Physics 132

Let us start

* http://org.coloradomesa.edu/~jworkman/teaching/teaching.php

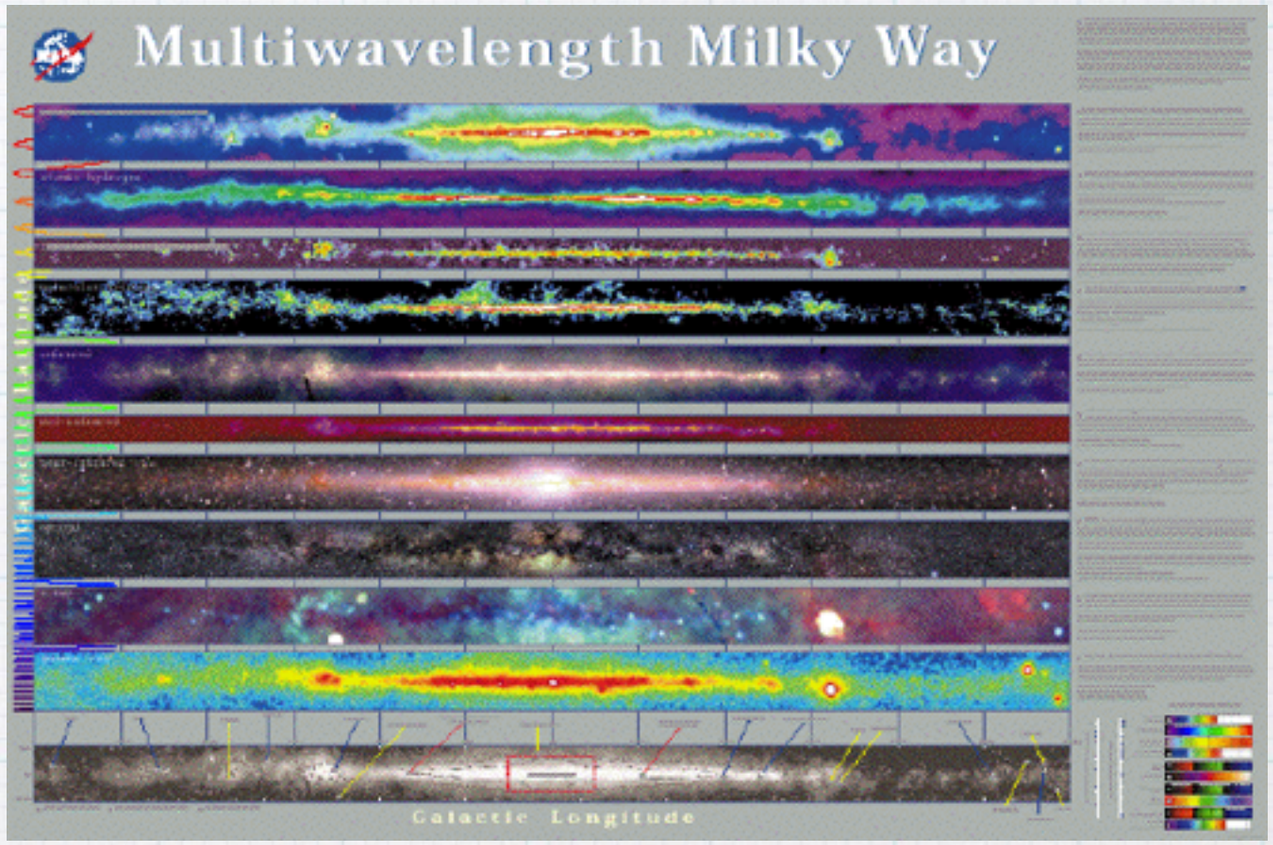
* Policies and procedures
* What we'll study
* What I want you to be able to understand

Policies and Procedures

What we'll study

* electric fields and forces
* magnetic fields and forces
* currents, resistance, circuits
* light and electromagnetic waves
* induction
* geometric Optics
* wave optics

