THE INTERNATIONAL EXHIBITION OF

SHERLOCK HOLMES

Curious Contraptions

Pre-Exhibit Field Trip: Grades 6-8

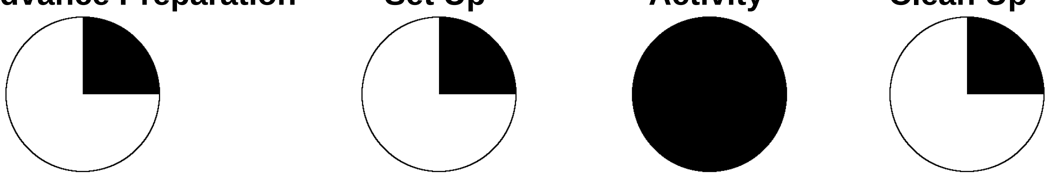
In this engineering design activity, students will design, test, and build a "haunting machine" to solve a Sherlockian mystery.

LEARNING OBJECTIVES

- Students will experience the engineering design process, including the importance of planning, creating a prototype, recording data, and making improvements to an original design
- Students will practice using open ended problem-solving skills

TIME REQUIRED

Advance Preparation	Set Up	Activity	Clean Up



15 minutes the day before	15 minutes	50-60 minutes	15 minutes

PROGRAM FORMAT

Segment	**Format**	**Time**
Introduction	Large group discussion	5 min
Design, Test, Improve	Partner Activity	35-45 min
Wrap-Up	Large group discussion	10 min

SITE REQUIREMENTS

- A room with plenty of floor space is preferred (i.e., a cafeteria, gym, multi-purpose room, etc.). It is helpful to have tables and/or chairs so that students may incorporate height and the pull of gravity into their designs.

NEXT GENERATION SCIENCE STANDARDS

Practices
1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
6. Constructing explanations and designing solutions

Crosscutting Concepts
1. Patterns
2. Cause and effect
4. Systems and system models
5. Energy and matter
6. Structure and function

Disciplinary Core Ideas

	Grade Level:	MS	HS
	Physical Science		
PS1	Matter and Its Interaction		
PS2	Motion and Stability: Forces and Interactions	✓	
PS3	Energy	✓	✓
PS4	Waves and Their Applications in Technologies for Information Transfer		
	Life Science		
LS1	From molecules to organisms: Structures and processes		
LS2	Ecosystems: Interactions, Energy, and Dynamics		
LS3	Heredity: Inheritance and Variation of Traits		
LS4	Biological Evolution: Unity and Diversity		
	Earth & Space Science		
ESS1	Earth's Place in the Universe		
ESS2	Earth's Systems		
ESS3	Earth and Human Activity		
	Engineering, Technology, and Applications of Science		
ETS1	Engineering Design	✓	✓

Topics: Physics, Engineering Design

SUPPLIES

Permanent Supplies	Amount	Notes
Scissors	1 per group	
Stopwatches or clock	1 per group	Could use classroom clock with a second hand

Consumables	Amount	Notes
Fasteners	Equal amounts per group	Velcro, twisty ties, rubber bands, or similar
Tape (optional)	1 roll or a set amount per group	See note about tape below
Building supplies*	A few of each item per group	See suggested items below

*Many common classroom supplies and recyclables can be used as building supplies in this activity. The ones listed below are only suggestions to give you ideas.

Possible Building Supplies:

- Pipe cleaners
- Rubber bands
- Popsicle sticks
- Straws
- Scrap paper
- Plastic containers (yogurt tubs, water bottles, soda bottles, etc.)
- Scrap cardboard
- String or yarn
- Various size balls (marbles, bouncy balls, tennis balls, ping pong balls, etc.)
- CD jewel cases
- Books
- Dominoes
- Funnels
- Cups (paper or plastic)
- Plastic spoons
- Aluminum foil
- Paperclips
- Toilet paper and paper towel tubes
- Newspaper
- Any other items you can imagine!

A Note on Building Supplies:

When we think of engineering activities for the classroom, it is hard not to think of a huge mess. Piles of craft sticks and puddles of glue or balls of tape and newspaper are not only messy, but also wasteful and expensive. There are some methods you can employ to avoid these problems.

