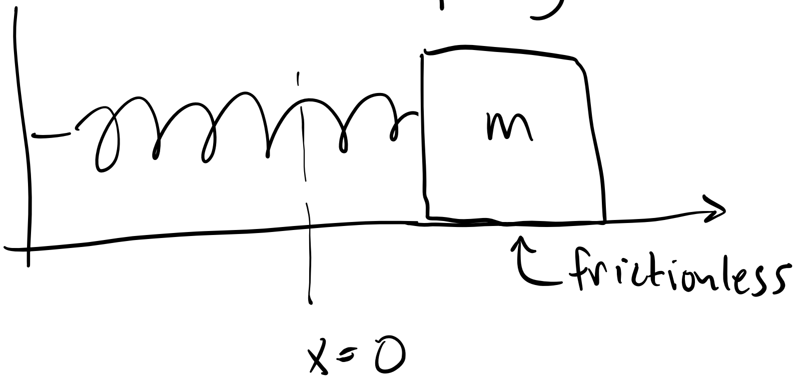
PHYS 121 Jan. 12, 2024

To do:
- ✓ complete survey by Jan. 15 @ 23:59
- ✓ complete HW1 on PL by Jan. 17 @ 23:59
- ✓ complete HW2 on PL by Jan. 19 @ 23:59

Last Time:

Mass on a spring



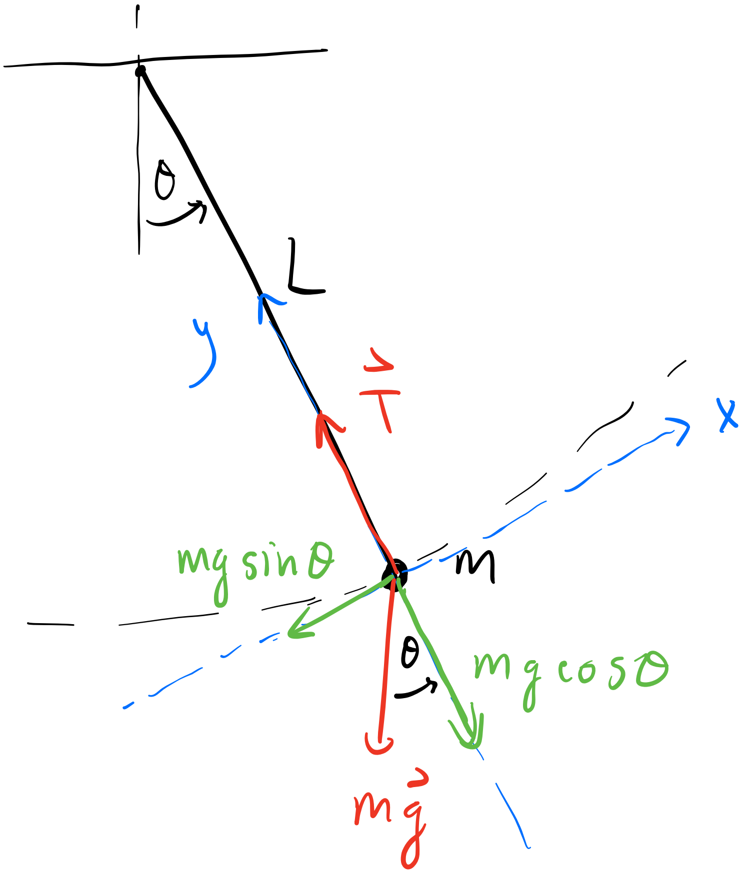
Eq'n of motion: $\frac{d^2x}{dt^2} = -\frac{k}{m}x$

