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| **Hands-On Activity Template**  Dear Author,  Welcome to TeachEngineering! The purpose of this cover sheet is to provide important resources and a checklist that will help you craft a **hands-on activity** that will be published on TeachEngineering.org.  TeachEngineering **activities** are hands-on and often have a design focus so students experience the engineering design process. Students actively gain knowledge through project-based learning, rather than passively from a book, lecture or worksheet. While many activities are standalone, others pair with supporting lessons. Another way to think about activities is that they **engage students in building, measuring, or testing something.**  We strive to provide teachers with activities that can be done “on a shoestring budget”. Please keep in mind the nature of the materials you are using, and ask yourself if these materials are readily available within a classroom or are *reasonably affordable* for a teacher who would like to perform this activity.   * Does your activity provide a tangible learning experience as described above?  **(check here)** * Each activity must be classroom tested before it can be published on TeachEngineering. Has your curriculum been classroom tested?  **(check here)** * Highlighted components below are **required**. Have you filled out those components**?  (check here)** * Have you included at least two original images or figures at the bottom of this template, including at least one image of this activity being performed in the classroom? If you included figures, have you cited where they should be placed within your curriculum?  **(check here)** * Are these materials readily available within a classroom or reasonably affordable for a teacher who would like to perform this activity?  **(check here;** if materials are not reasonably affordable or are specialized, please contact TeachEngineering.)   To assist you with planning your activity, explanations and example text, which you can replace with your text, are presented for each section. After you fill in each section, use the **”click or tap here to enter text”** prompt to submit updated information.  If you have any questions, please feel free to contact us.  Warm regards,  zen signature  Zain Alexander Iqbal  Digital Media and Technical Editor | TeachEngineering  University of Colorado Boulder  [zain.iqbal@colorado.edu](mailto:zain.iqbal@colorado.edu) **Part 1: Activity Overview** | | | |
|  |  |  |  |
| **Activity Title** | **Click or tap here to enter your Activity Title.** | | |
| **Focus Grade Target** | **Click to select a grade**. | **Grade Level Range:** | **Click to select a grade.**  to  **Click to select a grade.**  *If this activity works for a range of grades, provide them here. Example: 8th grade is the “target” but it can work for 7th and 9th graders. Limit to no more than 3 grade levels.* |
| **Subject Area(s)**  Check all subject areas that apply to this activity.  [Subject area definitions](https://www.teachengineering.org/subjectareas) | Algebra  Biology  Chemistry  Computer Science  Data Analysis and Probability  Earth/Space  Geometry  Life Science  Measurement  Numbers and Operations  Physical Science  Physics  Problem Solving  Reasoning and Proof  Science & Technology | | |
| **Time Required:** | **Click or tap here to enter the Time Required.** Estimate the time required to complete the activity in minutes; you may add a brief explanation for longer activities, such as “three 50-minute class periods”. | | |
| **Group Size**  Check the box that applies to this activity. | Independent (1 student)  Pairs (two students)  Small groups (three to five students)  Whole class) | | |
| **Expendable Cost Per Group** | **Click or tap here to enter text.** In US dollars; what material costs are associated with this activity **per group** that cannot be re-used in another activity? For example, do not include the cost of common classroom or laboratory items such as scissors, paper, a microscope, or beakers.  Important Note: we strive to meet the **“engineering on a shoestring”** approach of **no more than $20 per activity** – group size x cost per group. If the activity requires substantial non-expendable items that are not typically found in classrooms, such as Arduino, LEGO robots, etc., please contact your editors at TeachEngineering. | | |
| **Keywords** | **Click or tap here to enter Keywords.** Add 4-10 words here in alphabetical order that a layperson or teacher may use to search. | | |

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| **Educational Standards** |

In priority order, list up to four educational STEM standards that students would learn as a result of completing this activity. If students need a prerequisite skill to complete the activity~~, ,~~ then list what is required.

For each standard, include the source, year, grade band, standard nomenclature (e.g., number(s)/letter(s)), and standard summary. Example: North Carolina, science, 2004, 1.01 (grades 8-8): Identify and create questions and hypotheses that can be answered through scientific investigations. ID# S1028531

Provide at least ONE from each of the following:

**Click or tap here to enter text.**

List [Next Generation Science Standards](https://www.nextgenscience.org/overview-dci) (NGSS)

**Click or tap here to enter text.**

List [Common Core Math Standards](http://www.corestandards.org/Math/) (optional)

**Click or tap here to enter text.**

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| **Related Phenomena** |

**Click or tap here to enter text.** Identify a phenomenon that illustrates the selected educational standards. After choosing a phenomenon, determine the goal(s) of student learning in relation to the standards and phenomenon.

