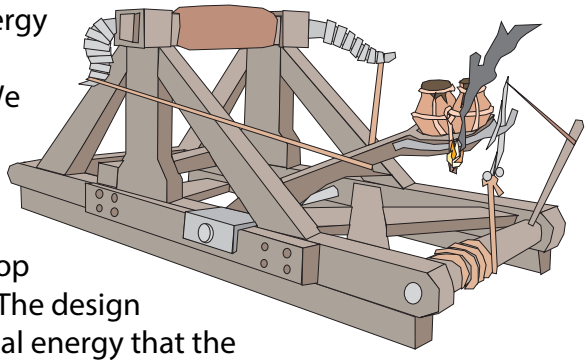
Loading a Launcher



Background: During our study of moving objects, we have learned about the conservation of energy and how it ensures that the energy in a system remains constant. If an object is at rest, then it has potential energy, and as it begins to move, that potential energy transforms into kinetic energy. We can use this energy to our benefit by creating machines that make our lives easier and more enjoyable. Engineers use kinetic energy and potential energy in a system to improve and build more effective machines.

Design Challenge: Design and build a projectile launcher. As practicing engineers, you will develop and test your launcher so that it demonstrates the concepts of both potential and kinetic energy. The design needs to have an arm to launch an object (marshmallow) into motion, thus illustrating the potential energy that the object possesses before launch and the kinetic energy that the moving object possesses during flight.

Criteria:

- ☐ Your launcher must stand alone and be portable.
- ☐ You must have a moveable arm to show potential energy.
- ☐ Your launcher must hold marshmallows of various sizes.
- ☐ You may not touch the marshmallow once it is loaded on the launcher.

Materials: Select from the list below.		**Tools:** Select from the list below.
• binder clips • bottle tops • cardboard rolls • craft sticks (various sizes) • duct tape or electrical tape • marshmallows (various sizes)	• paperclips • paper cups • rubber bands (various sizes) • shoeboxes or tissue boxes • straws	• low-heat glue gun • safety goggles • stopwatch • yardsticks or meter sticks

Targeted Standard of Learning: Science 4.2
Supporting SOL: Mathematics 4.1, 4.7

Targeted Standard for Technological Literacy: 16
Supporting STL: 1, 2, 8, 9, 10

Tips for Teachers

Targeted Standards of Learning:

Science 4.2 The student will investigate and understand characteristics and interactions of moving objects. Key concepts include
a) motion is described by an object's direction and speed;
b) changes in motion are related to force and mass;
c) friction is a force that opposes motion; and
d) moving objects have kinetic energy.

Supporting SOL: Mathematics 4.1, 4.7

Targeted Standards for Technological Literacy:

16 Students will develop an understanding of and be able to select and use energy and power technologies.
Supporting STL: 1, 2, 8, 9, 10

Prior Knowledge & Skill	Materials & Preparation	Safety Issues	Class Management	Materials Provided	Design Process
• Potential and kinetic energy • Measurement of length and time • Catapults, trebuchets, and amusement park rides	• Check Design Brief for recommended materials.	• Use of a glue gun • Launching a projectile into the air • Rubber bands may snap in the launcher construction, so safety goggles should be worn during construction.	• Intended for groups of three or four students; each student keeps his/her own portfolio • Launchers must be designed, tested, and retested, so you may need space outside of the classroom to complete all steps of the design process.	• Design Brief • Guided Portfolio (adapt as appropriate/ optional) • Rubric Assessments	Follow the Design Process: • Restate the problem. • Brainstorm solutions. • Create the best solution. • Test the solution. • Evaluate the solution.

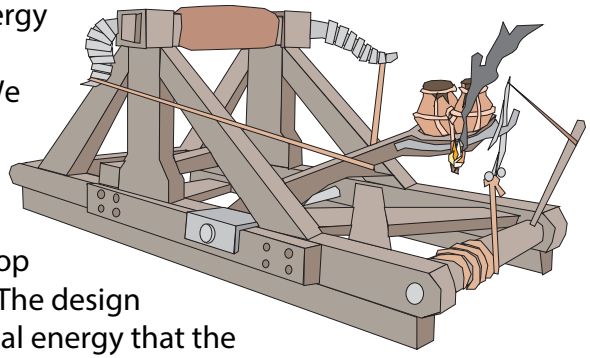
Tips for Teachers, continued

Extension Ideas:

- Have students create graphs of the distances traveled.
- Have students design targets toward which to launch the marshmallows, and associate point values with the distances to the targets.
- Hold a distances-travelled competition among the launchers.
- Have students use different materials, such as pom-poms and cotton balls, as independent variables to use to compare and contrast distances travelled.
- Give students a budget within which they must complete the project. Each shot at the target will cost the student part of his/her budget when testing the launcher.

