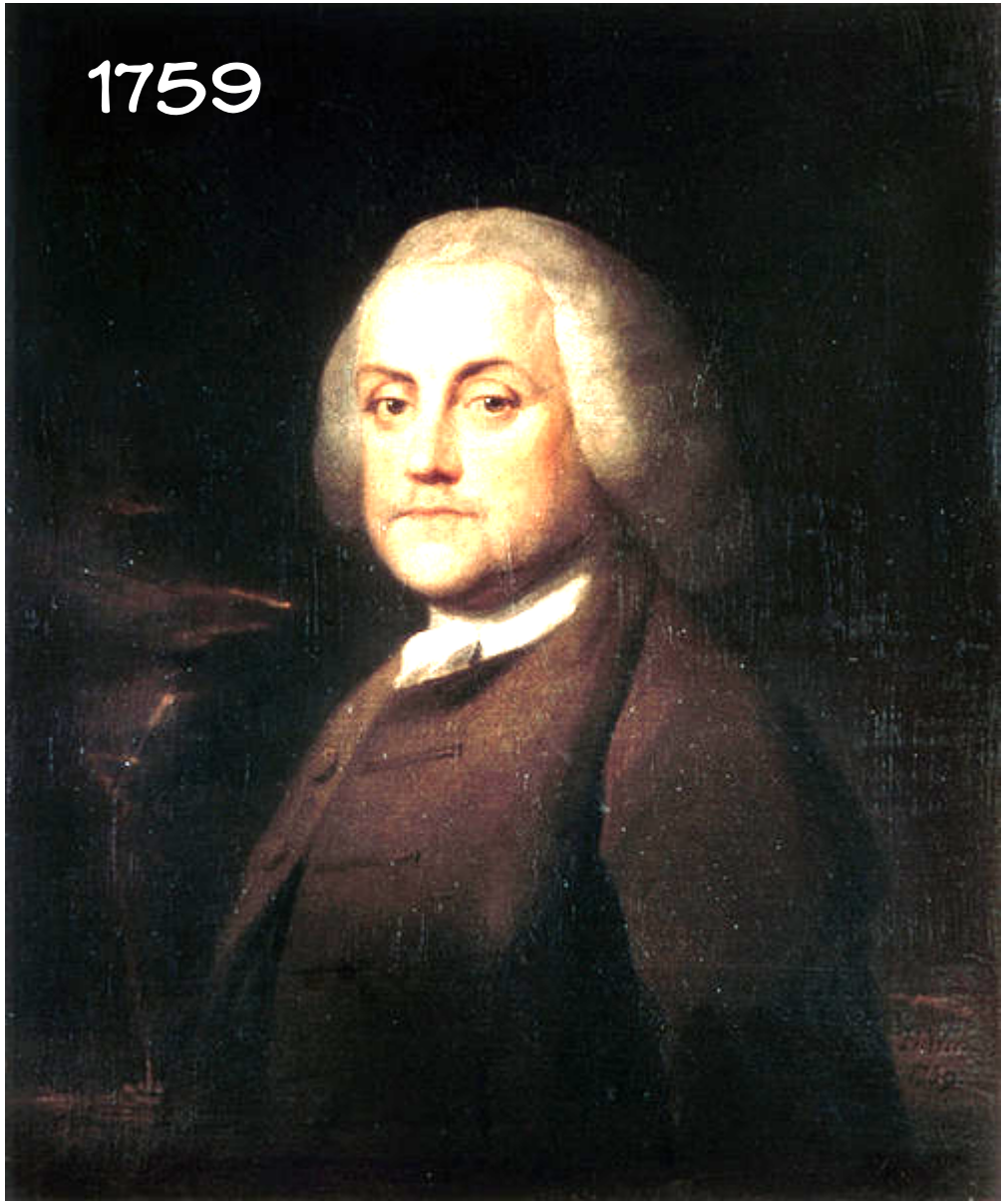
8/29/2010

Supplementary Material for PHY1308 (General Physics - Electricity and Magnetism)

ANNOUNCEMENTS

- Homework 1:
  - Due next Monday by 8pm
- First official in-class Quiz
  - Thursday, beginning of class
  - Bring pens/pencils and calculator
  - Covers homework 0 material

BENJAMIN FRANKLIN



1706-1790

Experimented with electricity around the 1750s.

CONVENTION

- In electricity, we discuss what happens to a positive charge
  - this is despite the fact that most electrical phenomena involve electrons, which have negative charge (thank you, Ben Franklin)
- Keep this rule in mind: positive charge always does the opposite of what negative charge does.

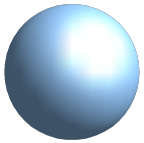
COULOMB'S LAW

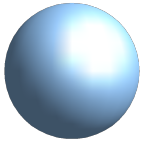
$$\vec{F}_{12} = \frac{k \cdot q_1 \cdot q_2}{r_{12}^2} \hat{r}_{12}$$

Tells you the force that charge 1 (the "source charge") exerts on charge 2:

