Basic Circuit

Gather Materials

Adafruit's LED Sewing Kit:

- 1 bobbin of 2-ply conductive thread
- 1 x sewable CR2032 battery holders
- 1 x CR2032 batteries
- 2 x candle flicker LEDs - they twinkle automatically, no need for a microcontroller or external circuit!
- 3 x 5mm snaps to use as as sewable switches
- Needle set

Other Materials:

- Sharpie
- Fabric
- Scissors
- Pliers

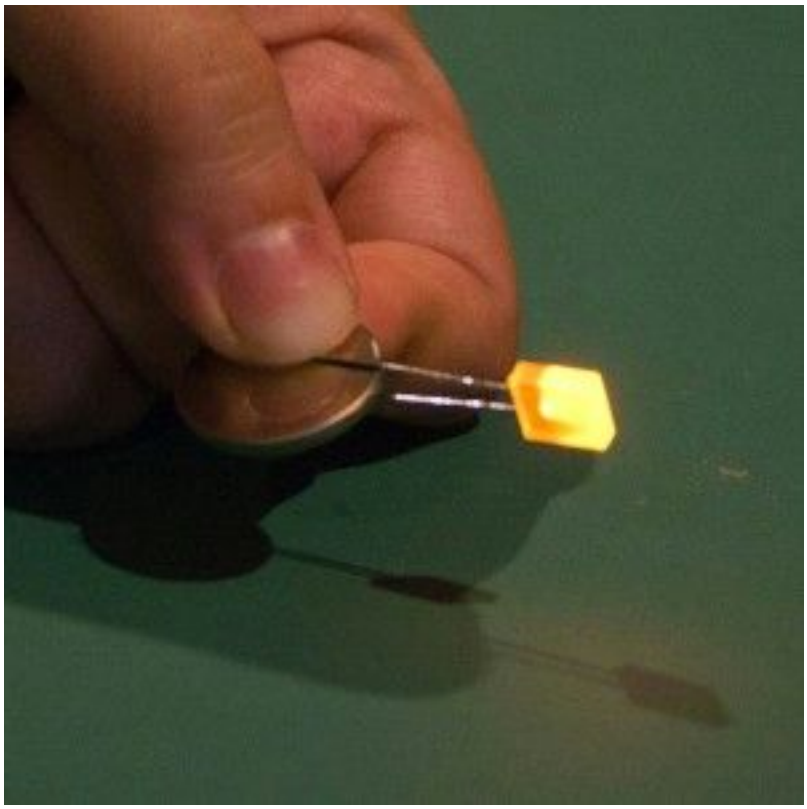
Optional Materials:

- Needle Threader
- Electrical Tape
- Alligator Clip Cables

IMPORTANT

By following these instructions you will create a working circuit (which means that the LED will light up once the bracelet is snapped together). You'll be stitching a circuit, it does matter that you stitch from one component to another in the exact order given. There can't be breaks in the thread in the middle of any two components that need to be connected. Also, crossed threads will create a short and the light will not turn on and the battery will be drained. Follow the instructions carefully and be aware of which side (negative/positive) you are working with. Ultimately, negative will connect with negative, and positive will connect with positive.

CHECK YOUR BATTERY AND LED



Before you get too far into this project,make sure that your LED and battery work. This is easiest to do before you sew everything together.

Identify the positive lead (the little wires that look like legs on the LED are the leads) – it's the longer of the two wires. Now find the positive side of the battery (it should be labeled with a +). Place the LED over the battery so that the positive lead is touching the positive side of the battery, and the negative lead is touching the negative side of the battery. The LED should light up – if not, your battery might be dead, your LED might be bad (not very likely), or you are doing it wrong. Make sure the leads are only touching the corresponding side of the battery and not accidentally touching the opposite side. Also make sure that the leads are being firmly pushed against the battery.

