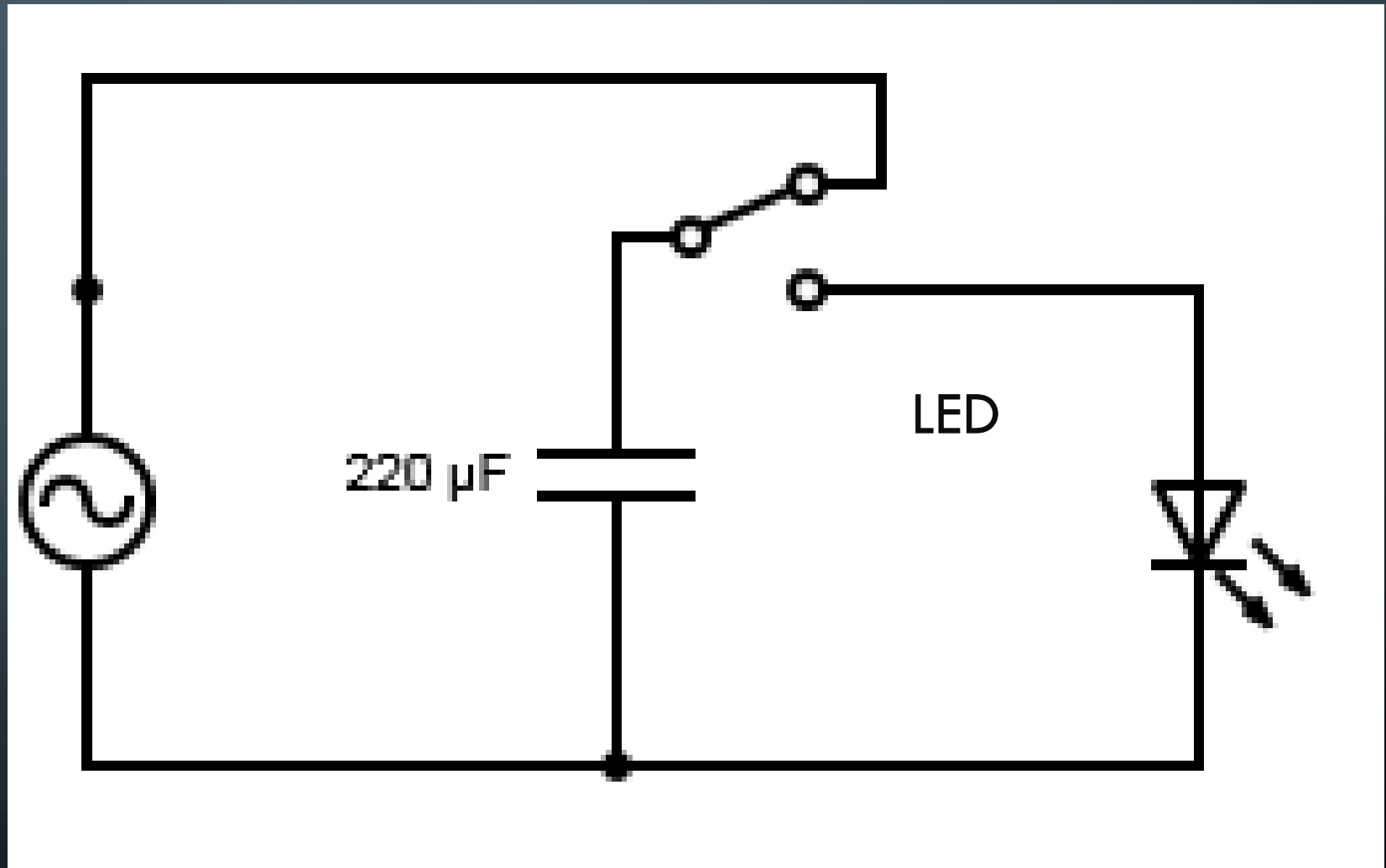




HOW TO BUILD A PIEZOELECTRIC GENERATOR

CIRCUIT DESIGN

piezoelectric
element



HOW MUCH ENERGY IS GENERATED?

The energy stored in a capacitor is given by the equation:

$$E = \frac{1}{2} V^2 C$$



For our circuit, $C = 220 \mu\text{F}$. When the multimeter shows 10 volts across the capacitor, the amount of energy stored is

$$E = \frac{1}{2} (10 \text{ V})^2 (220 \mu\text{F}) = \mathbf{0.011 \text{ joules}}$$

If a single tap on the piezoelectric element increases the voltage from 2 V to 2.05 V, the amount of energy generated for each tap is

$$E = \frac{1}{2} (2.05^2 - 2^2) (220 \mu\text{F}) = \mathbf{0.000022 \text{ joules/tap}}$$

HOW MUCH ENERGY IS 0.000022 JOULES?

