Aqueduct (Aquaducky) Engineering

The Problem: The herdsman who discovered Romulus and Remus has a problem. Remus is sad. His rubber duck was left behind in Rome. The fastest way to get the duck would be to float it through the Roman aqueducts to Remus. Can you help?

The Solution: As a civil engineer during the Roman times, you are being asked to build an aqueduct. The aqueduct must carry enough water to float the duck to Remus.

But what does an engineer do?
Engineers do many different things, but the basic elements of the engineering:

- brainstorming
- planning
- creating
- modifying
- team problem solving

Build an Aqueduct (Arcade) Model

1. Gather 4 cups, some poster board, aluminum foil, scissors, and tape.

2. Measure the width of one of the cups at the brim. Write down this number. (Example: 3 1/2 inches)

3. Carefully cut an arch on both sides of each cup starting at the brim. Allow for at least 1 inch uncut at the bottom of the cup.

4. Place the “arched, cut-out” cups (rim on the bottom) next to each other in a row.

5. Cut a strip of poster board for the water channel. The dimensions should be the width of the cup by the length of the four cups, plus three inches. (Example: If the cup is 3 1/2” at the brim, the length should be 14” plus 3” or 17” long by 6 1/2 “ wide.)
6. Tear off a piece of aluminum foil that is at least 2 inches larger than the poster board for the water channel. Option 1: Glue the aluminum foil to the poster board strip.

7. Fold 1.5” of the poster board on each edge at 90 degrees so that it forms a wall on each edge to hold the water and looks like a trench. Option 2: Curve the aluminum foil over the channel so the channel is waterproof.

8. Secure the bottoms of the 4 cups to the channel with pieces of tape.

9. Don’t be too worried about the exactness, it still should work.
# Rubric for Aqueduct (Aquaducky) Engineering

<table>
<thead>
<tr>
<th>Points</th>
<th>Requirement</th>
<th>Beginning</th>
<th>Developing</th>
<th>Applying</th>
<th>Innovative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge of concepts</td>
<td>Does not understand how an aqueduct works</td>
<td>Understands some of how an aqueduct works</td>
<td>Able to explain how an aqueduct works and can design one on paper</td>
<td>Able to take and make improvements to an aqueduct design</td>
</tr>
<tr>
<td>2</td>
<td>Design of Aqueduct</td>
<td>Design does not work.</td>
<td>Design is adequate</td>
<td>Design is good</td>
<td>Design is advanced</td>
</tr>
<tr>
<td>3</td>
<td>Construction of an Aqueduct</td>
<td>Structure collapses</td>
<td>Structure is weak</td>
<td>Structure is stable</td>
<td>Structure is solid with use of minimal materials</td>
</tr>
<tr>
<td>4</td>
<td>Function of Aqueduct</td>
<td>Does not work</td>
<td>Works with little spillage</td>
<td>Works with no spillage</td>
<td>Works with no spillage and moves water at a fast rate</td>
</tr>
</tbody>
</table>

**TOTAL:**

**Teacher comments**
Group Work Score Sheet for Aquaducky

NAME__________________________________________ Period_________

Participation in my group:
I give myself a score of: _____/10
Reasons:
______________________________________________________________________
___________________________________________________________________________

I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
___________________________________________________________________________

I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
___________________________________________________________________________

I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
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I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
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I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
___________________________________________________________________________

I give my teammate: ________/10   teammates name:______________________________
Reasons:
______________________________________________________________________
___________________________________________________________________________
# Aqueduct Essay Scoring Guide

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Points</th>
<th>Self</th>
<th>Teacher</th>
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</thead>
<tbody>
<tr>
<td>All parts of the aqueduct are explained</td>
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<td></td>
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<tr>
<td>Covered trench</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pressurized pipe</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wall</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Arcade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunnel</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>How an aqueduct works</td>
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<td>Friction</td>
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<td>Gravity</td>
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<tr>
<td>Grammar— Less than 3 errors</td>
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<tr>
<td>Voice—proper voice is used</td>
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<tr>
<td>Format—essay</td>
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<tr>
<td><strong>TOTAL points</strong></td>
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<tr>
<td><strong>TOTAL Score x 10</strong></td>
<td><strong>100</strong></td>
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</table>
Vocabulary

Parts of an Aqueduct
Here are different elements a water engineer can choose to build at any point along an aqueduct:

**covered trench--a long cut in the ground, a ditch**
Roughly four of every five miles of Rome's aqueducts run underground, many in covered trenches. Trenches are used when the aqueduct follows the contours of the land. They are quick and easy to build for they require neither the construction of arches nor the digging of tunnels. The Romans built trenches underground to hide and protect water from enemies. They also built underground trenches because they protected the aqueduct system from the stresses of wind and erosion. Covered trenches are also less disruptive to life on the surface of the land than are walls and arcades, which divide neighborhoods and farmers' fields.

**tunnel--an underground passage**
Sometimes, aqueduct engineers would carve a tunnel through a mountain rather than build a trench around one. When not too deep, shafts are dug down vertically from above to intersect with the proposed path of the tunnel.

By using shafts, more than one crew could work on a tunnel at a time. The shaft also served another purpose: Once the tunnel was finished, slaves could crawl down stone steps to clean the tunnel. They could fill buckets with silt or calcium deposits left behind from hard water and then haul the buckets out.

**pressurized pipe--a tube used to conduct liquid**
When faced with a deep valley, Roman engineers could use pressurized pipes. With the use of siphons, water travels down one side of the valley in pipes. Water pressure forces water up the other side. Water exits the pipes at nearly the same height as it entered. The pipes are usually built of lead so the material can handle strong water pressure.
wall--a structure of stonework, cement, or other materials built to retain a flow of water

When aqueduct engineers had to cross shallow depressions in the land, they could build the aqueduct on a wall. Simple to construct, walls were easier to build than arcades. However, when engineers needed to raise the aqueduct's channel more than five feet above the ground, they should resort to arcades, which allow people and water to move freely beneath them.

arcade--a series of arches supported by columns

In a valley, water engineers used arcades. The water moved through the aqueduct by gravity.

gravity—force by which bodies fall to earth

Identify how the Engineering Design Model applies to your group building the aqueduct.

Ask:

Imagine:

Plan:

Create:

Improve: