# TECHNOLOGY EVERYWHERE

## STEM²D Topics:
## Technology and Engineering

**Target Population:**
**Students, ages 11-14**

**Technology Everywhere** is part of the STEM²D Student Activities Series. Developed by FHI360 and JA Worldwide as part of Johnson & Johnson's WiSTEM²D initiative (**W**inning in **S**cience, **T**echnology, **E**ngineering, **M**ath, **M**anufacturing, and **D**esign), the series includes more than 10 interactive and fun, hands-on activities for youth, ages 11-18 globally.

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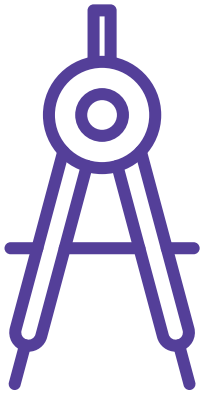

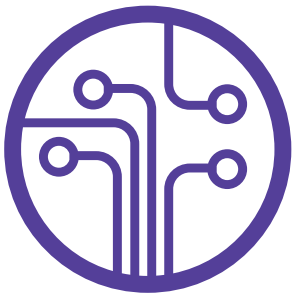

## ACTIVITY DESCRIPTION

Students use circuits to make an alarm. They learn about switches and use this new information and the engineering design process to complete a challenge.

## ESTIMATED TIME

This activity typically takes **45–60 minutes** to complete and should be conducted in one session.

## STUDENT DISCOVERIES

### Students Will

- Participate in a team-based learning experience.
- Learn how STEM²D-science, technology, engineering, Math, manufacturing, and design-subjects are involved in building circuits.
- Develop important STEM²D skills, such as exploring problems and designing solutions.
- Recognize that STEM²D offers diverse and exciting career opportunities.
- Have fun experiencing STEM²D.

## GETTING READY

### Materials

- Computer with projector, and Internet access
- PowerPoint: Technology Everywhere
- Activity Leader Checklist
- Tell My Story Form
- Student Handout *(1 per student)*
- Alarm Kit *(1 per team, each kit includes the following items)*
  - 1 AA battery
  - 1–2 feet of 22-gauge electrical wire

## STEM²D Skills

- Design Solutions
- Evaluate Information
- Creativity
- Critical Thinking
- Decision Making
- Problem Solving

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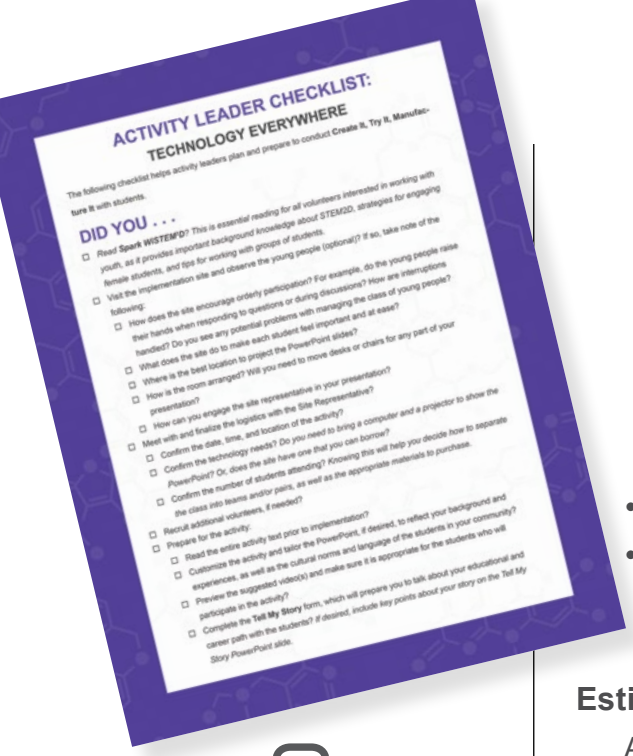
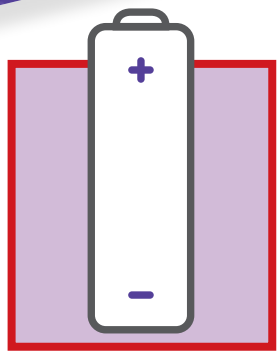
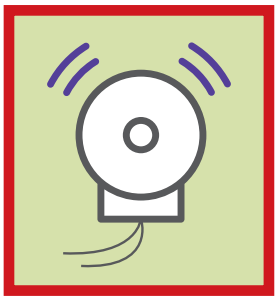
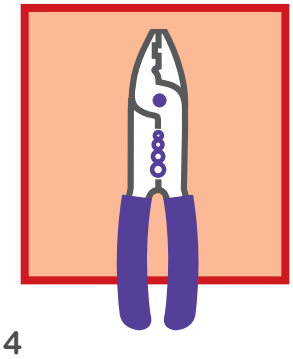

ACTIVITY LEADER CHECKLIST:
TECHNOLOGY EVERYWHERE

DID YOU . . .





