LIGHT UP EXPLODED STARS
(PAPER CIRCUITS #1)

A hands-on activity using printable templates and creating simple paper circuits. Good for MakerFaires, libraries, classrooms and other STEM related events where participants can create their own take-away.

What is a Paper Circuit?
Paper circuits help learners of all ages explore the basics of electricity (energy that results from the existence of charged particles like electrons or protons) and conductivity (the degree to which a material can conduct electricity). Paper circuits function as simple low-voltage electronic circuits (a path through which electrons from a voltage or current source flow) made using paper, LED lights, a type of conductive tape such as copper, as well as a small battery for the power source.

Directions: Download the attached .pdf and print double-sided (so the shapes are lined up) and cut in half (you will get two handouts per page)

1. Have participants cut out the rectangle - see handout for instructions
2. Ask participants to fold paper in half on the dashed line so that the directions are on the INSIDE/images are on the OUTSIDE.
3. Punch a hole for the LED light - see template
4. Following the remaining steps outlined on the handout - placing copper tape, finding the positive lead on the LED and affixing the leads to the circuit, and folding over with the coin battery.
5. Use a binder clip to hold battery in place on the circuit (so the light stays on)

Troubleshooting

- Flip the battery over. If the LED was put in backwards, it just means the positive and negative parts of the circuit are reversed
- Check all connections - around the LED leads, alignment with the battery, any broken places in the copper tape. Use more tape to reinforce connection.

Cost: About $0.50 (50 cents) per item, estimates are provided in the materials list

Time: about 5 minutes to make a single item

Materials:

- Coin Batteries ($0.30 each)
- Copper tape with conductive adhesive ($0.10) - Less than 12 inches per badge
- LED's ($0.05)
- Small binder clips ($0.05)
- NASA Images of exploding stars/ pulsars/neutron stars (download template here: chandra.si.edu/make/ template.pdf)
- Hand held hole punchers
- Small trash can – little bits of trash are produced during the activity

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NASA'S UNIVERSE OF LEARNING

The Science: Stellar Evolution and Exploded Stars

Our Milky Way galaxy contains several hundred billion stars of various ages, sizes and masses. A star forms when a dense cloud of gas collapses until nuclear reactions begin deep in the interior of the cloud and provide enough energy to halt the collapse.

Many factors influence the rate of evolution, the evolutionary path and the nature of the final remnant. By far the most important of these is the initial mass of the star.

If the star is about the same mass as the Sun, it will turn into a white dwarf star. If it is somewhat more massive, it may undergo a supernova explosion and leave behind a neutron star. But if the collapsing core of the star is very great-at least three times the mass of the Sun-nothing can stop the collapse. The central part of the star - the entire star if the star is massive enough - implodes to form an infinite gravitational warp in space called a black hole.

In the Light Up Exploded Stars activity, participants can find a neutron star, pulsar, black hole, white dwarf or supernova in the provided NASA images and make it light up with the paper circuits.

Glossary

star: a luminous ball of gas, mostly hydrogen and helium, held together by its own gravity.

pulsar: a rapidly rotating neutron star, that emits regular pulses of radio waves and other electromagnetic radiation at rates of up to one thousand pulses per second.

black hole: a place in space where gravity pulls so much that even light can not get out. The gravity is so strong because matter has been squeezed into a tiny space. This can happen when a star is dying.

neutron star: an extremely compact star produced by the collapose of the core of a massive star in the supernova process.

white dwarf: the end phase of a Sun-like star in which all the material contained in the star, minus the amount blown off in the red giant phase, is packed into a volume one millionth the size of the original star.

supernova: an explosion produced when a white dwarf becomes unstable due to the accretion of too much material or merger with another white dwarf.

supernova remnant: the structure resulting from the explosion of a star in a supernova. The supernova remnant is bounded by an expanding shock wave, and consists of ejected material expanding from the explosion, and the interstellar material it sweeps up and shocks along the way.

LIGHT UP EXPLODED STARS
(PAPER CIRCUITS #1 TEMPLATE)