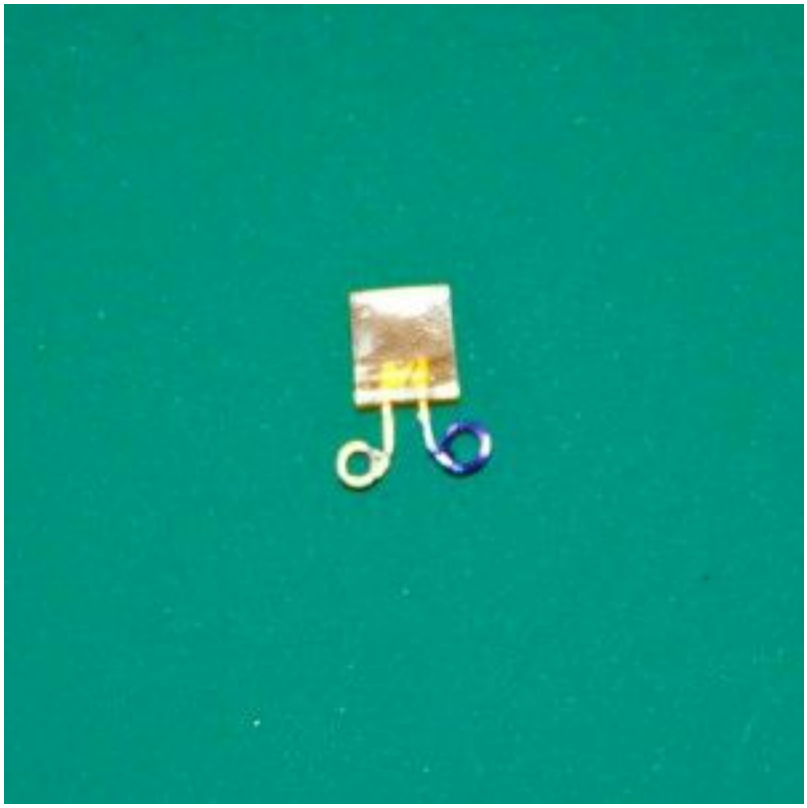
PREPARING YOUR LED

Before you start sewing, you need to wrap the leads of the LED into loops so that you'll be able to easily sew the LED onto the felt. Grab the Sharpie, LED, and round nose pliers.

Identify the positive wire on your LED – it will be the longest of the two leads. Mark it with a Sharpie.

Using your round nose pliers, curl the leads into loops. Make sure the leads don't cross or touch each other.

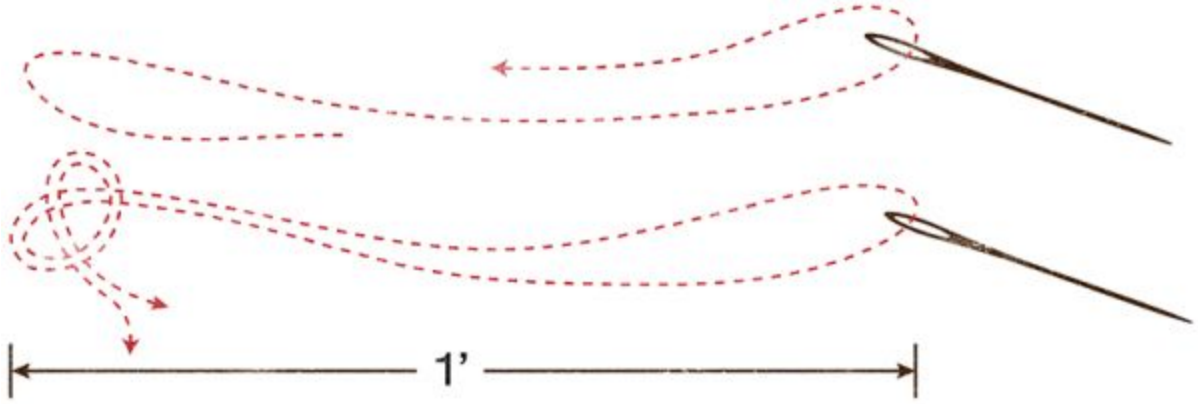
By bending the straight leads into loops, you now have something to sew through so that the LED will stay on.



Now your LED is ready to be sewn on! Take note of where the labeled positive lead is – we'll start from that side when we start stitching.

Threading your needle

Cut off a length of conductive thread roughly 2 feet long, and thread it through the needle. Pull it until your needle is in the middle of the length of thread, then pull the two ends together and tie them together into an overhand knot.You should now have a double length of thread about a foot long. In general, I recommend threading your needle with relatively short lengths of thread; try to avoid anything longer than two feet doubled over (four feet before doubling). Conductive thread is more prone to knots and tangles than traditional thread, and a shorter length will help with that.