- 1 buzzer with leads (*wires attached, visit www.xump.com search buzzers with leads*)
- 1 roll of tape (*duct or masking*)
- 1 piece thin cardboard (*also called paperboard or chip-board; cereal boxes work*)
- 1 piece aluminum foil
- Scissors

- Pencils
- Wire strippers *(1 pair, needed to strip the plastic coating off the ends to expose the wire)*

**Estimated Materials Cost:**

Activity leaders can expect to incur between $32.00 and $35.00 U.S. Dollars (assuming paperboard is not purchased, $11.00 added if wire strippers are needed) in materials costs when completing this activity with 20 students organized into teams of four students.

## Activity Leader Preparation

1. Read **Spark WiSTEM²D**? This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D, strategies for engaging students, and tips for working with groups of students. Download at STEM2D.org.
2. Review the **Activity Leader Checklist** for details and specific steps for planning and preparing to implement this activity.
3. See the **STEM²D Student Activities Series Overview** for additional information.

## STEP-BY-STEP ACTIVITY: TECHNOLOGY EVERYWHERE

1. **Welcome and Introductions (15 minutes)**
   - Greet the students. Begin the PowerPoint.
   - **(Tell My Story Slide)** Tell the students your name and your organization/company. Talk about your educational and career path. Use the Tell My Story form as the basis for your remarks. Be prepared to describe your job or a typical day, and provide information about your background including:

- Your education
- Current work projects
- Interests and hobbies
- Why you love STEM²D, and how your work is connected

- Ask the students and any volunteers helping today to introduce themselves.
- Use the Conversation Starters to learn more about the students and their interests.
- **(Today's Plan Slide)** Review Today's Plan. Ask the students to tell you what innovation (the process of introducing new ideas, devices, or methods) means to them. Is something new always innovative. Why or why not? Tell the students that new and innovative technologies and products often result when an individual or a team of people apply their understanding of science (our natural world) and human behavior to design products and services that people want to use.
- Define **technology**. Tell the students that putting science and other knowledge to practical use to solve problems, invent useful tools, envision new possibilities, and establish meaningful connections between people and the world that surrounds them is the definition of technology. It is the branch of knowledge dealing with engineering or applied sciences.
- **(Define Technology Slide)** Technology also is the machinery and equipment developed from the application of scientific knowledge. Sometimes the intention is not to create something new, but to make something better, less expensive, or more useful. Everyday examples of products improved through technology can include: smartphones, single-cup coffeemakers, scissors, fans, pens, rubber bands, and even work spaces (tables and chairs).
- **(Try It Slide)** Distribute the Student Handout. Ask the students to identify a partner to work with by turning to someone sitting near them. Allow time for the partners to move around the room, and identify three different items or products.
- Have the students list the items on their handout, making sure to identify those items they are familiar with or use often.
- Tell the students they will have 3 minutes to talk about the products with their partners. Ask them to consider (brain-

## KEY WORD

- **Technology**
- **Innovation**

## TIPS FOR STARTING CONVERSATIONS:

Conversation Starters are provided throughout and include questions designed to introduce students to the activity topics. Use the questions—modify them, or add others—to engage your students.

## CONVERSATION STARTERS: CAREER PLANNING

- When you consider your future, what are you most excited about? What interests you?
- Do you see yourself working with technology? Can you imagine a job that does not require people to use technology?
- What does the perfect work day look like to you? Are you outdoors? Are you working alone, or with others? Do you solve problems? Do you fix or build things?

## TIPS FOR STARTING CONVERSATIONS:

**Brainstorm**

- What are some different ways to think about these items?
- Who uses them?
- Are they easy to use?
- Difficult to use?

**Evaluate**

- Which idea is really possible, given the constraints you identified?