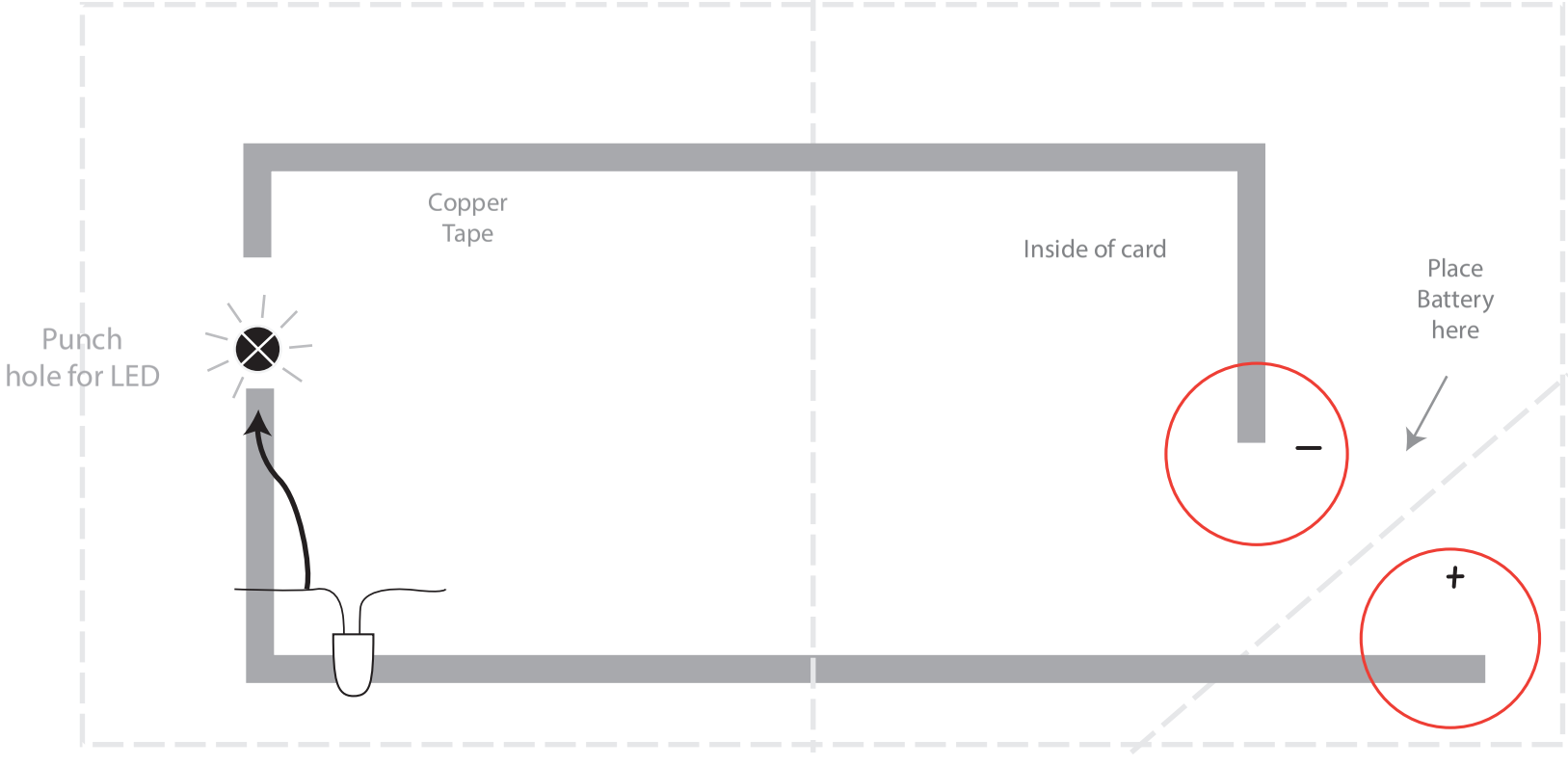
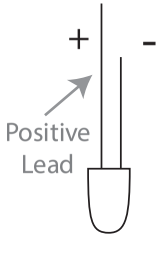


Image on opposite side here



1. Place copper tape along the gray lines
Note: Apply the foil as a continous piece rather than separate pieces, even when turning corners.

2. Find positive lead on LED. (it's longer)

3. Bend leads and place LED through punched hole with positive lead to the left

4. Connect the LED leads to the circuit using clear tape.

5. Fold the page corner along dotted line and place the battery "+" side-up over the "-" circle.

6. Fold the corner flap over, and clip the battery in place with a binder clip. Light should turn on.

LIGHT UP CONSTELLATIONS
(PAPER CIRCUITS #2)

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The Science: Constellations

"Constellation" is the name we give to seeming patterns of stars in the night sky. "Stella" is the Latin word for star and a constellation is a grouping of stars. In general, the stars in these groups are not actually close to each other in space, they just appear to be close when viewed from Earth.

If we could travel by spaceship to another part of the galaxy, we would imagine an entirely different set of constellations. In the meantime, for us on Earth, the constellations are a handy way to locate a star in the sky.

On Earth, we see different constellations as we travel to different parts of the globe. The fact that some constellations were visible in the northern hemisphere and not the southern hemisphere, and vice-versa, was used more than 2000 years ago by Greek astronomers to argue that the Earth is round.

