# LESSON 2:
# ANCIENT ENGINEERS

## SUPPLIES

### MAIN BIN

- Toilet Paper Rolls (15)
- Tin Foil (2)
- Plastic Cups (50)
- Paper Towels (1)

### PENCIL BOX

- Scissors (20)
- Markers
- Pencils (20)
- Clear Tape (2)

### HANDOUTS FOLDER

- Ancient Arches (5)
- Recording Sheet (15)

## OBJECTIVES

- ☑ To understand the architecture of Roman aqueducts and how they used gravity to carry water
- ☑ To create a model Roman aqueduct and experiment with water flow

## HOOK

3-5 min

What is the longest bridge or highway you have ever seen? How do you think engineers today manage to build such long structures? What materials do you think they use?" (Discuss.)

Have you ever driven over a bridge? Think about all the cars and trucks a bridge can hold. How do you think a bridge like this supports so much weight? What helps it to not collapse? (Discuss.)

Bridges today use support beams to make sure they can carry people and vehicles. Back in ancient Rome, they did not use support beams. Can you think of a way that a bridge could be stable without support beams?

## INTRODUCTION

5-10 min

Ancient Rome was a powerful and influential empire that lasted for over a thousand years. One of the most amazing achievements of Roman engineering were the aqueducts. The word “aqueduct” comes from the Latin words “aqua” (water) and “ducere” (to lead), meaning “to lead water.”

An aqueduct is a bridge-like structure built to transport water from one place to another. In ancient Rome, access to clean water was essential for drinking, bathing, cooking, and irrigation. The Romans built aqueducts to bring fresh water into their cities and towns.

Roman engineers designed aqueducts to use gravity to move water. Water flows downhill, so aqueducts were built with a slope from the water source to the city. These aqueducts were unlike the bridges we build today that have support beams underneath them. They used tunnels to go through hills, bridges to cross valleys, and a series of arches to support the structures.

Aqueducts were constructed using durable materials like stone, concrete, and sometimes lead pipes. These materials were chosen because they were strong and long-lasting.

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## STUDYING THE AQUEDUCT

20-30 min

Study the parts of the Roman aqueducts below. Think about the materials you have and how each material could be used to create a working aqueduct that carries water. Keep in mind the following:

**PIERS (ARCH SUPPORTS)**

**CURVED ARCHES**

Romans built bridges and elevated sections supported by arches to cross rivers and valleys. These structures allowed the aqueducts to maintain a steady, gentle slope necessary for water flow.

The Pont du Gard in France is a famous example of an aqueduct bridge with multiple tiers of arches. Arches distribute weight evenly, allowing the structure to support large volumes of water. The curved shape helps to channel the force of gravity and weight downwards into the supports (piers) on either side.

**DUCT**

The "duct" part of an aqueduct is the channel or pipe where the water flows. Imagine a long tube or a tunnel that carries water from one place to another.

## NOTE FOR TEACHERS

On the following page, there are detailed instructions for groups of students to create their own aqueducts.

- Encourage creativity and experimentation. There is no single "right" way to build an aqueduct. Provide guidance and support, especially for younger students who may need help with measuring and assembling materials.
- Create groups with younger and older students paired together to facilitate the activity. Be ready to assist students in troubleshooting their designs.
- Encourage students to think critically and try different solutions when they encounter problems.

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## ACTIVITY DIRECTIONS:

30-40 min

Students will work in groups of 3. Provide each group with the following materials:

- 3 toilet paper rolls
- Tin Foil
  (Approx. 4-5 inch sheets)
- 10 plastic clear cups
- Scissors
- Clear tape
  (students will need to share)
- Pencils
- Markers
- 1 ancient arches sheet per group
- 1 recording sheet for each student

## Building the Duct:

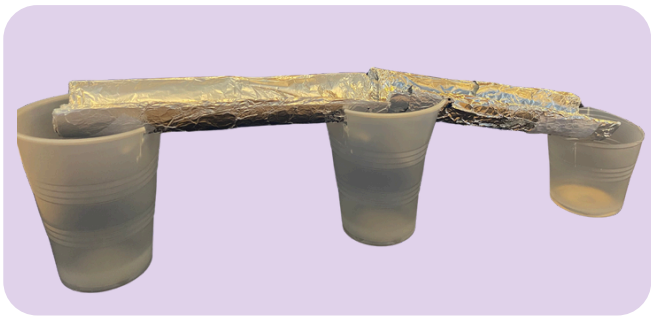
1. Cut the Roll: Have each student cut a toilet paper roll in half horizontally.
2. Reassemble: Tape the two halves back together to create the duct.
3. Waterproof: Line the inside of the roll with tin foil to waterproof it.

