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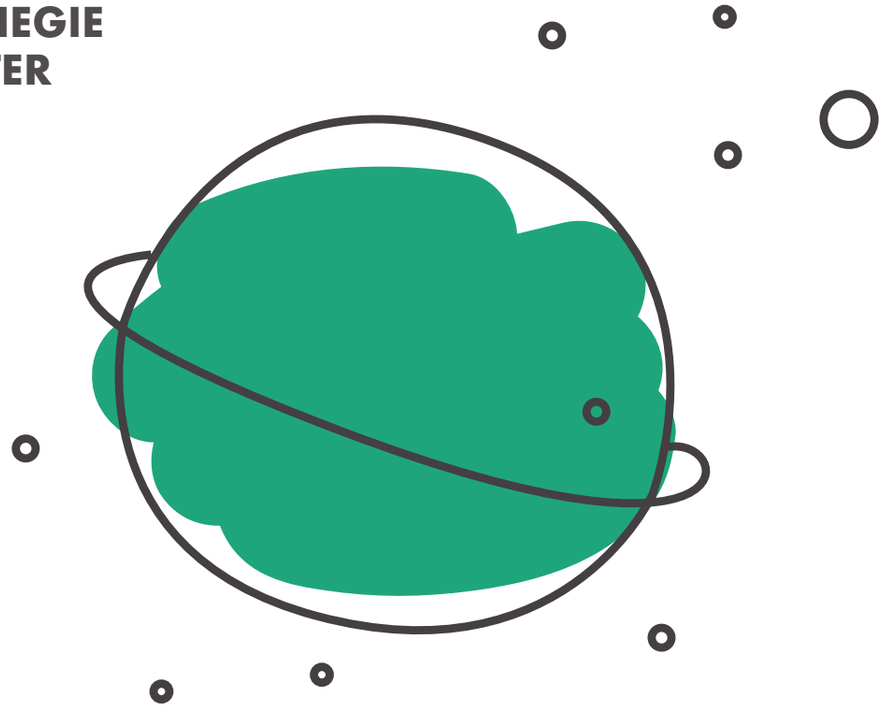
GIRL UP & CARNEGIE SCIENCE CENTER



STEM Toolkit
for Social Good

girl up™

INTRODUCTION

Ready to change the world with STEM innovations for social good?! Grab your curiosity and your Club, and let's get to work!

In 2018, Girl Up is pleased to partner with BNY Mellon and Carnegie Science Center to inspire girls to use STEM skills to promote gender equality and improve our communities.

Together, we are working hard to create new hands-on opportunities for all the STEMinists out there—leaders just like YOU. Through this STEM for Social Good Toolkit, we want you to feel connected with other girls and women rocking it in the STEM fields. You'll also learn how you can combine your leadership in the global movement for gender equality with 21st century STEM skills to address our world's most pressing issues. Even better - Girl Up can't wait to introduce you to your new #GIRLHEROES in STEM.

Your generation can end gender imbalance in the STEM fields. Whether or not you want to pursue a career in STEM, this toolkit is for you. You'll find information and activities to help you and your Club members develop STEM skills, which can be applied to any project or field. Plus, you might just discover some new interests – especially when you learn how STEM advances are directly benefiting the lives of girls and women every single day.

As a "by girls, for girls" initiative, Girl Up engages girls just like YOU to take action to achieve global gender equality and change our world. Through our leadership development programs, Girl Up inspires, convenes, trains, and connects girls globally, helping to position them as leaders and changemakers. Girl Up is hosted at the United Nations Foundation, working across a global community of partners to achieve gender equality worldwide.

Girl Up is excited to team up with partners BNY Mellon and Carnegie Science Center to continue offering ways for you to make a difference through STEM and enhance your own skills. Keep your eyes out for opportunities like STEM boot camps and Solution Labs in your area, or the chance to apply for the WiSci Girls' STEAM Camp.

What are you waiting for? It's time to change the world through STEM.

BNY MELLON

girl up

CARNEGIE SCIENCE CENTER

Toolkit

STEM
for Social Good

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ABOUT THE PARTNERS

BNY MELLON

BNY Mellon is a global investments company dedicated to helping its clients manage and service their financial assets throughout the investment lifecycle. Whether providing financial services for institutions, corporations or individual investors, BNY Mellon delivers informed investment management and investment services in 35 countries. As of March 31, 2018, BNY Mellon had $33.5 trillion in assets under custody and/or administration, and $1.9 trillion in assets under management. BNY Mellon can act as a single point of contact for clients looking to create, trade, hold, manage, service, distribute or restructure investments. BNY Mellon is the corporate brand of The Bank of New York Mellon Corporation (NYSE: BK).

CARNEGIE SCIENCE CENTER

As a leading Center for STEM initiatives and teaching, Carnegie Science Center provides students, teachers, and community members in the Pittsburgh area resources to delve into science and technology in their museum and outreach programs. There is no better time than now to start thinking about how you can learn more about tech, engineering and science in general! Girl Up has partnered with Carnegie Science Center to create a toolkit that merges critical thinking in STEM with social good outcomes. This toolkit outlines the basis of 10 STEM activities that you can use in your clubs or community. These are meant as a guideline as you start or continue your journey into STEM fields of interest.

STEM + Social Good

Close your eyes and think about the first thing that comes to mind with these words: scientist, tech innovator, engineer, mathematician. What did you picture? Did you see older people or younger people? Men or women? More importantly, did you see yourself reflected in those images?

By now, you've likely already taken a science or math class in school. How did it go? Did you learn about #GIRLHEROES like Marie Curie and Rosalind Franklin? Or instead, did you learn about Albert Einstein and Watson and Crick?

Better yet, did you connect with what you were learning and see how you could apply these approaches to actually make a difference in the world?

There are so many different ways you can create a career and lifestyle from all aspects of science, technology, engineering, and math. Just take a look at how these women have innovated in their field to improve lives around the world!

SCIENCE: Jennifer Doudna is one of the most culturally significant scientists studying today. She helped develop CRISPR, the genetic-engineering method that could allow for the eradication or treatment of diseases like sickle cell anemia, cystic fibrosis, Huntington's disease, and HIV. She is also a professor at UC Berkeley.

TECHNOLOGY: Elsa Marie D'Silva created SafeCity, a mobile application that gathers data from women to map sexual assault in public spaces. It's an ingenious way for women to anonymously submit tips to the app in order to help protect other women. We're always on board with women helping women and creating safe spaces!

ENGINEERING: Tiera Guinn is a senior at the Massachusetts Institute of Technology and she's already helping NASA on their next rocket! The project Tiera is working on could be one of the most powerful rockets ever made—pushing the boundaries of space exploration.

MATH: Dr. Lauren Neal is a data scientist helping to prevent human trafficking. Neal used problem-solving techniques to identify new ways to model the data used to map human trafficking networks—aiding law enforcement, service providers, and policymakers. The mapping tool now tracks criminal trafficking networks in some of the largest cities in the U.S. and has enabled a better understanding of recruitment tactics. Using math and data science, Dr. Neal is fighting for the freedom—and safety—of trafficking victims around the globe.

Who do you see NOW when you picture a scientist, tech innovator, engineer, or mathematician?
Can you picture yourself?

You got this, girl! You've got a supportive community of girls around the world cheering you on, Dr. STEMinist!

Intersectionality of the STEM Imbalance

Before we even begin to talk about STEM and social good, it's important to understand that just like feminism, STEM exposure and opportunity is also an intersectional issue. For example, in a 2017 UNESCO report, women represented only 35% of all students enrolled in STEM-related fields of study globally. From the same study, it is apparent that girls' interest in STEM-related fields starts to drop off around early adolescence.

Looking beyond just gender, other factors such as race, socioeconomic status, and sexuality all play a role in whether or not you are exposed to STEM training or hired in STEM jobs. In the tech industry for instance, a wage gap exists for self-identified females, and the gap becomes even wider in underrepresented minority groups.

It is important to understand the intersectionality of the STEM gender imbalance and recognize that girls' STEM exposure and opportunities will look differently in various communities around the world. In the same way, the activities in this toolkit can look different for Girl Up Clubs around the world. Some areas of the world have better access to internet or have the resources to be able to complete every single activity.

Think About It

Girls face disadvantages that are a result of varying factors including societal standards and learning processes. Based on the 2017 UNESCO report, the way that girls and boys are brought up around the world is a powerful force in shaping their identity, beliefs, behavior, and choices—including whether they believe they are qualified for a career in STEM.

No matter where you live or what resources you have, completing this toolkit will further your critical thinking skills and expose you to ways that STEM solutions can make our world a better place.

Careers in STEM

Careers in STEM are some of the most sought-after jobs in the market, and many companies are looking for motivated and talented people in these fields who can critically think through big challenges. No matter the industry - whether it's tech, public sector, private sector, or academia - almost all employers are looking for people who can dissect an issue into segments and think through realistic solutions. Plus, STEM skills are the foundation for startups — being your own boss by bringing your idea to life and getting paid to do it!

Around the world, however, there is a clear lack of female representation across all STEM fields. Not only is this an issue because STEM jobs are often the most high-paying (contributing to the wage gap), but also because we're missing the vital contributions of half of the world's population in these fields. According to a study from the U.S. Department of Commerce, those in a STEM field and career earn on average 1.5 times as much as their non-STEM counterparts. This shows the earning potential for those carving out a career in STEM fields. The discrepancy in pay between non-STEM and STEM careers is real and is causing a wider gender wage gap overall, but it doesn't have to be that way. What scientific discovery and tech innovations are missing from the world today because girls haven't had access or support to pursue their STEM interests?

For instance, just think about these incredible, out-of-the-box STEM careers:

- **Diana Vladimirova**, a Russian engineer who works at the Arctic and Antarctic Research Institute researching meteorological trends in the area. She even won the Young Scientists Award from the Russian Academy of Sciences in 2015!

- **Holley Moyes**, is an archaeologist who also has a knack for anthropology! She goes on excavations to understand ancient civilizations through their rituals.

- **You could be here!** The exciting part of STEM careers is that many paths haven't even been dreamed of yet. How can you be a changemaker in the STEM world?

Not all of us will pursue STEM careers. The skills you learn from STEM education—like scientific decision-making or human-centered design—will make you more successful in whatever you pursue, from international development to economics to communication, and more!

STEM #GIRLHEROES

If you can't see it, you can't be it. To highlight the incredible women making strides in various areas of science and technology, we've compiled a list of females making their mark in STEM fields! Read about these STEM #GIRLHEROES in this section and after every activity.

You and your Club can share the stories of these amazing women. Think about how you can create a presentation to educate your classmates (or younger students at local middle schools) about the awesome career paths available in STEM. Below are some talking points you can use when creating a discussion with the girls:

- How has your view of STEM careers changed after learning about these women? Have any of your stereotypes of STEM leaders been challenged?
- How many of you were interested in a STEM career prior to this conversation? Can anyone share if their interests have evolved?
- What are some career paths or women in STEM fields you've heard of that we haven't yet discussed?
- What's one obstacle you feel is in the way of girls pursuing STEM? What's one positive change we can make to alleviate that?
- What is an issue/problem affecting girls and women that could be addressed (or is not being addressed) in the STEM fields?

After the STEM #GIRLHERO discussion, keep the conversation going. Encourage younger girls to reach out to your Club whenever they have a question or want advice about STEM paths and careers!

Here are the amazing STEM #GIRLHEROES you can profile in your discussion.

- **Shurouq Al Hamaideh** is from Tafila, Jordan, and at age 22, started a social business with her friends to teach computer programming to teenagers in her community. Girls who participate in the programming class receive a certificate of completion and are better equipped for a job in the technology fields. Shurouq is bettering her community one course at a time!
- The young women of the **Afghan Girls Robotics Team** from Heren, Afghanistan won first place in the biggest robotics competition in Europe! Their project was a prototype of a robot that harnesses solar energy to support farmers in their city. The girls started a great chain reaction that benefits their larger community!

2017-2018 Girl Up Teen Advisor Co-chairs, Rachel Auslander and Lavanya Singh.

- Girl Up Teen Advisors **Rachel Auslander** and **Lavanya Singh** are leaders in the STEM education field. Both women have started non-profits that help educate grade school girls on science and technology. Rachel created Coder Gals in 2015 which helps to teach coding skills to middle and high school girls. Rachel will continue to run Coder Gals, along with its affiliate chapter across the country, as she heads to college in the fall of 2018. Lavanya created the organization Tech Girls which leads workshops on exposing girls to STEM education issues.

- **Kathrin Hoppner** of Germany is a climate researcher and geographer at the German Research Station. She's one of the world's only women at the top of the meteorology field, an area of STEM in which women are scarcely represented! She researches an atmospheric layer known as "airglow" located around 87 KM above the Earth's surface to better understand the processes taking place in our atmosphere. Her work is helping to build more effective climate models that can help prevent climate change.

10 STEM Activities for Your Club

In this section, you'll find a range of 10 activities for all skill levels aimed to show how YOU can be the next brilliant mind in STEM. All ten activities were created for high school students. As a result, these activities range in difficulty, so anyone can participate—from those who are new to STEM fields to the STEM pros in your Club.

At the beginning of each activity, you will find a "difficulty meter" highlighting the level of difficulty. It's up to you and your Club members to pick which activity is best for your meeting! You can also decide how many activities to complete. Clubs that participate in the STEM Challenge do not need to complete all ten activities. Submit a Club activity report in the Girl Up Community after your Club completes each activity, so you can earn points for your efforts!

The Goal:

As you work through these activities alone or with your Club, you'll have a better sense of intersectional STEM concepts, like understanding how to apply the scientific process for gender equality, or real-life applications of how thinking like an engineer can solve social issues. These activities are meant to challenge you to think outside of the box and create a new way of critically analyzing problems. We also hope you find them fun — and that you overcome any pressures of social stigma or stereotypes that can sometimes limit girls and women in exploring STEM fields.

Here are some tips as you lead these activities (or complete them individually):

- Be sure to gauge the experience level of Club members. Once established, you can refer to the "difficulty meter" on the first page of each activity to determine which ones to complete.
- The ten activities are intended for high school students and all members are encouraged to participate in at least one activity!
- Each activity has a different set of materials needed to complete it. Before starting each activity, be sure to allot enough time to gather all necessary materials.
- After completing each activity, be sure to submit a Club Activity report in the Girl Up Community.
- Have fun with it! These activities are meant to be a great learning experience with your Club members and failure is a part of it—so have a few laughs along the way!
- Adapt the activities to the needs of your Club.
- Share how your Club remixed or adapted the Activity.

1

DEAR GIRL UP

Building and Strengthening
Our Human Connections
Through Visual Storytelling

DEAR GIRL UP

Using inspiration from the analog art project of Dear Data (dear-data.com/theproject/) and thinking about all the ways in which the voices and stories of young women might be counted, design a postcard for girls around the world.

TIME
45 minutes

DIFFICULTY LEVEL – 2

MATERIALS

Scrap paper
Sturdy paper (cardstock)
Pens/pencils
Colored pencils, markers, or crayons
1 postcard for each Girl Up Club member
Rulers

Included:
Postcard template
Daily activity log

What is Dear Data?

Dear Data was a year-long, analog data drawing project by Giorgia Lupi and Stefanie Posavec, two award-winning information designers living on different sides of the Atlantic; Giorgia in New York and Stefanie in England. Each week for a year, the women collected and measured a particular type of data about their lives, used this data to make a drawing on a postcard-sized sheet of paper, and then dropped the postcard in an English "postbox" (Stefanie) or an American "mailbox" (Giorgia). The two friends learned more about each other as well as themselves by collecting and hand drawing personal data and sending the information to each other. (Paraphrased from Dear Data: The Project).

The Ambitious Challenge

How might you crowdsource the wisdom of the Girl Up Community to provide its own data about what life is truly like for young women around the world? Or, how might we use our personal data to understand ourselves and others better?

Giorgia and Stefanie collected data that was both qualitative and quantitative.

- **Qualitative data** is measured by descriptions. These can be understood by using details, types, and behaviors.

- **Quantitative data** is measured by numbers and values. These can be understood with terms such as "how many,", "how much,", or "how often."

Warm-Up Mini-Challenge Opportunity

Ponder this question: What are some ways that you can convey meaning or understanding in a visual way?

Have a discussion with your Girl Up Club members to make a list of ways that people understand new information. Try thinking of how different things might catch your eye as you travel to school or work, or how you decide what items to buy at a store. What made you look at it? What made you want to know or learn more about it?

Ready? Let's Begin!

Step 1: Brainstorm - Discuss some questions with your Club. What would you like to know about others? It can be daunting to try to answer a broad personal question, so start with a narrower approach.

Some examples include:

- What did you learn this week?
- How many days were you able to attend school?
- How many days did you work?
- How many girls were born in your area?
- How long is your commute to school or work?
- What did you eat?

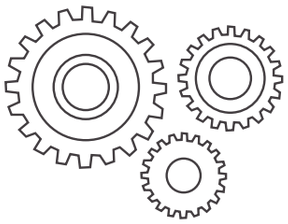
Which questions do you most want answered? Which ones will make the greatest impact to your community? To girls? To people around the world? The questions you ask are up to you!

Through consensus voting, choose one question to use when designing the data for your postcard.

Step 2: Research & Collect Data - Throughout the designated week, record your data in real time as it occurs. You can carry a notebook, use your phone or print and share the provided Daily Activity Log – whichever method you are most comfortable with to collect your data. Recording data as it occurs will ensure the most accurate collection. Tally the number of occurrences for items that are quantitative or make groupings for items that are qualitative according to the overall questions. Start looking for patterns and identify categories. It can be hard to remember each item or instance, but try to be as accurate as possible. It is also important to be truthful in your data collection. No cheating or fudging the data! Personal discovery is achieved by being honest with yourself. You may even learn something new about yourself!

STEM CONNECTION

Collecting and organizing the data you gathered requires not only an understanding of technical thinking, but also a great amount of creativity!



THINK ABOUT IT

Try to incorporate every aspect of your design into the meaning. Not only shape or color, but what could size, thickness, or amount represent?

Step 3: Design - Reunite with your Girl Up Club members after a week of collecting data. How do you want to tell your story? On scrap paper, begin designing what you want your data to look like for each postcard. Do you want to set up your data chronologically? Geographically? This will help you to construct your layout. Try to think outside of the box. The more creative the better! Don't forget to think about how to design the legend, and make sure it is easy to follow. If you don't understand your drawing, nobody else will. Begin thinking about the different elements of your data (color, shape, etc.) Be sure to assign each different component its own visual characteristic. If you're totally stuck, check out Giorgia and Stefanie's designs to gain inspiration: dear-data.com/by-week.

Step 4: Create - Once you feel comfortable with your drafts, create the final products using the postcards. The blank (back) side of the postcard is only for the illustration, and the text (front) side is for the legend and mailing address.

Step 5: Share - Once everyone has completed their postcards, have each member of the Girl Up Club choose a postcard to share with the group. Discuss the different aspects of each girl's design as well as her approach to creating it. What can be learned from the data that has been collected? What can it be used for?

Finally, snap a photo of your postcard and put it on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the amazing postcards made by girls just like you around the world.

Helpful Hints:

- The front of your postcard should only feature the visualization.
- On the reverse side, include a legend or key to explain your work.
- You can use any shapes, colors, or materials you want, just be sure it fits on a postcard.
- Be creative! Can you use a data chart other than a bar graph?
- Try to add minor details to give your illustration more pizzazz!

DEAR GIRL UP ACTIVITY LOG

(Use this activity log to keep track of what you're measuring for one week.)

DATE/TIME	ACTIVITY DESCRIPTION	NOTES/THOUGHTS

- What did you learn about yourself as you were documenting this activity for one week?
- What did you learn about others?

STEM SPOTLIGHT

DEAR DATA

Dear Data was a year-long, analog data drawing project by **Giorgia Lupi** and **Stefanie Posavec.** This is what they had to say about their project: "We prefer to approach data in a slower, more analogue way. We've always conceived Dear Data as a "personal documentary" rather than a quantified-self project which is a subtle – but important – distinction. Instead of using data just to become more efficient, we argue we can use data to become more humane and to connect with ourselves and others at a deeper level."

Learn more about them here: dear-data.com/aboutus

What Now?... Learn More!

- **Dear Data** pictures and background info about each week's postcards (dear-data.com/by-week)
  Learn more about each topic, the data, data gathering, their reflections, their data drawings, and their process for creating the final postcard to be mailed.
  About Dear Data (3:00) (bit.ly/1p632E9)
  Drawing Insights from Imperfection Dear Data (3:42) (bit.ly/2rVDXiT)
- **Empowering Women Through Storytelling** (bit.ly/2xbRtUE)
  Women and Girls Lead Global (WGLG) believes in the power of storytelling to shift the way women are marginalized through media by using "...powerful character-driven documentaries" to bring "women and girls' stories of struggle and triumph into the foreground."
- **Gapminder** (gapminder.org)
  Gapminder is an interactive visualization tool created by Ola Rosling, and made famous by his father Hans Rosling, designed to promote the Sustainable Development Goals. Explore and play around with this tool!
- **Dollar Street** (bit.ly/2x2SX3z)
  Invented by Anna Rosling, this tool helps connect to how people live from all around the world, learning about everything from toilets to toys.
- **Learn more about Women and Data with these websites:**
  The Power of Data for Women and Girls (bit.ly/2xgcb5q)
  UN Women Watch (bit.ly/2s54XeX)
  Facts and Figures: Economic Empowerment (bit.ly/1cTOSZA)

2

THE BOOK OF LIGHT

Illuminating Deconstruction
for a More Brilliant World

THE BOOK OF LIGHT

Over one billion people around the world live without electricity. Many countries lack a reliable means to get available electricity to citizens. As a result, serious problems affect people's health and well-being, such as indoor pollution and fires that prematurely kill millions of people each year. This obstacle also creates barriers to education, especially for girls who are unable to study once the sun sets.

TIME
90 minutes

DIFFICULTY LEVEL – 3

MATERIALS

Option 1 – Purchase a Hackable Design Kit from a store

One hardcover book
One pack of party lights with a battery pack
One eyeglass repair kit
5-10 thumbtacks
Batteries for the battery pack (2 AA)
Hobby knife, utility knife, or scissors
Foam board
Tissue paper
Scrap paper
Glue
Tape

Option 2 – Make Your Own Hackable Design Kit

One hardcover book
One pack of party lights with a battery pack
Solar-powered garden lights
Tiny screwdrivers (Phillips and flat head)
Glue, adhesive, duct tape or tacks
Batteries
Foam board or cardboard
Tissue paper
Scrap paper
Potatoes
Hobby knife, utility knife, or scissors
Glue

The Ambitious Challenge

How might you sustainably design a hackable book that provides light and can be used anywhere in the world?

Warm-Up Mini-Challenge Opportunity

Chalk Talk: Write out questions A and B on a separate piece of paper. Collectively answer the questions following the guidelines of a Chalk Talk.

A. How is your learning impacted by access to electricity? What are you able to do? What are you not able to do?
B. How is your education and ability to learn affected by having access to light 24 hours a day and 7 days a week?

Go to one.org and search a "A Classroom's Worst Nightmare? Energy Poverty" [1] and look over the article together as a group. Did your group come to similar conclusions?

What is deconstruction? What is reconstruction?

Deconstruction doesn't actually mean "demolition." Instead, it means "breaking down" or analyzing something (especially the words in a work of fiction or nonfiction) to discover its true significance.

Reconstruction is the act or process of building something that was damaged or destroyed again, or the process of putting something back into good condition.

In this activity, we are going to practice deconstructing or breaking down objects and reconstructing them for new uses.

Ready? Let's Begin!

Step 1: Brainstorm - Try to generate as many ideas as possible as a group by writing one idea per sticky note or a small piece of paper. No idea is too outrageous!!

What if you woke up one day and there was no electricity? What are all the ways that light can be produced without having electricity coming into one's home? (Consider methods that don't produce more waste, use up more resources, and are cheap to replicate or reproduce.)

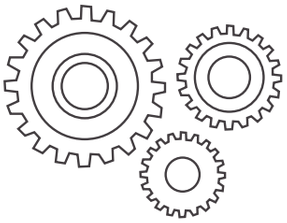
Step 2: Research & Collect Data - Grab the materials that you collected for this activity and put them in the center of the group. Think back to what your Club discussed during the Chalk Talk, the article "A Classroom's Worst Nightmare? Energy Poverty" and your brainstorming session. Based upon the materials you have in front of you, how might you design a hackable book that provides light in the most sustainable way?

Learn More:

1 A Classroom's Worst Nightmare? Energy Poverty: (bit.ly/2LkHVcT)

STEM CONNECTION

Engineers typically use a design process to come up with solutions to a problem. Ask, Imagine/Brainstorm, Plan, Create, Improve... then repeat.



THINK ABOUT IT

Ecological Footprint is the amount of natural resources used plus the amount of waste you produce. What is your Ecological Footprint?

Step 3: Design - Working in groups of 2-4, begin creating a paper sketch of a Book of Light based upon the materials in front of you. Deconstruct or break down the objects in front of you. Reconstruct a new tool to bring light and expand learning. Take a quick stroll around to the other groups to see how they are thinking.

Step 4: Create - Create a Book of Light that would allow a student to continue to learn without the restriction of darkness and lack of electricity using the materials in front of your group. Test out your design.

Step 5: Share - Once everyone's design is created, share them with the group! Take pictures of your brainstorming, design, and creation processes and share them with the greater Girl Up Community via social media.

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take some time to explore what other girls have created as well!

Helpful Hints:

- There are many different ways to think about creating light without electricity as well as repurposing materials. If you're truly stuck, check out this slideshow called "Book of Light" at GirlUp.org/BookofLight. Deconstruct2Reconstruct: Book of Light (tinyurl.com/yd5e6a5e).

STEM SPOTLIGHT

BOOK OF LIGHT

Edith Widder's early interests in the marine sciences at the age of 11 years old led her to becoming an oceanographer, marine biologist, and researcher. She is the Co-founder and CEO of **Ocean Research and Conservation Association (ORCA)**. ORCA ia a non-profit organization dedicated to the protection of aquatic ecosystems and the species they sustain through development of innovative and science-based conservation action. She has long appreciated and studied bioluminescence, the production and emission of light by a living organism, which most animals in the ocean produce. Her research pursuits and technological innovations are complemented by her commitment to stopping and reversing the destruction of our marine environments.

> *"We've only explored about 5% of our ocean. There are great discoveries yet to be made down there - fantastic creatures representing millions of years of evolution and possibly bioactive compounds that could benefit us in ways we can't even imagine."*
> *- Edith Widder*

photo credit: nobelprize.org

What Now?... Learn More!

- **The Weird and Wonderful World of Bioluminescence** (bit.ly/2s568ev)
  Bioluminescence expert Edith Widder was one of the first to film this glimmering world of the deep ocean. At TED2011, she brings some of her glowing friends onstage, and shows more astonishing footage of glowing undersea life.
- **A World Without Power** (wapo.st/1MCyu0q)
  Around the world, 1.3 billion people lack access to electricity. More than 600 million are in sub-Saharan Africa, and more than 300 million are in India alone.
- **Brazilian mechanic creates light bulb using water, bleach and a bottle** (nydn.us/12YMhzK)
  Alfredo Moser is a Brazilian mechanic that found a way to produce light that is the equivalent of a 40-60 watt light bulb just using a plastic bottle, water, and bleach. This simple and brilliant technology is a cheap way to bring light to the masses during the day.
- **A Liter of Light** (literoflightusa.org)
  Liter of Light is a global, grassroots movement committed to providing affordable, sustainable solar light to people with limited or no access to electricity. Liter of Light has installed more than 350,000 bottle lights in more than 15 countries and taught green skills to empower grassroots entrepreneurs at every stop.
- **Potato Power:** The Spuds That Could Light the World (bbc.in/18uuwqZ)
  For the past few years, researcher Rabinowitch and colleagues have been pushing the idea of "potato power" to deliver energy to people cut off from electricity grids.
- **Ocean Portal: Bioluminescence** (ocean.si.edu/bioluminescence)
  Fireflies produce light through a chemical reaction in their glowing abdomens, a process known as bioluminescence. But did you know that seascapes can also glow and glitter thanks to the light producing abilities of many marine organisms?

3

VIRAL MUSIC

Creating at the Intersection of the Arts and the Sciences

VIRAL MUSIC

We are surrounded by viruses! Every human ecosystem on Earth contains millions of viruses in all shapes and sizes. These infectious agents of change, despite not being recognized as a life form, spread in a variety of ways: plant to plant, animal to animal, and entering the human body via coughs, sneezes, food, water and many other paths. Although the majority of viruses are not all harmful, many have the capacity to expand from a few species to a large number.

TIME
90 minutes

DIFFICULTY LEVEL – 4

MATERIALS

Computer, tablet, or phone
Internet access
Everyday objects to make sounds that exist all around you

The Ambitious Challenge

How might you use the power of music and an understanding of how viruses work to produce a viral piece of art that spreads an idea?

Free Digital Software to Make Music

Tonecraft
labs.dinahmoe.com/tonecraft

Patatap
patatap.com

Plink
labs.dinahmoe.com/plink

The New Plink
labs.dinahmoe.com/plink

The Exquisite Music Engine
labs.dinahmoe.com/theme

Radar
lab.hakim.se/radar

Macchina 1
5013.es/toys/macchina

Microscale
(music generated randomly from Wikipedia articles)
alestsurko.by/microscale

Nodal
(generative music software)
nodalmusic.com

Warm-Up Mini-Challenge Opportunity

What is your favorite example of something going viral? What does it mean for something to go viral; what's actually happening? Why do some ideas spread and others do not?

Ready? Let's Begin:

Step 1: Brainstorm

Divide into two teams: Team Virus and Team Music Makers.

Team Virus: What is a Virus?

In the next 10-15 minutes, learn everything you can about how a virus works. Take time to watch the video below and read the background information about viruses. Be prepared to explain how viruses work to Team Music Makers.

- Flu Attack! How A Virus Invades Your Body (3:39) [2]
- How Stuff Works: Viruses [3]
- Viruses: Molecular Hijackers [4]

Learn More:

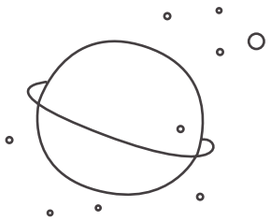
2 Flu Attack! How A Virus Invades Your Body: (bit.ly/1sEBxyy)
3 How Stuff Works: Viruses: (bit.ly/2kf5jvX)
4 Viruses: Molecular Hijackers: (bit.ly/2scBxyT)

Team Music Makers: What is Generative Music?

In the next 10-15 minutes, learn everything you can about what generative music is. Take time to investigate this interactive presentation on how generative music works:

How Generative Music Works: A Perspective [6]

Step 2: Research & Collect Data - Both teams will now take time to explain what each has learned about viruses and generative music. Working together, both teams can create a Venn diagram to show the similarities and differences between viruses and generative music. Working together, both teams can create a Venn diagram to show the similarities and differences between viruses and generative music. You can find the Venn diagram on page 39.



DID YOU KNOW?

The music video Gangnam Style by South Korean superstar PSY is the fourth on the list of most watched videos. It has over 3.1 billion views on YouTube. (bit.ly/2apvIC1)

We humans are part virus. At least 5 - 8% of the human genome is made up of viruses. These viruses aka retroviruses have fused themselves into the genome of an egg or sperm thus ensuring that they will be passed on from generation to generation.

Learn More:

6 How Generative Music Works: A Perspective: (bit.ly/2mrMaeq)

THE VIRAL MUSIC 3 MINUTE SONG CHALLENGE

Compose a song that reflects what happens when the flu invades the human body.	Flu Attack! How A Virus Invades Your Body (3:39) [7]
Compose a song that reflects what happens when someone is infected with HIV.	The Science of HIV/AIDS [8] (4:12)
Compose a song that mimics a dangerous relationship that a young woman might face.	Bjork's Virus Music Video [9]
Compose a song that shows what happens when a powerful idea goes viral and becomes possible.	The Power of Ideas [10] (2:06)
Compose a song that helps reduce stress.	The Nature of Sound: Symphony of Science [11] (3:13)
Compose a song that reproduces how human populations have grown - from how it took 200,000 years for our human population to reach 1 billion and only 200 years to reach 7 billion.	Human Population Through Time [12]

Learn More:

7 Flu Attack! How A Virus Invades Your Body: (bit.ly/2kh9CHn)
8 The Science of HIV/AIDS: (bit.ly/2s02oeS)
9 Bjork's Virus Music Video: (bit.ly/2IAXSxQ)
10 The Power of Ideas: (bit.ly/2wXWT5o)
11 The Nature of Sound: Symphony of Science : (bit.ly/2KLmKzC)
12 Human Population Through Time: (bit.ly/2ICyWGf)

THINK ABOUT IT

Perhaps you start off with a role play and assign a sound to each role (virus, host cell, T cells, etc.)

STEM CONNECTION

Virology is the study of viruses, and microbiology is the branch of science that deals with microorganisms. A virologist is a microbiologist who studies microorganisms that quickly duplicate and spread.

Step 3: Design - Make new teams with equal members of Team Virus and Team Music Maker. Pick one of the Viral Music 3-Minute Challenges. Watch or re-watch the video associated with the challenge, and then decide how your group will compose the music and what your idea must sound like.

Step 4: Create - Now you're ready to create your composition. Pick a music-making tool: either from Found Sounds or one of the Digital Music Software Tools. Experiment and play around with the tool, and then complete the creation of a three-minute composition from one of the Viral Music Challenges. Don't forget to record your song!

Step 5: Share - Share pictures of your brainstorming, design, and creation processes and your final song composition with your Girl Up Club as well as the rest of the Girl Up Community!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take some time to explore what other girls have created as well!

Helpful Hints:

- Read more about Bjork's process in how she created her song "Virus." Released as the third single, each song in the album features a theme related to nature. In "Virus", Björk explores "fatal relationships" such as the one between a virus and a cell, as Björk explained in an interview: "It's a kind of a love story between a virus and a cell. And of course the virus loves the cell so much that it destroys it." "Virus" features a gameleste (a hybrid between a celesta and a gamelan that can be controlled by midi and it was also used in 'Crystalline', built exclusively for these songs) base that plays through the whole song. The gameleste represents the 'virus' that continues multiplying until it takes control at the end of the song. Also, Manu Delago plays hang drum. Since Björk wanted the album to break the typical 4/4 time signature, "Virus" has a time signature of 3/4.

The lyrics to "Virus" talk about "dangerous relationships", symbiotic relationships in which one organism is a parasite for the other and takes a benefit, even changing the other's behavior. This fact is used as a metaphor between "love" and "parasiting." Björk took inspiration from a McGraw-Hill educative video about mind-controlling parasites and from candidiasis, an illness that she suffered from.

"I'd been fighting this candida issue in my throat and I had to really change my diet and use different medication and it sort of seems to pop up and its kinda hilarious. It's like I have this new neighbor that I have to sort of learn to live with. And obviously you know this fungus is inside all of us and it's never about eliminating it. You have to kind of just live with it."

- Read and share the article "How the Intersection of Art and Science Made History" [13]

"When we heed respect for artists, we often commend contemporary idols with discoveries and defiant actions that tear away from the norm, but we forget those artists living at the crossroads of the arts and sciences, who contribute to society in various unique ways. Artists such as Da Vinci, Picasso and Disney, who discovered a common ground where science and art meet, provided a degree of mental stimulation and a sense of independent exploration that moved society forward." Patrick Daniel and Theodora Karamanlis.