EXAMPLE

charge 1

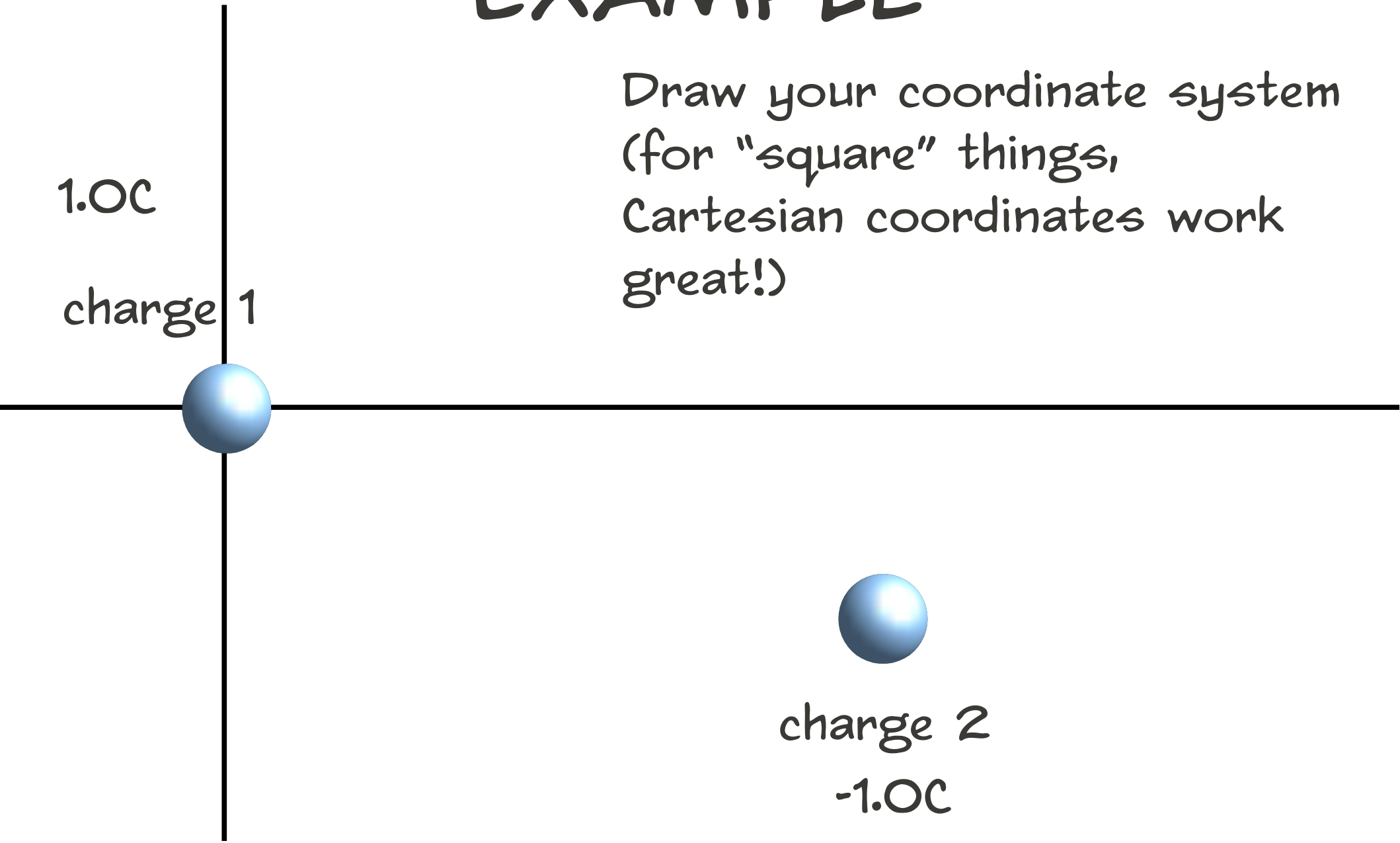




charge 2

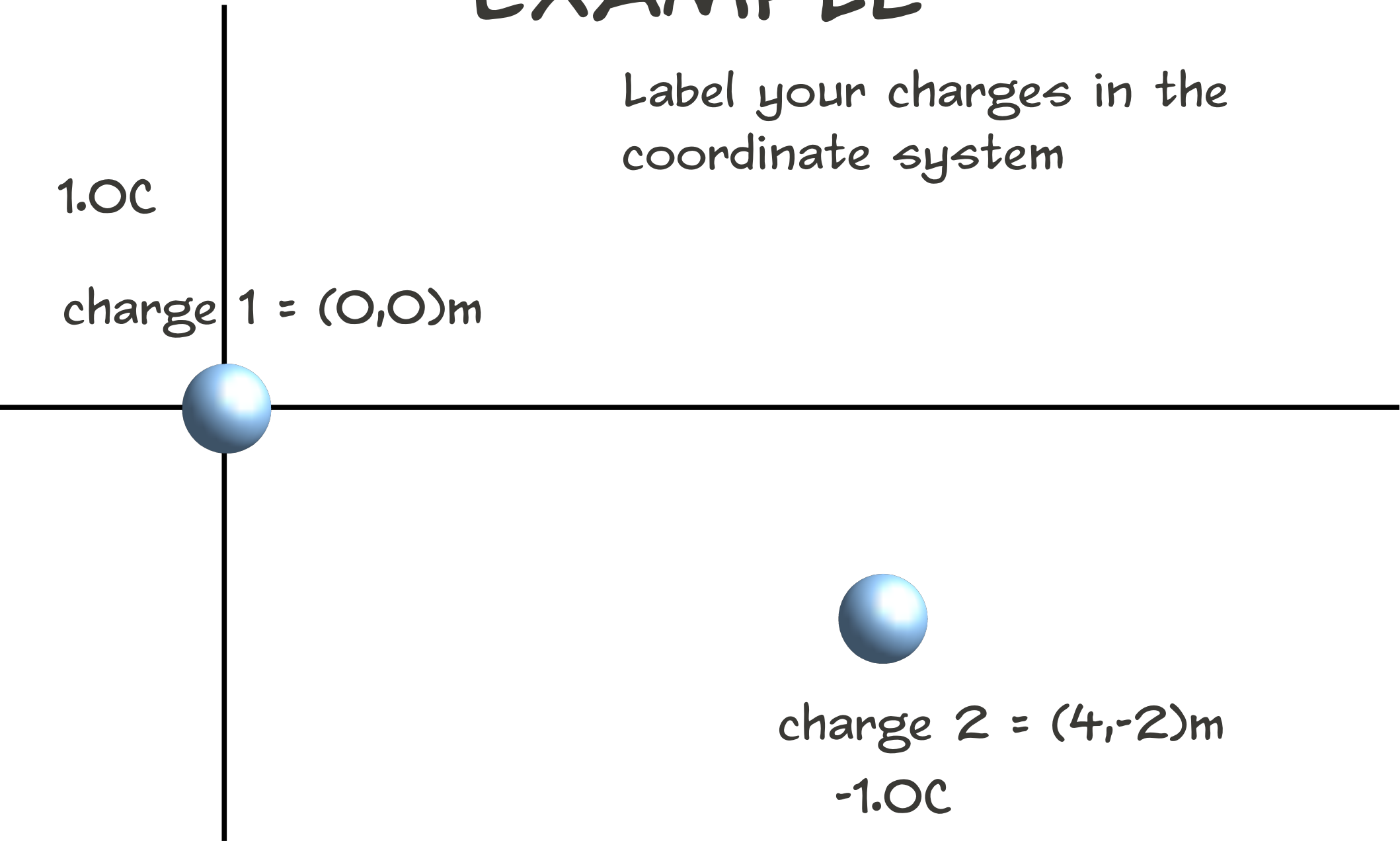
EXAMPLE

Draw your coordinate system (for "square" things, Cartesian coordinates work great!)