- **Reduce, Reuse, Recycle:** Make sure it is in that order! Encourage your students to use fewer materials by providing a limited amount of materials to start with or by using a budgeting system to encourage the frugal use of materials. Try to eliminate materials or processes that cannot be easily reused for future activities. Collect materials such as soda bottles or paper towel tubes for reuse. If a material cannot be reused, make sure it is recyclable at the end of the activity.

- **Limit Tape and Glue:** These are the two usual suspects of waste. Every teacher has seen students use miles of tape to hold something together when a few inches would have sufficed, and perhaps a few elastic bands would have worked even better. Tape can almost never be reused and can rarely be recycled. The expense quickly adds up, too. Glue can also create waste, because it often prevents the glued materials from being reused or recycled. It is also expensive, messy, and can be replaced in most applications by the clever use of elastic bands.

- **Use Constraints:** In the classroom, students will be constrained by the materials you provide them as well as how the materials are provided. Giving students full access to materials allows them to focus on their design and may encourage more testing and modifications. However, this free rein will also usually lead to students using more materials. By placing limits on the materials your students can use, you can prevent wasteful behavior. As an additional benefit, working with limited resources will force students to think through their plans more carefully. This methodology helps achieves your learning outcomes while also saving money, minimizing mess, and reducing waste.

ADVANCE PREPARATION

Previous Class:

❑ To give students a solid foundation and plenty of inspiration for this lesson, it will be useful for them to be familiar with Rube Goldberg machines before beginning the lesson. In the days before teaching this lesson, you may choose to assign students to collect information on Rube Goldberg and his imaginary inventions. Have the students write a paragraph on what a Rube Goldberg machine is, their favorite example of one, and what kind of Rube

Goldberg machine they would like to invent. You may also choose to have students view videos of real-life Rube Goldberg machines either at home or together in class. For example videos, see the Resources section (page 18).

- You may also wish to introduce Sherlock Holmes to the class if students are not yet familiar with this literary character. Students may read one of the original stories or watch an episode of one of the many television shows inspired by Sherlock Holmes. Ask students to pay attention to how Sherlock uses the scientific method to make observations, form a hypothesis, gather data, and draw conclusions.

Building Supplies:

- It may be helpful in the days or weeks before teaching this lesson to set out a collection box for students or co-workers to donate building supplies. Ask for common recyclable materials such as cardboard boxes, plastic yogurt containers, Styrofoam, film canisters, soda bottles, or other similar supplies (washed and clean, of course!). Offering a wide variety of materials will ensure that students can be creative with their designs.
- See the note on materials (page 8) and decide how the supplies will be distributed.

Group Dynamics:

- This activity will be more successful if you put some extra thought into how the student groups are formed. See the Working in Groups section of the Background Information (Page 16) for suggestions on forming student groups.

SET UP

Design, Test, Improve

For each student group:

- Scissors
- Tape (optional)
- Fasteners (Velcro, twisty ties, etc.)
- Stopwatch or clock

At a central location (or with the teacher):

- Wide variety of building supplies

INTRODUCTION

5 minutes

Notes

Let students speculate before offering answers to any questions. The answers given are provided primarily for the instructor's benefit.

Suggested script is shaded.
Important points or questions are in bold.
Suggested answers are in italics.

Begin by reading the following story to the students and then presenting them with their challenge:

Sherlock Holmes' latest client is Percy Carlisle, a very nervous man who is convinced that his house is haunted.

"I hear strange noises at night," said Carlisle, "and once, as I was walking past the parlor, I saw a strange object moving across the floor. But there was no one inside the room! It was so eerie that I haven't entered the parlor since." Carlisle mopped his brow with a handkerchief.

"I am at my wit's end, Mr. Holmes. A neighbor of mine has offered to purchase the house, and I am resolved to sell it to him, but I have come to you as a last resort. I can see only two explanations: either my house is haunted, or I have gone insane."