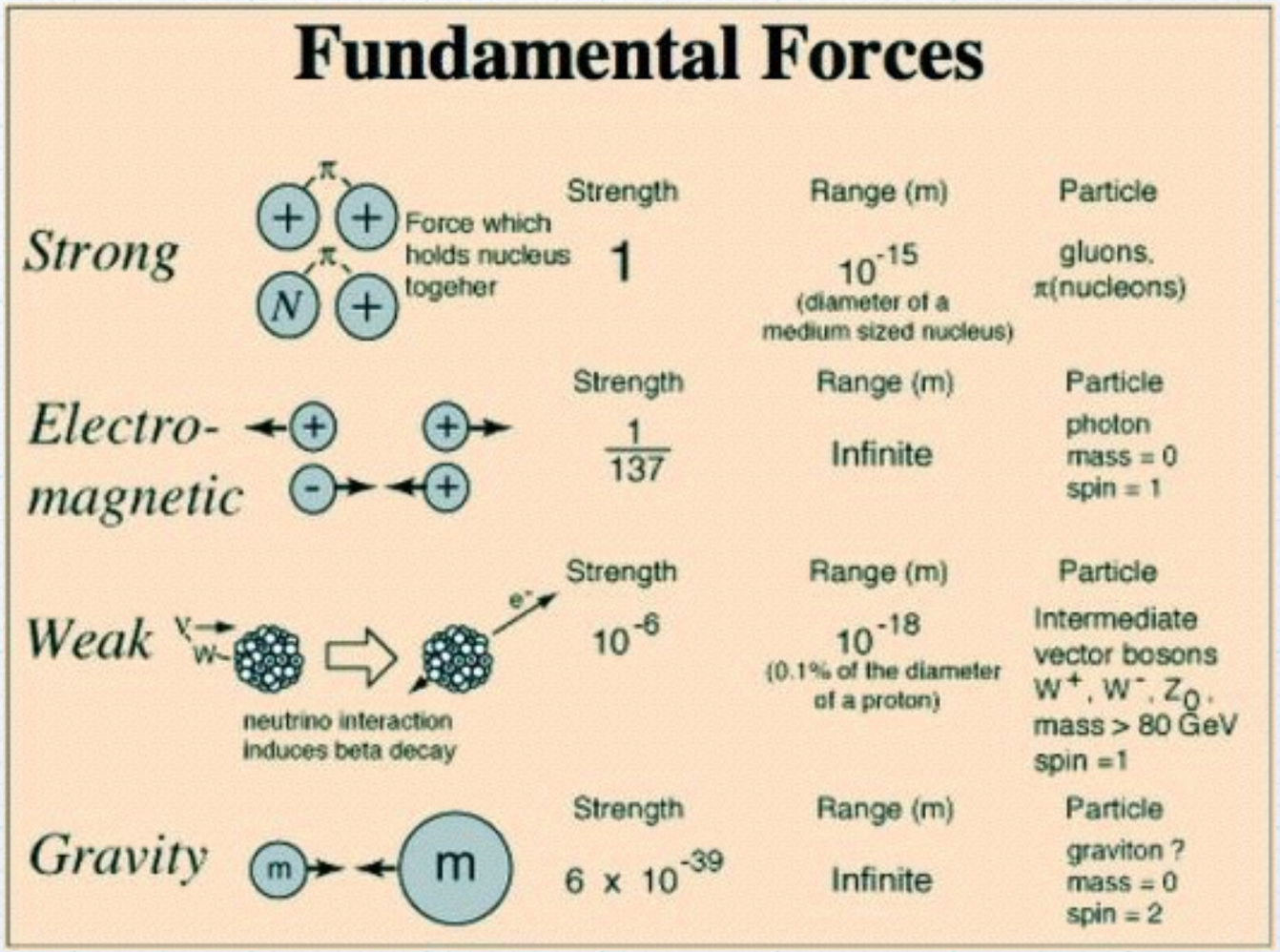
What you should be able to understand



Make sure you can do vector algebra, it's a prerequisite for passing. Also, work everything out symbolically first for credit.

There are four fundamental forces, four, that's it

* Strong
* Electromagnetic
* Weak
* Gravitational



This course is all electricity and magnetism

- Let's start with charge
- The unit of charge is Coulombs
- The fundamental charged particles are protons and electrons, neutrons are neutral (mostly)
- Important, notice the mass difference? Which particle accelerates more under the influence of the same force?

Properties of protons, neutrons and electrons

Property → Particle ↓	Mass (relative to p)	Charge (relative to p)	Description
Proton p	1.67 x10^{-27} kg 1 amu (u)	+ 1.6 x 10^{-19}C (+1e)	Nucleon (part of nucleus)
Neutron N	1.67 x10^{-27} kg 1 amu (u)	0	Nucleon
Electron e	9.1 x10^{-31} kg 1/1800 amu	- 1.6 x 10^{-19}C (-1e)	Found in a cloud around the nucleus

Basics DON'T FORGET THIS

* How do charged particles interact?
* + +?
* - -?
* + -?
* Board example

All charged objects are made up of

* An integer number of fundamental charges
* The symbol for fundamental charge is |e| = $1.602*10^{-19}$ coulombs

* For positively charged things q=Ne
* For Negatively charged things q=-Ne
* Use absolute values and your brain
* Example Doubly ionized helium
* Example charge in one second of using a vacuum cleaner