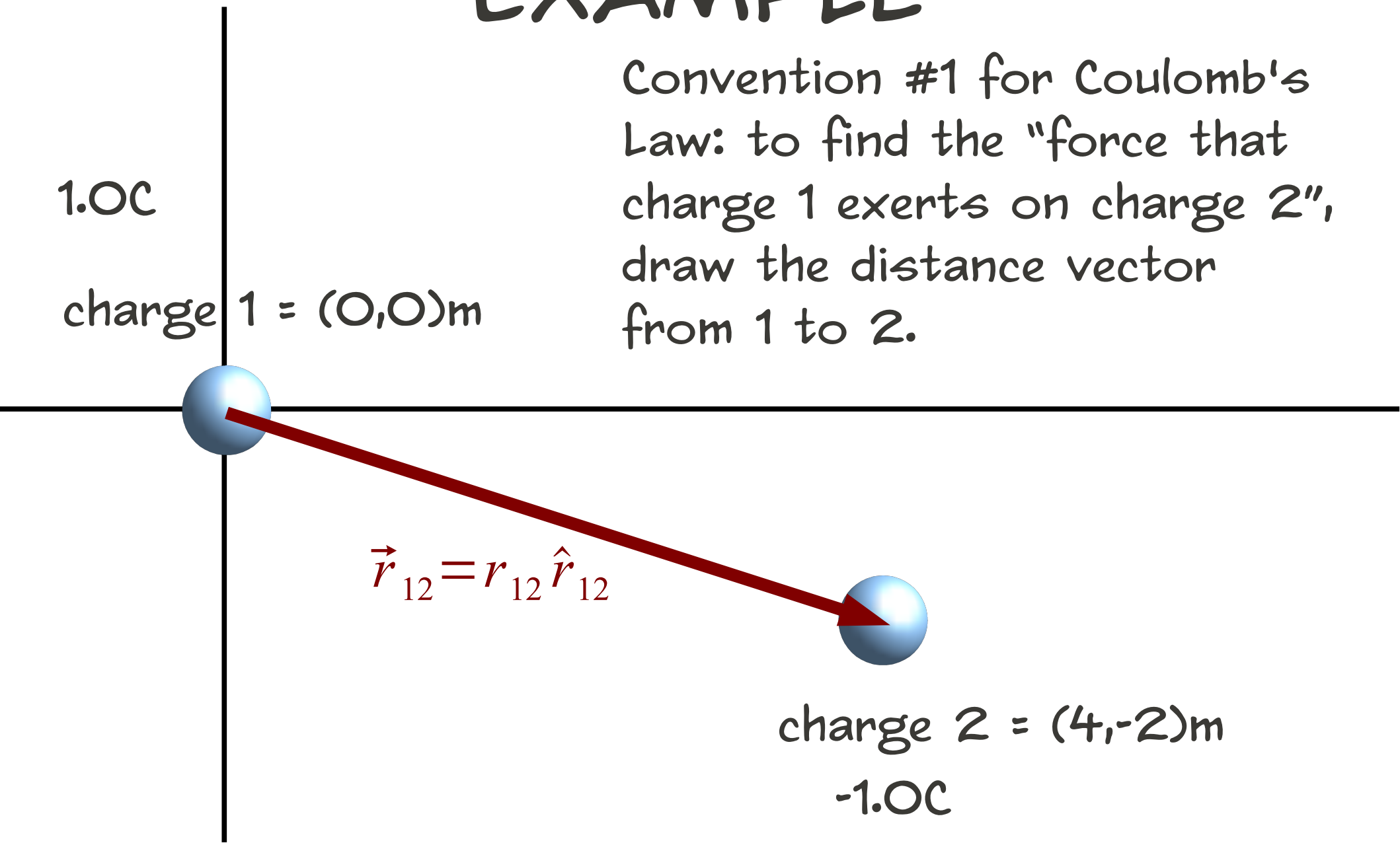
EXAMPLE

Label your charges in the coordinate system



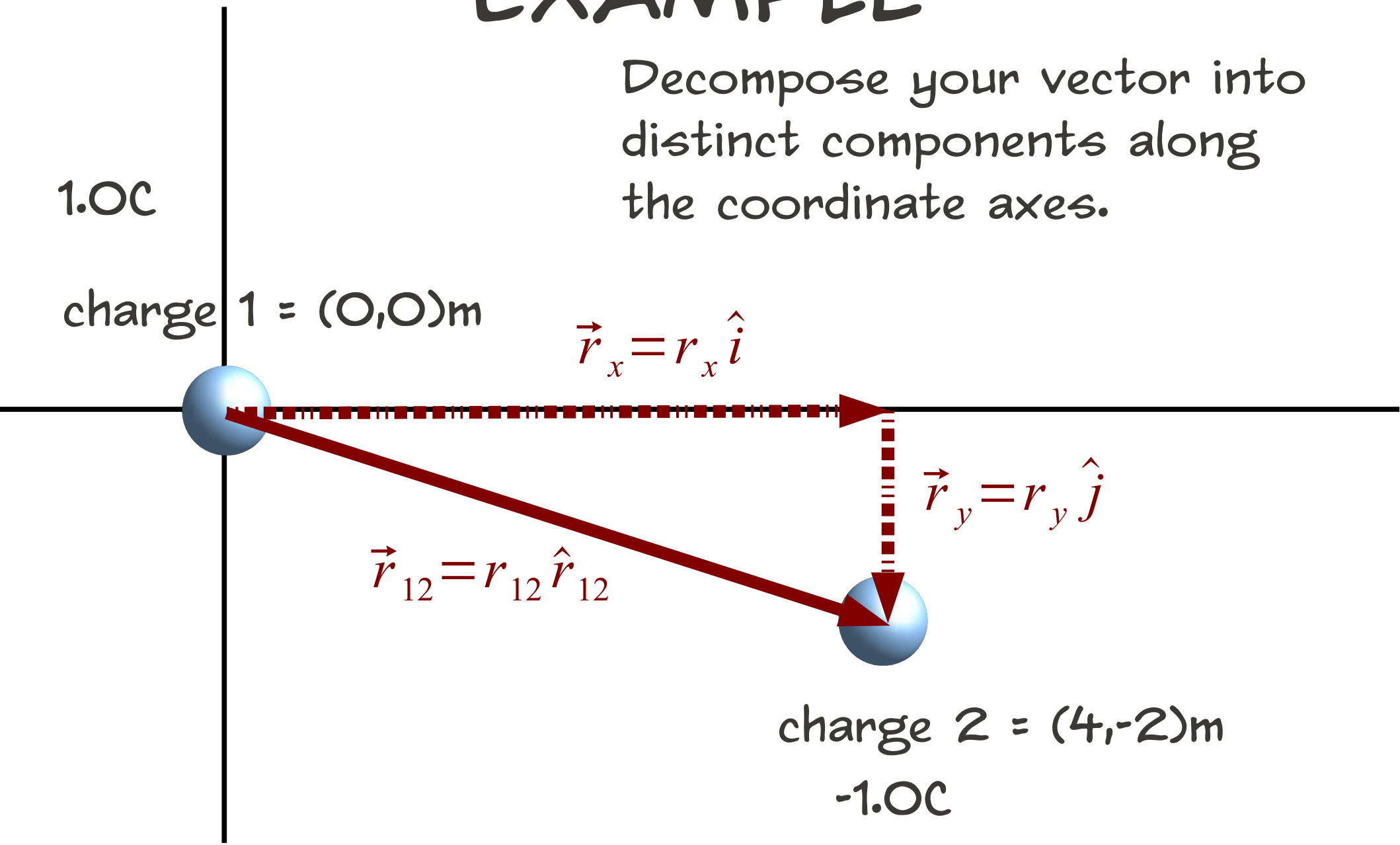
EXAMPLE

Convention #1 for Coulomb's Law: to find the "force that charge 1 exerts on charge 2", draw the distance vector from 1 to 2.



EXAMPLE

Decompose your vector into distinct components along the coordinate axes.