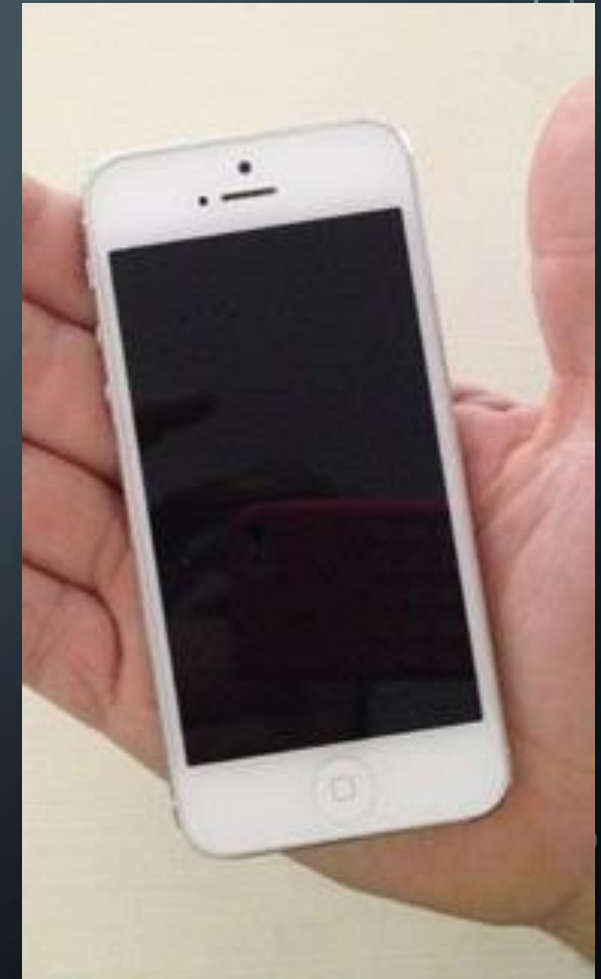
A typical cell phone battery stores $\sim 18,000$ joules of energy.

If we replaced our capacitor with a cell phone battery to charge, **how long would it take to fully charge it?**

$$\frac{18,000 \text{ joules}}{0.000022 \text{ joules/tap}} \approx 820,000,000 \text{ taps}$$

You would have to press this piezoelectric element almost **1 billion times** just to charge your cell phone!

If you tapped the piezo element 3 times every second, it would take **8.66 years** to fully charge your cell phone.



HOW CAN WE MAKE A PRACTICAL PIEZOELECTRIC GENERATOR?

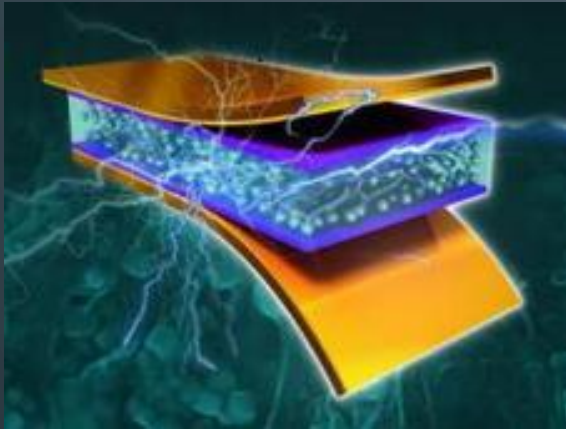
Two obvious ways to improve our piezoelectric generator:

1. Use a more efficient piezoelectric material
2. Place the piezoelectric element where it will get pressed very rapidly

If we have a piezoelectric material that can increase the voltage across our capacitor from 2 V to 12 V with a single tap, the amount of energy generated is now 0.0154 joules/tap, *700 times* greater than before.

It would now only take 1,200,000 taps to charge the cell phone, which could be done in 4.6 days!

HOW CAN WE MAKE A PRACTICAL PIEZOELECTRIC GENERATOR?



The second choice is to place the piezoelectric element where it experiences **MANY** more deformations.

This has been done by placing the elements under sidewalks and roads—**places where surface movement vibrations tap the element 10,000 times per second.** ↓

If our piezoelectric element could be pressed 10,000 times/second, it would take 22.8 hours to charge.

Finally, if we **combined both improvements**, the phone battery could be charged in as little as *2 minutes!*





QUESTIONS?

QUESTIONS?

CIRCUIT DESIGN