Reading Question 23.2

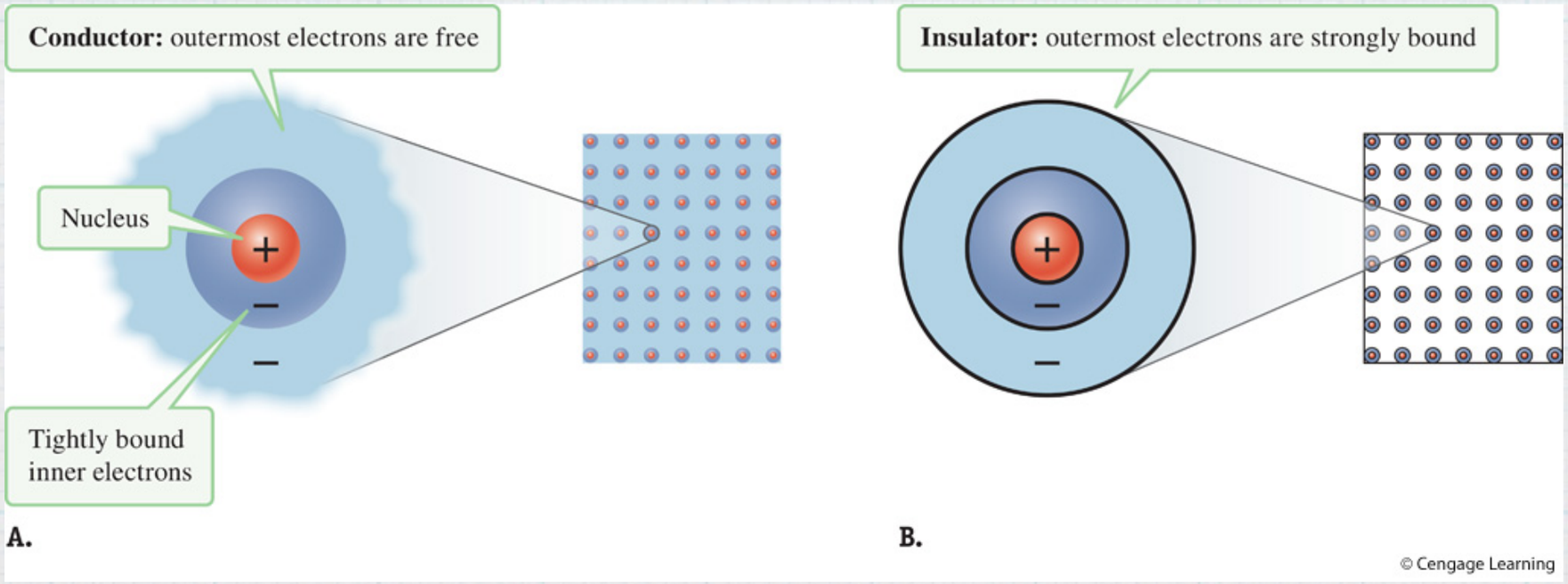
Which of the following is not a possible charge on a molecule?

a. $q = 1.602 \times 10^{-19}$ C
b. $q = -8.01 \times 10^{-19}$ C
c. $q = -4.005 \times 10^{-19}$ C
d. $q = 8.01 \times 10^{-19}$ C

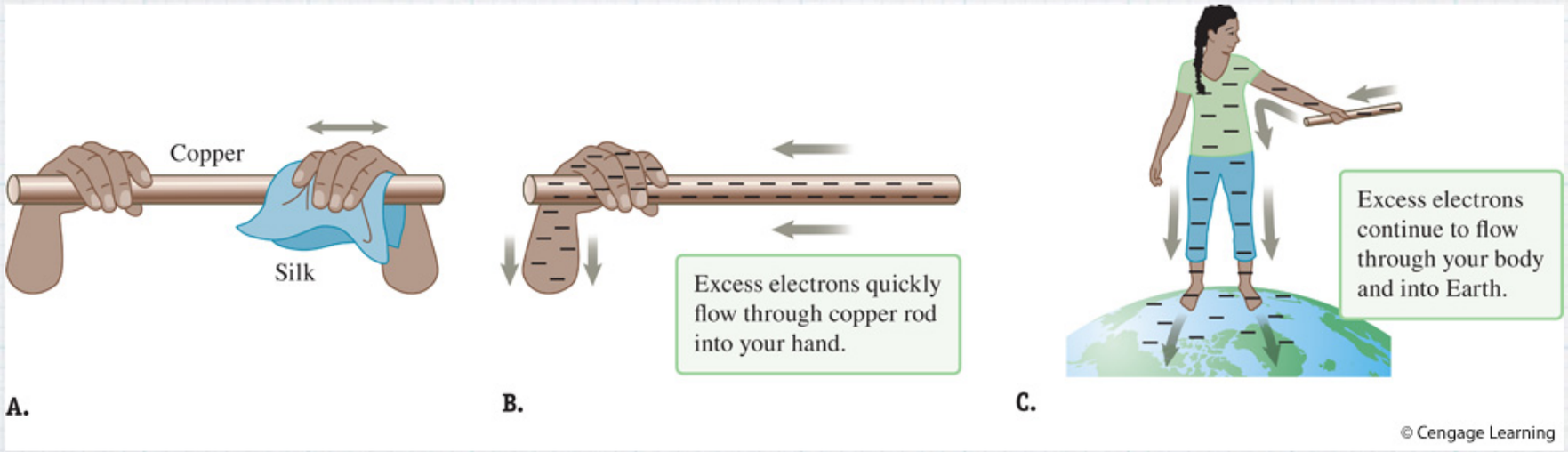
An electron has a charge
$-e = -1.602 \times 10^{-19}$ Coulombs