SOLUTION

$9.0 \times 10^9\ \mathrm{Nm^2/C^2}$ $1.0\,\mathrm{C}$ $-1.0\,\mathrm{C}$

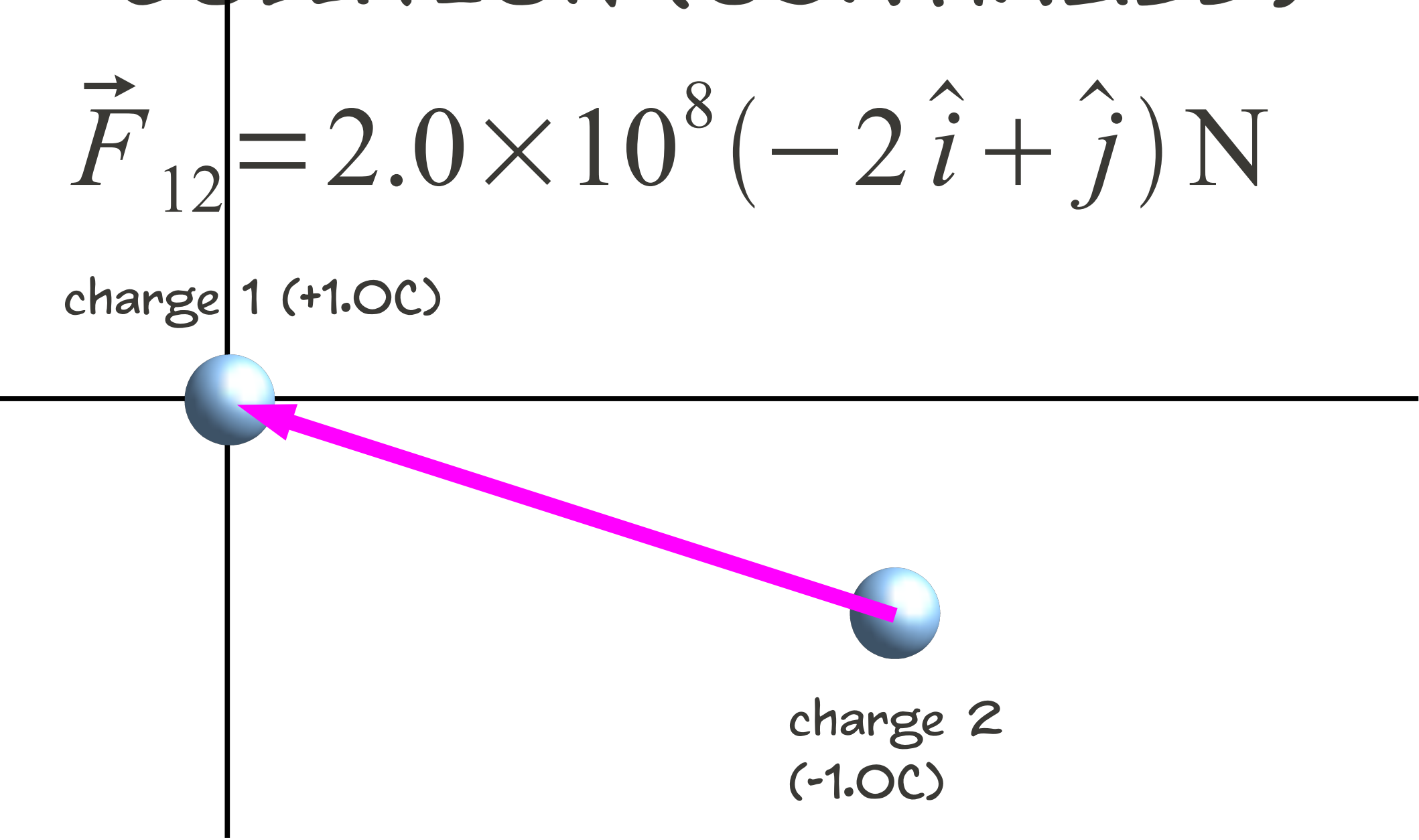
$$\vec{F}_{12} = \frac{k \cdot q_1 \cdot q_2}{r_{12}^2}\,\hat{r}_{12}$$

$$r_{12}^2 = r_x^2 + r_y^2 = (4)^2 + (-2)^2 = 20\,\mathrm{m}^2$$

$$\hat{r}_{12} = \frac{\vec{r}_{12}}{r_{12}} = \frac{4\,\hat{i} + (-2)\,\hat{j}}{\sqrt{20}}$$