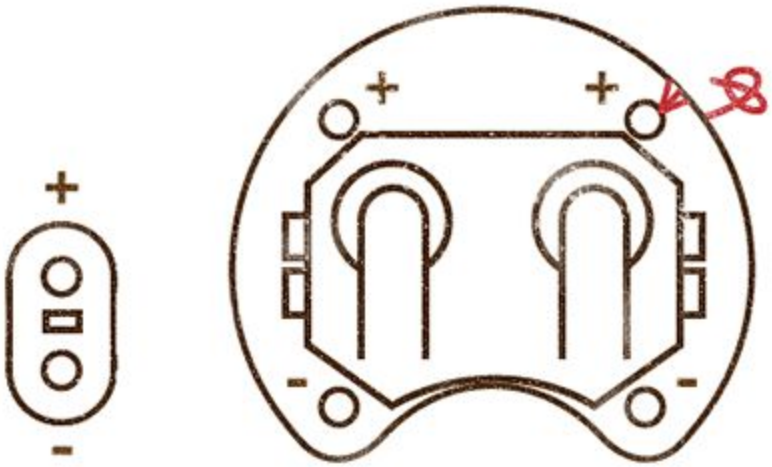


Positive Trace

The positive trace will take power *from* the power supply *to* the positive side of the LED.

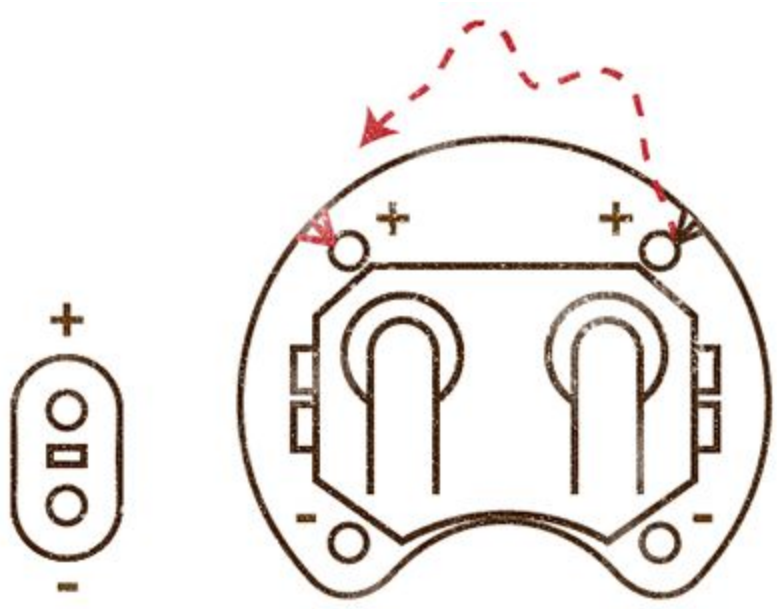
Start with your battery pack; this will supply power to your circuit. Don't put the battery in yet; we won't do that until the end. While you're sewing, you're liable to create small short circuits, just by touching across the circuit with your needle or the length of your thread. If the battery is on, these 'incidental shorts' will drain it.

Place the battery pack near where you would like to put your LED, making sure that you've got one hole with a plus sign and one hole with a negative sign pointed towards the intended LED location. These holes are called 'pins,' and you're looking at the positive and negative pins of your battery pack. When you've got your battery pack placed where you'd like it, you can start sewing. Push the needle up through the fabric, bringing it through the positive hole furthest from where you'd like to put your LED. Pull the thread all the way through until the knot you made is firmly against the back of your fabric. Pass the needle back through the top of the fabric to the bottom, just outside of the hole, so that you form a small loop that the edge of the board is trapped in. Pull the thread tight again- your board should now be attached to the fabric by one stitch. This is your first stitch. You'll repeat this process three times on this pin and on every pin you sew down in this circuit. Go ahead and tack this pin down with two more stitches, and it should look like this:



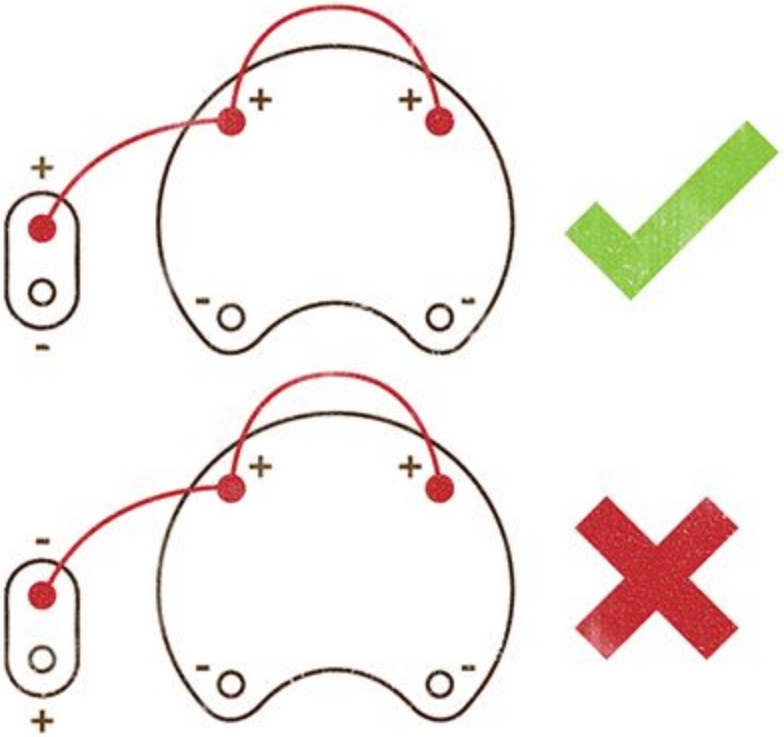
Next you need to sew the second positive pin of the battery pack. You **don't** want one big stitch between these two pins. Large stitches are loose, will move around, touching parts of the circuit they're not meant to touch, and will cause shorts. Instead, put several small stitches between pins, making sure you've pulled them tight before you begin to stitch down the next pin. The easiest way to do this is with what's called a running stitch.

Once you're at your second positive pin, sew it down with three tight stitches, repeating the process from the first pin.

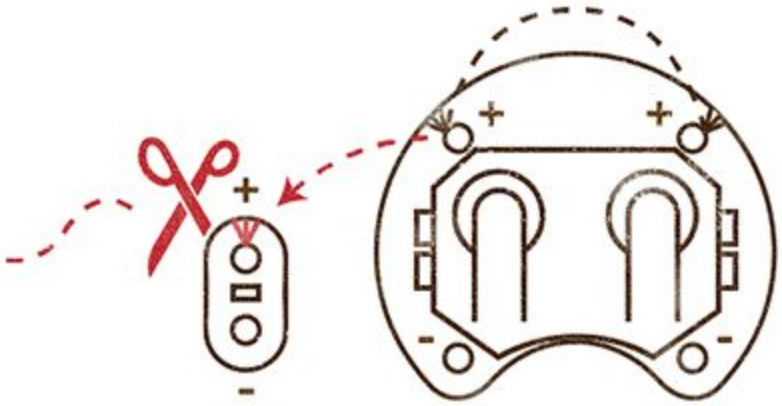


From here, it's time to sew to the positive side of your LED. Continue with the same thread you've been using and sew a straight line from the second positive pin to where you would like the positive pin of your LED to be.

Double check that you've got the positive LED pin- LEDs are polarized, so if you sew it in backwards, it won't light up. The good news is that this won't damage your LED at all; you'll just have to cut it back out and put it back in the other way.



Once you're sure you've got the orientation right, you can sew down the positive pin with three stitches, just like you did with both positive battery pack pins.

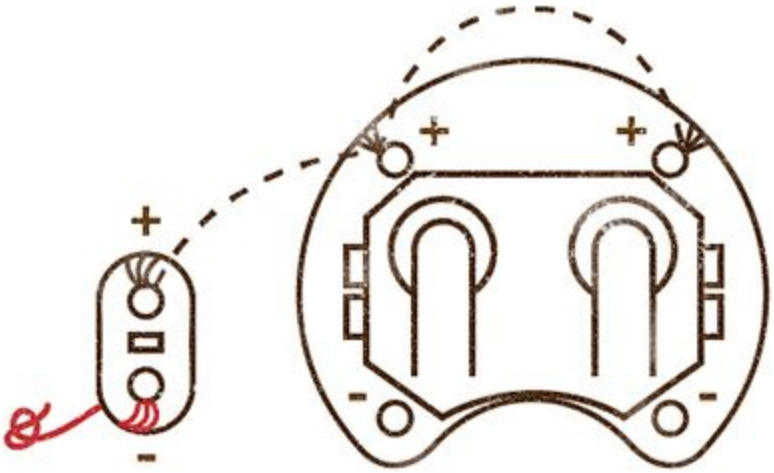


This is the end of the positive trace! We're half done, and you can tie off your thread and cut it. **Do not** continue around the LED and sew down the next pin!

Negative Trace

The negative trace will return current *from* the LED *to* the negative side of the battery pack. This way the current travels in a circle (hence 'circuit'!), which passes through the LED, lighting it up.

Re-knot your thread and start at the negative pin of the LED, sewing it down with three stitches. As you did on the battery pack, make sure that the knot in your thread is flush against the back of the fabric, and draw all of the stitches tight.

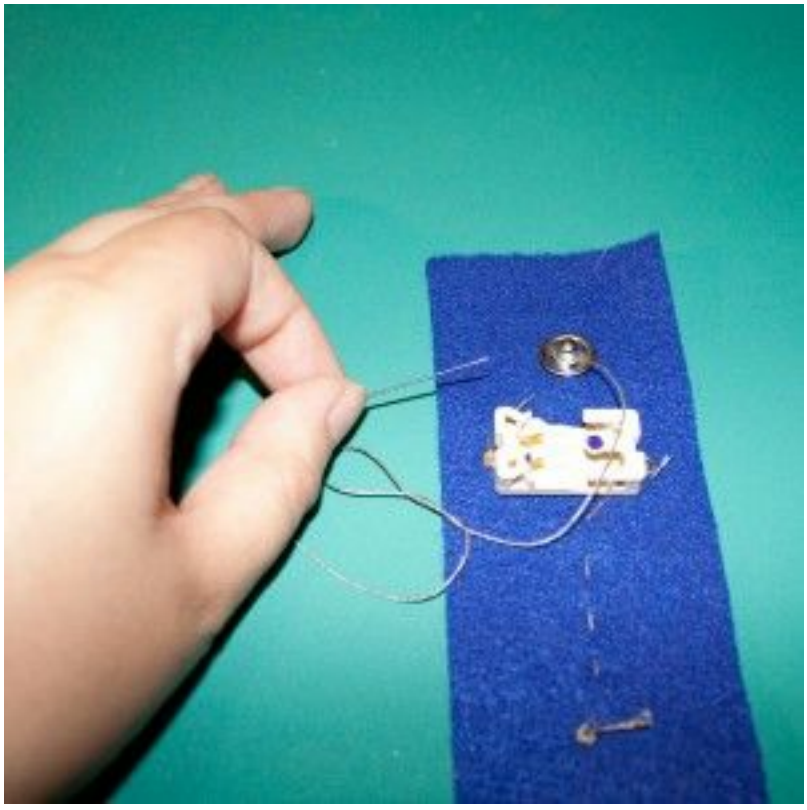


You've just connected the positive side of the LED to the positive side of the battery holder!

SEWING THE NEGATIVE SIDE OF THE BATTERY HOLDER TO THE SNAP

Tie a knot at the end of your thread (or thread and knot a new length of conductive thread if you have less than a foot left).

Stitch the other side (negative) of the battery holder to the felt. Just like before, make sure your stitches are making good connections with the metal tab and you'll probably only be able to get your needle through the hole a few times.



Once the negative side of battery holder is securely stitched, stitch a few stitches out to the end of the felt. This is where you'll sew in one side of the snap.

Take one side of the snap (I used the pointy side that pops into the hole side) and stitch it to the felt.

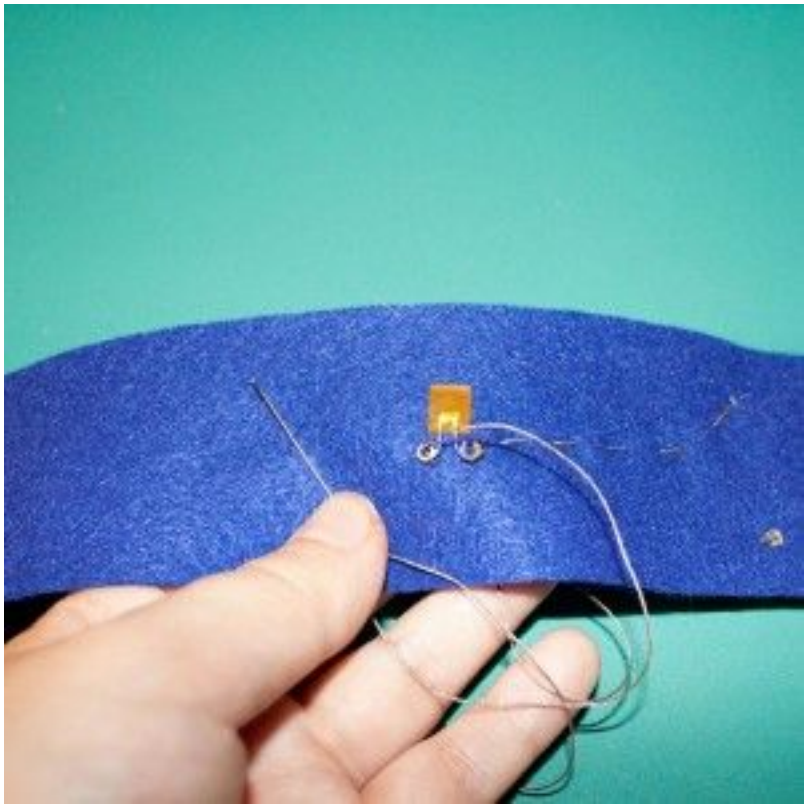
The snap will act at the switch for your circuit – when it is connected, electricity will pass through both sides of the snap and make the circuit complete. When the snap is disconnected, the circuit isn't complete and electricity can't flow through all the components.

Like always, make sure to stitch the snap in carefully, creating a tight connection between the thread and the metal snap.

Clip the end of the thread, leaving a short tail.

SEWING THE NEGATIVE LEAD TO THE OTHER SNAP

Thread a new length of conductive thread, making a knot in the end.

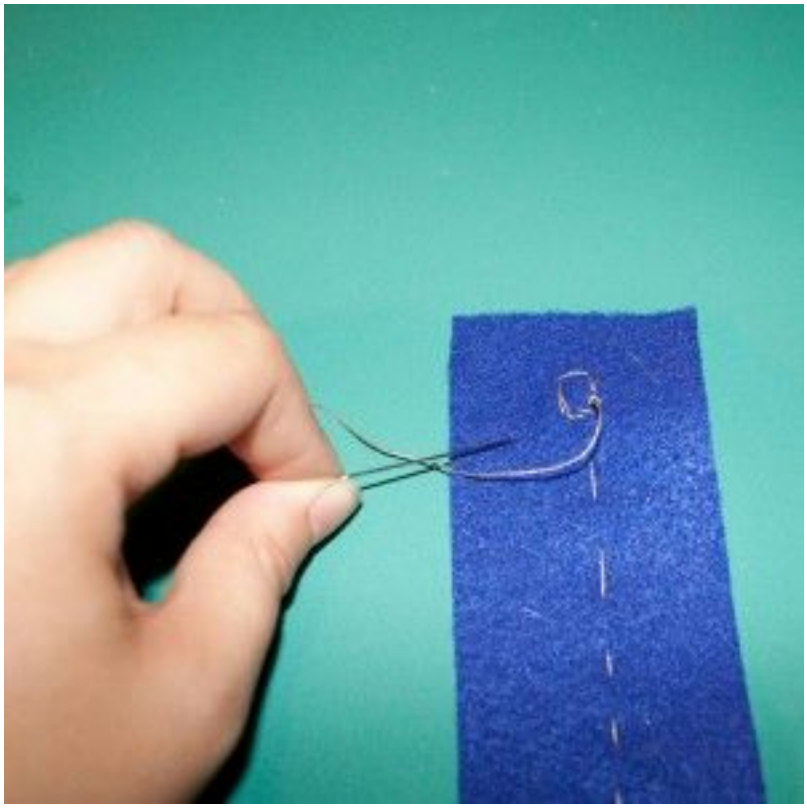


Go back to the middle – now you'll be sewing the negative side of the LED out to the other end of your material.

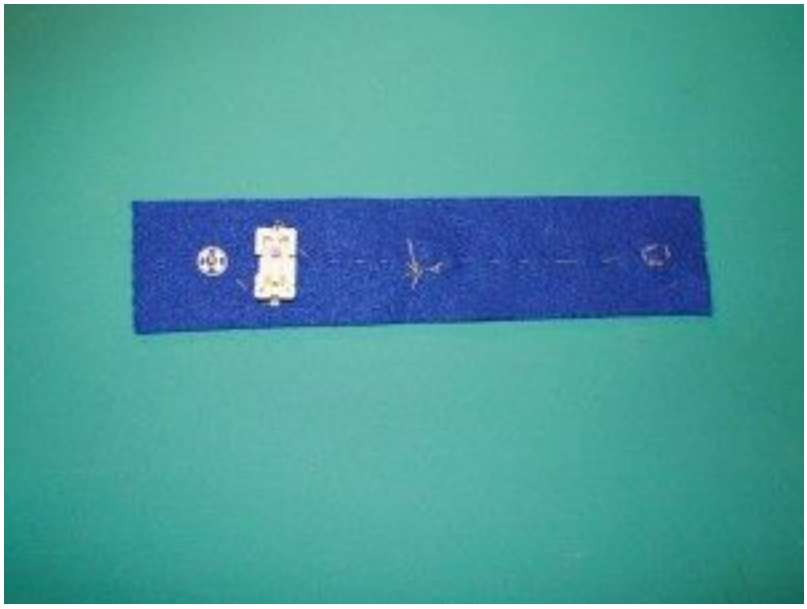
Stitch up through the negative loop on the LED (remember, that's the one that is *not* marked) and loop up and down through the felt and the LED legs a few times.

Now, stitch out to the other end of your material. Stop when you've reached the point where the other snap should go.

Begin stitching the other side of the material – Make sure you are stitching it to the front (LED side)

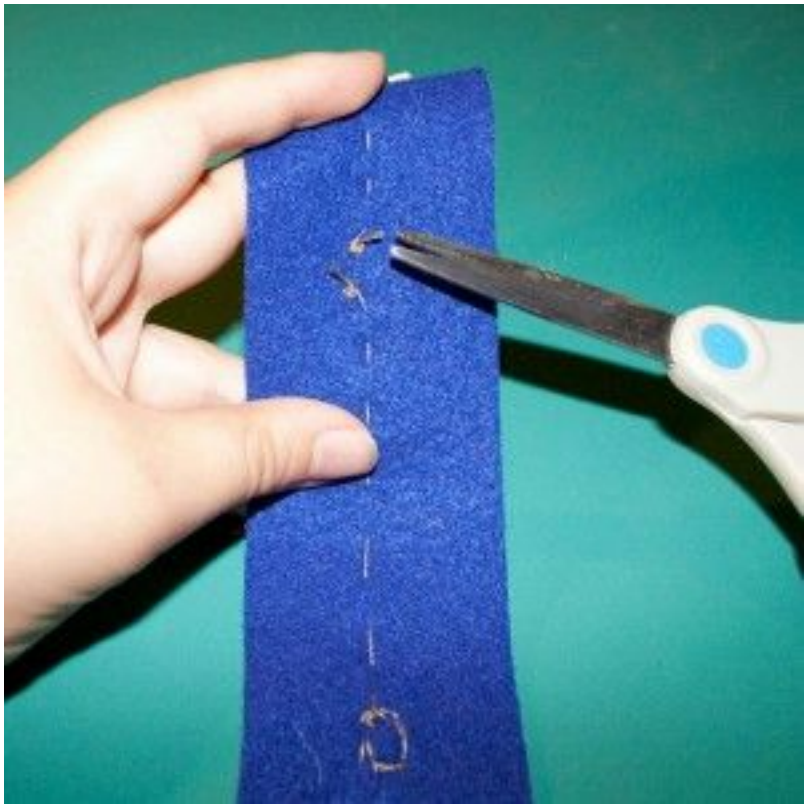


Stitch the snap in securely and clip your thread.