## KEY WORDS

- **STEM²D (science, technology, engineering, math, manufacturing, and design)**
- **Technical skills**
- **High-demand, high-growth careers**

storm) all the ways the products they identified could be improved. Use the Conversations Starters to get the students talking to each other.

- Give them the following constraints to consider:
  - Your improvement cannot result in a new product. It should only make the product easier to use, more efficient, or less expensive.
  - The improvement can result in a new and unexpected use for the item or product.
- Call time and allow the students one minute to evaluate their lists and identify the best improvement for each item on their list.
- Ask partners to share one item from their list and describe how they would improve it. Discuss any improvements that include new technology.

2. **Practice Using Circuits (10 minutes)**
   - Explain the importance of knowing what technologies exist. Tell the students that their learning should not stop at simply knowing how to use technology. They need to know how things work in order to be an integral part of the creation and development of new technologies.
   - Understanding how circuits work, learning to code, building a website, designing computer graphics, creating an app, or developing a video game all require people who have technical skills. Some **STEM²D**—science, technology, engineering, math, manufacturing, and design careers do not require a college degree and offer students exciting, high-paying opportunities.
   - People with **technical skills** have the ability to perform specialized tasks and are in demand in today's workforce. So much so that careers in STEM²D are considered **high-demand, high-growth careers** and are predicted to remain in demand over the next 10 years.
   - **(Hidden Alarm Challenge Slide)** Tell the students that they will design a hidden alarm, and like many improvements in technology, the smaller the better. Separate the students into teams (four students per team).
   - Explain that scientists, engineers, and people who use technology

follow a process to solve problems, and that the engineering design process is a great way for anyone to tackle almost any task. We use it each time we create something that did not exist before or when we solve a problem for ourselves or others.

- **(Engineering Design Slide)** Ask the teams to follow along on the handout as you review engineering design:
  - **DEFINE** engineering problems. Clearly state the problem, determine the criteria for success (Are we seeing the expected results?), and figure out the external constraints or limits (costs, time limits, resources, things to consider up front).
  - **DESIGN** solutions to engineering problems. Generate a number of different possible solutions, then evaluate potential solutions to see which ones best meet the criteria (clear purpose) and constraints (limitations) of the problem.
  - **OPTIMIZE** the solution. This involves systematically testing and refining. The final design is improved by trading off less important features for those that are more important.
- Before teams can begin designing their hidden alarm, they first must define the problem, determine the criteria for success, and figure out any constraints.
- Allow 3–5 minutes for the teams to copy the problem, review the criteria, and respond to the following questions on their Student Handout:
  - Where is the best place to hide your alarm? Can you hide it under a chair? In a book? Consider places that will hide your alarm and surprise people.
  - How small does the alarm need to be to fit in the designated hiding place?
  - What is your initial plan for turning the alarm on and off?
- **(Using Circuits Slide) Time to Design.** Have the teams follow along on their handout as you discuss circuits. Tell the students that a **circuit** is simply a path for electricity to travel along. Computers, laptops, and the alarm you will be making work in the same basic way by switching circuits on and off to cause intended results.
  - Explain that a path is needed for the electricity to get from the battery to the buzzer to make the buzzer buzz.
  - When all the parts are connected, and electricity is allowed

## KEY WORDS

- Circuit
- Closed circuit
- Open circuit
- Switch

## TIPS FOR WORKING WITH STUDENTS AND STARTING CONVERSATIONS:

**Circuits**

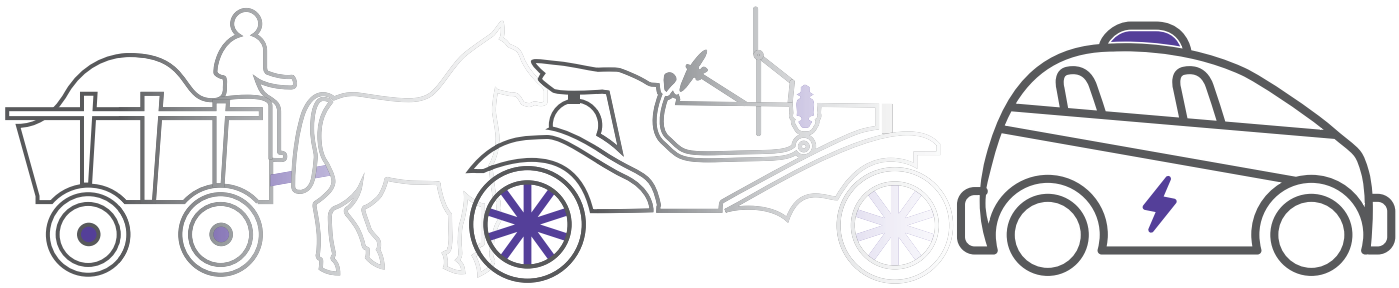
- Provide support to the teams as necessary, moving around the learning space to ensure participation from all team members.
- Encourage teams to keep testing if they are unable to get the buzzer to work.
- Initial ideas rarely solve the problem. Encourage them to try different ideas, learn from their mistakes, and try again.

to flow uninterrupted from the battery to the buzzer and back to the battery, you have a **closed circuit.**

- Tell the students that when parts become disconnected, preventing the electricity from flowing uninterrupted, it becomes an **open circuit.**

- **Time to Make Some Noise.** Distribute an alarm kit to each team. Allow time for the teams to test their buzzers by connecting them to the batteries using the wires provided in their kits.
  - Did they buzzers buzz? If not, encourage the students to keep testing.
  - If the teams are unable to get the buzzer to work, tell them to check that the red wire is attached to the positive (+) side of the battery and the black wire is attached to the negative (-) side. Have teams reverse the wires, if necessary.
- **(Adding Switches Slide) Time to Add a Switch.** Have the teams consider why non-stop sound coming from the alarm is a problem. Tell them that a **switch** is a device for making and breaking the connection in an electrical circuit. Have the students talk with their team members and draw the conclusion that a switch is needed. Next, review the following:
  - Switches make and break a gap in the circuit.
  - When the switch is closed (also called a closed circuit), electricity flows to the buzzer and it buzzes, non-stop!
  - When the switch is open (open circuit), electricity is interrupted and the buzzer stops buzzing.
  - Allow time for the teams to brainstorm ways they can open and close the circuit to ensure they can turn the buzzer on and off.

3. **Time to Build an Alarm (15 minutes)**
   - **(Building Hidden Alarms Slide)** Using the handout as a



guide, allow time for the teams to brainstorm their designs and evaluate them. Have the teams build their alarms and mount everything on the cardboard frames provided in their kits.
    - The cardboard frame can be used as a switch to open and close the circuit.
    - The tape and foil allow teams to close their circuits and get creative with their designs.
- **Test and hide the alarm.** Provide time for the teams to test and hide their alarms. The following questions are provided on the handout as a reference for students.
    - Does the alarm fit in the initial hiding place?
    - Does the buzzer buzz as expected?
    - Consider other places to hide the alarm that will surprise the other teams. Keep looking for unexpected hiding places around the room.
    - Tape the alarm parts in the identified hiding place. Use additional wire if necessary to hide the circuit.
    - Be sure to keep the circuit open until the person finds and closes the circuit by connecting the electrical pathway.
    - Try it out! Have teams work together to test the alarms and evaluate the hiding spots.
- **Refine.** If time permits, have the teams refine their designs and test them again. Tell them that testing can happen at different stages along the process. This helps engineers spot a problem when it occurs as opposed to at the end of the design process.
    - Can they make the alarm more reliable?
    - Can they make it smaller? Harder to detect?
    - Is there another hiding spot they want to try?
- Collect the alarm kits and tell the teams that understanding how circuits work is an important step to knowing how technology works.

4. **Student Reflection (5–10 minutes)**
    - **(Reflection Slide)** Wrap up the activity by asking the following student reflection questions:
        - New and innovative technology is applied to many products. How can you take what you learned today and apply it in your daily life?

## TIPS FOR BUILDING HIDDEN ALARMS:

1. The wires can loosen causing the alarm to stop buzzing. If this happens, encourage the teams to check their connections.
2. Cardboard can be used in multiple ways, as a base, or when folded, it can serve as the switch. It can act like a spring and open and close the circuit.
3. Metal, including the foil and wire, conducts or transfers electricity.

- How could you use circuits to build something or modify one of your favorite products?
- What would you change about your alarm if you had time to test it again?
- If you had the opportunity to explain why STEM²D skills are important to acquiring your ultimate career goal, what would you say?
- Did your original thinking about STEM²D careers and professionals change? Why or why not?
- Can you see yourself working in STEM²D? Why or why not?

- Thank the students for their efforts and participation, and congratulate them on completing this activity. Encourage the students to continue building their technical and engineering skills. Reassure them that they can do STEM²D!

## Extended Learning

There are many ways to extend the learning of this activity:

**Circuits**

- Have students play Fidgit Factory developed by Design Squad Global for PBS Kids at http://pbskids.org/designsquad/games/fidgit_factory/. It provides a fun introduction to electrical circuits.
- Extend this circuit activity to include soldering. Students can use this new skill to create jewelry or develop more sophisticated projects. Please note: The use of soldering tools is a technical skill involving extreme heat and risk may be involved. This type of activity should not be done without the permission of the site coordinator and the students' parents or guardians.
- Significant research is underway to identify ways to combine arts and craft projects with electronics and programming; the result is new electronic experiences for kids that require basic crafting skills. Visit Exploratorium Science Snacks at http://www.exploratorium.edu/snacks to find more fun ideas.
- Challenge: Using red and blue lights, a switch, a button switch, two AA batteries, battery housing, and wires, design a circuit where one of the lights will only turn on if the other light is on. Hint: The alarm activity involves circuits in a series. This activity involves parallel circuits.

- Check out Chibi® tronics at http://chibitronics.com/. This site encourages youth to create, craft, and code using the company's circuit stickers.

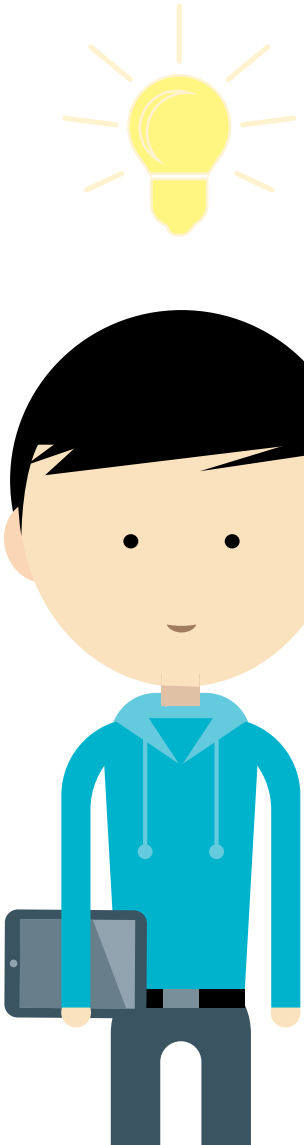
**Programming**

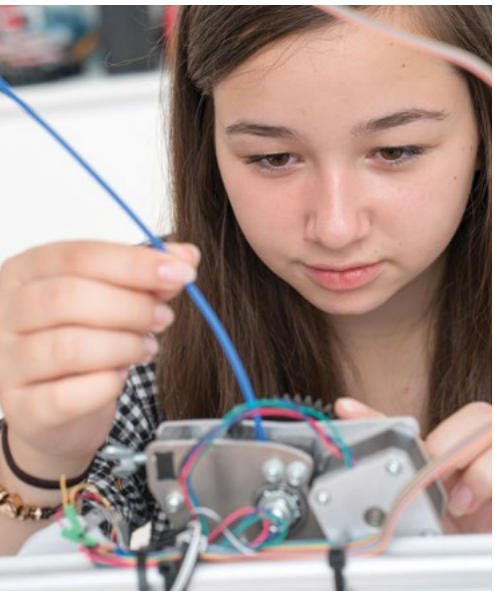
- Introduce kids to programming. Visit Grok learning at https://groklearning.com/csedweek/hoc-eliza/ to access activities designed for kids interested in experiencing programming first hand.
- Make a basketball game with Scratch (for the game interface) and PicoBoard (for the inputs).

## Key Words

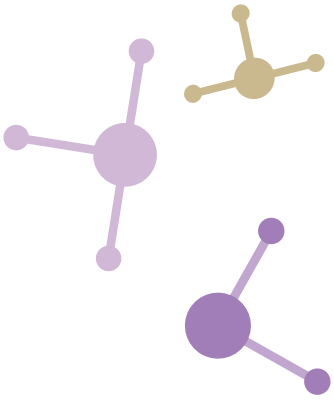
**High-demand, high-growth careers:** Occupations predicted to have more positions available than qualified applicants over the next 10 years.
**Closed circuit:** All parts are connected and electricity is able to flow uninterrupted.
**Circuit:** Simply a path for electricity to travel along.
**Conduct:** Transfer electricity.
**Innovation:** The process of introducing new ideas, devices, or methods.
**Open circuit:** A gap in the circuit that prevents electricity from flowing uninterrupted.
**Prototype:** An early model or experiment to rapidly create solutions to challenges and problems.
**Skill:** The ability to do something well.
**STEM²D:** An acronym that refers to Science, Technology, Engineering, Math, Manufacturing, and Design. The STEM²D subjects are:

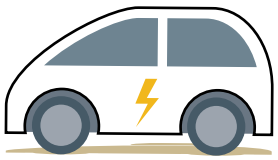
- **Science:** Observing, studying, and experimenting to better understand the natural world and how it works.
- **Technology:** Putting science and other knowledge to practical use to solve problems, invent useful tools, envision new possibilities, and establish meaningful connections between people and the world that surrounds them.
- **Engineering:** Applying science and math principles to design and develop products, structures, machines, tools, or systems that improve everyday life.
- **Math:** Using a quantitative framework (numbers, quantities, shapes, abstract principles, and problem solving) to describe the world.





➤ Building circuits is an example of putting science and other knowledge to practical use to solve problems, invent useful tools, envision new possibilities, and establish meaningful connections between people and the world that surrounds them.





- **Manufacturing:** Creating something from raw materials by hand or by machinery.
- **Design:** Creating, constructing, or inventing an object, plan, product, or system; it is also a human-centered mindset and collaborative approach that results in better experiences by uncovering unmet needs and championing meaningful relationships through user-friendly products, environments, and systems. .

**Switch:** A device for making and breaking the connection in an electrical circuit.

**Technical skill:** The ability to perform a specialized task well.

**Tinker:** Learning by creating and continuously refining and improving the creation. Tinkering is a driver of creativity, excitement, and innovation in STEM²D learning.

## Activity Leader Reflections

After completing the activity, take a few moments to reflect on the following questions about implementing this activity:

- What went well and what could be improved? What would you do differently next time?
- How comfortable did you feel talking about STEM²D, including: building and using circuits?
- Do you have a better understanding of STEM²D concepts?
- How useful was the information presented in **Spark WiSTEM²D** to implementing this activity?
- Will you volunteer for this type of experience again?

## Resources and References

Activity concepts and real-life connections provided by Ellen Oh, Global Strategic Design Office, and Binyah Kesselly, J&J Supply Chain, Johnson & Johnson.

Adapted from an activity used by Design Squad Global: http://pbskids.org/designsquad/parentseducators/index.html



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# ACTIVITY LEADER CHECKLIST:

## TECHNOLOGY EVERYWHERE

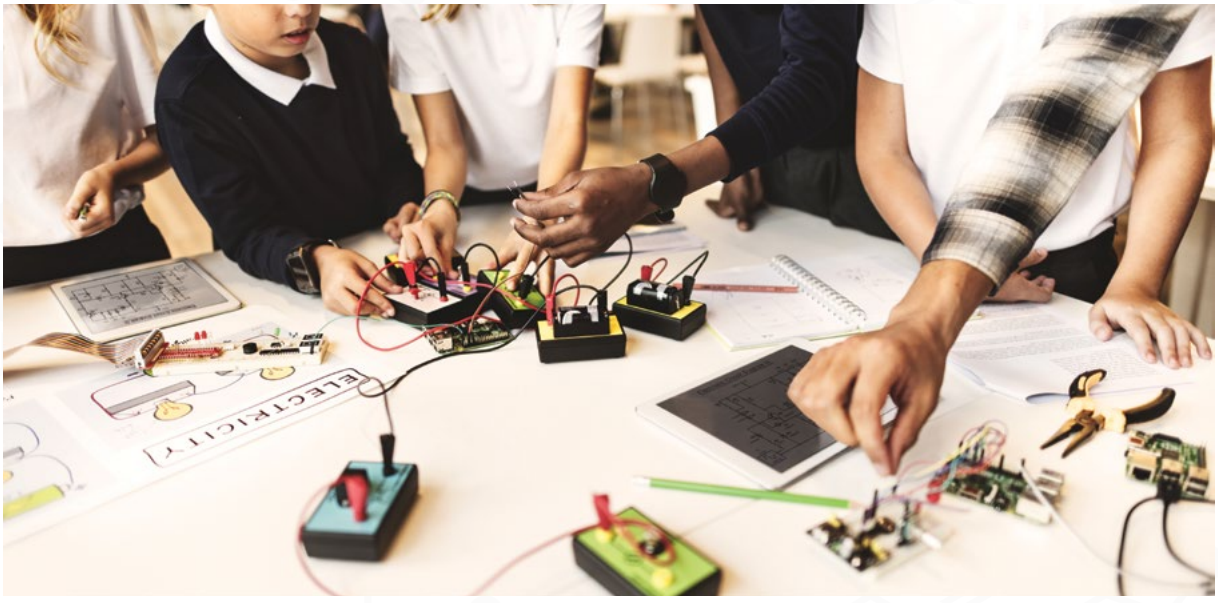
The following checklist helps activity leaders plan and prepare to conduct **Technology Everywhere** with students.