SOLUTION (CONTINUED)

$$\vec{F}_{12} = 2.0 \times 10^{8} (-2\hat{i} + \hat{j})\,\mathrm{N}$$



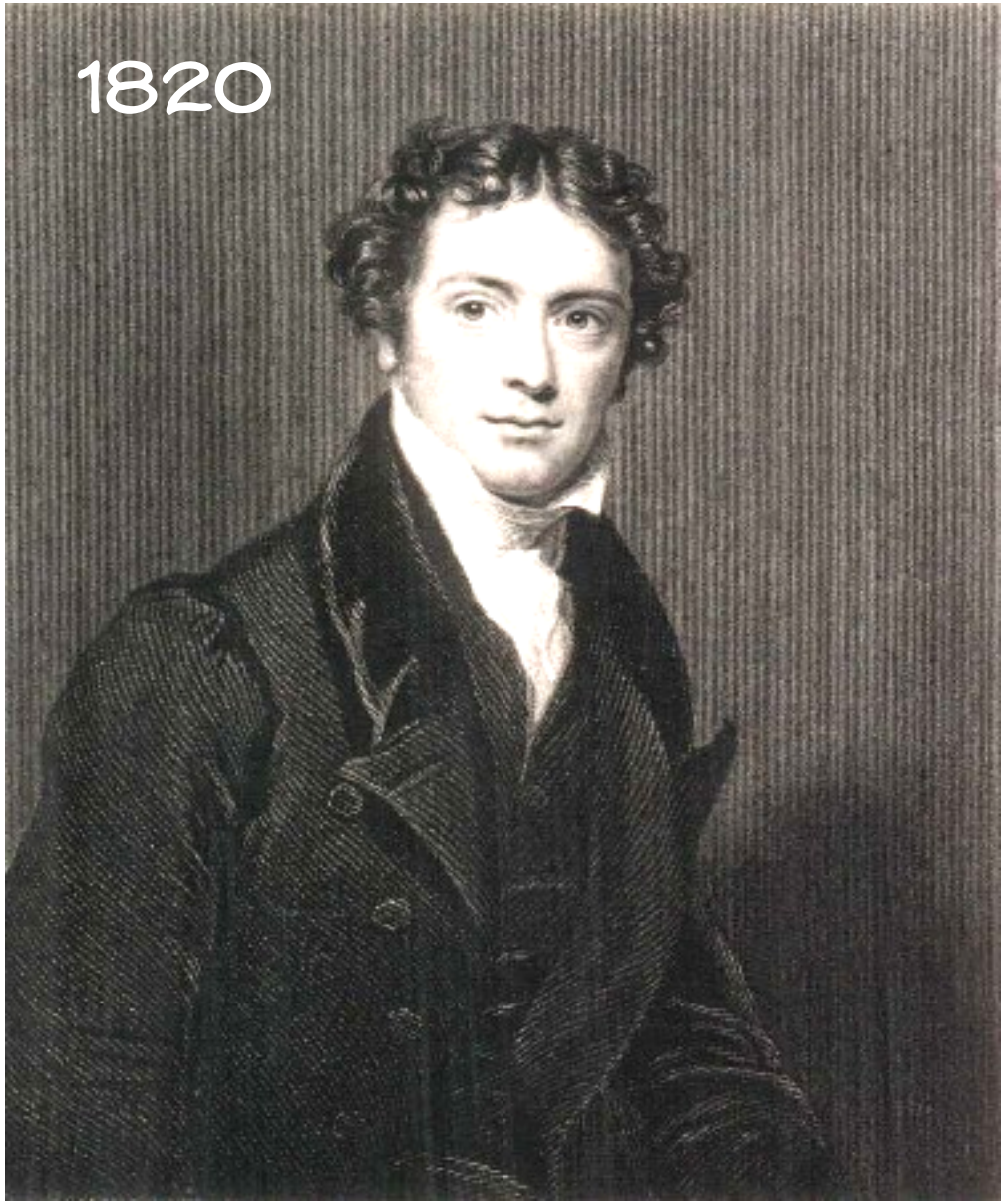
STRATEGIES

- Determine whether a problem involves Coulomb's Law
  - are there electric charges?
  - are you looking for the effect that the electric force from one charge exerts on another charge (or charges)?
    - "effect" implies a change in motion, and a change in motion means a FORCE.
- "Divide and conquer"
  - attack Coulomb's Law one piece at a time
  - write the charges, get the signs correct!
  - determine the vector(s) involved, using a coordinate system
  - find the magnitude of the distance(s) of separation and all related unit vectors

SUPERPOSITION

- Have many charges exerting forces on another charge? How do I get the total force?
  - add up all the forces *as vectors*!