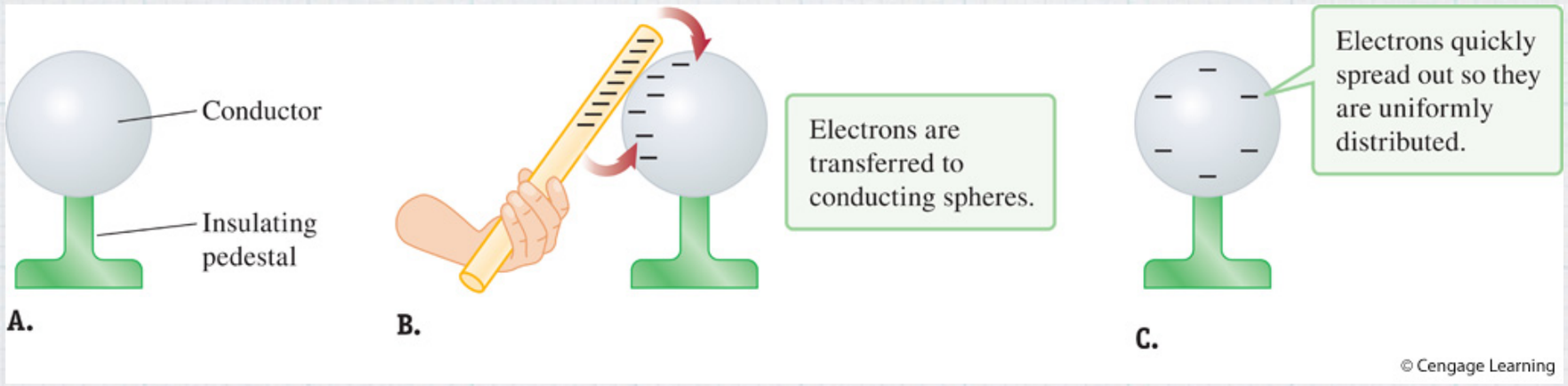
Conductors and Insulators

* Conductors have weakly bound outer electrons
* Insulators have tightly bound outer electrons
* This determines how well charges flow
* What happens when lightning strikes a tree versus a lightning rod, why?
* Demo