"I suspect there is a third explanation," said Holmes. "Your neighbor is determined to purchase your house, so he devised a contraption, activated by a single touch, that moves on its own and produces the noises that you hear. By the time you investigate the noise, the man has disappeared and the machine is in motion."

"Is such a thing possible?" asked Carlisle, astonished.

The Challenge
Is Sherlock correct? Can you create a device similar to the one being used to haunt this house? Your device can make noises or move objects across the room.

You must follow two rules when designing your machine:
1. It must be set in motion with a single touch.
2. It must continue to "haunt" for as long as possible.

What is a Rube Goldberg machine? *A Rube Goldberg machine is a contraption that takes many often comical, overly-complex steps to perform a simple task.*

Will a Rube Goldberg machine always work on the first try? *It can take many tries before coming up with a design that will work. Rube Goldberg machines depend on each component of the machine working in order for the task to be completed; if one section does not work, the rest of the machine will usually fail.*

What do you think you should do if you get frustrated when creating your design? *Stop, take a break, and relax. Then look at neighbors' designs to get ideas or ask a friend for help. Have a positive attitude!*

Is it OK to use your neighbors' ideas? *Yes! Engineers often take existing ideas and improve on them, or find a new use for an old design. You are encouraged to look at what your neighbors are doing and use their ideas - it might just lead to an even better idea! When you tell us about your designs, be sure to give credit to your neighbors!*

Discuss with students how their designs will be graded. Students should be assessed based on how persistent they are through the testing process, not on how well the machine actually works.

PARTNER ACTIVITY

Design, Test, Improve

35-45 minutes

Students should work in groups of 3-4 students, depending on class size and the amount of building supplies.

The students' challenge is to make a Rube Goldberg-style haunting machine that will make noise or move objects for as long as possible. You may also choose to give the students a more specific challenge such as make three different objects move or make two different sounds. Consider offering awards for the longest machine, the spookiest machine, the most creative design, etc.

Materials

Explain how the students will be allowed to use materials. Possible ways to distribute the materials include:

1. Give each group a set number of each item.
2. Create prices for each item and let students purchase supplies using a budget.
3. Allow students a certain number of items (i.e., 20), but let them choose which items they would like. Allow students to trade items with other groups or with the “bank” at the front of the room.
4. Set out all materials and allow students to take what they need when they need it.
5. Allow students to use whatever materials their group brings in and trade with any groups that agree to a trade.

Use whatever method you think would work best for your students and with the materials you have collected. Make sure to set clear ground rules and expectations for students.

Planning

- Have each group spend 1 minute silently looking at the supplies and thinking of designs. During this first minute of brainstorming, there should be no building or talking.
- Give students 5 minutes to discuss and sketch design ideas with their group. There is still no building at this point.

Building

- Give students 10-15 minutes to begin building their haunting machines.
- Encourage students to build the most finicky parts of the machine at the beginning and the more reliable parts toward the end. This method saves a lot of setup time in between trial runs.
- Younger or inexperienced students may need some hints on how to use the materials to create their machines. Avoid showing these students specific ideas of what to build. Instead, encourage them to think about each section of the machine separately. Ask them questions such as:
  - What do you want this section to do?
  - What parts need to move to make it work?
  - What will set those parts in motion?

- How can this section be connected to the next section to set it in motion?

Testing

- Have students test their prototypes, timing how long the prototypes "haunt". Be consistent with the number of tries each team gets and when you start and stop the stopwatch. Typically, time should start after all hands are off the machine and stop after the last object stops moving.
- All groups should watch as each prototype is tested and timed. This process will give struggling groups ideas on how to improve their design. Encourage students to use ideas from other groups.

Provide an additional 10-15 minute building period to see if the students can improve on their designs and make their haunting machines work even longer. Repeat as necessary to fill your allotted activity time.

WRAP-UP

10 minutes

Ask for student observations. There is no correct answer. Let students guide the discussion and present their hypotheses before discussing explanations.