MICHAEL FARADAY



1792-1867

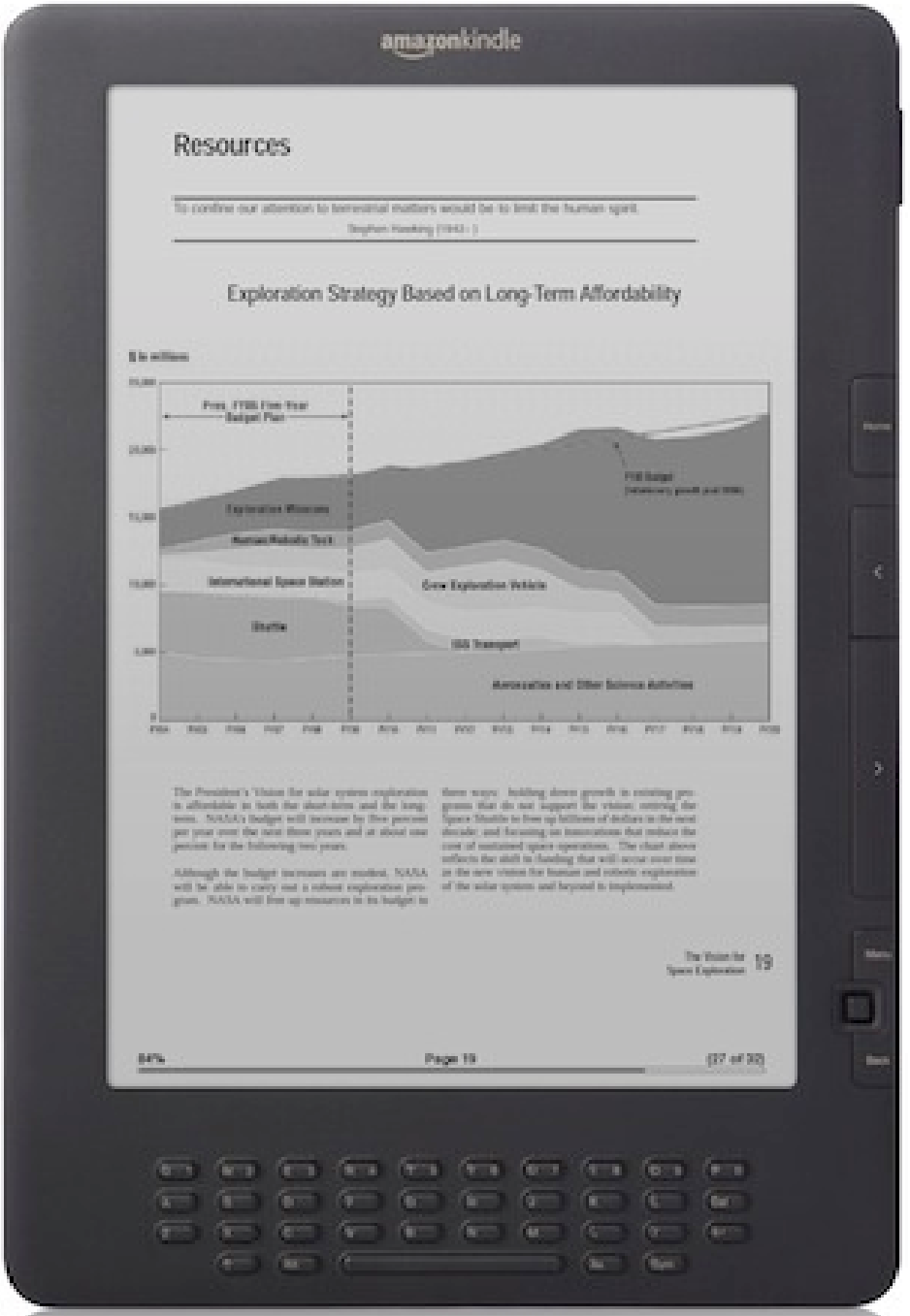
A brilliant chemist and physicist. Despite his origins in poverty, through persistence he was able to break into England's nobility-controlled scientific elite.

Introduced the concept of an "electric field".

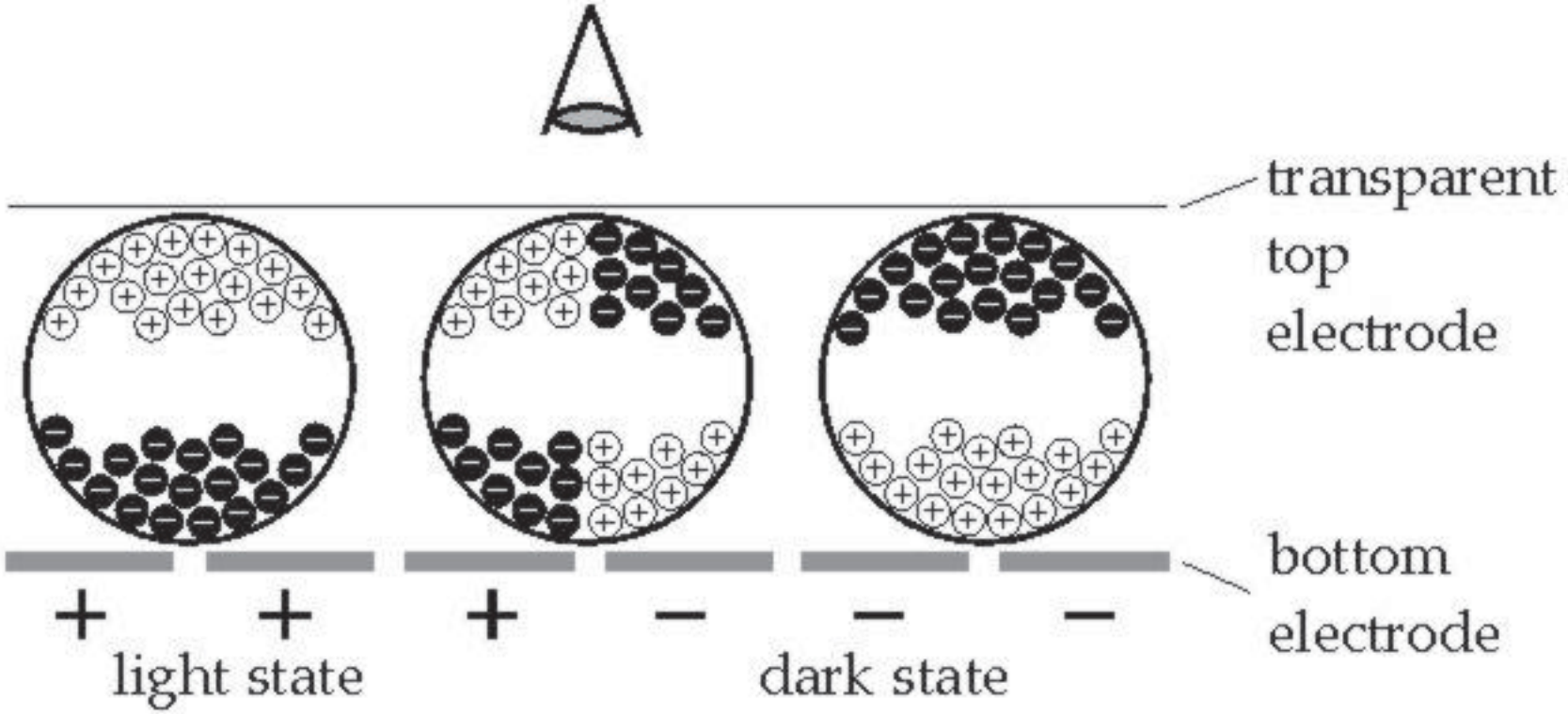
ELECTRIC FIELD DEMO

- Feel the electric field
  - Van de Graaff Generator
- Visualize the electric field
- PhET simulation:

  http://phet.colorado.edu/en/simulation/efield

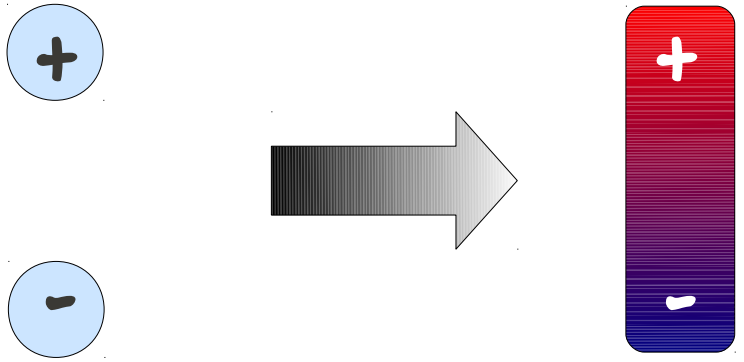

amazonkindle
Resources
Exploration Strategy Based on Long-Term Affordability
$ in millions
International Space Station
Shuttle
Crew Exploration Vehicle
84%
Page 19

E-INK (ELECTROPHORETIC INK)

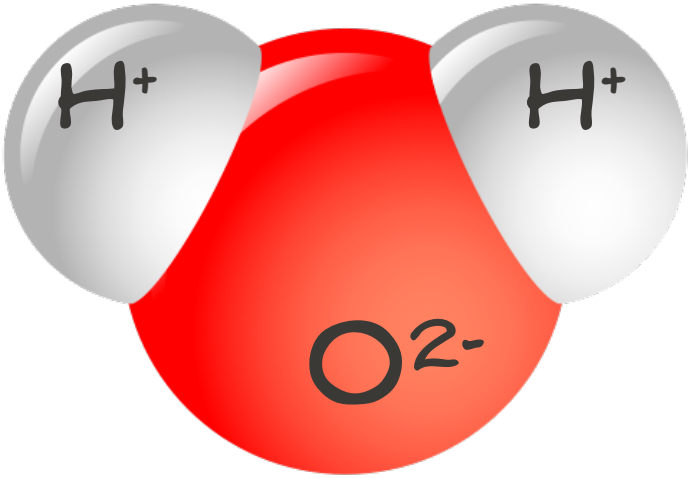


Examples: SONY and Amazon book readers.

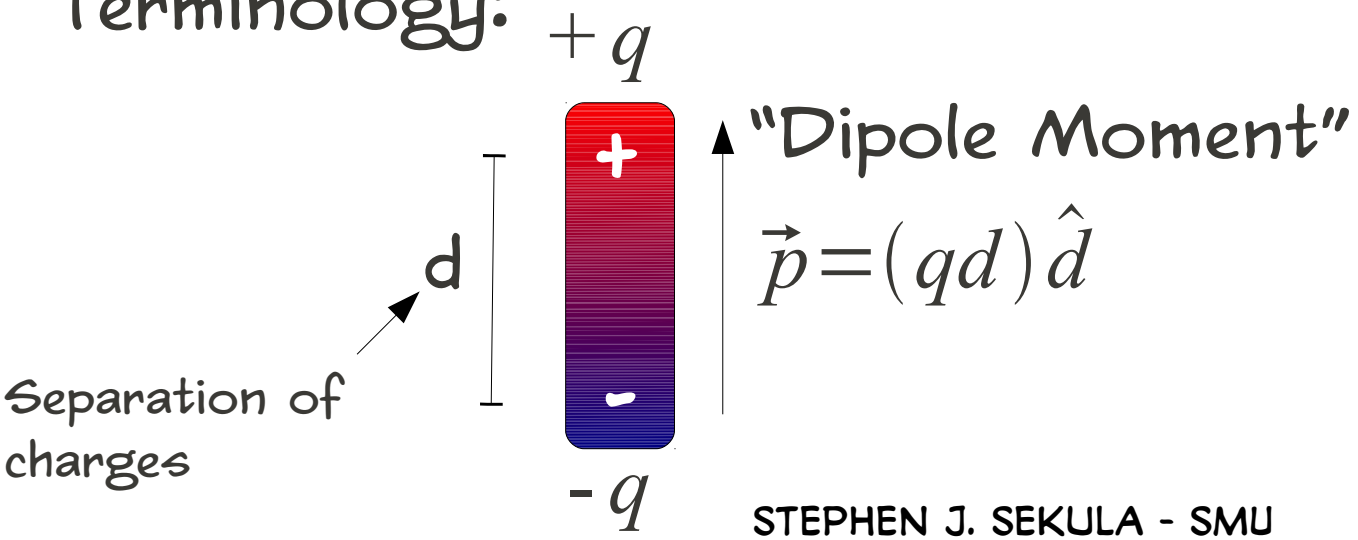
DIPOLE



Cartoon of a water molecule



Terminology:



"Dipole Moment"