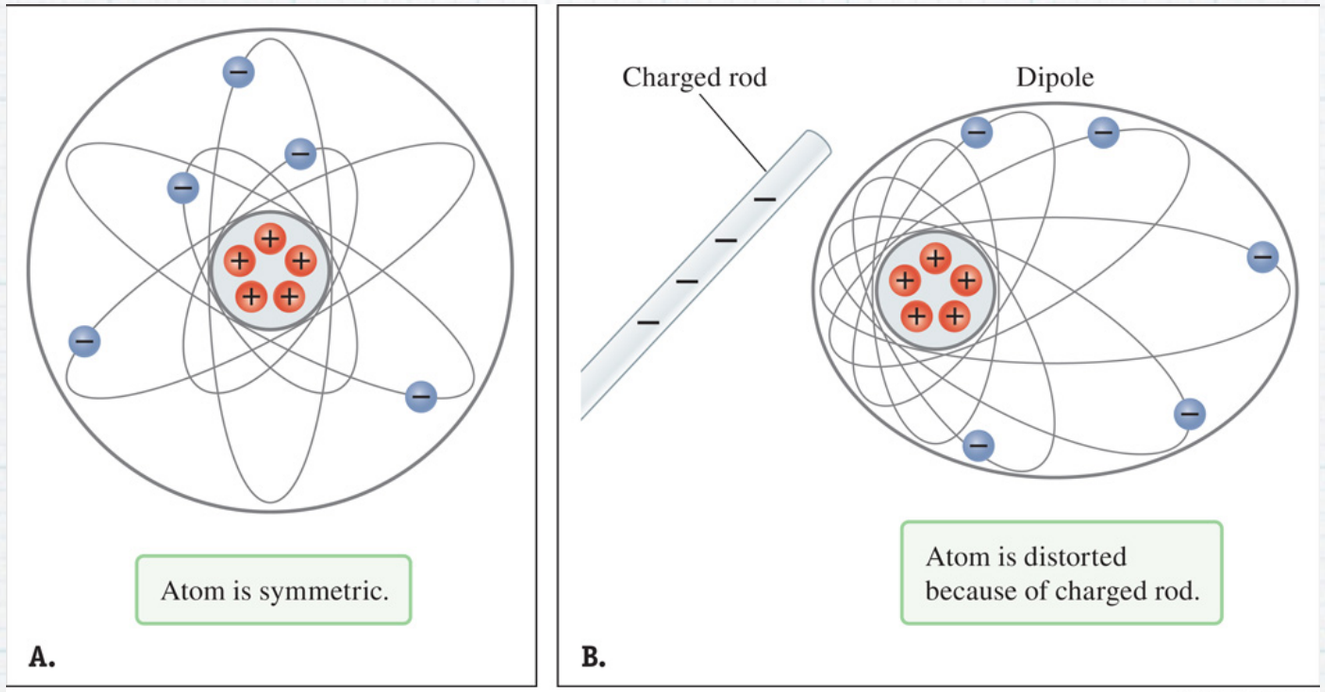


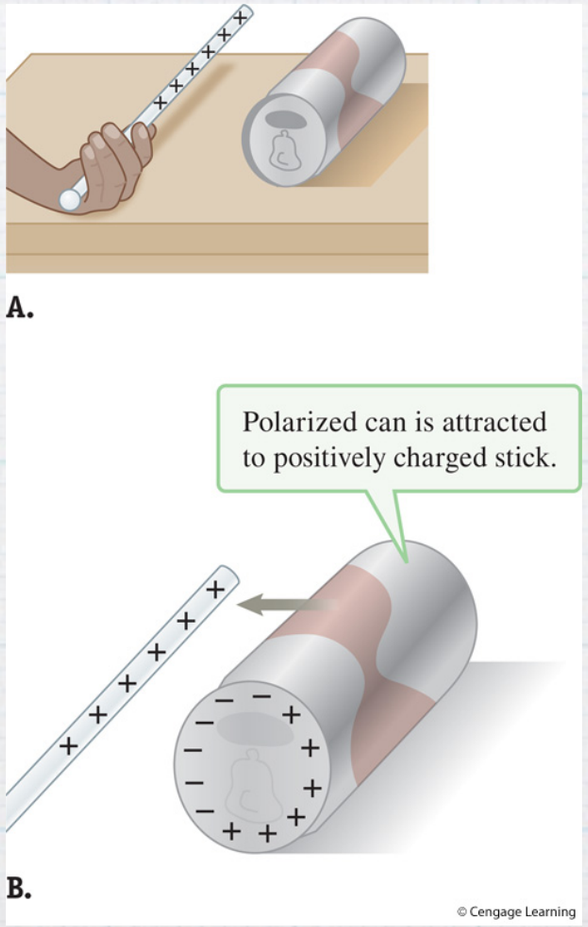
Conduction (touch)