The stories associated with the constellations come from many cultures and most exist in several variations. The purpose of this section is to give an overview of the main legends behind a few constellations that mark those parts of the sky in which the NASA images in this activity are located. While we give more details from the story associated with the official name of the constellation (as adopted by the International Astronomical Union), we also mention other legends and stories connected with a particular pattern. However, there are so many stories, from so many cultures, and so many variations on even well-known stories, that only a brief summary is presented here. Continue your own reading about the constellations by searching for other stories online or at your local library.

In the Light Up Constellations activity, participants can find and trace some select constellations and light them up with the paper circuits, or they can create constellations and background stories of their own. Enjoy!

LIGHT UP EXPLODED STARS
(PAPER CIRCUITS TEMPLATE)

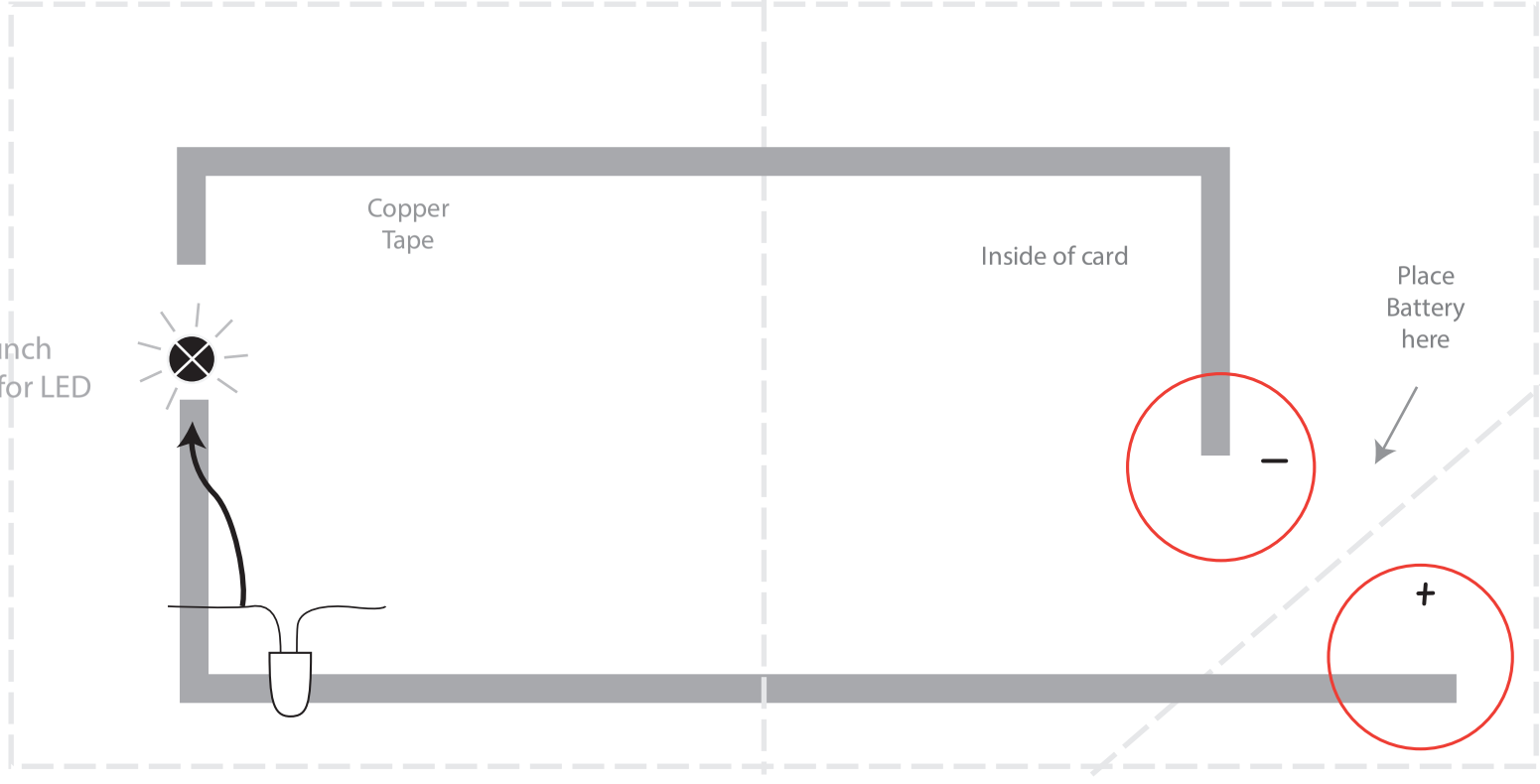
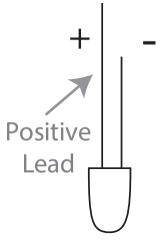


Image on opposite side here



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