Tell us about your design. *Ask specific questions about the number of steps they created for their machine, how they decided on a specific design, or if they tried to improve on any of their neighbors' ideas. This is also a good opportunity to talk about how the students used the materials. Ask how they improved their design after the first testing step.*

Did you have enough materials? *Students may point out that they ran out of one or two specific materials. Ask how they overcame the shortage. Ask what kind of supplies students think would have been available in Sherlock's time. What could have been used instead?*

What would you have done if you had more time to work on your machine? *Answers will vary from adding more paths to fixing parts that did not work during testing.*

Groups testing later in the order may reference other teams' designs. Use this opportunity to talk about how engineers do and do not share their designs and the role of "tinkering" in invention.

What were some of the most successful designs? What made them successful? *Answers will vary depending on your classes' designs. Be sure to relate student answers back to the original story. What parts of the machines would have been the spookiest to Mr. Carlisle?*

How could every machine be strung together to create an even longer haunting machine? *Answers will vary. Encourage students to think about how the last step of one machine could be changed to activate the next machine.*

CLEAN UP

Safety and Disposal Information

- Recycle or save materials for future use.

OPTIONAL EXTENSIONS

CLASSROOM-SIZED RUBE GOLDBERG MACHINE

Linking Machines
Have students design a first step for their machines that will allow each machine to be set it in motion by a rolling ball. Tell the students to design a final step for their machines that causes a ball to roll. After each group has completed these two additions to their machines, the entire class will be able to link their machines together so that each machine's final step activates the next machine. This activity will require a minimum of two balls per group. Ideally, the balls should all be the same size and type. Tennis, golf, or racquet balls may work well.

DRAW YOUR OWN CARTOON

Comic Artwork
After viewing a few of Rube Goldberg's famous comics, have students design and draw a mechanism that would solve a problem in their own life.

SIMPLE MACHINES

Deconstructing Machines
After a lesson on simple machines, have students either identify the simple machines they used in their designs or add simple machines to their contraptions. Alternatively, have students identify the simple machines used in one of the example real-life Rube Goldberg machine videos listed in the Resources section (Page 19).

BACKGROUND INFORMATION

This background information is for teachers. Modify and communicate to students as necessary.

History of the Rube Goldberg Machine

Rube Goldberg was a Pulitzer Prize-winning cartoonist, sculptor, and author who lived from 1883 to 1970. He started his career in engineering, but quickly left the field to become an office boy for the *San Francisco Chronicle*. While working, he submitted drawings and cartoons to the editor until finally, one day, his work was published. His cartoons often depicted some complicated contraption that usually accomplished a very simple goal such as moving a ball or turning out a light. As Goldberg himself put it, his cartoon inventions were a "symbol of man's capacity for exerting maximum effort to accomplish minimal results."

After building credibility, Goldberg began publishing his cartoons in the *New York Evening Mail* and his fame grew. Although he never actually built the machines that he drew, many of Goldberg's machines served as inspirations for other people to build similar contraptions. Shortly after his death, the Smithsonian Museum of History and Technology (now the National Museum of American History) debuted the exhibit "Do It the Hard Way." This exhibit featured more than a hundred drawings, song recordings, sculptures, and several bigger-than-life Rube Goldberg machines.

Every year there is a national Rube Goldberg contest, in which groups attempt to create the most creative and complicated machines. This annual tradition has challenged numerous college and high school students to perform simple tasks like popping a balloon or sharpening a pencil in the most complex ways.

The Engineering Design (ED) Process

Similar to scientific inquiry, Engineering Design (ED) is a process. When integrated effectively, the design process can make classroom activities more engaging and relevant, while increasing students' problem solving skills. The Next Generation Science Standards have recognized the importance of the engineering design process by integrating ED practices throughout the standards.

So, what is the Engineering Design process? In the world of professional engineers, the answer depends on context. Similar to the scientific inquiry process, there is no universally agreed-on, concise definition and the process is not necessarily linear. Instead, ED is more accurately described as a system of processes for solving problems. Different types of engineers use different processes, as do different corporations. Different state and national organizations also have different definitions. The definition of the process also gets more layered as students move through their education. However, there are some agreed-on necessary components of ED, including:

- Defining the problem
- Developing a solution
- Evaluating solutions
- Presenting your solution to an audience

Define the Problem
Benjamin Franklin's phrase 'Necessity is the mother of invention' is a perfect example of how the engineering process begins. Someone somewhere recognizes a need. The need could be a better way to bring water to fields in rural Africa or a smaller personal electronic device for listening to music on a bus. The problem may be identified by someone else, but the engineers are the people who dive in and find the solutions. Often, the problem may not be fully articulated and the engineers must work to get to the true root of the problem.