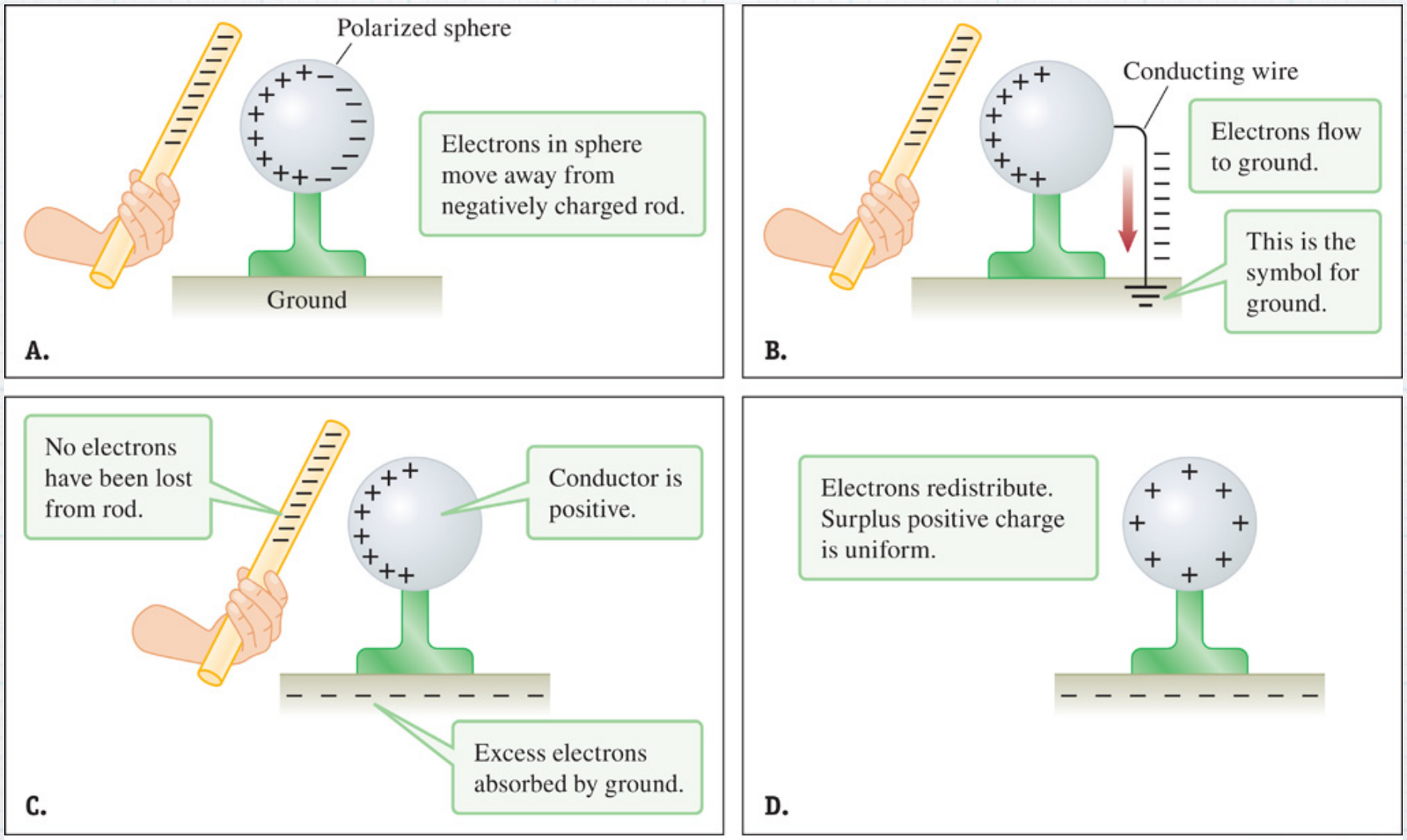


Polarization





Both



Reading Question 23.3

A material in which charge does not move freely is called

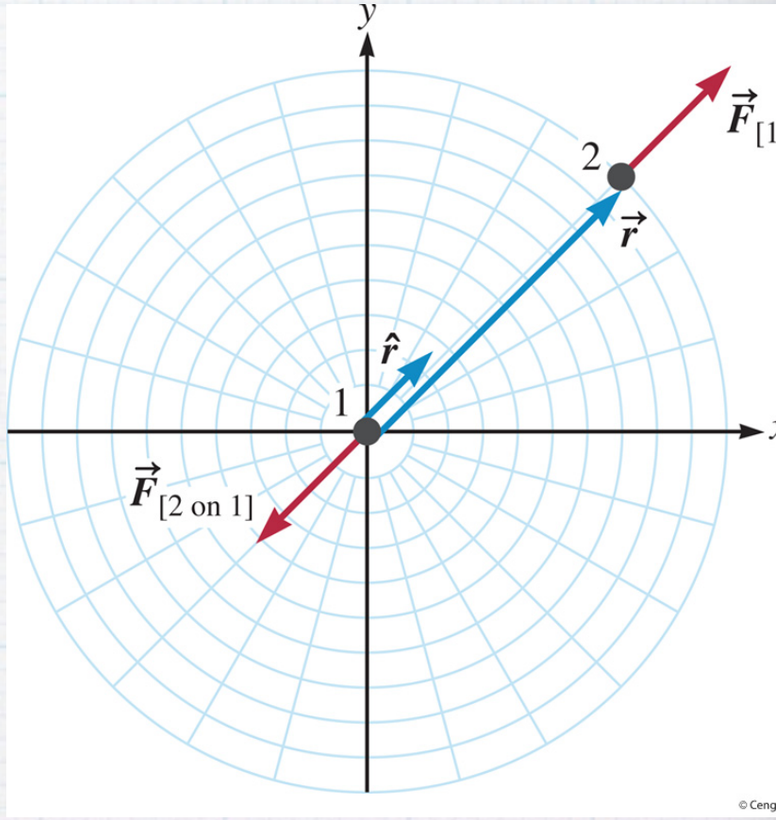
a. Conductor
b. Polarized
c. Insulator
d. Capacitor

Let's look at the demo again

* Let's start getting qualitative
* Why do the objects repel? What's different about the relative location of the electrons and protons?

Coulombs Law

$$\vec{F}_e = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r} = k\frac{q_1 q_2}{r^2}\hat{r} \quad \hat{r} = \frac{\vec{r}}{|\vec{r}|}$$



k = 8.99 x 10^9 Nm^2/C^2

What is epsilon nought?

It's an inverse square law like gravity

It depends on the magnitude of the charges and their signs

It's a vector law

Let's do an example, gravity versus electrostatic interactions

Caution