For help with what a phenomenon is, examples of phenomena-based learning and related links see here: link to NGSS Resources on submit curriculum page

For help with choosing a phenomenon see here: <https://sites.google.com/3d-grcscience.org/going3d/choosing-ophenomenon?authuser=0>.

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| **Investigating/Essential Questions** |

**Click or tap here to enter text.** Provide questions for the teacher to pose to students that require them to figure out the meaning of something. Students may come to somewhat different conclusions. The questions could serve as a brainstorming session or a quick activity wrap-up. Provide answers (or example answers) to aid the teacher.

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| **Learning Objectives** |

Using bullet points and statement form, identify up to four main goals or student outcomes of the activity. Learning objectives often come from the educational standards you chose above. Use **active** verbs such as “explain”, “calculate” or “summarize” and avoid passive verbs such as “understand”, “know”, or “realize”. For example:

After this activity, students should be able to:

* Describe the flow of electrical energy through a simple circuit.
* Discuss the effects of gravity and friction in the context of their roller coaster designs.
* Solve problems involving pressure, density and Pascal's law.
* Think and outline design iteration suggestions.

[See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#objectives)

**Click or tap here to enter your Learning Objectives.**

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| **Prerequisite Student Knowledge** |

List any skills or knowledge a student must already have in order to be successful in this activity, such as knowledge of a certain concept or topic, specific math skills, etc. Example: “A familiarity with compass directions” or “A basic understanding of gravity and friction” or “The ability to calculate median, mean, and mode.”

**Click or tap here to enter text.**

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| **Instructional Summary – 200 words** |

Summarize what your activity is all about in one paragraph using the present tense. [See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#summary)

**Click or tap here to write your Instructional Summary.**

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| **Engineering Category** |

Select one of the categories below that demonstrates this activity’s [depth of engineering content](http://content.teachengineering.org/content/documents/TE_EngrCategories_v7.pdf).

**Click here to choose a category.**

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| **Engineering Connection – 60 to 100 words** |

Describe how the scientific and mathematical concepts being studied in this activity pertain to real-world engineering. (Do not recap the activity summary.) Explain for the teacher how everyday engineering ties to what is being done in the lesson or activity. [See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#engineeringconnection)

**Click or tap here to write an Engineering Connection.**

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| **Assessment (Pre-Activity, Formative, and Summative)** |

Provide assessment tools/activities for teachers to assess the learning objectives. How do you know if the students “got it” during and after the activity? Provide active and embedded ways (formative assessment) for the teacher to gauge what students are learning about the topic/content throughout the activity, and a performance-based way to assess student understanding of the learning objectives at the end of the activity (summative assessment).

Browse the TE collection for example assessment tools and activities. [See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#assessment)

Pre-Activity Assessment

**Click or tap here to enter text.** Descriptive Title: Describe the assessment procedure so the teacher knows what to do. Include detailed sample items and/or list the name of the actual assessment that you will be attaching. .

Activity Embedded (Formative) Assessment

**Click or tap here to enter text.** Descriptive Title: Describe the assessment procedure so the teacher knows what to do.

Post-Activity (Summative) Assessment

**Click or tap here to enter text.** Descriptive Title: Describe the assessment procedure so the teacher knows what to do; if posing discussion questions, provide example answers. Include detailed sample items and/or list the name of the actual assessment that you will be attaching.

Making Sense Assessment

Have students reflect on the science concepts they explored and/or the science and engineering skills they used by completing the [Making Sense Assessment.](https://docs.google.com/document/d/1xeoj8kAu2h4OLnycDcfWBDB6oqfWRxPSPeekTqr710A/edit?ts=5f458065&pli=1)

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| **Please indicate what science and engineering practices, engineering design process steps, and engineering design thinking skills students will use in this activity:** | |
| [**Science and Engineering Practices**](https://ngss.nsta.org/PracticesFull.aspx)**:**  ❏ Asking questions (for science) and defining problems (for engineering)  ❏ Developing and using models  ❏ Planning and carrying out investigations  ❏ Analyzing and interpreting data  ❏ Using mathematics and computational thinking  ❏ Constructing explanations (for science) and designing solutions (for engineering)  ❏ Engaging in argument from evidence  ❏ Obtaining, evaluating, and communicating information | [**Engineering Design Process**](https://www.teachengineering.org/design/designprocess)**:**  ❏ Ask: Identify the Need & Constraints  ❏ Research the Problem  ❏ Imagine: Develop Possible Solutions  ❏ Plan: Select a Promising Solution  ❏ Create: Build a Prototype  ❏ Test and Evaluate Prototype  ❏ Improve: Redesign as Needed  [**Engineering Design Thinking**](https://www.teachengineering.org/design/designthinking)**:**  ❏ Formulating Problems  ❏ Seeking Solutions  ❏ Thriving in Uncertainty  ❏ Collaborating Constantly  ❏ Prototyping Ideas  ❏ Iterating Options  ❏ Reflecting Frequently |
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# **Part 2 Activity Instructional Plan**