## DID YOU . . .

- ☐ Read **Spark WiSTEM²D**? *This is essential reading for all volunteers interested in working with youth, as it provides important background knowledge about STEM²D, strategies for engaging students, and tips for working with groups of students.*
- ☐ Visit the implementation site and observe the young people (optional)? *If so, take note of the following:*
  - ☐ How does the site encourage orderly participation? For example, do the young people raise their hands when responding to questions or during discussions? How are interruptions handled? Do you see any potential problems with managing the class of young people?
  - ☐ What does the site do to make each student feel important and at ease?
  - ☐ Where is the best location to project the PowerPoint slides?
  - ☐ How is the room arranged? Will you need to move desks or chairs for any part of your presentation?
  - ☐ How can you engage the site representative in your presentation?
- ☐ Meet with and finalize the logistics with the Site Representative?
  - ☐ Confirm the date, time, and location of the activity?
  - ☐ Confirm the technology needs? *Do you need to bring a computer and a projector to show the PowerPoint? Or, does the site have one that you can borrow?*
  - ☐ Confirm the number of students attending? *Knowing this will help you decide how to separate the class into teams and/or pairs, as well as the appropriate materials to purchase.*
- ☐ Recruit additional volunteers, if needed?
- ☐ Prepare for the activity:
  - ☐ Read the entire activity prior to implementation?
  - ☐ Customize the activity and tailor the PowerPoint, if desired, to reflect your background and experiences, as well as the cultural norms and language of the students in your community?
  - ☐ Preview the suggested video(s) and make sure it is appropriate for the students who will participate in the activity?
  - ☐ Complete the **Tell My Story Form**, which will prepare you to talk about your educational and career path with the students? If desired, include key points about your story on the PowerPoint (see **Tell My Story Slide**).
  - ☐ Determine how you will assign the teams? Students will be working in teams of four students.

*It is recommended that you randomly assign students to each team; this will foster the skills needed to work with new people.*

- ☐ Obtain the required materials (see the **Materials** and **Estimated Materials Costs** section) and photocopy the **Student Handouts**? In addition:
  - ☐ Assemble one alarm kit per team. Each kit includes a buzzer with leads (visit https://www.xump.com/science/10-pack-buzzer-15v.cfm?SID=12 for a product example), along with a AA battery, electrical wire, tape, paperboard, aluminum foil, and a pair of scissors.
  - ☐ You will need one pair of wire strippers to strip the plastic coating off the ends to expose the wire.
- ☐ Practice your presentation, including the hands-on, minds-on activity? Be sure to:
  - ☐ Review the content introduced in this activity. This activity reviews simple circuits. Key Words and background information are provided to assist you with implementation.
  - ☐ Practice building an alarm. Visit http://pbskids.org/designsquad/video/hidden-alarm-challenge/ to see two engineers make and hide an alarm.
  - ☐ Be prepared to define technology and share the ways your work is impacted by technology.
- ☐ Set up the site appropriately for the activity? Specifically:
  - ☐ Make sure tables and chairs are arranged to accommodate teams of students—four students per team. Each team will need an alarm kit.
  - ☐ If additional volunteers are available, assign one adult to work with two or three teams.
  - ☐ Set up the computer and projector for the PowerPoint presentation.
  - ☐ Have the alarm kits available for distribution to the teams during the "Time to Make Some Noise" portion of the activity.
  - ☐ Bring a camera, if desired, to take photographs.
- ☐ Obtain and collect permission slips and photo release forms for conducting the activity if applicable?
- ☐ **Have fun!**

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# Tell My Story Form

This form will help volunteers serving as activity leaders prepare to talk about their **STEM²D** interests, education, and career path.