In the classroom, you may provide your students with the problems or needs they are to address. A design challenge is a common tool used to drive innovation. In a design challenge, a very specific need is posed, usually with some specific criteria for success.

Often, the problem you set forth (or that the students develop on their own) is the hook you can use to draw your students in. There are two sub-processes that are a part of defining the problem: identifying constraints and identifying criteria.

- **Identifying Constraints**
  Often, criteria can get confused with constraints. While criteria define the characteristics of a successful design, constraints set the limitations within which an engineer must work. The most common constraints are time and money. However, there may be limitations on size (minimum or maximum), the materials one can use, location, or other requirements specific to the challenge at hand.

  At first glance, it might seem that increasing constraints would make an activity more challenging. While you can use constraints to make simple activities more complex, in some cases constraints can help provide some much-needed guidance. Especially early in their engineering work, your students may become overwhelmed with too many options if you provide a vast array of materials and tools. Being intentional with the materials you provide can help students decide on a design quickly and may encourage creative uses of materials.

- **Identifying Criteria**
  Identifying criteria is the process of determining your measures of success. Using bridge design as a classic example, one rather obvious

criterion is that the bridge must completely cross a river. A bridge halfway across a river would be unsuccessful and likely be the last project an engineering firm is offered.

There are many other criteria for the success of bridges, however. The bridge needs to hold a certain amount of weight; it needs to withstand wind and earthquakes; vehicles and/or pedestrians need to be able to make it across - usually in both directions and often with multiple lanes; the bridge may need to lift up to accommodate tall boats passing beneath.

Discussions about criteria are an excellent opportunity to talk about how engineers must remain mindful of users when developing solutions. For example, pedestrians may be less likely to use a multi-use path if they perceive it as dangerous or are surrounded by the noise of traffic on all sides.

Most importantly, remind your students that the criteria for their engineering project are not necessarily the criteria you use for grading. The fear of failing to meet all of the criteria for the challenge deters students from taking risks and pushing the limits of their creativity. A team of students that clearly understands and applies the relevant science concepts as they work through the design process deserves grades that reflect their effort, regardless of the success of their design.
In our activity, the criteria for success were that the machine be activated by a single touch and that it “haunt” for as long as possible. Discuss with students if there should be other criteria for the machine.

Developing a Solution
During this stage, students are actively working on solutions to the identified problems. This stage of the process is often the most exciting, frustrating, and rewarding. It often includes the hands-on building of models, prototypes, or other physical objects, but it also includes all the planning and design required for construction.

There are two general approaches to this stage. Some students may prefer to think through their design in a very organized format. Others may prefer to ‘just do it’ by grabbing materials and trying things out. Both styles have their strengths and weaknesses. Encouraging your students to learn the strengths and weaknesses of each style is a very valuable lesson.

A team of students that thinks through their design fully before trying anything is typically displaying a better understanding of the ED process and any related scientific content. Often, teams will have discussions about criteria and constraints while they sketch out solutions before touching any building materials. The downside of this approach is that teams may spend too much time working out their design and end up without enough time for testing and refining.

The other approach embraces the idea of ‘failing early.’ Here, students may grab a handful of materials and begin tinkering. This process often produces some interesting ideas and leads to lots of refining of ideas. Activities with wide-open criteria and constraints encourage this type of experimenting. On the negative side, students who tinker may do so independently of their team, creating several different solutions within a single team. This approach may also use more raw materials, as students try and fail more often.

Testing and Refining
As with many parts of the process, testing and refining solutions is heavily integrated with the development phase. There are typically many ‘back to the drawing board’ moments during the process, and designs are constantly being adjusted to improve performance.
The key to testing is data. As your students are collecting data, encourage them to keep a log of the small and large changes they make to their design. Revisions to their designs should be made one at a time, so they can easily see the influence their changes have on the performance of their design. This methodology is equivalent to changing only one variable at a time in a scientific investigation. This technique also allows students to ‘rewind’ their design if the revisions have a negative or even neutral effect.

