

## States of Matter Lesson 3: “The Engineer”

### Educator’s Resource Guide

**Objective:**

The city of Particleville is having some problems: excessive potholes, and a desperate demand for fresh water.

1. Select one of the problems and design a solution.

**Time Required:** 150 minutes

Materials Required	Safety/Other Considerations	Science & Engineering Practices
<ul style="list-style-type: none"><li>• Regular and colored pencils, erasers</li><li>• Blank sheets for sketches (8.5 x 11)</li><li>• Construction/poster paper and markers (for final prototype design)</li><li>• Computers (for research on materials as well as option if making presentations on the computer)</li><li>• Student handout</li><li>• KQED <a href="#">article</a> about a pothole solution</li></ul>	<ul style="list-style-type: none"><li>• None</li></ul>	<ul style="list-style-type: none"><li>• Designing Solutions</li><li>• Communicating Findings/Design (Oral Presentation)</li></ul>

## **Inquiry Scale: Leveling Information**

### **Level 1:** *(recommended for grades 4-5)*

Teacher leads students through the design process after class votes on one problem to solve together. Pass out the planning organizer and have students complete the organizer tasks as a class. Give each group recommendations from the suggested solutions in the Appendix.

### **Level 2:** *(recommended for grades 5-6)*

Class votes on one problem to solve together. Students are given the opportunity to create discussion questions in table teams and share with whole class. After teacher leads whole class discussion, table teams decide on their own solution to the problem and complete the rest of the activity as individual teams. Provide students with recommendations in Appendix as needed.

### **Level 3:** *(recommended for grades 6-7)*

Table teams will determine which problem they will solve after considering all of them. Teacher provides the potential questions that the team can consider while designing a solution. The tasks are completed by table teams with support as necessary. Provide students with recommendations in Appendix as needed.

### **Level 4:** *(recommended for grades 7-8)*

Table teams will determine which problem they will solve after considering all of them. Teams work together to design questions to be considered while designing a solution. The tasks are completed by table teams independently. Provide students with recommendations in Appendix as needed.

## **Engineer Agenda:**

### **I. Show PowerPoint to introduce the Engineer Activity (10-15 minutes)**

The PowerPoint will review essential concepts learned in “The Make” and provide context for their upcoming “Engineer” challenge.

### **II. Engineer (140 minutes)**

Students spend the first portion of the activity identifying what problem they wish to solve

1. Students fill out the planning organizer
  - a. Students make a final technical drawing of their prototype using construction paper, colored pencils, and markers

### **III. Presentation/Assessment**

1. Students present their final solution designs; assessment parameters are suggested below.

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## Engineer Assessment: Project Grade and Rubric Score Sheet - States of Matter

Project Submitted by \_\_\_\_\_

### States of Matter Engineer Checklist:

Your Challenge: Design a solution to one of Particleville's problems.

#### Project Completeness:

- A title with a creative name for your solution
- Identifies the problem and its importance to Particleville
- Contains a detailed sketch, with all functioning parts labeled, as well as materials and dimensions

#### DCI Standards Checklist:

- Gives a brief overview of constraints/questions considered when designing the solution
- Justifies the solution by explaining how changes in particle motion correspond with changes in states of matter

### Science & Engineering Practices Rubric:

	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<b>Designing Solutions</b>	Applies no scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies minimal scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies adequate scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies complete scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.
<b>Communicating Findings/Design (Oral Presentation)</b>	Findings/Design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/Design are completely communicated with some misconceptions. Or Uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings/Design are completely communicated but lacking depth and complexity. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/Design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.

Teacher Comments:

Final Score:

Final Grade:



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## Appendix A

Suggestions to spark student ideas:

**Potholes:** Design a solid surface for driving that can withstand any kind of weather

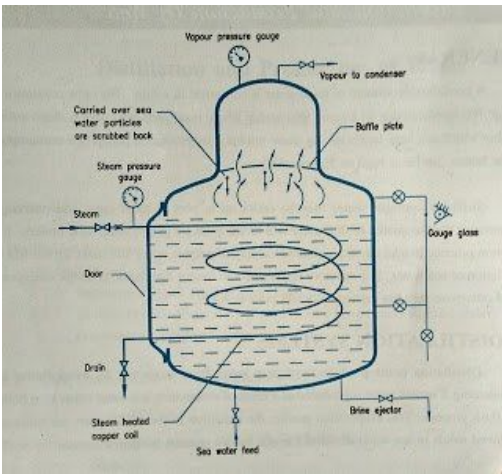
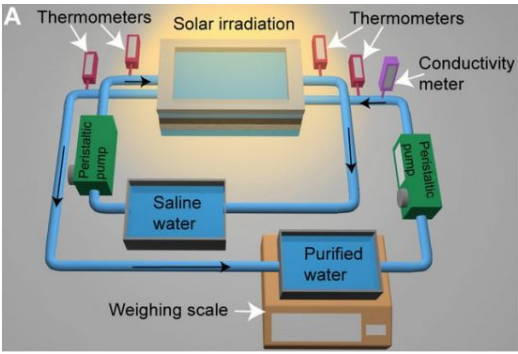
**Facilitating questions for students:** What kinds of substances maintain their properties in heat and cold? What kinds of materials would NOT be good choices for a solution?

	<p>Deposit the designed mixture into the pothole.</p> <ul style="list-style-type: none"><li>- Mixture is a tough surface made from a combination of powder particles (solid) of a substance, and a liquid solvent that, when mixed together, form a bond structure in a solid that is flexible and allows for the material to be a bendable (to absorb impact) and durable (resists cracking) solid.</li><li>- The extruder has one tube of the powder particles, right next to a tube of the liquid solvent, and when they are squeezed out side by side, they mix to make the pothole repair mixture.</li></ul>
	<p>Use support forms to help make a resilient repair.</p> <ul style="list-style-type: none"><li>- Flexible tube forms are cut from used automobile tires</li><li>- Forms are placed inside potholes or areas of road to be repaired</li><li>- Shavings from the reclaimed tires are combined with a dry concrete, sand and pebble solids</li><li>- Warm water is added to the dry mix to activate the concrete to form a solid that is more flexible than regular concrete because of the tire shavings.</li></ul>

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**Fresh Water:** Design a system that uses distillation and filtration to make freshwater from saltwater

**Facilitating questions to students:** How do distillation or filtration processes remove unwanted substances from water? How will the water get from the ocean to the machine, and then to the citizens of Particleville? What kinds of energy will be used to run the machine?

	<p>Heat the liquid salt-water with a coil and capture the fresh-water steam (gas).</p> <ul style="list-style-type: none"><li>- The salt water enters a chamber through an uptake valve. The water molecules and salt particles in contact with the heating coil become more energetic.</li><li>- Because of the heat, the attractive bonds between the water and the salt particles dissolved in it are broken</li><li>- The water molecules are able to rise off of the liquid salt water as steam (gas)</li><li>- The steam is captured at the top of the chamber as pure water molecules when they condense to form a liquid again</li></ul>
	<p>Expose the liquid salt water to the Sun, killing any bacteria, and use special filters to separate out the bacteria and salt. No phase change here and clear, clean drinking water is obtained from solar irradiation and filtration.</p> <ul style="list-style-type: none"><li>- Salt water collected in a collection tank is pumped to a chamber that has convex lenses as its roof</li><li>- UV light in the intensified sun rays kill harmful bacteria and heats the saltwater</li><li>- Next, the heated salt water is pumped through a filter that allows water to pass through but not salt</li><li>- The purified water is then weighed to make sure it is pure, since purified water weighs less than salt water of the same volume.</li></ul>