$$\vec{p} = (qd)\hat{d}$$

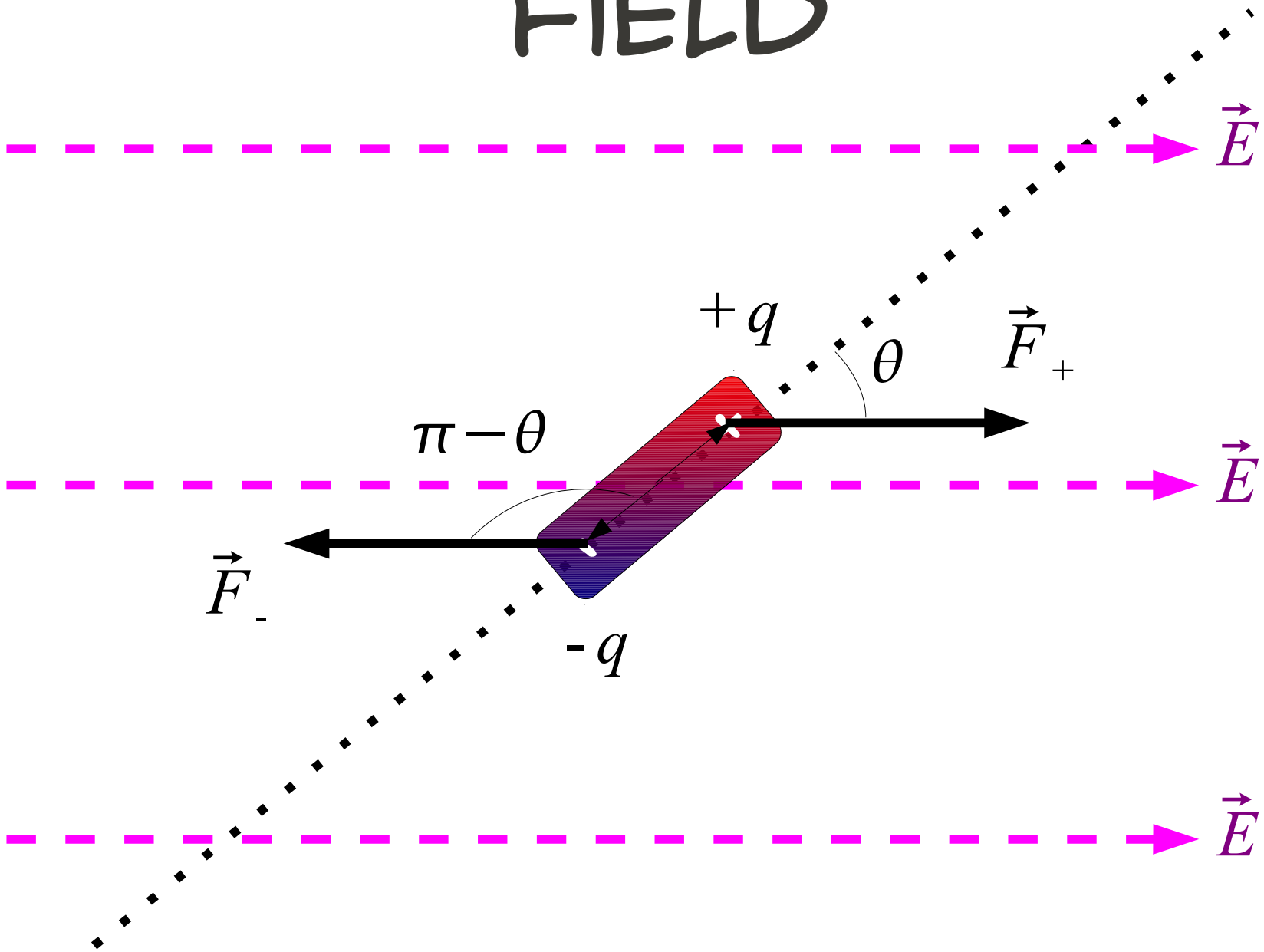
QUALITATIVE: DIPOLES IN ELECTRIC FIELDS

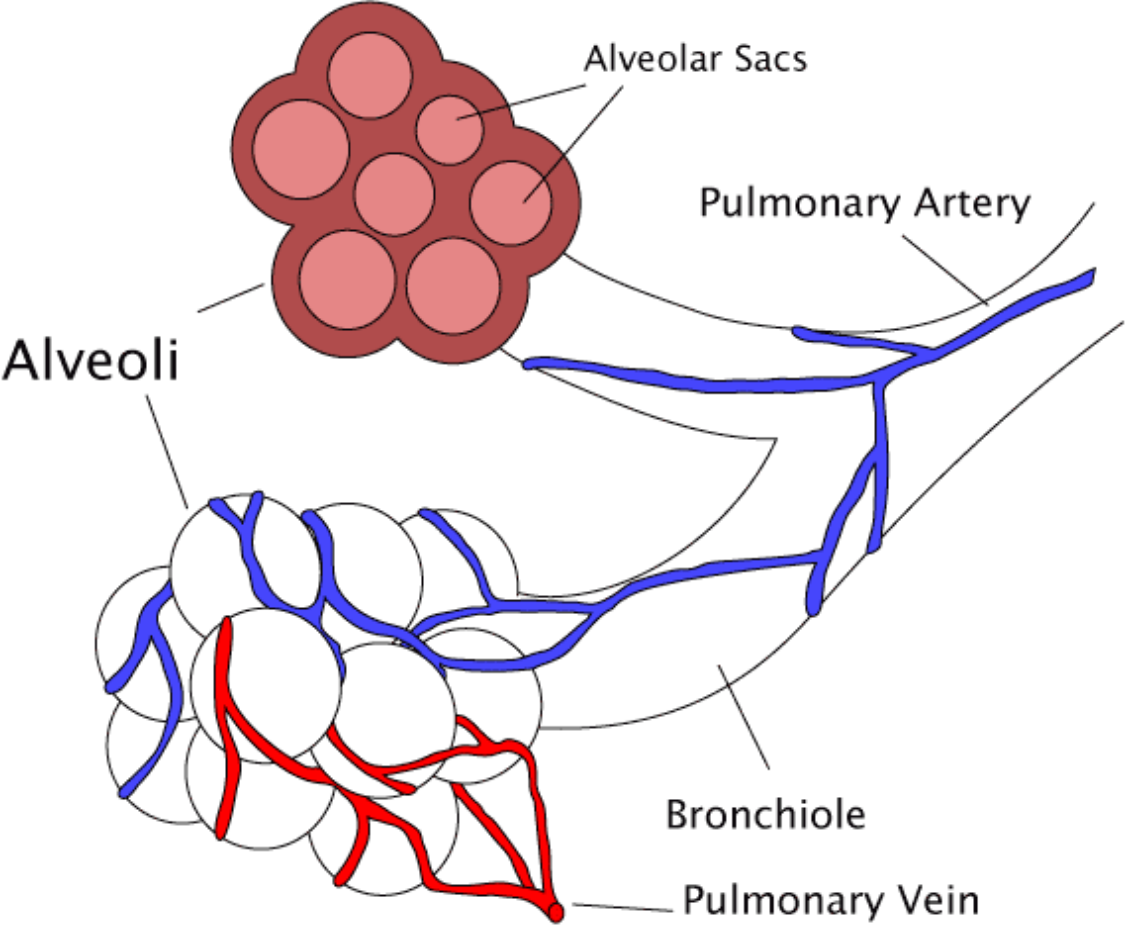
- Visualize and Predict
  - in the simulator, make two charges, one with +2 and one with -2 charge. Change the electric fiel and see how the dipole responds.

    http://phet.colorado.edu/en/simulation/efield

- If water is a dipole, what will it do in the electric field of a negatively charged object?

DIPOLE IN ELECTRIC FIELD




Alveolar Sacs
Pulmonary Artery
Alveoli
Bronchiole
Pulmonary Vein