Evaluating Solutions
This part of the process refers back to the initial criteria. If a design does not meet the defined criteria for success—if, in our case, the machine fails to start with a single touch—the engineers have more work to do. Again, data are central to this process. Evaluations of a design are often based on analyzing data collected during the testing and refining phases. The fact that students are able to interpret the data they gather is arguably more important than the ability to collect the data. This ability is tied closely to how the data are presented.

Facilitating Learning
In a climate where test scores and grades are central to how students measure their success, one of the most critical parts of an engineering lesson is encouraging your students to be comfortable with “failure.” Their idea for a solution may not work, but often the knowledge of what does not work is just as valuable as an instant success. There are many stories of inventors working tirelessly with disastrous or imperfect results, before finally finding the best solution. There are also plenty of stories of inventors who never achieved the solution they were looking for. Often, another engineer would solve the problem by looking at the work done by these struggling predecessors, sometimes generations later.

But how does this process translate into the classroom? First, create an environment in which students are encouraged to develop their ideas, no matter how outrageous they may sound. This does not mean allowing students to take each crazy idea to full prototype, but try to avoid pointing out any obvious flaws in those crazy ideas. Encourage the students to think through the idea more fully, to draw sketches or do more research. Hopefully, the students will discover flaws on their own, but if they do not, let them try. Spectacular failures are often great teachable moments.

Although failing can be an important part of the ED process, in a results-oriented environment such as a school, not finding the solution can make some students anxious. Assure the students that you will be grading them on the process they go through and not on their results. A major part of that process is examining results and making recommendations. Taking this into account, the only way students could fail would be to give up and stop making attempts to modify their design.

As your students work to solve the problems in front of them, they will often work independently within their groups. As a facilitator, your role is to help the students articulate what they are working on. Check in with groups regularly to ask them to describe what they are working on. Not only does this methodology give you a chance to assess their progress, it also forces students to self-assess their solution. Finally, asking your students to regularly describe their process will provide practice for when they need to communicate their final recommendations.

Working in Groups

A common misconception is that engineering is a solitary process, carried out by individuals working in isolation. However, engineering is almost entirely team-based. While specific individuals may work on small deliverables, their efforts contribute to larger team-based projects. Group work is a necessary part of the process for engineers and will contribute to social learning for your students.

Students may gravitate toward particular roles when they work in groups. One member may assume a leadership role in the group, while another may be content to take on the majority of the construction. While this fact is an accurate representation of how engineering teams operate in the workplace, it is important to give students the opportunity to rotate through a variety of roles over time in order to build a broader understanding of engineering teams. Ensuring that each student is taking part in the process in a way that is personally challenging and rewarding is not always easy.

In particular, it is important to encourage a wide range of individuals to take on leadership roles. As you get to know your students, identify those who naturally assume the role of group leader and those who to sit back and follow. Try shifting the students out of their comfort zones by placing them in groups with other students with similar dispositions. A group comprised entirely of students with leadership tendencies may struggle initially as they learn the fine art of following and how to work in a support role. The students less inclined to leadership roles may find that it is easier for their voices to be heard and will often step up to the challenge.

There are several explicit strategies you can mix and match to make working in groups a positive experience and a valuable addition to your curriculum.

1. ***The whole group works together on each part.*** In this format, the educator actively encourages the groups to avoid taking on roles. Instead, each element of the process must be done by consensus.
   Pros: each student gets to try different parts of the process; no complaints about wanting a different role; requires little planning by the educator or groups of students; can provide insight into areas where students need more experience or subjects that students are particularly interested in.
   Cons: requires regular check-ins by the educator; feels less authentic; students have less ownership over specific parts of their work; less room for individual approaches.