* From now on I want you to right your vectors in the following forms (either component form or magnitude angle form.

$$\vec{R} = R_x\hat{i} + R_y\hat{J} \quad \text{or} \quad \vec{R} = (|\vec{R}|, \theta_R)$$

* Failing to distinguish between a scalar and a vector will result in grade penalties

The electric force is a vector quantity

* Let's offset the electron and proton and see how this is done

* We'll be using $\hat{i}$ and $\hat{j}$

* Let's look at the two ways to express answers in this course

Reading Question 23.4

An electrostatic force F results from two electrons separated by a distance r.

In terms of F what is the force between two protons separated by a distance 2r?

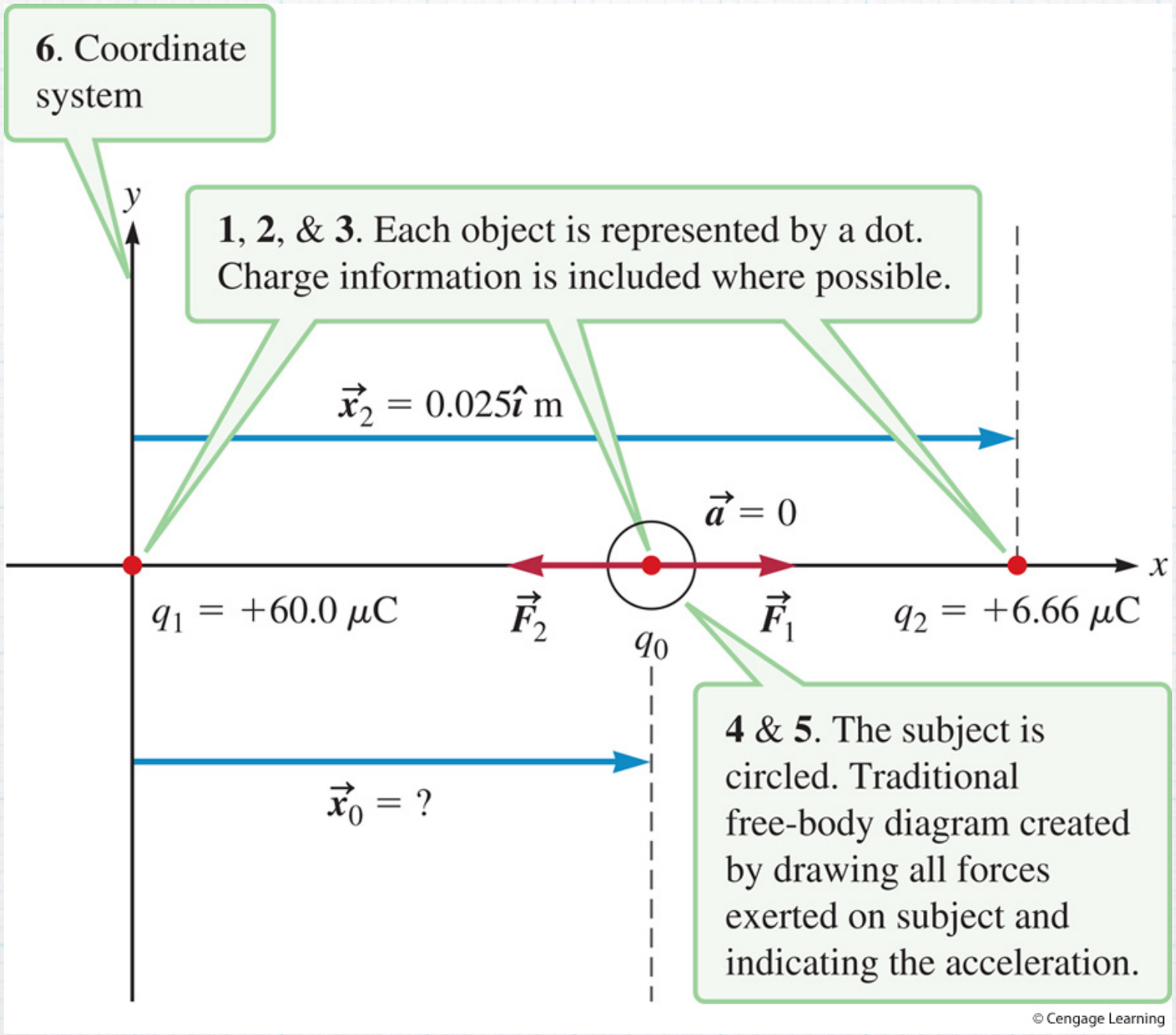
a. ½ F away from each other
b. ¼ F towards each other
c. ½ F towards each other
d. ¼ F away from each other