## Testing Procedure:

- Students will go through three testing models to evaluate their aqueduct construction abilities and use the recording sheet to track their observations
- After each test, deconstruct the model and use the same supplies for the next test.
- For each test, groups will test water flow through their model. They will pour water into the highest point of the path and observe how it flows to the end.
- After each test, check to see if the group was successful and inform them of the next challenge.

## Testing the Aqueduct:

Test #1
Each group member uses a **single duct** to transfer water into a cup without any leaks.



Test #2
Groups will use **two ducts** to transfer water into a cup. Ensure no leaks.

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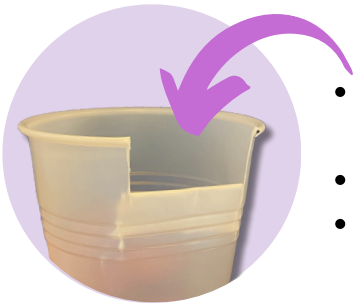
## ACTIVITY DIRECTIONS:

10-20 min

Test #3

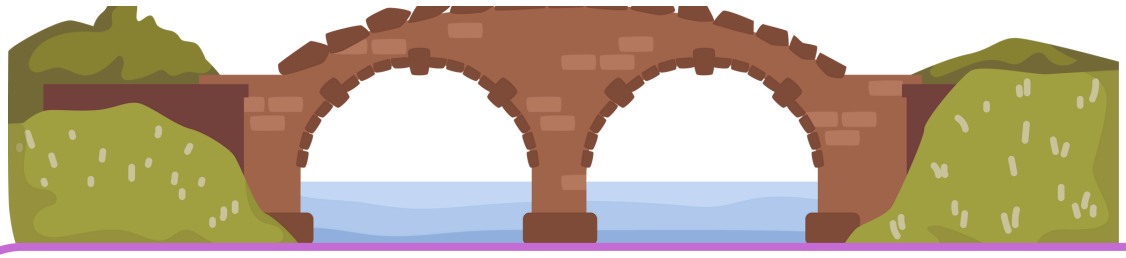
Groups will use all **three ducts** to transfer water into a cup, including a curved segment in the setup and ensure that there are no leaks.



- Students cut slits into the cups to provide support for their ducts
- Students can stack cups for height
- Encourage students to be creative

## EVALUATE AND REDESIGN

- Students can color and cut the Ancient Arches and incorporate them into their final design.
- After students experiment with pouring water through the aqueduct, have students look for weak spots or areas that need fixing based on their observations.
- Make necessary adjustments, like strengthening supports, fixing leaks, or changing the slope. After making changes, pour water again and see if it works better.



## TIPS FOR ENGINEERING

- Water Flow Control: If the water flow slows down or stops at certain points, check for blockages or sections where the channels aren't aligned properly. Adjusting the height and stability of the arches can also make a big difference.
- Conserving Water: Roman aqueducts were designed to transport water efficiently, so try to minimize any leaks or spills along your aqueduct. You can use extra tape to seal any leaks and keep the water flowing smoothly.

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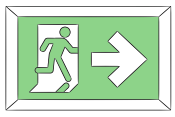
## CONCLUSION

10 min

Facilitate a discussion to help students reflect on what they learned. Use the following prompts:

- Learning About Aqueducts:
  - What is an aqueduct and why did the Romans build them?
  - What materials did we use to represent the duct in our models?
- Challenges and Solutions:
  - What was the most challenging part of building your aqueduct?
  - How did you solve any problems you faced during the construction?
- Observations on Water Flow:
  - How did the water flow through your aqueduct? Did it reach the end smoothly?
  - What changes did you make to improve the water flow?
- Importance of Design:
  - Why do you think the Romans used arches in their aqueducts?
  - How did your design choices affect the stability and efficiency of your aqueduct?
- Real-World Connections:
  - Can you think of any modern structures that are similar to aqueducts?
  - How do we use similar engineering principles in our daily lives today?



## Exit Ticket


**Ask each student one of the following questions as they walk out the door.**

- "Q: What is the purpose of an aqueduct?
  - A: The Romans built aqueducts to access clean water from distant sources because local water sources like wells were often contaminated or insufficient to meet the needs of growing cities.
- Q: Why were arches such an important feature in the construction of Roman aqueducts?
  - A: they provided strong support for the channels, allowing the aqueducts to span valleys and uneven terrain while maintaining a steady flow of water.

# ANCIENT ENGINEERS RECORDING SHEET

| Test | Observations |
|---|---|
| Test 1 | |
| Test 2 | |
| Test 3 | |

Draw your aqueduct below:

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**EVALUATE AND REDESIGN:**

What changes can you make to improve the water flow? Draw or write them below.

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# ANCIENT ARCHES