## ABOUT YOU

Name: _____

Job Title: _____

Company: _____

When/Why did you become interested in STEM²D? _____

_____

_____

What do you hope young people will get out of this activity? _____

_____

## FUN FACT

Share a little about your background. Ideas:

- Share a memory from childhood where you first had your spark or interest in STEM.
- Detail your journey; highlight what you have tried, what you learned, steps to success, etc.
- Failures or set backs are also great to talk about—difficulties, and/or challenges and how you overcame them.

## EDUCATION AND CAREER PATH

What classes/courses did you take in secondary school and in college that helped or interested you most?_____

_____

How did you know you wanted to pursue a STEM²D career?_____

_____

What was your postsecondary path, including the institution you attended and your degree? *If you switched disciplines, make sure you explain why to the students.*

_____

_____

What your current position entails. *Be sure to include how you use STEM²D on a typical work day.*

_____

_____

# TECHNOLOGY EVERYWHERE

## Student Handouts

Identify **three different items/products** located around the room that you and your partner are familiar with or use often throughout the day. Record your responses here.

| Item/Product: | Improvements: |
| --- | --- |
| 1. | |
| 2. | |
| 3. | |

# Hidden Alarm Challenge

**DEFINE THE PROBLEM**

Clearly state the problem to solve.

**DETERMINE CRITERIA AND CONSTRAINTS**

Consider the criteria (clear purpose, expected results) and constraints (costs, time limits, resources) that should be considered up front.

## Problem:

## Criteria:

- The team must be able to turn the alarm on and off.
- It must be small enough to hide.

## Before the team starts designing, ask each other:

- Where is the best place to hide your alarm?
- How small does the alarm need to be to fit in the designated hiding place?
- What's your plan for turning it on and off? Do you have one yet?

## Record the team's responses here.

**DESIGN**

Generate (brainstorm) a number of different possible solutions, then evaluate potential solutions to see which ones best meet the criteria and constraints of the problem.

A **circuit** is simply a path for electricity to travel along.

- When all the parts are connected, and electricity is allowed to flow uninterrupted from the battery to the buzzer and back to the battery, you have a **closed circuit.**
- When parts become disconnected, preventing the electricity from flowing uninterrupted, it becomes an **open circuit.**

A **switch** starts and stops the flow of electricity.

Switches open and close a gap in the circuit.

- When the switch is closed (also called a closed circuit), electricity flows to the buzzer and it buzzes, non-stop!
- When the switch is open (open circuit), electricity is interrupted and the buzzer stops buzzing.

**Close this circuit.**

# Design an Alarm

### Brainstorm

- What are some different ways you can open and close the circuit?
- How creative can you be?
- Off-the-wall suggestions often spark amazing ideas.

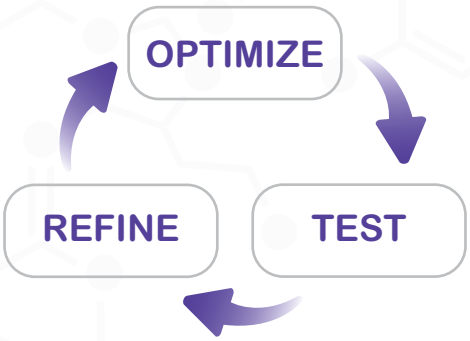
### Evaluate

- Which brainstormed ideas are really possible, given the constraints you identified?
- What are some problems you need to solve as you build your solution?

### Space to Design:

# Test and hide the alarm

- ☐ Does the alarm fit in the initial hiding place?
- ☐ Does the buzzer buzz as expected?
- ☐ Consider other places to hide the alarm that will surprise the other teams.
- ☐ Keep looking for unexpected hiding places around the room.
- ☐ Tape the alarm parts in the identified hiding place. Use additional wire if necessary to hide the circuit.
- ☐ Be sure to keep the circuit open until the person finds and closes the circuit by connecting the electrical pathway.
- ☐ Try it out! Work together to test the alarms and evaluate the hiding spots.



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