What about more than 2 particles

* DO NOT FORGET NEWTON'S 3rd LAW!!
* Calculate magnitudes of forces between pairs
* Decompose forces into x and y components putting signs in with your brain
* Add components
* Write down resulting force in vector form

Let's do this mentally first

Let's do three examples algebraically and numerically


6. Coordinate system
y
1, 2, & 3. Each object is represented by a dot. Charge information is included where possible.
$\vec{x}_2 = 0.025\hat{i}$ m
$\vec{a} = 0$
x
$q_1 = +60.0\ \mu C$
$\vec{F}_2$
q_0
$\vec{F}_1$
$q_2 = +6.66\ \mu C$
$\vec{x}_0 = ?$
4 & 5. The subject is circled. Traditional free-body diagram created by drawing all forces exerted on subject and indicating the acceleration.
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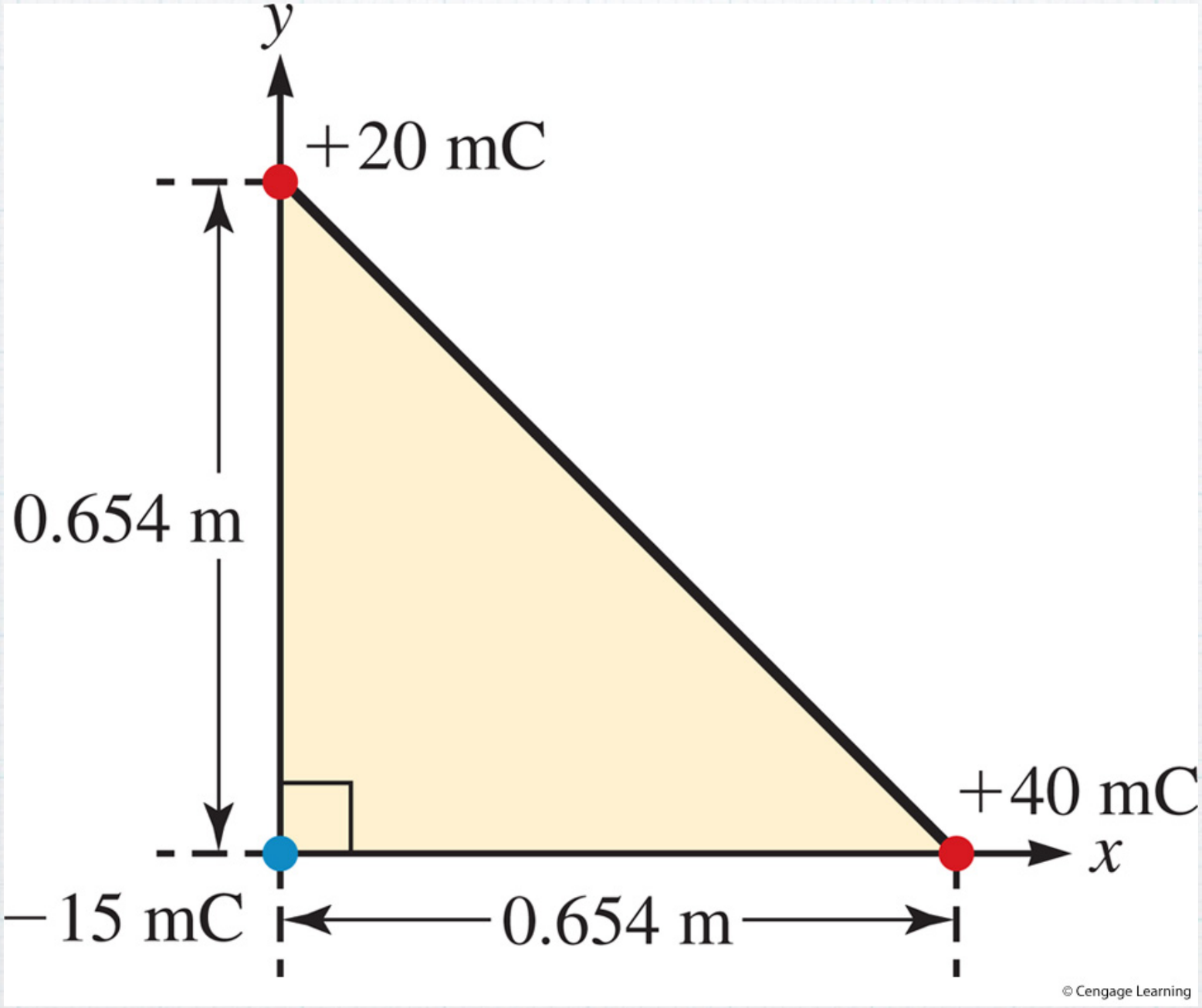
y
+20 mC
0.654 m
+40 mC
x
−15 mC
0.654 m
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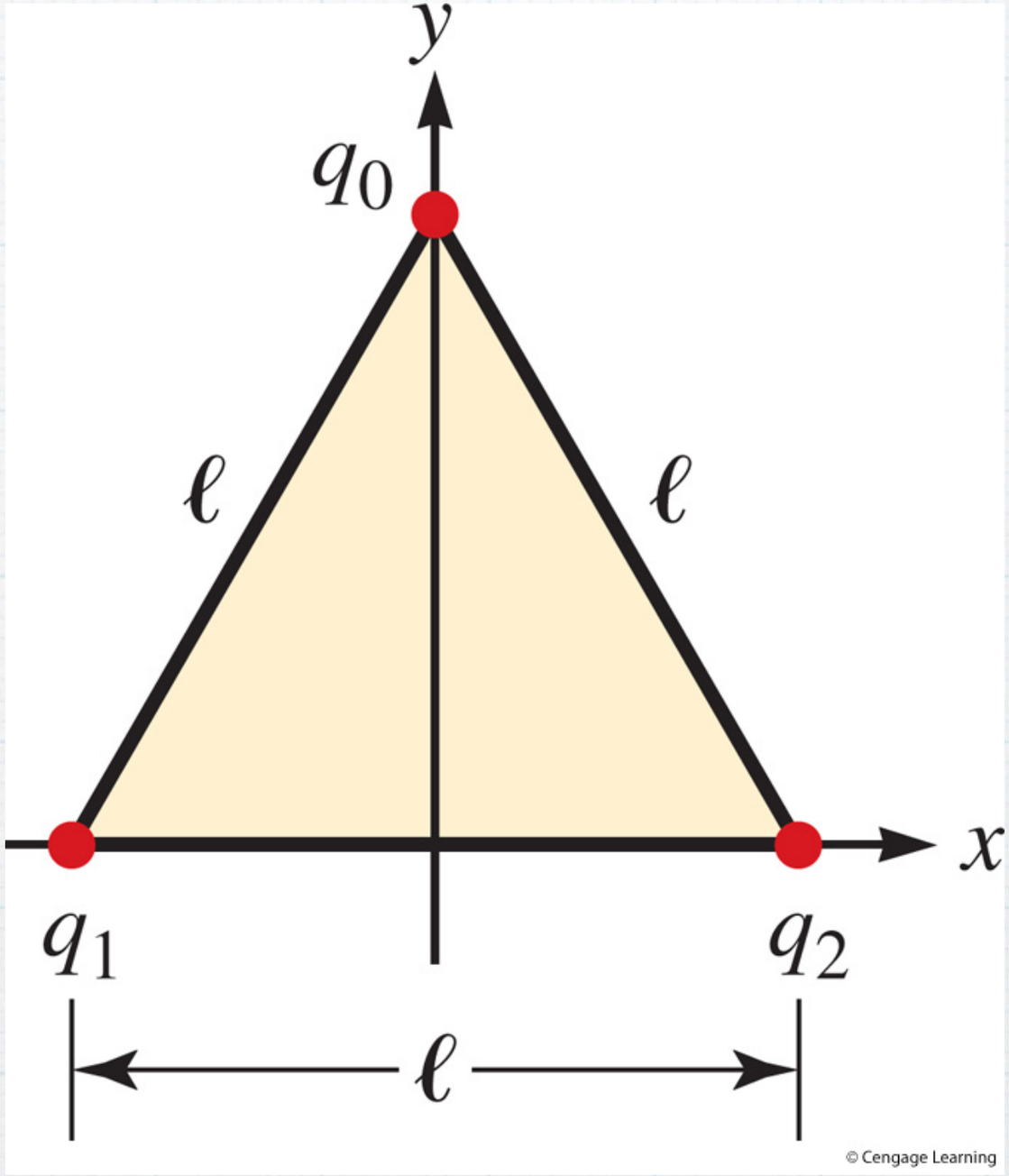
y
q_0
ℓ
ℓ
x
q_1
q_2
ℓ
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Problem 51,65