$$x = A\cos(\omega t)$$

$$\omega = \sqrt{\frac{k}{m}}$$

$$\boxed{T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}}$$

Pendulum

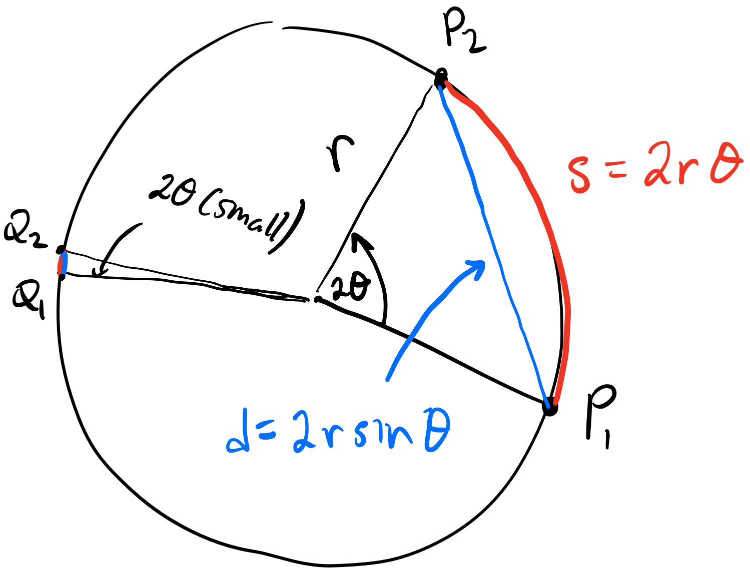


Eq'n of motion

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\sin\theta \quad \circledast$$

---

sin θ approximation



$s > d$

$\therefore \cancel{2r}\theta > \cancel{2r}\sin\theta$

$\theta > \sin\theta$

↗ radians.

If we consider a small angular displacement 2θ between points Q_1 & Q_2, then the red arc & blue line are approximately the same length.

$$s \approx d$$

$$\cancel{2r}\theta \approx \cancel{2r}\sin\theta$$

θ in radians.

∴ $\sin\theta \approx \theta$ when θ is small

Small-angle approximation

Let's apply the small-angle approx. to our pendulum problem.

In this case, Eq'n ⊛ becomes

$$\frac{d^2\theta}{dt^2} \approx -\frac{g}{L}\theta$$

$\sin\theta \approx \theta$

mathematically identical to mass on a spring

$$\left(\frac{d^2x}{dt^2} = -\frac{k}{m}x, \quad x = A\cos(\omega t) \rightarrow \omega = \sqrt{\frac{k}{m}}\right)$$

$\therefore$ soln for pendulum angle θ vs time is

$$\theta = A\cos(\omega t)$$

where $\omega = \sqrt{\frac{g}{L}}$

$$\omega = \frac{2\pi}{T} \quad \therefore \; T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{g}{L}}}$$

For our pendulum

$$T = 2\pi\sqrt{\frac{L}{g}}$$

valid for small angles.

Labs #1 & #2.

Note that the period of osc. is independant of both the mass m of the pendulum bob & the initial amplitude of the oscillations.

Large amplitude osc. move with higher average speed than small-amplitude osc.

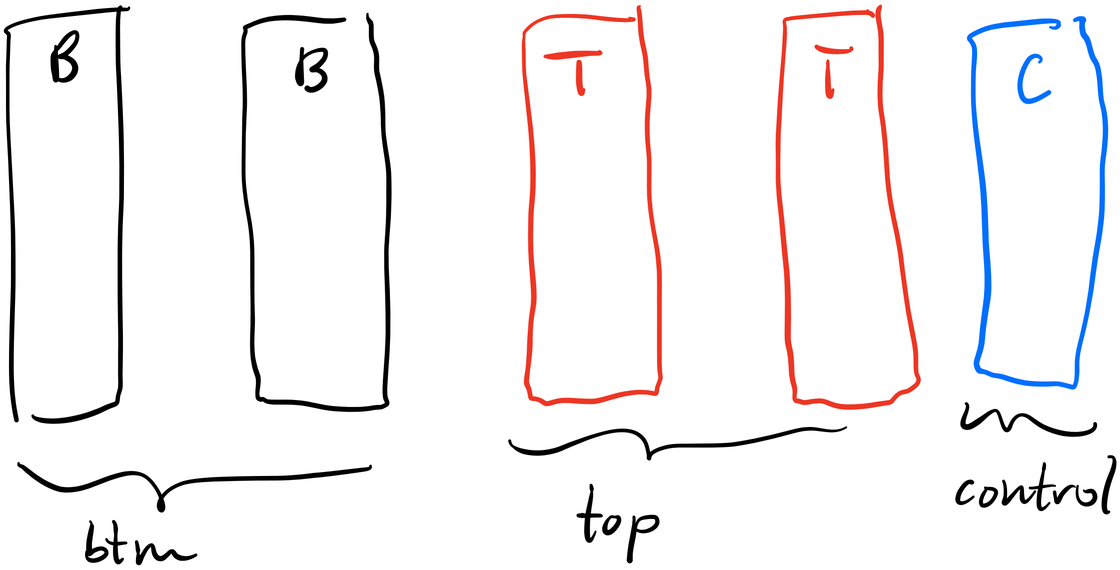
Chapter 5 Sec 1 & 2 in OSUPv2.