Differentiation Option: For students with more advanced reading skills, the following page is provided as an alternative to page 1.

Loading a Launcher



Background: During our study of moving objects, we have learned about the conservation of energy and how it ensures that the energy in a system remains constant. If an object is at rest, then it has potential energy, and as it begins to move, that potential energy transforms into kinetic energy. We can use this energy to our benefit by creating machines that make our lives easier and more enjoyable. Engineers use kinetic energy and potential energy in a system to improve and build more effective machines.

Design Challenge: Design and build a projectile launcher. As practicing engineers, you will develop and test your launcher so that it demonstrates the concepts of both potential and kinetic energy. The design needs to have an arm to launch an object (marshmallow) into motion, thus illustrating the potential energy that the object possesses before launch and the kinetic energy that the moving object possesses during flight. The launcher must hold marshmallows of various sizes. Your launcher must stand alone and be portable, and you may not touch the marshmallow once it is loaded on the launcher.

Materials: Select from the list below.		**Tools:** Select from the list below.
• binder clips • bottle tops • cardboard rolls • craft sticks (various sizes) • duct tape or electrical tape • marshmallows (various sizes)	• paperclips • paper cups • rubber bands (various sizes) • shoeboxes or tissue boxes • straws	• low-heat glue gun • safety goggles • stopwatch • yardsticks or meter sticks

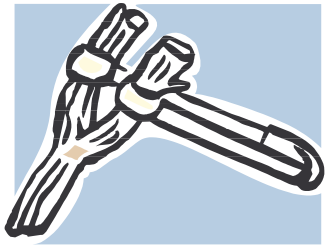
Targeted Standard of Learning: Science 4.2

Supporting SOL: Mathematics 4.1, 4.7

Targeted Standard for Technological Literacy: 16

Supporting STL: 1, 2, 8, 9, 10

Guided Portfolio



Name _____

Group Members _____

1. What is the problem? State the problem in your own words.

Name _____

2. Brainstorm solutions. Sketch and/or describe some possible solutions.

Name _____

3. Create the solution you think is best.

Keep notes about your problems and how you solve them. Make sketches if they help.

Name _____

4. Test your solution.

Does your launcher project an object into the air? YES NO

- What was the farthest distance that you were able to launch the marshmallow?_____

Does your launcher include an arm for launching? YES NO

- What materials did you use to allow the launcher to move and transfer energy?_____

_____

Does your launcher stand alone? YES NO

Can you change the object that is loaded into your launcher? YES NO

Name _____

5. Evaluate your solution.

What materials provided the most support for allowing potential energy to be represented in your launcher?

_____

_____

_____

What could you have done differently to allow for more energy in your launcher?

_____

_____

_____

Could you add to your launcher to make it more efficient? If so, what would you add to it?

_____

_____

_____

Rubric for Loading a Launcher

Name _____ Date _____

0—no evidence; 1—limited understanding; 2—some understanding with room for improvement; 3—good understanding with room for improvement; 4—substantial understanding

Design Brief Rubric	**0**	**1**	**2**	**3**	**4**
The student restated the problem in his/her own words.					
The student brainstormed more than one idea.					
The student kept notes and/or made sketches while creating a solution, to include problems and how they were solved.					
The student tested the launcher to make sure					
• it stands alone and is portable					
• it has a moveable arm to show potential energy					
• it is able to hold marshmallows of various sizes.					
The student did not touch the marshmallow after it was loaded onto the launcher.					
The student evaluated how he/she could make it better next time.					