Learn More:

13 How the Intersection of Art and Science Made History (bit.ly/2Ln3N7u)

STEM SPOTLIGHT

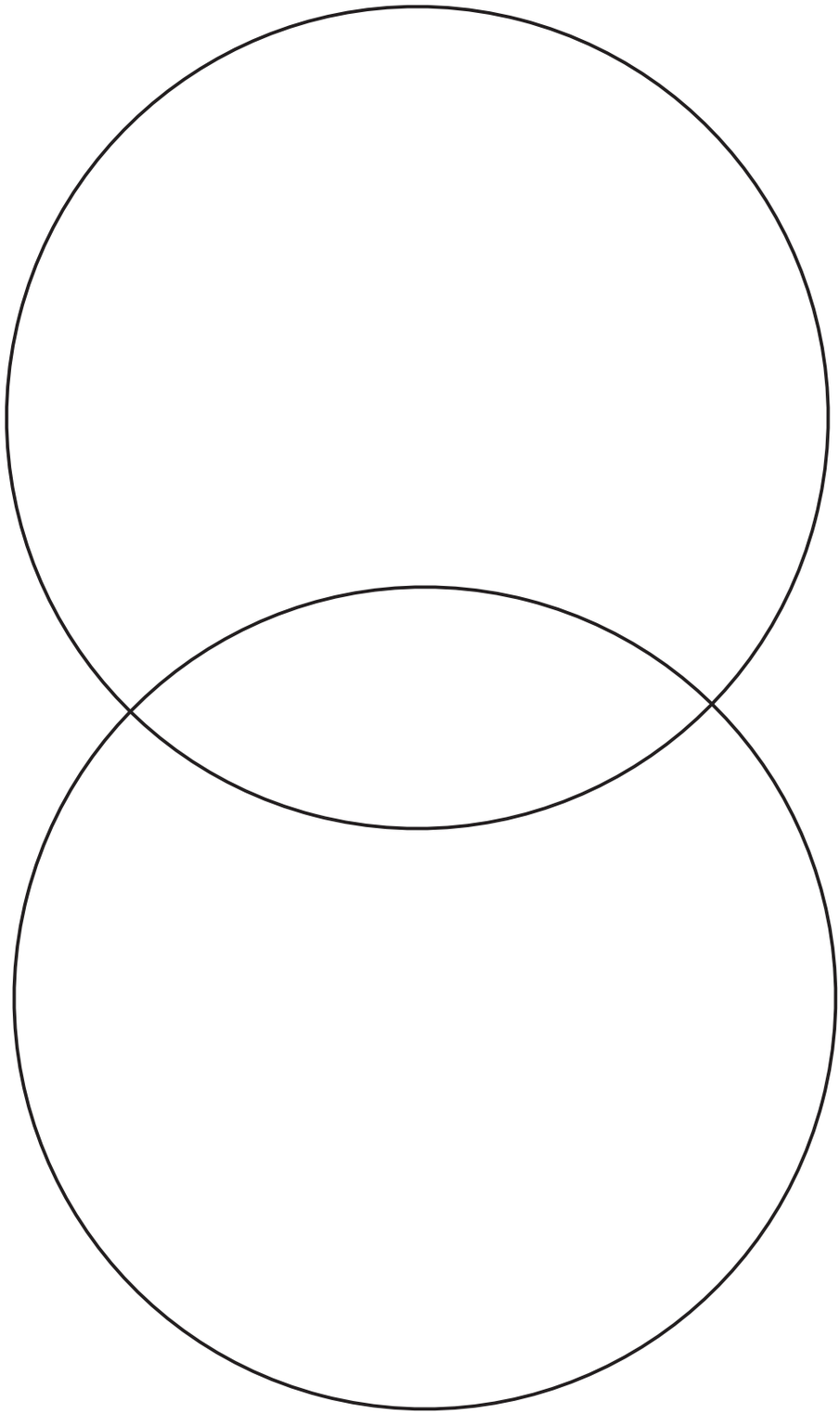
GOING VIRAL

Deeply influenced by her love of nature, **Françoise Barré-Sinoussi** spent most of her youth studying and observing plants and animals near her home in Paris, France. Despite her humble roots, she studied to become a virologist, and worked for the Institut Pasteur. She discovered the retrovirus in patients with swollen lymph glands, known as **Human Immunodeficiency Virus (HIV)** which proved to be the cause of AIDS. She travelled to Africa and Asia to find out more about AIDS, co-authored many scientific publications, and conducted vital laboratory research. She also became active in humanitarian organizations fighting the AIDS crisis. In 2008, she won and shared the Nobel Prize in Medicine with virologists Luc Montagnier from France and Germany's Harald zur Hausen.

What Now?... Learn More!

- **Microbes: A Love Story** (nyti.ms/2lCswa8)
  Genes may not be the only factor responsible for our beauty...perhaps it's microbes too!
- **Probiotic Bacteria Induce a 'Glow of Health'** (bit.ly/2x31Eed)
  Radiant skin and hair are universally recognized as indications of good health. However, this 'glow of health' display remains poorly understood. Learn more about insights into mammalian evolution and novel strategies for integumentary health.
- **Music Improviser and Generative Sequencer** (bit.ly/2xbBiXm)
  Read about an Arduino-based project. Jack & Jill is a little box that generates MIDI notes quantized to a musical scale. It produces pseudo-random music which occasionally repeats.
- **Computer scientists use music to covertly track body movements, activity** (bit.ly/2w7zXwl)
  Researchers at the University of Washington have demonstrated how it is possible to transform a smart device into a surveillance tool that can collect information about the body position and movements of the user, as well as other people in the device's immediate vicinity.
- **Music Plays Crucial Role in Non-Violent Civic Movements** (bit.ly/2wiNnc9)
  For hundreds of years, music has been integral to rebellion, resistance and revolution. USIP is highlighting the power of a melody to inspire alternatives to violence. Music and the arts are strategic tools of non-violent action, says USIP Senior Policy Fellow Maria Stephan, one of the world's leading scholars on strategic nonviolent action.
- **Ancient Viruses Are Buried in Your DNA** (nyti.ms/2kpFuMz)
  Read about a particular protein called Hemo, naturally made by a fetus and placenta during pregnancy, that was made by a gene that originally came from a virus that infected our mammalian ancestors more than 100 million years ago.
- **Our Inner Viruses: Forty Million Years In the Making** (bit.ly/1F0anqN)
  Learn about viruses that meld with the genome of their hosts and become part of the genetic legacy their hosts pass down to future generations.

Venn Diagram for Viral Music Activity



4

DIY .PAD

Shattering the Stigma
about Menstruation

DIY .PAD

While the stigma has diminished in many locations around the world, menstruation is often viewed as a taboo subject. In fact, there are still some places in the world where people who menstruate are shunned and isolated for the duration of their menstrual cycles, which prevents them from going to school or work. Your challenge is to design and create an eco-friendly, cost-effective menstrual pad for people who menstruate.

TIME
90 minutes

DIFFICULTY LEVEL – 2

MATERIALS

Cardstock/foamboard/paper
¼ yard of cotton flannel/cotton fabric per group, or individual (different fabric patterns allow for creativity)
Scissors
Sewing needles
Thread
Sewing pins (optional)
Velcro patches and/or sew-on snap fasteners
Measuring tape/ruler
Pens/pencils
Paper
Tablet/computer (optional for designing/researching purposes)

The Ambitious Challenge

How might we increase the freedoms and opportunities for women and girls through the creation of homemade menstrual pads?

What is the History of Menstrual Products?

If possible, read this section aloud to your entire Club prior to starting the activity.

Though half the population have been menstruating since before humans officially evolved as a species, there is little documentation about the menstrual cycle among ancient society. A variety of materials were used to absorb menstrual flow: papyrus in Egypt, lint-wrapped wood in Greece, and wool in Rome. Other materials that were readily available, like moss, animal skins, and grass, may also have been used.[14]

In medieval times, there was still little documentation about products used by women on their periods. However, it is generally concluded that, "...aside from using rags or other absorbent materials on occasion (hence the term "on the rag"), many medieval European women simply bled into their clothes." [15]

Since the mid-1800's to present day, a multitude of menstrual products emerged. Products such as sacks and bandages as well as contraptions made of springs, wires, and buttons were created, many of which never made it to the consumer market. The Hoosier sanitary belt was one such contraption that allowed people who menstruate to wear washable pads that were attached to the belt. The first commercial and disposable menstrual pads were Lister's Towels developed by Johnson and Johnson in the 1890s. Around the time of World War I, many nurses realized that the bandages used on soldiers were more absorbent than cotton. The company Kotex (a combination of the words "cotton" and "texture") debuted their disposable pads in the 1920s; however, the products still required the use of a belt to hold them in place. The first reusable menstrual cup and tampon were introduced in the early 1930s. The company Tampax began in 1933 with the patent for the first tampon. The Hoosier belt was phased out by the 1980s with the introduction of adhesive strips to menstrual pads. Currently, there is a growing market for absorbent panties, which negates the need for an extra product entirely.

The most common products used by women today are tampons and pads, though menstrual cups are making a comeback. The choice to use menstrual cups is benefitting our environment and your finances. Don't know where to start? Take the Menstrual Cup Quiz [16] and then head over to Reusable Menstrual Cups and check out their reviews and product comparison charts. [17]

It is important to note that many products and associated times are location-specific. Thousands of women in underdeveloped areas within different countries still use simple rags, newspaper, or even husks and leaves as menstrual products.

Warm-up Mini-Challenge Opportunity

Ponder these questions: What have your experiences been with menstrual cycles? How does your menstrual cycle affect your life?

This may seem like a very taboo subject, but it happens to everyone who menstruates! Talk it over with your Club members, discussing things such as: how you learned about them, what products you use, what you think about them, etc. If members of the group do not feel comfortable openly expressing their thoughts, pose a question to the entire group and have them write anonymous answers, collect them, and discuss together. The Club Leader can also be the moderator to help move the discussion forward.

It is ok to feel embarrassed to discuss this subject, but there is no need. Who knows, you all may have had very similar experiences, and you may even help each other answer some questions!

How are other girls around the world affected? Take a look at the article "Around the World in 28 Periods" [18] to learn about other women's experiences. "There are still places in the world where women miss out on opportunities, are denied access to school and jobs, and in some cases, become a man's property the moment her first cycle begins."

Learn More:

14 History of Feminine Hygiene Products: (bit.ly/2KLpQ6l)
15 A Brief History Of The Menstrual Period: How Women Dealt With Their Cycles Throughout The Ages: (bit.ly/2lEa6Sd)
16 Menstrual Cup Quiz: (bit.ly/2rYWlC6)
17 Reusable Menstrual Cups and check out their reviews and product comparison charts: (bit.ly/2s1Omc0)
18 Around the World in 28 Periods: (bit.ly/2lY6kql)

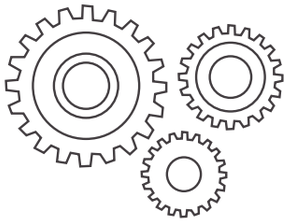
Ready? Let's Begin:

Step 1: Brainstorm - As a group, think about the different products you have used during your menstrual cycles. Here are some questions to get you started:

- Do you use tampons or pads?
- Have you tried both?
- Have you tried alternative products?
- What materials are these products made of?
- How many do you use in a month?

How many (potentially) do all girls use during a lifetime? What kind of impact does that have?
Can you design and create a more eco-friendly, cost-effective menstrual pad for girls and women to use?

Step 2: Research & Collect Data - It's time to discuss the pros and cons of menstrual pads. Discuss with your Girl Up Club members: How are current menstrual pads designed? What have your experiences been with them?



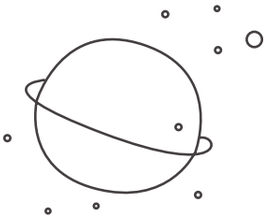
THINK ABOUT IT

Can you devise an efficient and effective way to address each type of flow in one pad?

After the discussion, split into groups of two (or work independently!). Begin discussing the details of how your cloth pad prototype will look and work.

Here are some questions to get the creative juices flowing!

- What age will you design your pad for?
- How will you address the different flow types in your design? How will you address a light flow? A heavy flow?
- What shape will you use for the pad?
- What dimensions will work best for comfortability?
- Will you make a one-piece pad or a two-piece pad (holder and inserts)?



DID YOU KNOW?

There are many countries around the world that tax menstural products as "luxury items." This Pink Tax is the extra amount charged to personal care products and services directly affecting women. Does your country or state have a tax on menstrual products? How does this impact girls and women? (bit.ly/PinkTAX)

TAKE ACTION!

Send letters to your local politicians (or another country's or state's if yours does not tax menstrual products) to lobby for tax reform,

Step 3: Design - Begin drawing up the design of your group's pad based on the information from the research phase using the cardstock, foamboard, or paper. Not sure where to start? Take a look at a pad template from simplelifemom.com[19] (The larger template is for the two outer layers and the smaller template is
for the layers in between.)

Other aspects to consider:

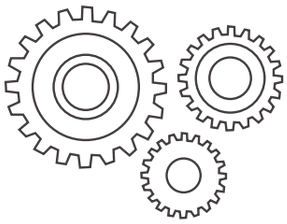
- How will you design it so that the pad doesn't move?
- What type of flow or time of day will you design your pad for?
- Consider designing waterproof pad holders to carry in case of necessary switches as well.
- What sewing technique will you use? Remember to account for seam allowance when hand-sewing.

New to sewing? Check out these handy sewing tips!

- Basic Sewing By Hand Tutorial [20]
- Hand Sewing Basics: Tools & Techniques [21]

Learn More:

19 Pad Templates: (bit.ly/2ICEjW4)
20 Basic Sewing By Hand Tutorial: (bit.ly/2rYtcwc)
21 Hand Sewing Basics: Tools & Techniques: ((bit.ly/2s2EYpl)



THINK ABOUT IT

Want to try a method other than sewing? There are many options out there! Some options include using: bonding tape, fabric glue, and fringe-tying!

Step 4: Create - After completing the design, make a prototype of your cloth pad. Using the template from the design, measure and draw the outline of each piece needed for the completed pad and sew the pieces to create the product. Remember to sew on the Velcro or buttons, too!

Step 5: Share - Regroup as a whole to present each group's prototype. Discuss similarities and differences amongst designs. Are there certain aspects that are creative and effective? How would you combine efforts to create another prototype that addresses more needs? Share pictures of your process and final product with your Girl Up Club as well as the rest of the Girl Up Community!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take some time to explore what other girls have created as well!

Helpful Hints to create a more effective pad:

- Higher quality fabric equates to a longer life for your cloth pad.
- Whatever fabric you use, make sure it is 100% cotton as artificial fabrics will cause you to sweat.
- Wash the fabric before creating the pad to avoid shrinkage.
- Be sure to rinse the fabric in cold water after use. It is then safe to clean with other laundry.

STEM SPOTLIGHT

THE DIY .PAD

Claire Coder is the founder and CEO of **Aunt Flow**. After getting her period unexpectedly in public without the supplies she needed, she decided she was going to start a company to ensure everyone has access to these necessary products. Toilet paper is offered for free, why aren't tampons? ® At age 18, she left college to start her company. Aunt Flow stocks over 100 businesses with freely accessible menstrual products. Do you think your school should stock tampons and pads in the bathrooms? Contact support@auntflow.org to get started!

People helping people. PERIOD.

What Now?... Learn More!

- **Menstrual Hygiene Day** (menstrualhygieneday.org)
  Learn about the global platform that raises awareness of the challenges women and girls world wide face due to their menstruation and highlights solutions that address these challenges.
- **How Periods Affect Potential** (ti.me/2m6Xzux)
  Read an article about the reality some girls face because they are unable to attend school during their cycles.
- **Period Myths** (bit.ly/2J3yUH3)
  Discover what people thought (and still think!) around the world about menstruation and what girls and women had to endure during their periods.
  5 Things to Know About Menstrual Hygiene Around the World (bit.ly/2mmx8Ex) Read about some of the key issues surrounding menstrual hygiene management.

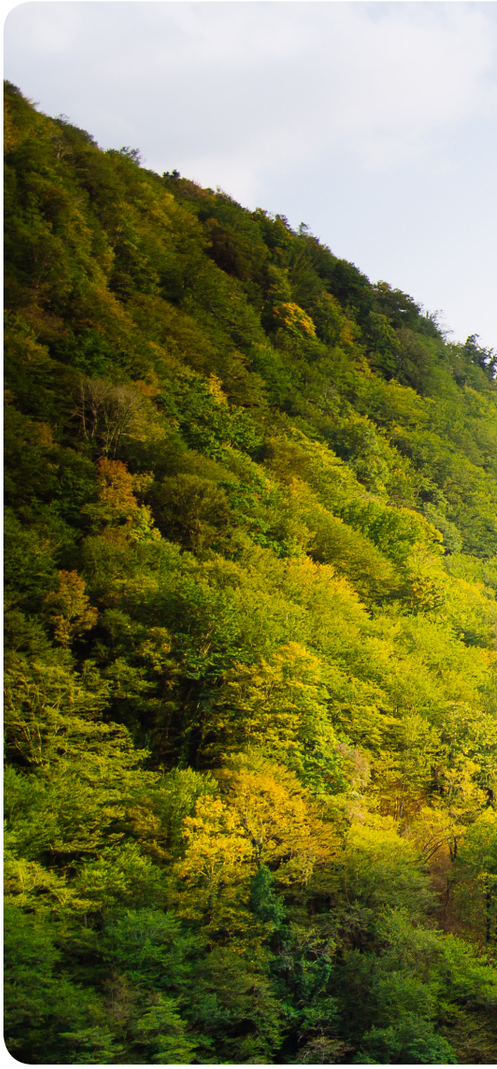
5

BIORECYCLING

Improving Our Earth and Inspiring Girls through Composting

BIORECYCLING

Many countries lack a reliable source for food available to its citizens. This obstacle presents a health issue to girls who are unable to receive proper nutrition. Do you know where your food comes from? With the ever-growing population, the acquisition of different foods including crops for fruits, veggies, and grains can be improved by different agricultural methods, particularly ones that are sustainable and environmentally-friendly. In this activity, you will learn about recycling and the carbon cycle through composting. By designing and creating a compost bin prototype, you will also learn about how to diminish food waste and generate fertile material to encourage the production of more crops.



TIME
90 minutes

DIFFICULTY LEVEL – 4

MATERIALS

Paper
Pencils/pens
Work gloves
Bins/containers, various sizes
(Upcycled if possible)

Wood pallets, various sizes (Upcycled if possible)
Drill (Adult supervision required if under 18 years of age)

Optional: computer for graphic design

What is Composting?

Decomposition is a process during which microorganisms break down complex organic matter into its basic elements. Though it cannot be seen, these microorganisms consume oxygen and release carbon dioxide and heat into the atmosphere as a result. Composting takes advantage of this natural process to create nutrient-rich fertilizers to assist in the production of new organic material, such as vegetables, fruits, and other plants.

The Ambitious Challenge

How might we alleviate or improve insufficient nutrition or food waste in our community or in other locations around the world?

In order to reduce waste, people have begun using compost bins to collect In order to reduce waste, people have begun using compost bins to collect organic materials that are no longer needed. A compost bin is an outdoor or indoor container in which garden refuse and other organic waste is deposited in order to produce compost.

Warm-Up Mini-Challenge Opportunity!

Ponder this question: What materials can be recycled?

Work with your Girl Up Club members to make a list of different items that can be recycled. Try to categorize them according to material.

Now, think about how materials are recycled in nature. What happens to organic waste?

Discuss what happens to materials when they break down naturally. What is the process? Why is it important? What would happen if organic materials did not decompose?

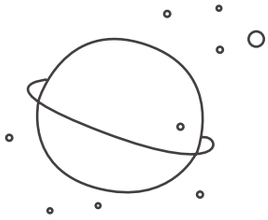
Ready? Let's Begin:

Step 1: Brainstorm - Talk with your Club members about the advantages and disadvantages to composting.

Can your Club design and create a prototype of a compost bin for your organization or school? Discuss with your Club members some important questions that will need to be addressed before designing and making a compost bin. How big of an impact do you want to make?

Examples of questions to think about:

- What size/shape should the compost bin be?
- Should there be multiples bins?
- What type of weather will the bin be subject to?
- What materials should the bin be made of?
- Where would you place the compost bin?



DID YOU KNOW?

Composting helps soil hold or sequester carbon dioxide. In addition to emission reductions, compost replenishes and revitalizes exhausted farm soils by replacing trace minerals and organic material, reduces soil erosion and helps prevent stormwater runoff. Recycling is an effective way to reduce greenhouse gases.

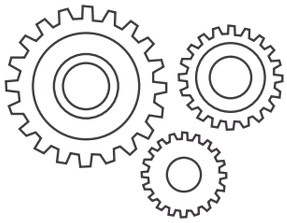
Step 2: Research & Collect Data - Now that you have an idea of what the bin may look like and where it might go, it is time to think about what you would compost. In order to compost properly and efficiently, there needs to be a balance of carbon- and nitrogen-rich materials, or "brown" and "green" materials. Having the right ratio of brown and green materials helps the microbes and speeds up the process of decomposition.

Examples of questions to think about:

- What are some organic materials that can be composted?
- Where might you obtain these organic materials?
- Is there more of an abundance of some organic materials over others in your area?
- How can you balance the "brown" and "green" waste in your compost bin?

STEM CONNECTION

Environmental engineers mimic the natural carbon cycle in many processes, often designing systems that process carbon faster than would occur in nature. Anaerobic digestion (which turns human or food waste into methane gas) and biofuel production (such as fuels from corn, sugarcane and algae) are excellent examples of using the carbon cycle to generate energy from waste. (bit.ly/2tl0gPA)

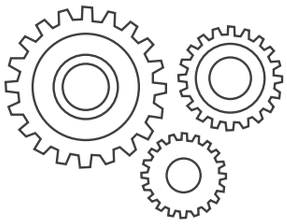


THINK ABOUT IT

How do you take care of a compost bin? How does it need to be layered? How often does it need to be aerated? When can the composted material be used?

Step 3: Design - Using the answers from the brainstorming questions and what you have researched, draw (or design on a computer) a blueprint of the compost bin with your Club members. Be sure to include materials used, dimensions, and a possible location in addition to other elements.

One important component that makes composting successful is having enough oxygen and air flow to properly allow the decomposition process to occur. How will you ensure that your bin is properly aerated? Make sure your design allows for free air and liquid flow. Consider the types of organic waste that will be added to the compost to decide what size the holes should be.



THINK ABOUT IT

Consider creating the full-scale version of your compost bin design during another Club session! Reach out to the community for supplies!

Another aspect to consider is protection. How will the compost bin be protected or how will others be protected from it? Think of these questions and more as you draw your blueprint.

Step 4: Create - Once each Girl Up Club member approves of the design, begin construction on a prototype. Safety first! Be sure that everyone involved in the construction has appropriate safety gear and that each member of the group understands their role.

Step 5: Share - At the completion of construction for your prototype, talk with the other Girl Up Club members about how to share your new compost bin. You can discuss drafting a proposal on how to incorporate composting to your school, organization, or community!

Finally, snap a photo of your new compost bin with your Girl Up Club and put it on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the amazing compost bins made by girls just like you around the world!

Helpful Hints:

- Depending on your location, it may prove more beneficial to have a wooden bin or a trash can with a lockable lid.
- Dried lawn clippings are great for compost bins. However, be sure to check if they have been treated with harmful chemicals or pesticides before adding them.
- Avoid meat scraps, bones, dairy, and meat-eating animal/human droppings. These materials attract pests and make the compost putrid. While not good for home composting, industrial composting facilities can take these materials.
- Check with your school cafeteria to see if fruit or vegetable food scraps could be donated to help start your compost bin!

STEM SPOTLIGHT

BIORECYCLING

Native to Cameroon in Africa, **Patu Ndango Fen** is the founder and managing director of **Closed-Loop System Ventures**, a social enterprise that deals with the collection of organic waste from various sources such as households, markets, restaurants and farmlands and its eventual transformation into organic fertilizer.

> *"I have always had a burning desire to impact my country and Africa at large in the struggle against environmental degradation. This burning desire justifies my chosen academic and career path. It equally justifies my involvement in various environmental associations, projects, and activities."*

Read more about Patu's journey here: bit.ly/2GHU87M

What Now?... Learn More!

- **The Composting Council** (compostingcouncil.org)
  Learn more about the national organization dedicated to the development, expansion and promotion of the composting industry.
- **EPA - Reducing the Impact of Wasted Food** (bit.ly/2ee1pye)
  Information from the United States Environmental Protection Agency (EPA) about composting
- **Biogas** (bit.ly/2x2ELr9)
  Take it a step further and learn how you can use the gas produced from the decomposition process of composting.
- **Homebiogas** (bit.ly/2kh9nfu)- Video
  Explore a product that is currently available on the market for commercial sale that is already making a difference around the world.
- **Environmental Benefits of Recycling and Composting** (bit.ly/2Gt2i5A)
  Learn about the negative impact our waste makes and how we can change it to a positive impact with recycling and composting

6

PROTECT OUR POTENTIAL

Empowering Our Minds and Bodies through Self-Defense

PROTECT OUR POTENTIAL

Violence against girls and women is a worldwide pandemic that affects roughly 1 in 3 females during their lifetime. "Violence against girls and women can appear differently and in different locations around the world, which can make it difficult, especially for the victim, to identify." [22] The United Nations defines violence against women as "any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life." [23]

TIME
90 minutes

DIFFICULTY LEVEL – 3

MATERIALS

Video camera (Phone/tablet/etc.)
Paper
Pens/pencils
Props (optional)
Computer (optional for research/editing)

Not only does this violence affect the victim, but it also has serious consequences on social and economic issues. One solution is promoting access to "safe spaces" for girls and women. "Safe spaces" are physical or non-physical places intended to be free of bias, conflict, criticism, or potentially threatening actions, ideas, or conversations. Sometimes, even safe spaces aren't enough.

The Ambitious Challenge

How might we utilize the engineering design process to better prepare girls to defend themselves should a situation arise through the creation of a video PSA?

Why Should I Know Self Defense?

Violence against women – particularly intimate partner violence and sexual violence – is a major public health problem and a violation of women's human rights. Violence against women includes but is not limited to:

- Gender-based violence
- Rape, marital rape and incest
- Forced marriage
- Human trafficking including cross-border prostitution rings and bride kidnappings
- Female genital mutilation
- War crlmes including rape as a weapon of war
- Murder and assault including dowry-related violence and honor killings (cited from Statistics and Facts on Violence Against Women) [24]

Below are some statistics about violence against girls and women around the world.

- Global estimates published by the World Health Organization indicate that about 1 in 3 women worldwide have experienced either physical and/or sexual intimate partner violence or non-partner sexual violence in their lifetime. (cited from World Health Organization Report on Violence Against Women). [25]

- It is estimated that of all women who were the victims of homicide globally in 2012, almost half were killed by intimate partners or family members, compared to less than six percent of men killed in the same year. [26]

- More than 1 in 4 women in Washington DC, United States, have experienced some form of sexual harassment on public transportation, according to a survey conducted in 2016. [27]

- Worldwide, almost 750 million women and girls alive today were married before their 18th birthday. Child marriage is more common in West and Central Africa, where over 4 in 10 girls are married before age 18, and about 1 in 7 are married or in union before age 15. Child marriage often results in early pregnancy and social isolation, interrupts schooling, limits the girl's opportunities and increases her risk of experiencing domestic violence. [28]

- Around 120 million girls worldwide (slightly more than 1 in 10) have experienced forced intercourse or other forced sexual acts at some point in their lives. By far the most common perpetrators of sexual violence against girls are current or former husbands, partners or boyfriends. [29]

- At least 200 million women and girls alive today have undergone female genital mutilation in the 30 countries with representative data on prevalence. In most of these countries, the majority of girls were cut before age 5. [30]

- Approximately 1,500 acid attacks are recorded worldwide annually. Bangladesh, India, Pakistan, Nepal, Cambodia and Uganda are countries with the highest reported incidence. More than two-thirds of recent victims in the U.K. are men. But globally, 80 percent of acid attack victims are women and girls. [31]

Warm-Up Mini-Challenge Opportunity

Ponder this question: If, on your way home today, you were approached by someone in a threatening way and needed to physically defend yourself, what would you do?

Think silently to yourself for a minute or two before discussing amongst your Club members.

This is a very real threat that anyone can face at any time, especially girls and women. Have you ever been in a situation where you needed to defend yourself? What was the situation and your response? If you feel comfortable doing so, share experiences you may have had with the rest of your Club.

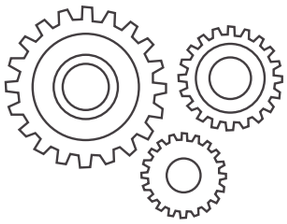
Ready? Let's Begin:

Step 1: Brainstorm - First, discuss what you think you know about self-defense situations. What is needed in a self-defense situation? Talk with your Girl Up Club members about items that they think they will need if confronted with a threatening situation.

Next, watch some of the videos of Lina Khalifeh's work with SheFighter: Global Leadership Awards 2018. [32] Because I'm a Fighter! TED xTalk, [33]and Defensive Techniques with SheFighter. [34] Discuss the different methods of defense utilized in the videos. Analyze the defensive strategies shown. What did you notice about them? Does this change your concept about what might be needed in a self-defense situation?

Learn More:

22 The World Bank: (bit.ly/2LkTfFV)
23 Declaration on the Elimination of Violence against Women, 1993. (bit.ly/2IChFZL)
24 Statistics and Facts on Violence Against Women (bit.ly/2kfcFQ5)
25 World Health Organization Report on Violence Against Women (bit.ly/2IYa773)
26 UN Women Report on Facts and figures: Ending Violence Against Women: (bit.ly/2KNioYJ)
27 UN Women Report on Facts and figures: Ending Violence Against Women: (bit.ly/2KNioYJ)
28 UN Women Report on Facts and figures: Ending Violence Against Women: (bit.ly/2KNioYJ)
29 UN Women Report on Facts and figures: Ending Violence Against Women: (bit.ly/2KNioYJ)
30 UN Women Report on Facts and figures: Ending Violence Against Women: (bit.ly/2KNioYJ)
31 The Conversation--Acid attacks are on the Rise and Toxic Masculinity is the Cause: (bit.ly/2KKXDNv)
32 SheFighter: Global Leadership Awards 2018: (bit.ly/2s0fl20)
33 Because I'm a Fighter! TED xTalk: (bit.ly/2IClpKN)
34 Defensive Techniques with SheFighter: (bit.ly/2IYqa4U).



THINK ABOUT IT

What is a PSA? A PSA stands for Public Service Announcement. The goal of a PSA is to change public opinion and raise awareness for a problem. The goal of a PSA is to educate first and provoke a feeling and reaction that will cause viewers and listeners to respond.

Can you create a self-defense PSA video to help encourage and empower girls and women to defend themselves against violence?

You can choose to break up into groups for a variety of videos, or all work together on one video. Keep in mind that everyone needs to serve a purpose, which may be easier done in smaller groups.

Step 2: Research & Collect Data - Now that you have discussed the prevalence of violence among women and the importance of self-defense, it is time to explore what components your video PSA might include.

What kinds of threatening situations might you run into in your area? Research some occurrences of assault in your area. Check local newspapers and local news websites for articles. Also, think about instances you have heard about in class, on the news, or in conversation; not just locally but around the country or world. What information do you learn about the perpetrator; the victim? Is there any correlation in what you have learned and what you already perceived to be true?

Discuss with your group members what approach you wish to take with your video.

Step 3: Design - Using the information from brainstorming and researching, choreograph a self-defense scene. Decide the roles of the people in the group. Not everyone needs to be in the video; there are multiple "behind-the-scenes" roles like special effects, editors, and researchers. Remember, PSAs are educational messages intended to persuade viewers to change their attitude through persuasion and facts, so be sure to include appropriate language to make your point very clear!

Making a video is just like writing an essay or book. What message do you wish to convey? Will you use urgency, humor, or something else? Be sure to also discuss the style, tone, and perspective your group will use.

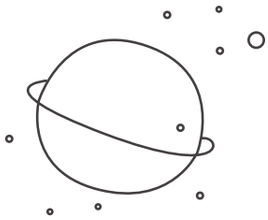
Other things to consider:

- Will you use bright or dark colors?
- Will you use graphics?
- Will you include sound effects or music?
- How can you evoke the emotions you wish to convey?

Because viewers are either "hooked" or not in the first few seconds of a PSA, try to keep your entire video to under 30 seconds.

STEM CONNECTION

Looking for patterns and recognizing similarities are effective ways to evaluate and understand results.



DID YOU KNOW?

Physical assaults against individuals aren't always executed by strangers; many are, in fact, performed by someone the victim actually knows.

TAKE ACTION!

Share the PSA with your principal, school board, or president and find out if they are able to advertise it for all the students in the district and/or college.

Host a free workshop teaching others quick, effective methods for self-defense.

Once you have a general idea and outline, storyboard the film. Storyboarding helps bring together the shots, script, and text on paper. After planning out your storyboard, test the mechanics by doing a run-through of the scenes.

Step 4: Create - Once the group feels ready, film the scenes of your choreographed self-defense. It is okay to film multiple times! Edit the film as necessary and add the text and/or graphics. Once you have completed the video, watch it to make sure your video is relevant and compelling for your audience.

Step 5: Share - Congratulations! You are ready to share your finished PSA! Share your video with the rest of the Girl Up community on social media.

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtags: #STEM4SocialGood and #safespaces

Take time to explore some of the great self-defensive choreography and PSAs made by girls just like you around the world.

Helpful Hints:

- Not flexible? No problem! Don't choreograph an elaborate routine with kicks and spins if you cannot physically do it. Work to your strengths!
- Try different angles and perspectives when filming! It provides for a more stimulating visual to the audience.
- Your video does not need to be filmed in one shot. In fact, filming multiple takes (and from multiple angles) provides depth and character. It also allows you to piece together the best video.
- The Ad Council distributed three excellent examples on raising awareness on sexual harassment in the workplace called #ThatsHarrassment. Try watching some effective PSA videos for ideas! (bit.ly/2khhoB3)

STEM SPOTLIGHT

PROTECT OUR POTENTIAL

After experiencing an act of violence, **Rana Abdelhamid** founded **Women's Initiative for Self-Empowerment (WISE)** at 16 years old. The goal is to inspire a network of young Muslim female leaders to become catalysts for the advancement of their communities and the world. Through leadership, self-defense, and social entrepreneurship trainings, WISE strengthens the skills of young women to overcome violence and become ambassadors for female empowerment. Watch this video to see Rana in action! - Muslim Women Learn to Fight Back (bit.ly/2kghqsT)

"Our model is focused on providing tangible skills to young women so that they can become their own advocates for social change."
- Rana Abdelhamid, Founder

What Now?... Learn More!

- **Visual Data of Inequality with Women** (bit.ly/2kghNUj)
  Delve deeper to discover some visual representations of some of the statistics regarding the inequality surrounding women from a variety of different facets including income and violence.
- **R.A.D. Programs** (rad-systems.com)
  Look into R.A.D. (Rape, Aggression, Defense) classes. These are for women and men of all ages and are international. You can also do a simple google search to find something similar where you live.
- **Basic Self-Defense Moves** (bit.ly/2ATsxzd)
  Read through the informative article and view a variety of videos that showcase some basic defensive
- **Capoeira** (bit.ly/2KK86IQ) (video)
  Capoeira is a Brazilian martial art that combines elements of fighting techniques, dance, acrobatics, and music. It was developed in Brazil mainly by African descendants with native Brazilian influences.
- **Krav Maga** (bit.ly/2lHbq78)
  Krav Maga (pronounced "krahv mahGAH") is an effective, modern, and dynamic self-defense and fighting system. It is designed to be practical and intuitive for people of any age, shape, or size. Learn how to defend yourself and your loved ones, while gaining increased awareness and instinctive reflexes.
  Read an article and watch a video here (ind.pn/2HflbIB) about some particularly effective techniques for women.
- **SheFighter** (shefighter.com)
  Learn about Jordan's first self-defense academy founded by Lina Khalifeh.
- **Jordan's First Self-Defense Academy For Women Wants To Fight Domestic Abuse** (bit.ly/2s5aUsr)
  Read an article about the origins and mission of SheFighter.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7

LIGHT IT UP!

Generating Ideas and Enlightening
Our Understanding of Electrical Circuits
by Mapping Inequalities

LIGHT IT UP!

How can we enlighten the world about the differences between the lives of women and men globally? How might we better highlight how important gender statistics are towards advancing gender equality?
In a world filled with gender inequalities, we need relevant and reliable gender statistics as well as storytellers and creators who draw attention to pressing issues around the world.

TIME
90 minutes

DIFFICULTY LEVEL – 4

MATERIALS

Copper/Conductive Tape (¼ inch width)
Or Aluminum foil
Clear tape
3mm or 5mm LEDs (bulk pack of ~100)
Paper (colored, construction, scratch)
Pen/pencil, Markers
Paper
Coin cell batteries (3V)
World Map with country names
Simple Circuit and Parallel Circuit templates
Statistics for girls and women

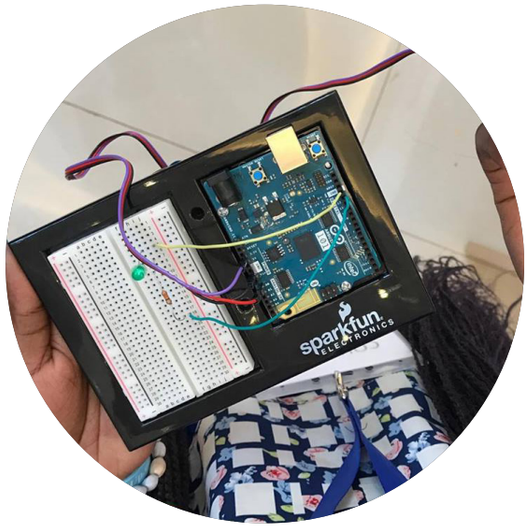
The Ambitious Challenge

How might you design and construct a working circuit and use that knowledge to design a map that would "illuminate" the inequalities that girls and women face?

What is a Circuit?

Ever wondered what happens when you flip a switch or press a button to turn on a light, the TV, a vacuum, a computer, etc.? How does a device go from being "off" to "on" by flipping a switch? Every time you flip a switch, or press a button, you are connecting and closing the path of an electric **circuit**, allowing a current of electrons to flow through the wires. Just like the arteries in your circulatory system carry blood throughout your body, the wires of a circuit carry electric currents to various parts of an electrical system. Similar to how your heart produces the pressure to pump blood throughout your body, the power source or **battery** of a circuit produces the pressure to push the electrons through a circuit. This force is called **voltage** and is measured in volts (V). The rate at which the electrons flow through a circuit is called current and is measured in amperes or amps (I). Like the flow of blood is sometimes hindered by the size of the vessel or artery it is traveling through, so is the flow of electrons through a circuit as the electrons bump into the walls of the wire. This is called **resistance** and is measured in ohms (Ω). The amount of resistance depends on a variety of factors including the material used, the diameter, and length of the wire.

Ohm's Law is a fundamental mathematical equation in circuitry and deals with the relationship between resistance, voltage, and current. The flow of electrons (current) is like the amount of blood flowing through your veins. When the walls of your veins are smaller or close in due to plaque (resistance), it makes it more difficult for the blood (current) to flow. Blood, and electrons, will always be directed towards the path of least resistance, so if there is a path that offers less resistance, the electrons will go that direction to complete the circuit. Therefore, as resistance increases, current decreases and vice versa.



There are different types of circuits. A **closed circuit** is one in which the path for the electrons is complete while an **open circuit** is one in which the path for the electrons is broken or incomplete. In order for a circuit to work, it needs to be closed. Open circuits often use switches that, under the right conditions, can close and complete the circuit. This is how appliances and light switches work. A **series circuit** is one in which the same current flows through all components and there is only one pathway. The total voltage and resistance is additive of each component. An example of this is a string of Christmas lights; if one light burns out, the others will not light because the flow of electrons has been broken. A **parallel circuit** includes multiple pathways and differences in current depending on the resistance of each pathway. An example of this is an outlet. It provides the same amount of voltage to all items plugged into it, but if one socket of the outlet doesn't work, the other one still works because the electrons can be redirected and still flow to complete the circuit.

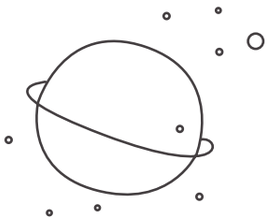
Warm-up Mini-Challenge Opportunity

60 second challenge! Look at the materials provided. Can you make a simple circuit with an LED (Light-Emitting Diode) in under a minute?

Treat the materials with respect – you'll still need them for the rest of the challenge. Have everyone attempt this challenge at the same time to see who can create a secure and sustained connection the fastest.

Topics for discussion: What materials did each member use? What components are necessary to create a complete circuit? Did anyone add anything "extra"?

Have everyone take a coin battery and an LED to create a circuit. Which leg (or "lead", pronounced with a Long E sound) of the LED needs to be in contact with the positive side of the battery to complete the circuit? Try multiple LEDs on the same battery. What do you notice and what can you conclude about it?



DID YOU KNOW?

LEDs have many advantages compared to incandescent and fluorescent light sources. LEDs are smaller, more versatile, more powerful, consume less energy, and are longer-lasting.

Discuss with the rest of the group about the sustainability of LED light sources and how they compare. How are these light sources beneficial and how might they benefit underdeveloped areas around the world?

LEDs are not only used as necessary light sources, but they can also be used to enhance creations and inventions, making them really "pop"! Can you design and create a circuit using a paper overlay that promotes the idea that every girl counts? How can you visually represent gender inequality statistics using a map of the world?

Ready? Let's Begin:

Step 1: Brainstorm - Discuss as a whole group: How are girls and women represented in your country? Who decides which stories get told about the lives of girls and women? Who benefits? How will your answers inform your group in Steps 2, 3, and 4?

THINK ABOUT IT

All LEDs and batteries have a positive and negative side. It is important that all sides are lined up correctly or the electrons will not be able to flow all in the same direction and complete your circuit.

Step 2: Research & Collect Data -

A. Break off into groups of two or work individually. Continue in your research by learning about the mechanics of the type of circuit you would like to create. Are you going to create a series or parallel circuit? Could you make multiple circuits? How many LEDs will you use? Does it matter which LEDs you use? Try experimenting to see which works best for you. If you're not sure how a circuit is made with copper tape or aluminum foil, take a look at a simple circuit template design (bit.ly/2LnjYBB) and parallel circuit template design (bit.ly/2KLEUkC).

B. If you're up to using your super sleuthing Internet skills, find a world map with country names (or use one of the maps provided at the end of this document) to use for mapping inequalities.

C. Now it's time to pick one set of statistics (found at the end of this document) to use with your world map. It will act as an overlay, something laid as a covering over something else. Remember you are going to design a map that will "illuminate" the inequality of girls and women in the world.

Paige Kassalen, recognized by Forbes as one of the "30 Under 30" young leaders in the energy sector.

Step 3: Design - Now that you have become familiar with a set of statistics, you can combine the information with the type of circuit (series, parallel, or a combination of both) you want to build. What will your map focus on? How many lights will you have? How much power will you need? Begin drawing up the blueprints of how your circuit will look with your map. The drawing that you create of the circuit layout is called a "schematic". A schematic is a symbolic and simplified diagram or representation. Schematics are our map to designing, building, and troubleshooting circuits. Understanding how to read and follow schematics is an important skill for any electrical engineer.

See Appendix Figures 7.1 and 7.2 for an example of how to map inequalities and a map template!

Step 4: Create - As you are creating the design you drew, make some observations. Are all the lights working? Is each color of LED lighting up? If you wanted to, how could you make the LEDs brighter?

Remember, in order to maintain the electrical current, a strong mechanical connection is required, meaning there can be no breaks in the circuit (except for the switch) and all components must be connected. The more surface touching, the better. In what ways can you or your group achieve this? How might your battery be positioned?

Step 5: Share - Once everyone's design is created, share them with the other groups. Explain what each creation represents about the state of girls and women around the world, and how you built your circuit. Take pictures of the process. Now that you have created a circuit and overlay related to some of the statistics provided regarding gender inequality, how could you take it a step further? What statistics and facts would you be interested in representing in a circuit and overlay as they relate to girls and women? How can you use what you have learned in this activity and apply it to your community? Discuss these points as a whole group. You are only limited by your imagination!

DID YOU KNOW?

In large-scale circuits (ones that use a more powerful energy supply), a current-limiting resistor is a MUST. However, the coin cell battery of this challenge has a maximum current output that is within the safe operating current range of the LED, so a resistor component is not necessary!

LED Color	Voltage
White	**3.2 V to 3.8 V**
Warm White	**3.2 V to 3.8 V**
Blue	**3.2 V to 3.8 V**
Red	**1.8 V to 2.2 V**
Green	**3.2 V to 3.8 V**
Yellow	**1.8 V to 2.2 V**
Orange	**1.8 V to 2.2 V**
Pink	**3.2 V to 3.8 V**
UV	**3.2 V to 3.8 V**

Finally, snap a photo of your completed circuit with accompanying overlay and put it on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the amazing LED circuit creations made by girls just like you around the world!

See Appendix Figures 7.3 and 7.4 for bar charts on the best places to work as a woman and top cities for female entrepreneurs. See **Figure 7.5** for an example of a parallel circuit and **Figure 7.6** for a simple circuit.

STEM SPOTLIGHT

LIGHT IT UP!

Paige Kassalen is a graduate of Virginia Tech University with a degree in Electrical Engineering. She was honored with the opportunity to work on two revolutionary projects; solar powered airplanes and autonomous vehicles. Ms. Kassalen's experiences with groundbreaking technology has given her a unique perspective and insight into the real-life world of innovation. Paige is an active, enthusiastic and passionate supporter of early and continuing education in science, technology, engineering, and math. She is proud to serve as a mentor and professional role model for young women who are pursuing careers in engineering and science. In 2017, at the age of 23, Ms. Kassalen was recognized by Forbes as one of the **30 Under 30 young leaders in the energy sector.**

"Shoot for the moon and land on it. You don't have to settle for the stars."
- Paige Kassalen

Read more about Paige at (paigekassalen.com) and about Paige's work with Solar Impulse: bit.ly/2LqDuxl

What Now?... Learn More

- **Pu Gong Ying Tu (Dandelion Painting)** (bit.ly/1FYFnlC) (video)
  Pu Gong Ying Tu is an interactive painting of a dandelion field created by Jie Qi. When you blow on the white puffs, the seeds disperse and generate new flowers. These flowers begin as yellow dandelions, but after a few moments bloom into responsive white seed puffs.
- **"Ellie" circuit children's book** (bit.ly/2x3m9qR) (video)
  Explore the story of "Ellie" the LED to see some of the possibilities of combining programming and paper circuits with specialized components.
- **MakerSpaces** (bit.ly/2d1BZZ9) and **Chibitronics** (chibitronics.com)
  Great tools to blending the arts with electronics through paper circuitry.

8

SKIN DEEP

Better Living Through Chemistry

SKIN DEEP

Cosmetics are ubiquitous artifacts found around the world today and throughout human history. These products or substances are designed to enhance or alter one's hair, skin, body or appearance. According to the research found in the Cosmetic Skin Care Market: Global Industry Analysis, Trends, Market Size & Forecasts to 2023, the cosmetic skin care market is expected to grow between 4.7 % and 5.3 % from 2017 to 2023. To give you a sense of the value we're talking about, consider that this global market was worth $130.7 billion dollars in 2016. The report findings suggest an increasing trend toward natural products, demands for natural active ingredients based cosmetics, and a higher adoption of grooming products for young people.

TIME
90 minutes

DIFFICULTY LEVEL – 3

MATERIALS

Small plastic containers with lid
Microwaveable/stove-top-friendly bowls
Kitchen knives
Measuring spoons/cups
Blender/food smashing tool/"mushing" tool
Wooden spread sticks

Food ingredients:
Bananas
Avocado
Honey
Mint
Oatmeal/oatmeal soap
Vitamin E oil
Coconut oil
Tea tree oil
Apple cider vinegar
Sea salt
Argan oil
Castor oil
Shea Butter
Note Cards
Pens
Pencils
Microwave or hot plate

The Ambitious Challenge

How might you design and produce an ethical and sustainable skin care product that promotes health and beauty?

Chemistry and Cosmetics

It is a common misconception that "chemicals" are harmful and limited to substances created in labs. In reality, everything you hear, see, smell, taste, and touch involves chemistry and chemicals (matter). Hearing, seeing, smelling, tasting, and touching all involve intricate series of chemical reactions and interactions in your body. All matter is composed of various combinations of about 100 basic elements from the familiar oxygen or hydrogen to the lesser-known Rubidium or Thulium. Part of what makes chemistry so compelling is that when these basic particles are combined, they make something new and unique. For example, take sodium and chlorine. Sodium is a soft metal that will explode when met with water. Chlorine is a toxic, green gas. When combined, however, they form sodium chloride, or ordinary table salt, which does not explode when it meets water nor is it a toxic gas.

When elements are chemically combined and changed, physical characteristics of the elements involved are changed as well, and are often completely different.

How does this relate to cosmetics?

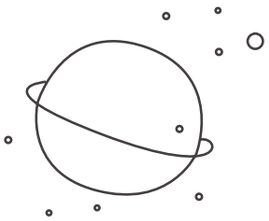
Cosmetics are made by combining chemicals to achieve a certain physical effect. Everyone has a unique chemical makeup and therefore, we all require slightly different compositions of substances to remain healthy on our outermost layer: the skin. However, most people fall into one of the five main categories for common skin types: oily, dry, sensitive, combination, and normal. Check out the information at the end of the activity to learn more about each skin type and the main classifications of personal care and cosmetic products.

Warm-up Mini-Challenge Opportunity

What does your Girl Up Club think beauty is? How do you define it? How does society define it? Type "beautiful woman" or "beautiful women" into your favorite search engine and find images. What did your group observe? How do your beliefs about beauty align or not align with the search engine results?

The Atlas of Beauty is a project created by the photographer Mihaela Noroc in which she traveled to over 50 countries in the past five years redefining what beauty means to her. You can find out more about the Atlas of Beauty by reading: Stunning photos capture what beauty looks like in over 50 different countries around the world [35] and checking out her Facebook page. [36]

How might you redefine beauty?



DID YOU KNOW?

The average person's skin covers an area of 2 square meters, and has about 300 million skin cells. A single square inch of skin has about 19 million cells and up to 300 sweat glands.

Ready? Let's Begin:

Step 1: Brainstorm - What is the largest human organ? Hopefully, you said the skin! Our skin is responsible for protecting us from the heat and cold. It acts like a filter, and protects our internal system from the outside elements. Our skin, at over two square meters long, renews every 28 days. It is in a constant state of shedding, dying off, and regrowth with 30,000-40,000 dead skin cells shed each minute. We must think of skin care as a lifelong process.

- Think of all the variables to consider for maintaining healthy and beautiful skin over one's lifetime. Keep track of all your ideas on paper.
- Think about the concept "sustainability" and sustainable practices.
    - The UN World Commission on Environment and Development defines sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."
    - Sustainable practices support ecological, human, and economic health and vitality.

How might you design and produce an ethical and sustainable skin care product that promotes health and beauty for all?

Step 2: Research & Collect Data - Before beginning the research and testing your product, it is important to understand what goes into it. There are many misconceptions regarding cosmetics. Watch "Are Natural Beauty Products Better?" [37] and discuss your thoughts amongst the Club members. Does this help you understand how you might want to design a skin care product?

Next, decide for whom you want to make your product. Perhaps you might want to design for someone in the Atlas of Beauty. What skin type are you aiming for? Also consider the type of environment the product will be subject to including weather, temperature, etc. Research some of the common skin types as well as what ingredients would be beneficial in improving the overall health of your chosen skin type. Remember the skin acts as a barrier to keep things out. Is it possible to know if your product is having any effect?

Learn More:

35 Stunning photos capture what beauty looks like in over 50 different countries around the world (bit.ly/2LleFmc)
36 Mihaela Noroc's facebook page (bit.ly/2LlfSKp).
37 Are Natural Beauty Products Better? by Lab Muffin Beauty Science (7:55) (bit.ly/2x0z50E)

From the ingredients you have available, decide which ones would work best to complement and improve the skin type you chose. By now, you know that certain ingredients are more beneficial than others to achieve your desired objective, but do you know why? It's the chemistry! The different chemicals that make up (no pun intended) the ingredients play a huge role in the effects of your skin. Take a look again at The Lab Muffin, [38] a blog created by female chemist, Michelle Wong, to learn more about the chemical properties of some ingredients in skin care products and why they work (Hyaluronic Acid, [39] Niacinamide, [40] Avenanthramides, [41] Vitamin C). [42] Also, take a look at the article, Understanding the Ingredients in Skin Care Products, [43],to read about how some of the main chemicals in products benefit our skin.

STEM CONNECTION

Engineers globally are governed by a code of ethics. They are expected to reflect the highest standards of honesty, integrity, fairness, impartiality, and equity. The products and services they create are to uphold the protection of the public's health, safety, and welfare. Moreover, they are also to protect the natural and built environment with sustainable practices.

Step 3: Design - Once you have decided on the skin type and understand the chemical components of your product according to the ingredients you wish to use, it is time to decide on the balance of each ingredient. Keep in mind what type of product texture you'd like. Scrubs are usually harsh on dry or normal skin types, but great for someone who often uses makeup on a more regular basis or for someone who is more heavily involved in physical activities. Whereas smoother textures usually do not benefit oily skin and instead may work better for dry skin. Also, keep in mind the consistency of your skin care product. Are you looking for more of a thick or thin texture? Will it be something that will blend and dissolve into your skin or will it be used to clean your skin and be washed off?

Not sure where to start? Take a look at Making Cosmetics [44] for some basic, tried-and-true cosmetic formulas as well as a comprehensive ingredient list. [45]

TAKE ACTION!

- After successfully testing a product, donate multiples to girls in need in your community
- Present a workshop where other girls outside of the Club can create their own products while also raising awareness about equality in beauty standards.

Step 4: Create - Once you have a chemical formula to your liking, test it out! How does it look? Do you like the way it feels? What does it smell like? Explore your creation through each sense (yes, even taste if you want!). Remember, the popularity of a product depends on its overall appeal. Try out different amounts of each ingredient to create the most ideal cream in your opinion. There will likely be a few iterations of this, and that is ok!

Step 5: Share - Once everyone had completed a product, share it with the rest of your Club. If there is time, create a sales pitch for your product, and hold a vote to see whose product would do well in the market. Finally, snap a photo of you with your ethical and sustainable skin care product and post it on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the sustainable products created by girls just like you around the world.

Helpful Hints:

- Get lots of feedback! Ask the other member of your Club if you are unsure about how something looks, feels, etc.

- Less is more! Don't feel like you need to include every single ingredient. Some of the best skin care products have only a few, simple ingredients.

- Still not sure about how chemistry connects to cosmetics? Take a look at How Do Moisturizers Work? [46] The Chemistry of Cosmetics, [47] and 7 Kinds of Makeup Chemistry. [48]

Learn More:

38 The Lab Muffin (LabMuffin.com)
39 Hyaluronic Acid (bit.ly/2wZK7na)
40 Niacinamide (bit.ly/2KNP9oT)
41 Avenanthramides (bit.ly/2rVvUCH)
42 Vitamin C (bit.ly/2GGKWAE)
43 Understanding the Ingredients in Skin Care Products (cle.clinic/2GFX19o)
44 Making Cosmetics (bit.ly/2IZaG0f)
45 Comprehensive Ingredient List (bit.ly/2KLA4UE)
46 How Do Moisturizers Work? (bit.ly/2x2YxTd)
47 The Chemistry of Cosmetics (bit.ly/2GFYfBw)
48 7 Kinds of Makeup Chemistry (bit.ly/2LIjw6U)

Skin Care 101: Important Information

5 Main Categories for Common Skin Types

Oily - Oily skin is characterized by shine and excess oil, blackheads or acne, and/or large, visible pores. Those with oily skin have more active oil glands and produce a higher amount of sebum, an oily substance created to help keep the skin soft and hydrated.

Dry - Those with dry skin may feel a tightness in the skin. There may also be scaly patches or flaking. Those with dry skin generally have almost invisible pores, and may suffer from premature wrinkles and regular irritation to the skin. Cracked skin, rough patches, and itching are indicators as well.

Sensitive - Those with sensitive skin can have one or more of the other skin types such as oily, dry, or combination, but are likely to have dry and flaky skin along with redness and irritation. Those with fairer skin are more likely to have the sensitive skin type because lighter skin can burn more easily and is more easily irritated due to changes in weather, chemicals, and other products.

Combination - Combination skin features two or more different skin types on the face, and typically presents with dry and flaky skin on portions of the face, with excessive oil on others. Many mistakenly believe they have oily skin when they, in fact, have combination skin type. Unless an individual's skin is oily all over, there are likely portions of skin that are dry or normal, which would qualify under combination skin.

Normal - Normal skin has a tone that is generally even with no noticeable blemishes. Normal skin is still subject to the same conditions and effects as other skin types such as acne or flakiness, it just tends to not be as severe or as prolonged.

Primary Classifications for Cosmetics

Below are the primary classifications of products used in personal care and cosmetics. If you look at the text of a cosmetic or skin product, you will likely find one or more of these mentioned.

Emollients include a large variety of compounds with softening and smoothing properties. As compared to plant oils, specialty emollients are resistant to oxidation and can therefore not spoil and need no antioxidants for preservation. In addition, most specialty emollients show very good spreadability on the skin and provide a satiny, smooth and non-greasy feel to the skin. Typically, they are non-comedogenic, non-allergic and non-irritant.

Emulsifiers are used in creams and lotions to mix water with oils. Since water and oil do not mix but stay separated, an additional agent (emulsifier) is necessary to form a homogenous mixture keeping water and oil together. There are 2 types of emulsifiers. Oil-in-water (o/w) emulsifiers keep oil drops packed in water, while water-in-oil (w/o) emulsifiers keep water drops packed in oil. W/O emulsifiers are used for a fatty feel (e.g night & sun protection creams). O/W emulsifiers are used more in moisturizing products (e.g. body lotions, day creams).

Humectants (or moisturizers) are important cosmetic ingredients allowing to prevent loss of moisture thereby retaining the skin's natural moisture. Some compounds also have the ability to actively attract moisture. Humectants are key ingredients in most skin care products but are also often used in hair care products to volumize the hair by attracting moisture which expands the hair shaft. There is a large variety of very different compounds providing moisturizing effects including proteins, acids, polysaccharides, and various small molecules (e.g. glycerin, sorbitol, urea, aloe vera etc.).

Antioxidants are very useful active ingredients for the manufacturing of cosmetics. Generally, antioxidants interrupt oxidation reactions and prevent the effects of oxygen radicals (e.g. peroxides) both processes known to damage the integrity and function of various natural substances. Antioxidants are useful in two ways: On the one hand they prevent degradation of natural ingredients (proteins, sugars, lipids) in the cosmetic product. On the other hand antioxidants protect the skin cells from being damaged and slow down the aging process. Antioxidants have been shown to boost the skin's radiance, minimize age spots, sun spots, and fine lines.

Exfoliants (or abrasives) are compounds able to slough away the top layer of dead epidermal cells of the skin, thereby leaving the skin appear smoother, fresher and less wrinkled (peelings). The result of exfoliation is to promote blood circulation in the skin and to increase the turnover of surface skin cells. Exfoliation can be achieved either mechanically by scrubbing the skin with cleansers containing small, hard particles (scrubs) or also chemically by applying cleansers containing active ingredients with a peeling effect (e.g. alpha-hydroxy acids, beta-hydroxy acids and others). (All info found at makingcosmetics.com)

STEM SPOTLIGHT

SKIN DEEP

Zandra Azariah Cunningham's fascination with entrepreneurship began when she was 9 years old, when her father said that he wouldn't purchase the lip balm she enjoyed using anymore. She then decided to do the work and make her own. Afterwards, she started her own business called **Azariah's Innocence**, just before her 10th birthday. Her first products, lip balms and shea body butters, were sold at local farmers markets. Because of her history with commercial products, Zandra wanted to provide an alternative with her products to keep skin soft without irritating it and to smell good!

"I believe that young ladies should be confident in their own skin and learn what beauty is from the inside out. My hope it to inspire youth to take action and make things happen for themselves and their communities."
- Zandra

Check out Zandra's website at zandrabeauty.com

What Now?... Learn More!

- **Human Cost of Mica** (bit.ly/2xcHAWT)
  Watch a video that depicts how children are illegally mining in India to keep up with beauty demands.
- **The Chemistry of Cosmetics** (bit.ly/2IIIYIn)
  Read an article from the Australian Academy of Science about cosmetics.
- **The Chemistry of Beauty** (bit.ly/2LkKLyx)
  Learn about the ethics and science behind cosmetics. What is "natural" and is it better than "chemical"?
- **Ethics in Cosmetics Case Study, Anna Bauer, 28 October 2014** (bit.ly/2s42qBl)
  One woman's ethical journey as a chemical engineer deciding whether she will accept or not accept a job offer for the makeup brand Make-up Artist Cosmetics (MAC) after she learns about their testing on animals.
- **How Skin Care Became an At-Home Science Experiment** (theatln.tc/2FocW0b)
  Skin care is one of our newest obsessions…There over 300 lotions for body and face and over 100 anti-aging products on the market. How do we separate fact from fiction when we want to care for our skin? Well, a new class of citizens has evolved to address the complexity of the skin care market: the citizen scientist. These citizen scientists are using their bodies to test out what works and doesn't work.
- **How to Better Your Skin** (bit.ly/2s0zVoo)
  Crowdsourced tips on how to care for your skin for free or low cost.

9

SUPERHEROINE ACTION KIT

Inspiring and Building the Next Generation of Dynamic Leaders

SUPERHEROINE ACTION KIT

Only 56 out of the 146 nations (38%) studied in 2014 [49] and 2016 [50] have had a female head of government or state for at least one year in the past half-century, according to the World Economic Forum. From the 1950s to 2018, there have only been 70 women who have been head of state. Curiously, one nation that is built upon freedom and equality, the United States of America, has never had a female leader elected to be President of the United States. (For the record: Woodrow Wilson's second wife, Edith Wilson, ran the Oval Office for 17 months because President Wilson was left disabled due to a massive stroke.)

TIME
90 minutes

DIFFICULTY LEVEL – 5

MATERIALS

Pencils/pens Wildflower seeds
Plastic bottles Solar power garden lights
Hardcover book Soil
Clay
Fabric
Glue,
Scissors
Pool Noodle
Scrap paper
Tissue paper
Umbrella
Mason jars
Paint

The Ambitious Challenge

Now that you have taken on the previous Girl Up STEM Challenges, how might your Club create a Superheroine Action Kit to support a variety of leadership opportunities so we see many more women in leadership positions?

Warm-up Mini-Challenge Opportunity

What does it mean to be an effective leader? What does effective leadership as a woman look like? Leaders come in all shapes, sizes, sectors, and don't have to be "famous." Who are leaders you admire from the past and present? Remember women can lead in their own distinct ways. Check out these "Five Myths About Women in Leadership" from Forbes Magazine.[51] Among the members of your Girl Up Club, create a list of qualities of an effective leader.

Ready? Let's Begin:

Step 1: Brainstorm - Every SuperHeroine needs superhero tools to support her work as she fights for what's right. Refer to your list of Qualities of an Effective Leader. What are the proper power tools to help her be a powerful and mighty leader? You and your Club will create a prototype of a bag/backpack that will support her efforts in a variety of topics: accessing education, staying safe and preventing violence, staying healthy, being counted, and expanding leadership opportunities. Design a dream Superheroine Action Kit for a member of your Girl Up Club or for another Girl Up member from anywhere around the world.

Step 2: Research & Collect Data - Now you and your Club members are going to figure out two major aspects of this project: what type of bag to make and what to put in the bag. How might each of the tools and compartments support her leadership efforts? Begin by looking at many of the activities you have participated in previously and some new mini projects below.

Learn More:

49 The Global Gender Gap Report, 2014
50 The Global Gender Gap Report, 2016
51 Five Myths About Women in Leadership, Forbes Magazine (bit.ly/2LIki3O).

DIY Pencil & Pen Case [52]

Using fabric, ribbon, buttons, and/or other creative materials, design a pencil and pen holder.
(15 minutes)

Book of Light [53]

Create a light source that uses little to no electricity to empower learning by re-using a book, LEDs, and other found objects.
(60 minutes)

DIY .Pad [54]

(Refer to the Activity)
Design a sew or no sew, reusable sanitary pad using cotton fabric.
(60 minutes)

Wildflower Earth Dumplings [55]

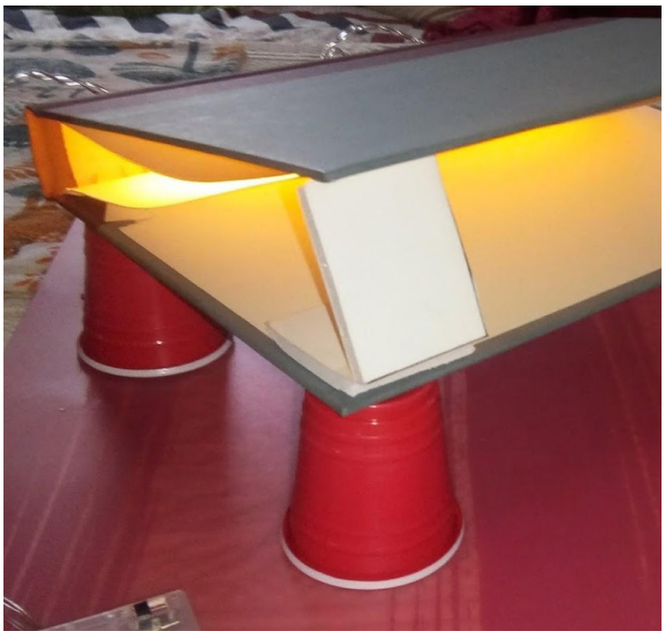
Earth Dumplings aka seed bombs are made of soil, clay, water and local seeds from the area you live in.
(20 minutes)

WILDCARD

What new DIY creation might you add to your SuperHeroine Action Kit?

Plantable Paper & Natural Creations [56]

With minimal ingredients: recycled paper, water, and seeds, blend up plantable paper and other creations.
(60 minutes)



Book of Light

DIY Hidden Book Safe [57]

Hide your most precious belongings in plain sight by designing a "safe" with a hardback book, a box cutter, glue, paintbrush, ruler, and felt.
(60 minutes)

DIY Solar Lantern Hack [58]

Hack a cheap garden solar light and combine it with a mason jar and you get a portable solar lantern. Add creativity with paint, paper, stones, and glue.
(40 minutes)

DIY Portable Water Filter [59]

A portable water filter can be created with a recycled plastic bottle, sand, activated charcoal, a cloth and the force of your breath.
(30 minutes)

DIY No-Sew Backpack [60]

Can't sew? Won't sew? Don't let this stop you from creating a backpack with old pants or jeans, ribbons, buttons and glue.
(60 minutes)

DIY Backpack [61]

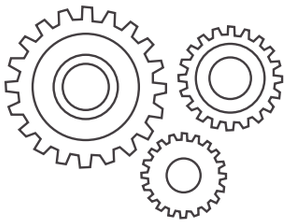
Fabric of your choice, thread, measuring tape, pins, and a zipper can be sewed to produce a tailored, custom backpack.
(120 minutes)

DIY Durable Tote Bag [62]

Too many plastic shopping bags taking up space? Convert these plastic bags into a durable tote bag with an iron, baking paper and a ruler.
(60 minutes)

Learn More:

52 DIY Pencil & Pen Case (bit.ly/1KcQNtc)
53 Book of Light (tinyurl.com/yd5e6a5e)
54 DIY. PAD (Refer to Activity)
55 Wildflower Earth Dumplings (bit.ly/2GEe4sd)
56 Plantable Paper & Natural Creations (bit.ly/2s3SGrg)
57 DIY Hidden Book Safe (bit.ly/1qFnDPk)
58 DIY Solar Lantern Hack (bit.ly/2kdZ3EW)



THINK ABOUT IT

Consider creating the full-scale version of your Superheroine Action Kit design during another Club session! Reach out to the community for supplies!

Step 3: Design - Start designing a working prototype of the Superheroine Action Kit. In your working prototype, show how each leadership quality is represented in your bag. Remember there are many ways to communicate non-verbally--use of color, material, slogans, etc. Free up your mind!

Step 4: Create - Build your Superheroine Action Kit!

Step 5: Share - Once each group has completed their SuperHeroine Action Kit prototype, have your peers test out the bag and provide constructive feedback:

I wonder…
I'm curious about…
I'm challenged by...

Finally, snap photos of your list of qualities of an effective leader, your Superheroine Action Kit prototype, and your design process and post them on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the amazing Superheroine Kits created by girls just like you around the world.

Helpful Hints:

- Find a bag or backpack that is no longer being used and deconstruct it. In understanding how something is put together, you can learn from other people's successes and failures.

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59 DIY Portable Water Filter (bit.ly/2ked3OK)
60 DIY No-Sew Backpack (bit.ly/2j17t4p)
61 DIY Backpack (bit.ly/2KL7z9L)
62 DIY Durable Tote Bag (bit.ly/2KLWwx0)

STEM SPOTLIGHT

SUPERHEROINE ACTION KIT

Michelle Obama said, "Success isn't about how much money you make; it's about the difference you make in people's lives." In 2014, over 100,000 residents were potentially exposed to high levels of lead in their drinking water. **Amariyanna "Mari" Copeny** and **Gitanjali Rao** are two fearless young women who are not waiting to be picked to lead. Each has been inspired and motivated to make a difference in the clean water crisis in Flint, Michigan. Mari, aka Little Miss Flint, is a brilliant young activist who has the power to motivate and organize people into action through her powerful speaking skills, demonstrating, media savvy, and fundraising efforts. Also uniquely and significantly talented, Gitanjali developed a portable device called **Tethys**, a sensor that can detect lead in water faster and easier than other current techniques.

What Now?... Learn More!

- **Learn more about Mari aka Little Miss Flint @littlemissflint**
  Meet the 8-year-old girl who inspired President Obama to visit Flint (wapo.st/2sd8N5V)
  Getting to Work With Little Miss Flint (bit.ly/2knUub7)
  Mari Copeny - Girl Up (bit.ly/2J4rgMt)
- **Learn more about Gitanjali Rao @gitanjaliarao**
  Indian American Gitanjali Rao is the winner of 2017 Discovery Education 3M Young Scientist Challenge (bit.ly/2sa8FUJ)
  11-year-old girl inspired by Flint water crisis creates cheap kit to test lead - ABC News (abcn.ws/2J0LqXN)
  America's Top Young Scientist Gitanjali Rao Talks About How Science Can Make A Difference (bit.ly/2KVJsF5)
- **Suzelle's How to Hack Your Backpack** (bit.ly/1KcQNtc)
  Look no further for inspiration and hilarity hacking your backpack than Suzelle!
- **25 Female STEM Superheroes of Today** (bit.ly/2J9MIPY)
  Only 20% of STEM bachelor's degrees are held by women and only 25% of STEM jobs are filled by women. Visualizing and knowing successful role models can help increase these low numbers.
- **The Secrets To Success: Incredible Career Insights From Some Of The World's Leading Creatives** (bit.ly/2KVVVsx)
  Artists, creatives, photographers, and designers have so much to teach us about success!
  Women Leaders Around the World (pewrsr.ch/2mmSgcf)

10

THE PHYSICS OF GENDER-BASED VIOLENCE

Gaming Our Way to a More Equitable and Just Society

THE PHYSICS OF GENDER-BASED VIOLENCE

By conservative estimates, more than one in three women around the world experience gender-based violence. One in four girls worldwide (70 million) said they were the victims of physical violence by the age of 15. Gender-based violence is defined as any violence against a woman that results in or is likely to result in physical, sexual or psychological harm or suffering to women, including threats of acts such as coercion or arbitrary deprivation of liberty, whether occurring in public or in private life." [63] There are two distinct forms of violence: direct and indirect.

TIME
90 minutes

DIFFICULTY LEVEL – 5

MATERIALS

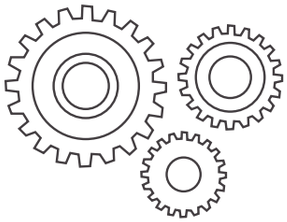
Imagination
Paper
Pencils
Scissors
Game Design Elements: cards to be printed out (Game Values, Physics Concepts, Games to Modify, and Safety & Violence Themes)
Before Your Play the Game Checklist
Debriefing the Game Handout

Make a Game Box:
Fill that box with materials to make any game: balls, trinkets, random object, lost game pieces, stones, shiny objects, etc...

The Ambitious Challenge

How might you use physics and game design to help end gender-based violence; and to deconstruct social attitudes and structures that privilege men over women in societies around the world?

Direct violence against women includes physical, sexual, psychological, and economic violence. Indirect violence against women is the use of institutional or structural violence to maintain systems and support believing women remaining in a subordinate position within her family, household, place of work or community. These problems touch the lives of women and girls all over the world and can feel intractable or hard to control, move or deal with. However, physics-the study of matter and energy and their interactions - reminds us that what appears to be unchangeable is not. In essence, physics is about how things move.



THINK ABOUT IT

What are game mechanics? Game mechanics help the gameplay by prodividing constructs of rules or methods designed for how players interact within the game. All games use mechanics. Some examples are a timed element like in "Pictionary" or a repeating element like in "Simon Says."

Warm-up Mini-Challenge Opportunity

Think about the game "Rock, Paper, Scissors." Play a few rounds with your Girl Up Club members. What do you notice about the gameplay?

How can you change the **game mechanics**? Modify an aspect of the game. (Example: figure out how to make it multiplayer, add, take away, or change a rule, change one or more of the "objects," change the meaning of the "objects," etc.). Here is a more thorough list of potential game mechanics. [64]

Create a new title and play a couple of rounds. Was it fun? Was it too easy? Did it create confusion?

Learn More:

63 United Nations General Assembly, 1993, Declaration on the Elimination of Violence against Women: (bit.ly/2IChFZL)
64 List of Potential Game Mechanics (bit.ly/2wYm4EW).

Ready? Let's Begin:

An amazing game designer by the name of Jesse Schell said simply, "A game is a problem solving activity approached with a playful attitude."

Step 1: Brainstorm - Decide how you would like to split off into groups. A major element that shows up in game design is values. All games have values...human values such as trust, kindness, greed, honesty, justice, equity, power, beauty, etc. You're going to get an opportunity to infuse one value into your game. Shuffle the Game Values cards: Equity, Beauty, Security, Empathy and Creativity. Each group will choose one card at random from this deck and make a note of the choice. Keep track of your thoughts and discuss following questions/statements around values:

1. What does the value mean to each member of the group?
2. Describe examples of when this value shows up in your life.
3. Describe examples of games where this value is exhibited or not exhibited.

STEM CONNECTION

Why physics? A large component of this field of science is about the way matter interacts and moves. How can you utilize it in a game?

Step 2: Research & Collect Data - Next you are going to collect two more game design cards: Physics Concepts and Safety & Violence Themes. Take the time to learn more about your chosen concept and theme. You will fill in a working definition for your Safety & Violence Theme.

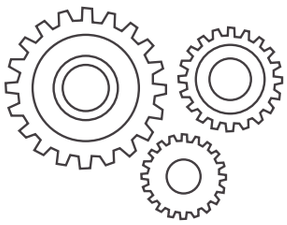
Note any ideas you and your group have after initially receiving your choices from each category. Try to stick with the choices you have selected but if, at any point, it is decided that the choices you have selected are too difficult, you may choose to change the choice of one category.