Electric Charge:

Imagine the following expt:

- Take two pieces of cellophane tape stuck to one another (sticky side to non-sticky side)

- Pull the pieces apart
- Repeat w/ two more pieces of tape
- Take a fifth piece of tape that has had to treatment (control)



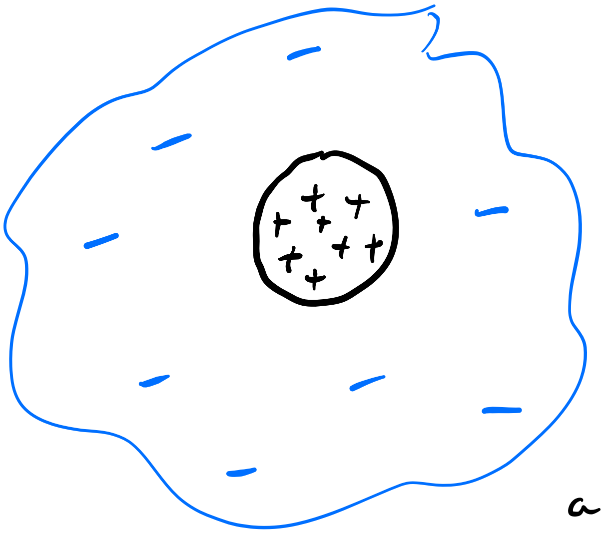
Observations

- The B pieces of tape repel one another
  " T " " " " " "

- The T & B pieces attract strongly

- The control tape C weakly attracts both T & B pieces.

Model of atoms that form all materials:



- have a nucleus w/ neutral neutrons & positive protons.

- Surrounding the nucleus is a cloud of negative electrons

- overall, the atom is electrically neutral.

proton/neutron mass

$\sim 1.67 \times 10^{-27}$ kg

Electron mass

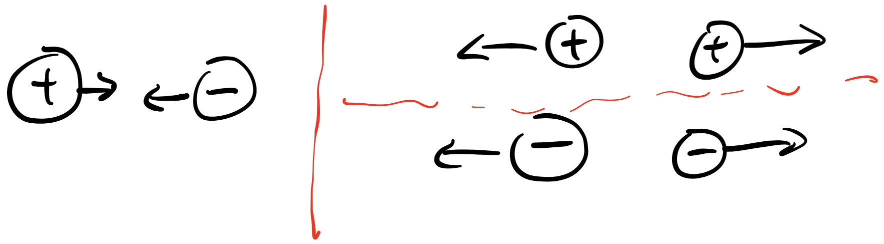
$\sim 9.11 \times 10^{-31}$ kg

Because electrons are light c.t. protons, they can be displaced relatively easily when interacting w/ other objects.

When the two pieces of tape are pulled apart, some electrons from one piece are transferred to the other piece. Tape that gains e^- becomes charge negatively & the tape that lost e^- becomes charged positively.

From the first two observations, our model suggests that:

1. Like charges repel
   Opposite charges attract



When a charged object is brought close (but not touching) to a neutral object, the atoms in the neutral object become "polarized".