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| **Introduction and Motivation – at least 250 words (or 1/2/ page)** |

# Begin by introducing the phenomenon or design challenge. Introduce the activity with a phenomenon, by anchoring it with an observable event. Students can be exposed to the phenomenon through a short video clip, image, hands-on experience, teacher demonstration or verbal description. Provide an engineering context. After they have a chance to observe the phenomenon, direct students to write down what they notice and wonder. Provide a discussion in which you ask your students to identify the questions that must be asked in order for them to figure out why that phenomenon occurs. The questions posed by your students should drive the instruction. Note: Be sure not to give away any answers explaining the phenomenon. [See an example.](https://www.teachengineering.org/activities/view/cub_natdis_lesson03_activity1)

# Include teacher instructions and answers in parentheses, such as: (Write the equation on the classroom board.) or ( (Possible answers: xxx, yyy, zzz.)]

# **Click or tap here to enter your Introduction and Motivation brief.**

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| **Equipment and Materials** |

Provide a bullet list of equipment and materials and the quantities needed for each group/class needs for the activity; this includes multimedia resources such as links, YouTube/Vimeo videos, etc.

We recommend providing source information, part numbers, estimated pricing, and/or links to online stores to assist teachers in finding unique items, etc. Make sure all materials and equipment are listed in the Procedure below.

Provide all measurements in **metric units**. You may also provide customary US or English units as a secondary measurement. Example, “a length of string, 2 m (~6 ft.)” For example:

Each group needs:

* 1 laptop computer
* 1 scale
* 10 g iron filings
* 1 Arduino Uno microcontroller ([available online](https://store.arduino.cc/usa/arduino-uno-rev3)) for $22

For the entire class to share:

* poster paper
* cardboard
* magic markers

**Click or tap here to enter text and follow the examples above.**

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| **Procedure** |

**Clearly explain the step-by-step procedure to follow to conduct the hands-on activity.** Make sure to include connections to engineering and address activity objectives. To clarify the activity setup and procedure, reference images throughout this section and the activity write-up. Use figure numbers if the image is referenced in the text. Include metric units. Use the following format below. [See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#procedure)

Background (for teachers only; use as a guide to help students make sense of the concepts on their own)

Clearly explain any essential background information (such as the explanation of science, engineering and/or math concepts related to the activity) the teacher may need to know to successfully complete this activity. Usually in paragraph format.

**Click or tap here to enter Background text.**

Before the Activity

* Gather materials and make copies of the worksheet.
* Describe any other pre-activity preparation here…
* Bullet format suggested.

**Click or tap here to explain the Before the Activity procedure.**

With the Students

**Step 1** or **Part 1**

1. Example: Divide the class into groups of three or four students each.
2. Describe step-by-step procedures here…
3. Numbered list format suggested.

**Click or tap here to explain how to perform the activity With the Students.**

(For images, see **Part 5: Photos and Images** below on how to properly reference and cite images in your submission.)

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| **Academic Vocabulary** | **Definitions (you may source definitions from Wikipedia or Wiktionary; )** |
| *orbit* | *The gravitationally curved trajectory of an object.* |
| *particle* | *A small localized object to which can be ascribed several physical or chemical properties such as volume, density, or mass.* |

[See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#vocab)

Click or tap here to insert a table and add text.

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| **Safety Issues** |

# **Click or tap here to enter text.** What safety measures must be considered for this activity? Examples:

# Use eye protection (goggles or safety glasses) during this activity.

# Use caution near the small flame from the sterno canned heat.

# Resulting chemical solutions are safe to dispose of down the sink drain.

# While the bacteria that occur naturally during the experiment are generally harmless, students should nevertheless wash their hands after handling the soil and vegetables.

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| **Multimedia Support or Technology Integration** |

* **Click or tap here to enter text.** Provide ideas and sources for additional information that supports the activity, such as online images, animations, videos, websites, etc. Also include suggested exceptional resources.

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| **Required Internet Materials (Redirect URL)** |

* **Click or tap here to enter text.** If your activity is dependent on a resource from a website, please include it here. Provide one URL to direct teachers to required internet materials; “Attention: This activity requires the following resource: (insert URL here)”.