Step 3: Design - Your research is completed and now your group is ready to choose from the Games to Modify category. There are two categories to choose from: cooperative (meaning all players win, or nobody wins) and competitive (meaning one player or players win while others lose). Now that you have all four Game Design Elements, lay out all of information and materials and start thinking how all of the elements are connected.

Step 4: Create - Grab the Game Box! You're ready to start creating! Remember what you learned earlier, "A game is a problem-solving activity approached with a playful attitude." How can your game teach about gender-based violence?

Can you create a game that:

- Includes a Game Value?
- Has a dexterity (skill in performing tasks, especially with the hands) element?
- Modifies a childhood game?
- Includes a physics concept as a game mechanic?
- Incorporates a Safety and Violence Theme?



THINK ABOUT IT

How can you adapt your game further to include players with various physical abilities?

Step 5: Share - Once each group has completed their game design, it's time to playtest the games to see if they are fun and one learns about gender-based violence and physics. Have your peers give feedback about the four Game Design Cards were used as well as the quality of play. See figure 7.8 on page 129.

Finally, snap a photo of your game and the rules and put it on social media!

Instagram: @GirlUpCampaign
Twitter: @GirlUp
Facebook: Girl Up
Share with the hashtag: #STEM4SocialGood

Take time to explore some of the amazing games created by girls just like you around the world.

After sharing and playing the games with the other groups, read the "Debriefing section" on page 109.

Helpful Hints:

- Get lots of feedback! Allow your game to be played from your peers in and outside of Girl Up.
- Iterate. Iterate. Iterate (to repeat or perform again). Make adjustments to your game design.
- Go and study other kinds of games (board/card/video). Can you apply what you learned?

See Appendix Figure 7.7 for Newton's Laws of Motion and **Figure 7.8** for cards you can cut out for your game!

Debriefing Section: Safety & Violence

Violence against girls and women, including sexual and gender-based violence, is prevalent around the world. Every day, a girl or a woman is a victim of violence. Violence against girls can happen at different moments in their lives and in a number of different ways. In some countries, violence against girls and women is common. Just walking back and forth to school or going to get water can put girls at risk.

The Facts

- 14% of girls' deaths aged 15-19 are attributed to violence
- Self-harm is also a serious issue – suicide is now the #1 cause of death among girls aged 15-19
- Violence affects boys and girls differently – studies have found boys to be at greater risk of homicides and gang related violence while girls are disproportionately affected by sexual and gender-based violence (SGBV)
- ¼ of girls worldwide (70 million) said they were the victims of physical violence by the age of 15

Girl Up and the United Nations

Girl Up is working with the United Nations to make sure adolescent girls are safe and free from violence. UN programs that are supported by Girl Up work to prevent and protect girls from all forms of gender-based violence, abuse, exploitation and to ensure that girls who experience violence receive prompt protection, services and access to justice.

One solution is to provide increased access to firewood, water and toilets so that girls do not have to travel far from their home. Providing a girl with a safe space gives her the chance to be with other girls and mentors, and lessens her worry about becoming a victim of violence.

Guatemala

Guatemala is working to make progress after three decades of violence but the country is still experiencing widespread poverty that affects girls and women. Adolescent girls in Guatemala, especially indigenous girls living in rural areas, face high rates of violence. Close to half of all reported cases of violence against women are among girls and young women between the ages of 13 and 27, and approximately two girls or women are murdered every day in Guatemala. Girl Up is supporting UN programs that bring together government institutions responsible for the protection of adolescent girls as well as programs that raise awareness in communities about gender-based violence and teach community leaders how to respond when violence occurs. In addition, Girl Up supports educational institutions that teach adolescent girls about their rights, provide girls with Clubs where they can have a safe, public space to meet with mentors and participate in skill-building activities.

Malawi

In Malawi, Girl Up is working with UN partners to keep adolescent girls free from sexual and gender-based violence by supporting a campaign against child marriage that will educate and mobilize girls, boys and families to end the practice of child marriage. Girl Up also helps to empower girls to speak out for themselves about decisions that impact their lives. Girl Up supports the launch of a Say NO to Gender-based Violence campaign that will teach adolescents about girls' rights and the harm of gender-based violence. Furthermore, with Girl Up's support, the UN is working to establish case management plans and service delivery structures, such as school-based child protection committees, to support girls who have experienced violence.

Ethiopia

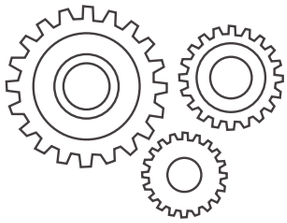
Girl Up supports UNHCR's work to address some of the challenges that Somali refugee girls face living in Ethiopia who have been displaced by the humanitarian crises. The program provides solar lamps for girls to study in the evening. This is an environment-friendly way to reduce the risk of violence that girls may otherwise face if they had to gather firewood for their family's energy needs. The program also works with schools and teachers in the refugee camps to improve teachers' understanding of gender issues in the classroom, establish anti-harassment and anti-bullying policies in the schools, and provide girls with a safe environment.

Liberia

Because Liberia experienced a civil war, girls and women are more vulnerable to being a victim of widespread sexual and gender-based violence. Girl Up supports the UN's efforts to reduce the prevalence of harmful traditional practices and violence against girls by providing psycho-social support in community youth centers for girls affected by sexual or gender-based violence. Funds also help to establish community dialogue on girls' education, health and cultural practices

India

One of the largest challenges facing girls and women in India is violence, both in public and inside the home. Girl Up supports UNFPA's Action for Adolescent Girls (AAG) Initiative in one of India's most populated regions, Rajasthan, which addresses the issue of gender-based violence. Reports show that 49% of women in Rajasthan have experienced some type of sexual or physical violence, and one out of every five survivors of rape is younger than 18 years old. The AAG initiative is building partnerships with local organizations to provide safe spaces for adolescent girls to promote their safety and teach them about their basic human rights.



THINK ABOUT IT

Now that you know some more specific instances of gender-based violence directed at girls and women around the world and what is being done to improve conditions, how might you further modify your game?

STEM SPOTLIGHT

THE PHYSICS OF GENDER-BASED VIOLENCE

Mary Flanagan is a visionary, game designer, artist, poet, author, and a distinguished professor of Digital Humanities at Dartmouth College. In 2003, she created and founded the **Tiltfactor Lab**, one of the first academic game research labs in New York. Her deep interests are in humans and their relationships with systems. One of the critical questions the Lab is trying to answer is, "Can we make a more just and equitable world with games?" As a result, Tiltfactor Lab helps to develop board games, card games, physical games and digital games to promote learning, attitude change, and behavior change for the betterment of society.

What Now?... Learn More!

- **Tiltfactor** (tiltfactor.org/)
  Read more about how Tiltfactor is engaged in producing games that combat biases and stereotypes against women in STEM
- **Games for Change: Featured Games** (gamesforchange.org/games)
  A comprehensive list of over 175 digital and non-digital games focused on contemporary social issues aka serious games.
- **The Cost of Life** (ayiti.globalkids.org/game)
  This online game simulates life in Haiti and the right to an education while trying to avoid poverty and sickness.
- **Science Videos**
  Explore some of the science topics of this activity with the Crash Course Team!
  Newton's Laws: Crash Course Physics #5 (bit.ly/2kGe9Bs)
  Friction: Crash Course Physics #6 (bit.ly/2j1CKBy)
  Light is Waves: Crash Course Physics #39 (bit.ly/2LkJF65)
- **Forms of Gender-Based Violence** (bit.ly/2khLdBq)
  There are two forms of gender-based violence: direct and indirect. Learn about each type and what is classified under each.
- **Art and Physics**
  Amy Shackleton - Painting Timelapse (bit.ly/2LjpMMu) - Amy is an artist that uses not brushes but gravity to create her pieces.
  Rube Goldberg Machines (bit.ly/1PTvmPU) - Rube Goldberg Machines are devices that use a chain reaction to accomplish a very simple task in a very complicated manner using a multitude of physics principles.
- **Sporty Science** (bit.ly/2s5RyU5)
  Explore the physics behind some of your favorite carnival games!
- **Female Mobile Game Designers are Changing the Industry** (bit.ly/2nEhDbl)
  Read an article on how the mobile game design industry is changing for women.
- **The Effect of Women in Gaming** (bit.ly/2xbzKMU)
  Read about the male dominance in gaming history, implications of GamerGate, and pay equality and what it means for the future of female game designers.

Ethical Engineering

Since engineering has a direct and integral impact on the quality of life for living beings on the Earth, it is critical that engineers abide by the highest standards of ethics in performing their services. Below is an example of the WFEO. Does your nation have a code of ethics for engineers?

World Federation of Engineering Organizations (WFEO):

MODEL CODE OF ETHICS

In the course of engineering practice, professional engineers will:
1. DEMONSTRATE INTEGRITY
1.1 Refrain from fraudulent, corrupt or criminal practices
1.2 Be objective and truthful
1.3 Practice fairly and with good faith towards clients, colleagues and others

2. PRACTISE COMPETENTLY
2.1 Practice in a careful and diligent manner in accordance with their areas of competence
2.2 Practice in accordance with accepted engineering practices, standards and codes
2.3 Maintain and strive to enhance the body of knowledge in which they practise

3. EXERCISE LEADERSHIP
3.1 Practise so as to enhance the quality of life in society
3.2 Strive to contribute to the advancement of the body of knowledge within which they practise, and to the profession in general
3.3 Foster the public's understanding of technical issues and the role of engineering

4. PROTECT THE NATURAL AND BUILT ENVIRONMENT
4.1 Create and implement engineering solutions for a sustainable future
4.2 Be mindful of the economic, societal and environmental consequences of actions or projects
4.3 Promote and protect the health, safety and well being of the community and the environment

Call to Action: Build Your Own STEM Solutions

Congrats! You've completed most, if not all, of the 10 STEM activities in this toolkit. You're well on your way to utilizing these newly acquired skills to make real change. Now put it into practice! Think of a social problem that your local community faces, especially those disproportionately affecting girls and women; it could be anything from food waste to homelessness to lack of quality education. How can you, your Club, and your community members use critical thinking skills and scientific methods to make social change?

Get Started

It's easy to apply for Girl Up funding (up to $500) for your STEM proposal! To be eligible, submit a 2-page proposal with a budget in the Girl Up Community by clicking on the link on the STEM for Social Good Challenge page. You can submit your proposal through December 31, 2018, and proposals will be reviewed by Girl Up on a rolling basis. Funding will be given out on a first-come, first-serve basis — so apply as soon as possible!

Expectations

You and your Club members will be accountable for reporting back to Girl Up on the progress and status of your project twice in a six-month period — after three months and after six months. Your proposal should have measurable goals and outcomes, so you can report back to Girl Up on your progress. The project must be overseen by a non-relative adult advisor to ensure funds are used properly.

Selection Criteria

The selection criteria will be based on quality and creativity of the proposal and the soundness of the budget and work plan. Your proposal should include SMART goals and your budget and project work plan should be as detailed as possible.

Below is a sample proposal, sample budget, and sample work plan that you and your Club members can utilize as you develop your project proposal.

Girl Up STEM Grant Sample Proposal

SECTION	DESCRIPTION
Overview	Describe the issue you and your Club members are trying to tackle. Why do you all believe this is a significant problem to address? How has the problem affected your community or town?
STEM skills being utilized	Describe the specific STEM skills you learned within the ten activities you'll be utilizing when thinking through solutions for the problem/issue facing your community.
Solution	What is a solution you and your Club members have come up with in order to tackle the current problem/issue?
Implementation	How will you and your Club members implement the plans outlined in the solution? Will you all rally other members of the community to help implement? Will you get others in your school to help out?
Monitoring and Evaluation	It's vital that your solution and implementation is sustainable and effective. Please describe how you and your Club members will implement benchmarks and tracking systems to make sure you've created a sustainable solution for the problem/issue facing your community.
Budget	Girl Up will be granting money towards the winning proposal in order to implement their idea in their community. Please outline a budget you will need in order to implement your solution.

Girl Up STEM Grant Sample Budget

ITEM	COST	REASON
Materials needed (this may be multiple lines depending on how many materials you need, be sure to use as much space as you need) **Space rental** (does your project need to rent out a Community space or space in your school?) **Promotional material** (any materials you'll need in promoting your project if it's a community-based project) **Anything else** (the items are limitless for the budget, be sure that you think through all aspects of your project in order to submit a thorough budget)		Be sure to specify why your project needs these specific materials

Girl Up STEM Grant Sample Work Plan

TIMEFRAME	ACTION ITEMS
WEEK 1	
WEEK 2	
WEEK 3	
WEEK 4	
MONTH 2	
MONTH 3	Complete Girl Up STEM grant report in Community
MONTH 4	
MONTH 5	
MONTH 6	Complete Girl Up STEM grant report in Community

Resources for Continued Learning

- Stanford Design School (dschool.stanford.edu)
- Luma Institute (luma-institute.com)
- Code Academy (codeacademy.com)
- #BuiltByGirls (builtbygirls.com)
- Black Girls Code (blackgirlscode.com)
- Carnegie Science Center (carnegiesciencecenter.org)