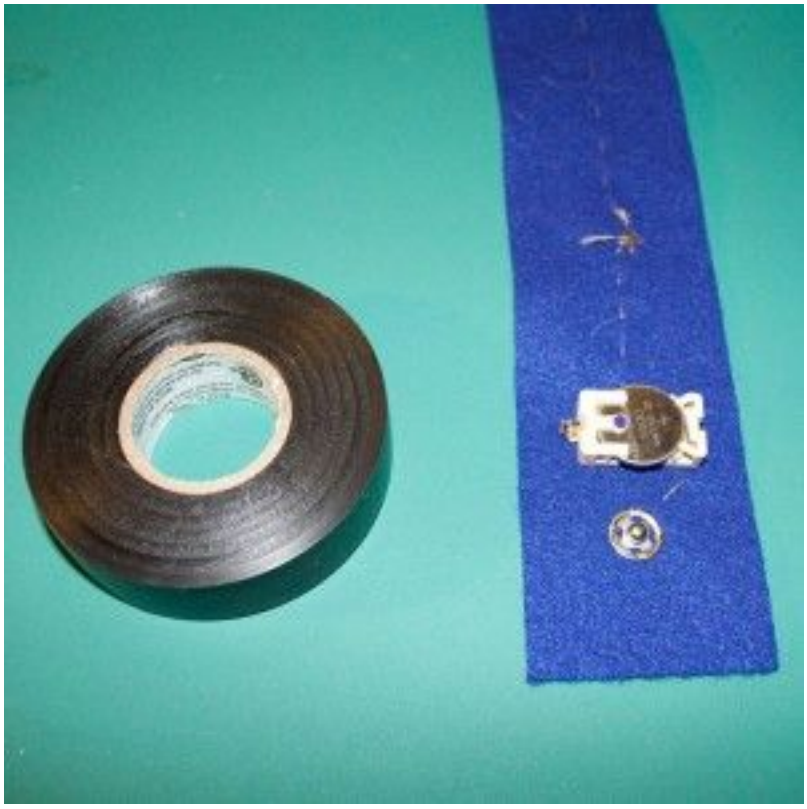
Double check your work. The back should look like this: One side of the snap, battery holder, stitches.

The front should look like this: Other side of the snap, LED, stitches



Check (front and back) for any ends of thread that may be touching another thread. All of these need to be clipped.

Now you can snap the battery into the holder. The battery is labeled – one side with a + the other with a – . In the SparkFun battery holders, the + side of the battery needs to face up. Slide the battery in and push it in place.



For added battery safety, you can tape the battery into the holder using electrical tape. Cut a two inch piece of tape and slide it underneath your battery holder with the sticky side facing up.

Securely tape around the battery holder and battery. If you need to change the battery in the future, you can just lift off the tape and install a new battery.

Now the moment of truth! When the snaps are connected, the LED should light up.

If not (gulp!) you might want to check the following things:

- Is your battery dead?
- Is your battery installed correctly in the holder (+ side facing up)?
- Are all of your connections good (sometimes you have to jiggle things a little)?
- Is your snap conductive and well connected?
- Is the positive leg of the LED sewn to the positive side of the battery holder?
- Is the negative side of the LED sewn to a snap that, when connected, is sewn to the negative side of the battery holder?
- Make sure there aren't any crossed or disconnected threads.

Parallel LED circuit

Sewing a soft circuit with a battery and a two LEDs involves nearly the same steps as a single LED circuit.

Begin by creating that loop containing the battery and one LED. We don't need to worry about using a resistor because the conductive thread has some resistance and the coin cell battery cannot supply *that* much current.

Once you have the first loop done, simply add another LED by sewing from the positive leg of the second LED to the conductive trace leading to the positive leg of the first LED. Then sew the negative leg of the second LED to the conductive trace leading from the battery to the negative leg of the first LED.

The only trick here is to make sure your LEDs are oriented in the same direction!

Lessons adapted from
https://learn.sparkfun.com/tutorials/ldk-experiment-1-lighting-up-a-basic-circuit
and
http://www.atxdiy.com/2010/07/05/tutorial-sew-a-simple-circuit/