2. ***Student-selected roles.*** Here, the students can decide within their groups what parts of the process they would like to work on.
   Pros: allows students to focus on their interests and strengths; provides excellent experience with team-based work and group dynamics.
   Cons: may create conflicts about who has specific roles; some roles may be undesirable; students may not gain as much experience in the roles they do not select; may require extra time for the students to work out the roles.

3. ***Assigned roles.*** There are many variations to this approach, from selecting just the team captain to specifically selecting each team member and the roles they will assume.
   Pros: allows for a rotation system, giving students the opportunity to work in different roles; assigning teams based on known personalities may reduce conflicts.
   Cons: less student control; may require more preparation by the educator; may create disappointment in assigned roles.

Most importantly, remember to include group dynamics as part of your discussions following the activity and in your assessments of how the students performed during the activity. Some sample questions you may wish to include:

- How was your team successful?
- What challenges did your team face?
- How did your group divide the work between members?
- What was it like acting as the (insert role)?

The groups could also conduct a group or self-evaluation that you collect after the activity to gain insight on what worked and did not work for the students.

CROSS-CURRICULAR CONNECTIONS

HISTORY

Ghost Stories
Have students research the era of the Sherlock Holmes stories (late 1800s to early 1900s). What did people think about ghosts at this time in history? What are some ghost stories from Victorian London?

LANGUAGE ARTS

Sherlock Stories
Watch *The Case of the Haunted Gainsborough* (http://www.hulu.com/watch/106663) or read *The Adventure of the Sussex Vampire* to see Sherlock Holmes in action as he debunks the mystical beliefs of his peers.

CAREER CONNECTION

Haunted House Tour
Try to arrange a behind-the-scenes tour of a real life haunted house. There are some amazing contraptions engineered for some haunted houses and seeing how these contraptions work would be a very memorable experience for students.

RESOURCES

Web

Engineering Design Process
NASA has provided a great overview of how the engineering design process works. Details for each step are provided and the overview focuses on the design of a lunar plant growth chamber.
http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html

Engineering is Elementary
The Museum of Science in Boston developed one of the leading engineering curricula in the nation. Twenty units connect engineering process activities to science topics, while storybooks provide context and offer cross-curricular connections to language arts and cultural studies.
http://www.eie.org/

Kids Invent!
Provides innovation-based learning kits for students ages 7-15.
http://www.kidsinvent.com/

Books

Dr. Ed Sobey's books
Dr. Ed Sobey is the author of more than 20 books about technology, innovation, and education. He provides professional development workshops around the world. The following link is to Amazon where his books are available for purchase.
http://www.amazon.com/Ed-Sobey/e/B002N2HSYO

Video

Honda Cog
This two-minute advertisement features a Rube Goldberg machine designed from car parts.
http://www.youtube.com/watch?v=_ve4M4UsJQo

Ok Go: This Too Shall Pass
Not just an ordinary music video, this video will leave students imagining what they can create.
http://www.youtube.com/watch?v=qybUFnY7Y8w

2D Photography Rube Goldberg Machine
This advertisement, for a photography studio, took the form of a Rube Goldberg machine using only photography equipment and cameras!
http://www.youtube.com/watch?v=qKpxd8hzOcQ

GLOSSARY

Contraption	A machine or device that appears strange or unnecessarily complicated.
Engineering	The branch of science and technology concerned with the design, building, and use of engines, machines, and structures.
Innovation	The process of thinking of and creating a new method, idea or product.
Prototype	A first or preliminary model of something, from which other forms are developed or copied.
Rube Goldberg Machine	A machine that is a deliberately over-engineered to perform a very simple task in a very complex way.
Tinkering	Attempting to create, repair, or improve something in an informal way.

SUPPLY WORKSHEET

Curious Contraptions

Recommended group size: 3-4

Number of Students: ☐ Number of Groups: ☐

Supplies	Amount Needed	Supplies on Hand	Supplies Needed
Scissors	1 per group		
Stopwatches or clock	1 per pair (or 1 on a classroom wall)		
Fasteners (Velcro, twisty ties, rubber bands, etc.)	1 roll or 2 handfuls per group		
Building supplies (See note in Supplies Section on Page 4)	A few of each item per group		
Tape (optional)	1 roll or a set amount per group		