APPENDIX

Resources to complete activities

Handmade Circuit Sample

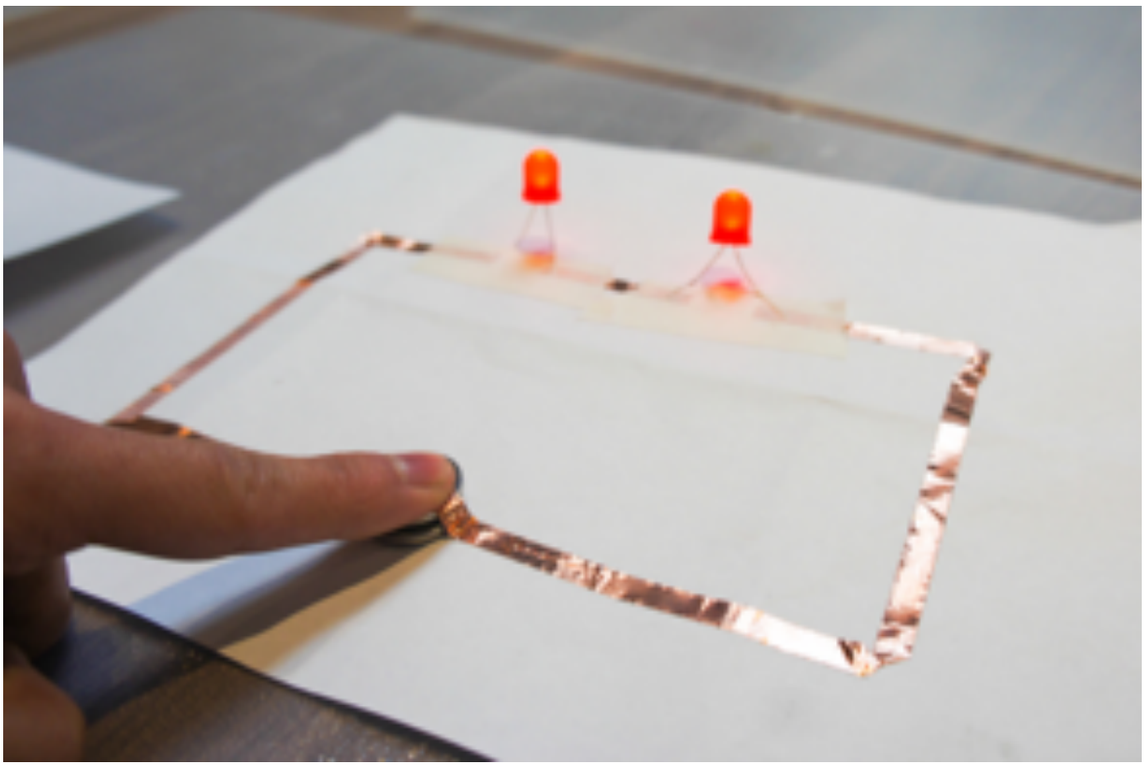


Figure 7.1

Map Activity

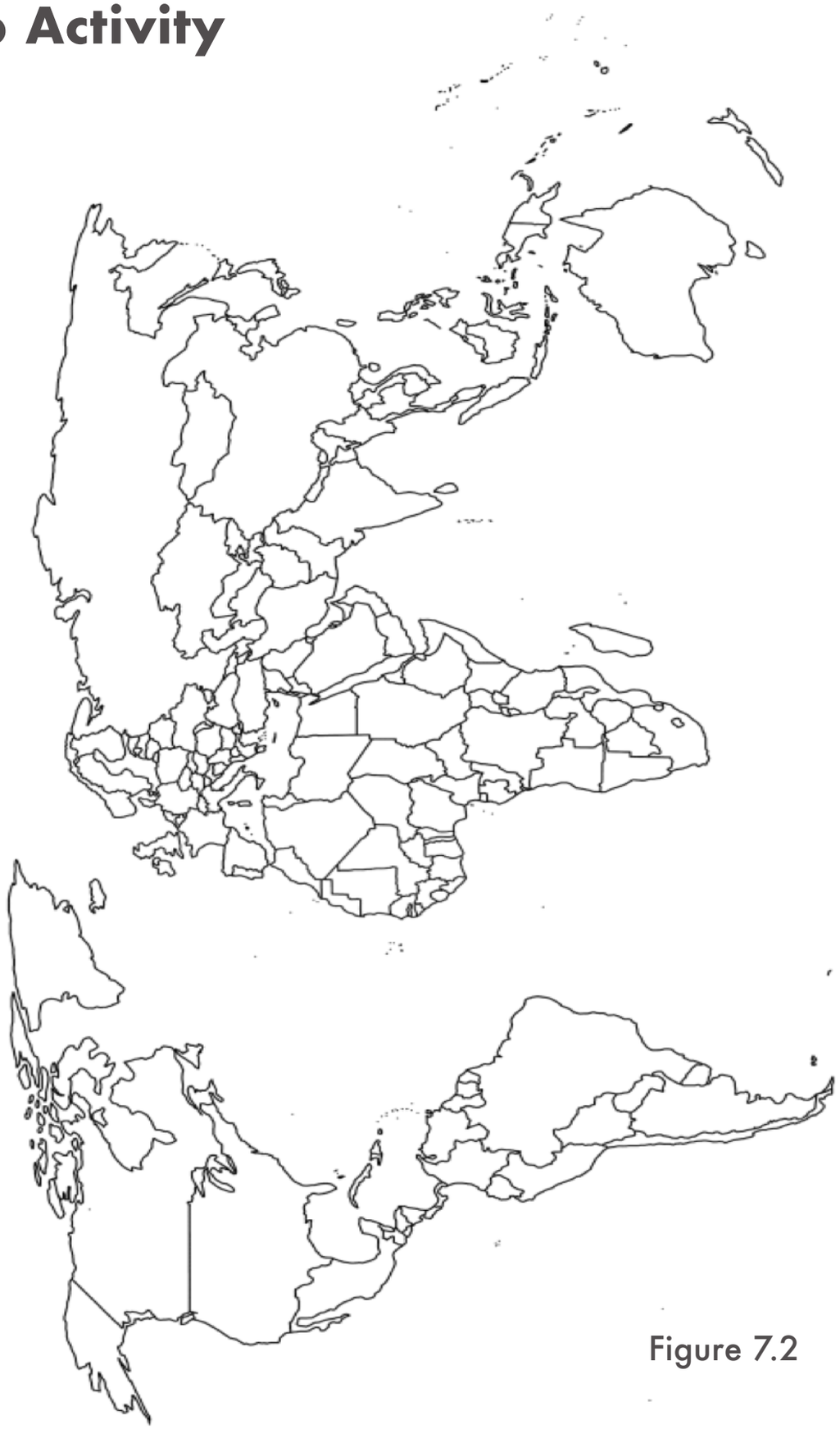


Figure 7.2

Best Places to Work as a Woman

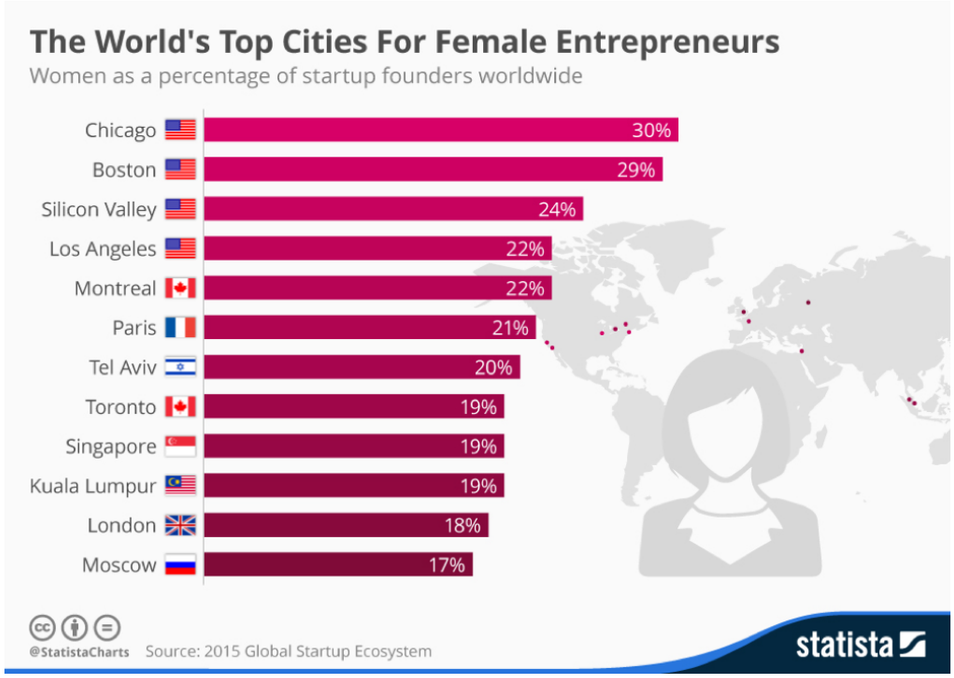


Figure 7.3 The Best Places to Work as a Woman

Figure 7.4 The World's Top Cities for Female Entrepreneurs

Parallel Circuit

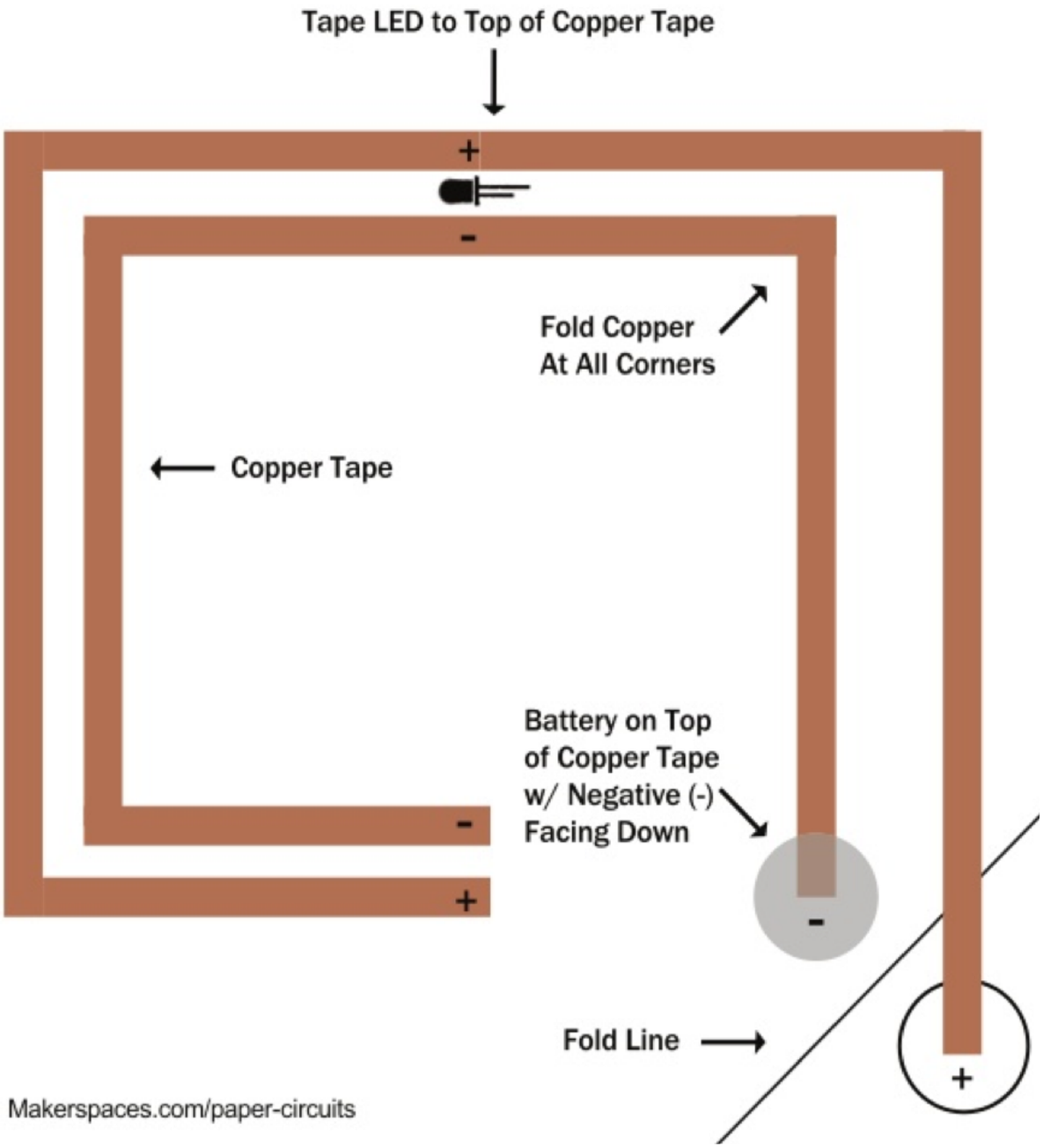


Figure 7.5

Simple Circuit

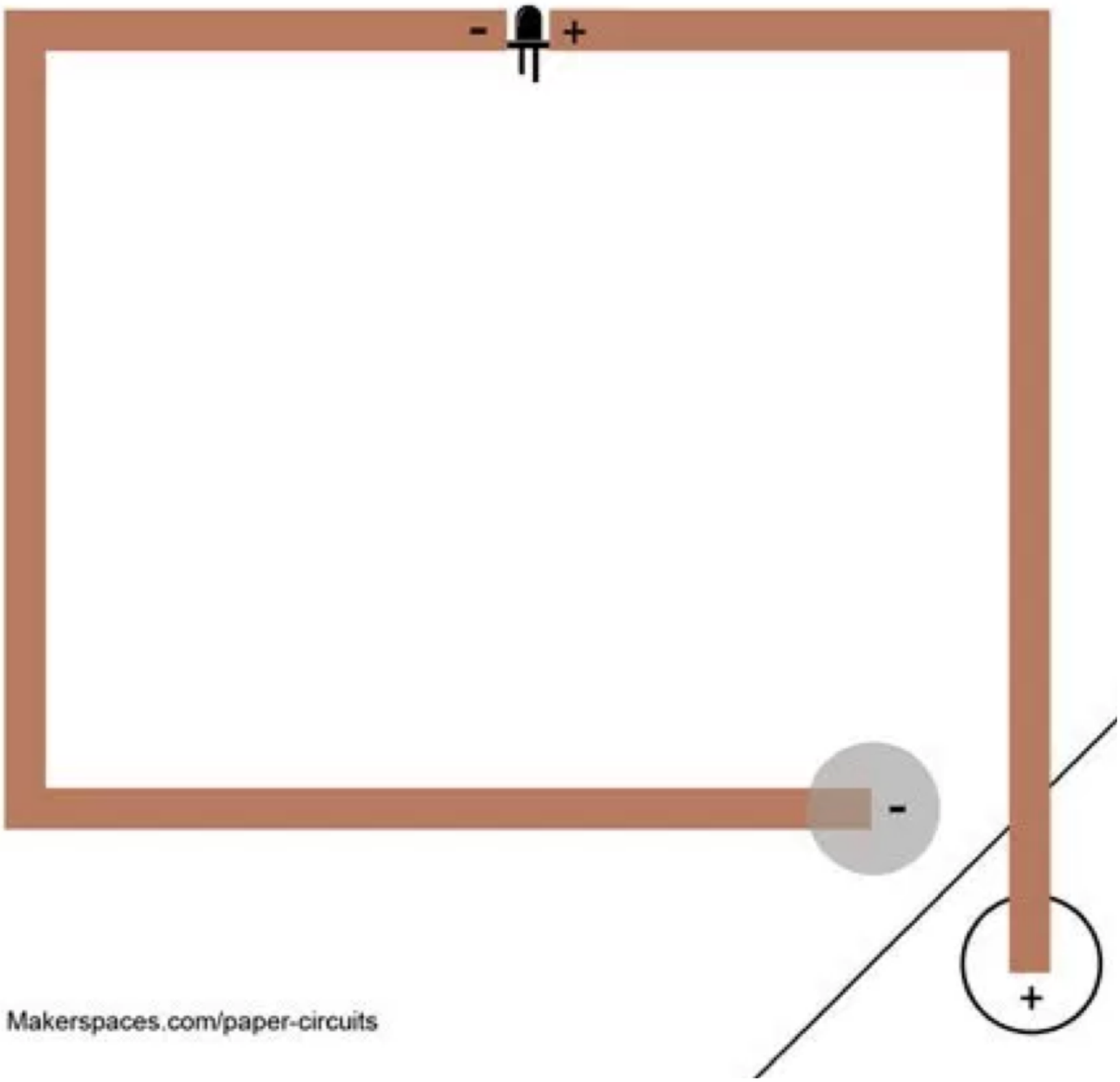


Figure 7.6

FRICTION

Without friction, it would be very tough to do almost anything. Friction is not a fundamental force like gravity and electromagnetism. However, many scientists believe friction is about the electromagnetic interactions that happen between the tiny bumps on surfaces of each object as they rub against each other. **Friction is a force that impedes motion when two surfaces are in contact.** There are two types of friction: kinetic friction and static friction. Kinetic friction is a resistive force acting upon objects in motion. Static friction is also a resistive force that and prevents slipping and sliding. Heat and/or sound can be produced when objects are moving against each other. Is there anywhere in the Universe containing a frictionless environment?

Key Ideas to Remember:

- All surfaces have microscopic, tiny bumps
- When objects are moving against each other, the tiny bumps on their surfaces get pushed against one another
- Friction causes a force on a surface which is in the opposite direction to its motion.
- Lubricants, a substance such as oil or grease, can be used for minimizing friction.

NEWTON'S LAWS OF MOTION

Physics is the study of matter and energy and the interaction between the two. In essence, physics is about how things move. Newton's three laws of motion make up the foundation of most physics concepts involving movement.

Newton's Laws of Motion:

- **1st Law of Motion:** An object at rest will stay at rest, and an object in motion will stay in motion, unless acted on by an outside force. This is also known as inertia. An example of this is if you are riding a bike or in a car and you come to a sudden stop. You will continue forward in your motion until another force acts on you. This is why cars have seatbelts and airbags; to help counteract inertia.

- **2nd Law of Motion:** The acceleration of an object is produced when an unbalanced force acts on an object. The more matter or mass an object has, the larger the force needed to move it. This law is represented by the equation: F(force) = m(mass) × a(acceleration). It is easier to push an empty box than a full box because the full box has more mass and therefore requires more force.

- **3rd Law of Motion:** For every action, there's an equal but opposite reaction. Essentially, if you exert a force on an object, it exerts an equal force back on you. The 3rd Law of Motion helps understand the lift of an airplane wing, the launching projectiles in the air to even a human jumping up and down.

Figure 7.7

Light

Light is special because it is classified as being both a particle and a wave. All waves transfer energy, but not mass, as they travel.

Diffraction occurs when light waves are reshaped by obstacles other than waves. **Interference** occurs when waves run into each other. *Constructive interference* occurs when the crests (top bumps) and troughs (bottom bumps) of both waves end in the same spot and mirror each other. This makes the light brighter or stronger. *Destructive interference* occurs when the crest of one wave and the trough of another wave run into each other. This makes the light dimmer or unable to be seen.

When a precise amount of light hits an atom (the basic building blocks of matter), the electron (the negatively-charged subatomic particle of an atom) can "jump" up a level or more to a higher energy state. The electron can also "jump" down a level or more, emitting the same precise amount of light energy needed to get it to the higher energy level in the first place.

Reflection occurs when light bounces off an object. This bounce occurs because the electrons quickly jumped up to the next energy state, but jumped back down, sending out a similar wave of light. **Absorption** occurs when light enters an object, but doesn't exit it. This occurs because the energy was the precise amount to move the electrons to another level. **Transmission** occurs when light passes through an object. This occurs because the energy from the light is not the precise amount needed to "excite" the electrons, so it cannot be used.

Before You Play Your Game

TITLE OF GAME		
Game Design Element	What did your group choose?	How is the Game Design Element used in the game?
GAME VALUE		
PHYSICS CONCEPT		
GAME TO MODIFY		
SAFETY & VIOLENCE THEME		
RULES OF THE GAME		

Figure 7.8

Instructions: Cut out the cards and paste a description on the back of the purple side.

EQUITY	Each of us getting what we need to thrive by having access to opportunities, networks, resources, supports and to fair and equal treatment under the law, regardless of race, social class or gender.
BEAUTY	A characteristic of a person, animal, place, object, or idea that provides a perceptual experience of pleasure or satisfaction.
SECURITY	Safety, harmony, and stability of society, of relationships, and of self

Instructions: Cut out and write in definitions and examples on the back side.

EMPATHY	Perspective taking: the ability to sense other people's emotions, as well as the ability to imagine what someone else might be thinking or feeling
CREATIVITY	the use of the imagination to transcend traditional ideas, rules, patterns, and relationships to create meaningful new ideas, forms, methods, interpretations in the production of an artistic work

Online Harassment

(Direct Violence)

Sexual Violence

(Direct Violence)

Denying Access to a Quality Education

(Indirect Violence)

Human Trafficking

(Direct Violence)

Child and Forced Marriages

(Direct Violence)

Denying Access to Quality Healthcare

(Indirect Violence)

Violence in Close Relationships

(Direct Violence)

Denying Access to Financial Resources For Women

(Indirect Violence)

Hide and Seek	One or more players hide while one designated player looks for the hidden players. The round is over once all hidden players are located.
Capture the Flag	Two teams of players each hide a colored cloth, representing the team's flag, then try to find the other team's flag and return with it to their home base.

Telephone or Whispers	Players form a line. The first player in line whispers a message to the next player and that player whispers the message to the next player and so on until it reaches the last player. The last player announces the message they received, and it is compared to the original message.
Tag	The player designated as "It" will chase the other players until "It" successfully touches or "tags" a different player. Usually, "It" shouts, "Tag, you're It!". That player is now "It".
King of the Hill	One player is "King of the Hill". Other players attempt to knock the current King off the pile and take their place, thus becoming the new "King of the Hill". The method of removal is discussed before gameplay. Normally pushing is the most common way of removing the King. This game is often banned in schools.
Monkey in the Middle or Keep Away	Two or more players must pass an object, usually a ball, to one another, while a player in the middle attempts to intercept it. If the player is successful, the intended recipient of the object is now in the middle.

4 Way tug of war	That playground classic is still a hit — not to mention inexpensive and simple to execute. For a unique variation, set up a multi-directional game by tying ropes in such a way that three or four teams tug at once. Some teams might choose to work together to eliminate the other groups before going head-to-head.
Fire escape!	Fire Escape! Equipment: 2 large hula hoops. Set Up: Stand in circle with joined hands. Goal – get the entire group through the hoop as quickly as possible without touching the hoop. • Each person must remain physically in contact with the rest of the class via at least one other person. Hoop holders must remain in contact with both the class and the hoop. • If anyone touches the hoop, group must start over.
Horizontal spider web	Horizontal Spider's Web Equipment: Horizontal spider web or tarp marked as a web Objective: To move all members of the group safely from one side of the web to the other. Rules: 1. All team members must begin on the same side of the web. 2. In moving from one side to the other, no one may step on the web – it will wake the spider! 3. Once a person steps inside a cell of the web and then steps out, leaving it unoccupied, that cell may not be used again by any one in the group. 4. There may be no more than two feet in any cell at one time. 5. If someone steps on the web or into a closed cell, they (or their whole team) must return to the beginning.
Toxic waste removal	Toxic Waste Removal Objective: To move the toxic waste container from its original location to a new location and pour the contents (packing peanuts) and the top into another container without touching the container, losing the top off the container (ball), or spilling any of the contents. Rules: 1. Cannot touch the container, its contents or the ball on top. 2. Must hold the ropes within a foot of the end (marked by a knot). 3. If the top falls off the container (ball drops), one person can pick it up using the "toxic protection gloves", place it back on the container and start over from the original location. 4. If the contents spill anywhere other than in the "disposal container", one person can pick it up using the "toxic protection gloves" and place it back into the original container. 5. Each time a new spill occurs, a different team member must be chosen to clean it up. 6. Take as many trials as you have time for. Score: The fastest time from beginning to end of task.

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