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| **Troubleshooting Tips** |

**Click or tap here to enter text.** Think through likely common snags that might be encountered while conducting the activity. Suggest solutions, approaches to avoid pitfalls, etc. What should you consider if the activity does not work right the first time? What could you change?

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| **Worksheets and Attachments** |

List the names of any documents you will use as part of this activity such as **presentations, handouts, assessments, coding language**, etc. Please also provide **answer keys** for all handouts/assessments. **Upload these documents separately along with this template.**

Clearly label each activity and include the activity name in the file (for example, all-about-bridges-homework-assignment.docx. TeachEngineering accepts most files in an **editable format** including Microsoft Word (.docx) Microsoft Excel (.xlsx) Microsoft PowerPoint (.pptx), JPEG files (.jpg) and Portable Network Graphics (.png) and others. If you have any questions, please contact your editors at TeachEngineering.

[See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#attachments)

1. Click or tap here to enter text.
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# **Part 3: Supporting Activity Information**

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| **Extensions** |

**Click or tap here to enter text**. Provide suggestions of additional activities that explore the activity topic further, and suggestions for thought-provoking questions for students in the weeks ahead. [See an example.](https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2#extensions)

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| **Scaling** |

**Click or tap here to enter text.** Explain modifications or suggestions to activities that would make them more or less challenging for use at various grade levels, For example: reducing or increasing the number of redesign steps, shorter time period to complete the activity, graphing the collected data, etc. Example lead-ins:

* For lower grades,
* For younger students,
* For upper grades,
* For older students,
* For more advanced students.

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| **References** |

List all references used to create the activity, especially the background knowledge section.

Use this modified MLA format (see below). Provide in A-to-Z order according to authors’ last names or website

banner page name, whichever appears first in citation.]

**For books:** Lastname, Firstname. Book Title. City, ST: Publisher Name, year.

**For websites**: Author(s) [Lastname, Firstname]. BannerPageName. LastUpdated/Posted/RevisedDate. OwnerName,

**Organization**. Accessed date. <http://www.colorado.edu> – examples below:

Dictionary.com. Lexico Publishing Group, LLC. Accessed September 15, 2016. (Source of some

vocabulary definitions, with some adaptation) http://www.dictionary.com

National Data Buoy Center. Last modified May 10, 2015. Center of Excellence in Marine Technology,

NOAA. Accessed September 15, 2016. (Source of much teacher background information; also excellent

interactive map of buoy locations around the world) http://www.ndbc.noaa.gov/

**For magazine articles:**

Doe, Juanita Q. “Title of Article.” Magazine Name. July 2014, pp. 32-40. URL if available.

**For journal articles:**

Doe, Jon R. “Title of Article.” Scholarly Journal Name. (1999) Vol. 3, No. 6, pp. 112-28. URL or DOI number.

**Click or tap here to enter text.**

# **Part 4: Contributor, Supporting Program, Acknowledgements, and Classroom Testing**

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| **Contributors** |

**Click or tap here to enter text.** List the names of any person who participated in the development of this activity (teachers, mentor, lab director, education staff, etc.). List the primary author first.

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| **Classroom Testing Information** |

Briefly describe the K-12 classroom or informal learning center testing conducted with this curriculum. Please include the date, school, location, grade level, and number of students.

**Click or tap here to enter Classroom Testing Information.**

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| **Supporting Program** |

**Click or tap here to enter text.** If this instruction was developed as part of a special program, list the name of the supporting program and/or organization.

Example: Research Experience for Teachers (RET), Center for Bio-mediated & Bio-inspired Geotechnics (CBBG), in partnership with Arizona State University, Georgia Institute of Technology, New Mexico State University, University of California-Davis, and the National Science Foundation.

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| **Acknowledgements** |

**Click or tap here to enter text.** This curriculum was developed under National Science Foundation RET grant number ABC-XXXXXXXX. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

# **Part 5: Photos and Images**

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| **Activity Photos** |

**TeachEngineering requires a minimum of two original photos per activity.** This helps teachers visualize the nature of the activity. We don’t expect nor require expert photos—smartphone photos work fine! However, we would like to see how teachers and students engage in the activity. (There are five placeholders below for photos, but we encourage you to add as many as you like.)

You may supplement your images with additional content sourced from the internet as long as they are licensed for public use (see [Requirements and Tips for Using Images](https://www.teachengineering.org/content/documents/TEAboutImages_v8.pdf)). Note: if authors plan on submitting photos that include their students, the author is responsible for securing the appropriate permissions from parents, guardians, or administrators. TeachEngineering classifies photos into two categories:

**Images** are photos or illustrations that enhance the activity’s visual appeal. Reference where you want the image to go in the activity by simply saying **(Insert Image 1)** in the text above and attach the photo in a box below.