Rubric for Loading a Launcher

Name _____ Date _____

0—no evidence; 1—limited understanding; 2—some understanding with room for improvement; 3—good understanding with room for improvement; 4—substantial understanding

Oral Communication Rubric	**0**	**1**	**2**	**3**	**4**
4.1 The student will use effective oral communication skills in a variety of settings.					
a) Present accurate directions to individuals and small groups.					
b) Contribute to group discussions across content areas.					
c) Seek ideas and opinions of others.					
d) Use evidence to support opinions.					
e) Use grammatically correct language and specific vocabulary to communicate ideas.					
f) Communicate new ideas to others.					
g) Demonstrate the ability to collaborate with diverse teams.					
h) Demonstrate the ability to work independently.					
4.2 The student will make and listen to oral presentations and reports.					
a) Use subject-related information and vocabulary.					
b) Listen to and record information.					
c) Organize information for clarity.					
d) Use language and style appropriate to the audience, topic, and purpose.					

Standards of Learning

Mathematics (2009)

Number and Number Sense

4.1 The student will

a) identify orally and in writing the place value for each digit in a whole number expressed through millions;
b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and
c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.

Measurement

4.7 The student will

a) estimate and measure length and describe the results in metric and U.S. Customary units; and
b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).

Science (2010)

Force, Motion, and Energy

4.2 The student will investigate and understand characteristics and interactions of moving objects. Key concepts include

a) motion is described by an object's direction and speed;
b) changes in motion are related to force and mass;
c) friction is a force that opposes motion; and
d) moving objects have kinetic energy.

Standards for Technological Literacy

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

Standard 2: Students will develop an understanding of the core concepts of technology.

Standard 8: Students will develop an understanding of the attributes of design.

Standard 9: Students will develop an understanding of engineering design.

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.

Please give us some feedback.

Complete the form below to let us know how this design brief worked for you and your students. Please be specific so that we might use your suggestions to improve the activity. *You can fill this out on your computer, or you can print it, fill it out manually, and scan it.*

Teacher: _____

School: _____

School division: _____

Design brief title: _____

Background *Put an X in the appropriate column:*	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Does it set the context for the activity?			
Is it age-appropriate in language, length, and complexity?			
Does it reference prior learning and/or research that the students did that will facilitate designing a solution to a problem?			
Is it detailed enough that an adult will understand the purpose for the design brief?			
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*			

Design Challenge	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Does the challenge support your curriculum?			
Is it age-appropriate in language, length, and complexity?			
Is it detailed enough that an adult will understand the purpose for the design brief?			
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*			

Criteria Criteria are part of the challenge. They set the limitations for the design. They are not directions.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use	N/A
Are the limitations age-appropriate?				
Do the limitations encourage critical thinking?				
Is the application of mathematic knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Is the application of science knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Is the application of social studies knowledge/skills integrated into the criteria? If not, should the skill area be addressed?				
Are language skills integrated into the criteria? If not, should the skill area be addressed?				
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*				

Materials Materials help set the limitations for the design. The list should include materials that might work.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use	N/A
Does the materials list encourage a variety of design solutions?				
Does the materials list include a variety of choices for joining items?				
Does the materials list include materials that force students to make decisions?				
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*				

Tools Tools can be used in the construction of the designed product. They are used to manipulate materials. They cannot become part of the product.	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Are the tools listed age appropriate?			
Are all tools needed for the activity included?			
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*			

Standards of Learning	Yes	No
Does the design brief reinforce the targeted Standard of Learning(s)?		
Are the supporting Standards of Learning appropriate?		
What Standards of Learning would you add or remove?		

Standards for Technological Literacy	Yes	No
Does the design brief reinforce the targeted Standard(s) for Technological Literacy?		
Are the supporting Standards for Technological Literacy appropriate?		
What Standards for Technological Literacy would you add or remove?		

Tips for Teachers	Yes	No
Are the tips listed in the chart helpful for a first-time teacher?		
What tips would you add?		

Guided Portfolio	Needs to be rewritten	Needs minor adjustment	Is ready for classroom use
Are the instructions and questions age appropriate and clear?			
In the "Test your solution" section, do the questions force students to thoroughly test their solutions?			
In the "Evaluate your solution" section, do the questions force students to honestly evaluate their solutions			
COMMENTS. *If any of the questions above are marked other than "ready for classroom use," please provide suggestions here.*			

Additional Comments Please use this area to provide general suggestions for improving this design brief.