**Figures** may be photos or illustrations as well as diagrams or drawings that specifically reference a topic within the text. For example, in explaining the parts of a cell or how a suspension bridge works, a figure may reference that explanation. Figures may also be used to help explain how to build a tool or a machine. Reference where you want the image to go in the activity by saying **(Insert Figure 1)** in your text above and attach the photo in a box below.

 How to format images and figures; see below for a finished example:

**Image 1:** Insert into Procedure under “Day 1”

**Image file**: lesson01-image1-prism.jpg

**ADA Description**: A glass prism sits on a black background; a light source shining through the prism is demonstrating refraction of white light into the visible light spectrum.

**Source/Rights**: 2009 D-Kuru, CC BY-SA 3.0, Wikipedia, [source link](https://en.wikipedia.org/wiki/Prism#/media/File:Light_dispersion_of_a_mercury-vapor_lamp_with_a_flint_glass_prism_IPNr%C2%B00125.jpg).

**Caption**: Why does white light diffract into the colors of a rainbow when it shines through a prism?

**Click the center of the box below to upload an image.**

**Image 1 / Figure 1:** *Enter the location of where you want the image or figure in the text by saying* (Insert Figure 1) *here*.

**File name:** *The photo must be included as an attachment and must have the exact same name as you type here.*

*Example: lesson05-image1-pilot.jpg*

**ADA Description:** *Write this text as if describing key elements of the image to a blind person.*

**Source/Rights:** *Include copyright or identifying information for any images used. Images pulled from the Internet should be either in the public domain or licensed for use through Creative Commons (CC-BY or CC-SA); you must still attribute them to the person or website from which they were pulled as well as provide a* ***direct link*** *to the image.*

**Caption:** *This text will appear directly below the Image. This should not be the same text as used for the ADA Description.*

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**Image 2 / Figure 2:** *Enter the location of where you want the image or figure in the text by saying* (Insert Figure 1) *here*.

**File name:** *Example: activity05-image1-pilot.jpg*

**ADA Description:**

**Source/Rights:**

**Caption:**

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**Image 3 / Figure 3:** *Enter the location of where you want the image or figure in the text by saying* (Insert Figure 1) *here*.

**File name:** *Example: activity05-image1-pilot.jpg*

**ADA Description:**

**Source/Rights:**

**Caption:**

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**Image 4 / Figure 4:** *Enter the location of where you want the image or figure in the text by saying* (Insert Figure 1) *here*.

**File name:** *Example: lesson05-image1-pilot.jpg*

**ADA Description:**

**Source/Rights:**

**Caption:**

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**Image 5 / Figure 5:** *Enter the location of where you want the image or figure in the text by saying* (Insert Figure 1) *here*.

**File name:** *Example: activity05-image1-pilot.jpg*

**ADA Description:**

**Source/Rights:**

**Caption:**

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| **Submission Checklist** |
| This material has been tested in a K-12 classroom or out-of-school setting.  **(check here)**  The submitted curriculum is my own original work. (Note: Submissions will be checked for originality via [TurnItIn](https://www.turnitin.com/).)  **(check here)**  All activity and lesson template files as well as their associated handouts, images, presentations or other files are ready to upload as a single ZIP file, organized into folders within the ZIP file to clarify which handouts go with which lessons and activities.  **(check here)**  Image files and attachments (such as student handouts) are included as separate files in the ZIP file. (Note: Make sure images are inserted both in the template to show where they belong as well as submitted as separate image files, as described in the [Requirements & Tips for Using Images](https://www.teachengineering.org/content/documents/TEAboutImages_v8.pdf) on the [Submit Curriculum](https://www.teachengineering.org/getinvolved/submitcurriculum) page.)  (check here)  Curricula meets all of the requirements of the [K-12 Content Review Rubric](https://www.teachengineering.org/content/documents/TE_K-12_reviewcriteriarubric_v4.pdf) on the [Submit Curriculum](https://www.teachengineering.org/getinvolved/submitcurriculum) page.  **(check here)**  Curricula submitted lends itself to phenomena-based learning and students making sense of phenomena/engineering design problems (see NGSS Phenomena resources on the [Submit Curriculum](https://www.teachengineering.org/getinvolved/submitcurriculum) page.  **(check here)**    Submitted curricula fits into one of the TE engineering categories as described in the [TE Engineering Categories Description](https://www.teachengineering.org/content/documents/TE_EngrCategories_v7.pdf) on the [Submit Curriculum](https://www.teachengineering.org/getinvolved/submitcurriculum) page.  **(check here)** |