



Mesopotamian Filter Project

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Target Grade: 6th grade, Science

Time Required: 6 days, 50 minute lessons

Standards

Next Generation Science Standards (NGSS):

- **MS-ETS1.3:** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **MS-PS1-2:** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- **MS-PS1-1:** Develop models to describe the atomic composition of simple molecules and extended structures.

Lesson Objectives

Students will:

- Compare and contrast physical and chemical properties of various materials such as salt, sand, shells, bitumen, rocks and gems.
- Interpret various ways to separate mixtures and solutions.
- Analyze different craft/engineering materials and determine their ability to help separate mixtures and solutions.
- Synthesize a filter using their knowledge of physical and chemical properties of various materials such as salt, sand, shells, bitumen, rocks and gems.
- Analyze the accomplishment of their goal by testing the pH level of their filtered water.

Central Focus

Students will create a water filter system by conducting research on materials, illustrating a blueprint design, and building with their given materials. This project will allow student to research different chemical and physical properties, follow a budget, and create their system. The class will test their filters by collecting pH of their filtered water.

Key Terms: physical properties, chemical properties, developing, design, engineering, chemistry, filter, pH, acids, bases



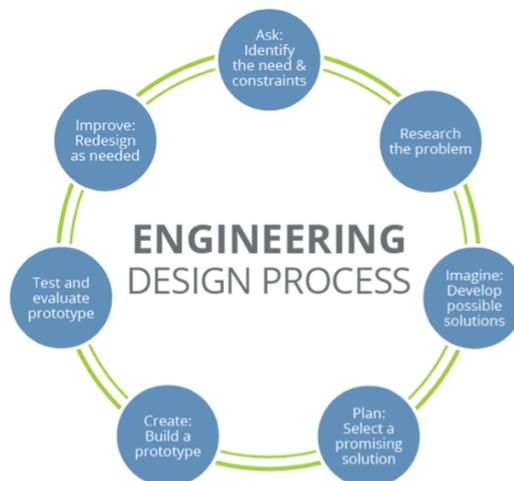
Background Information

Throughout the lesson, students will engage with matter and its interactions. The key terms the lesson focuses on are the following:

- **Matter:** any substance that has mass and takes up space by having volume
- **Mass:** both a property of a physical body and a measure of its resistance to acceleration when a net force is applied.
- **Physical properties:** any property that is measurable, whose value describes a state of a physical system.
- **Chemical properties:** any of a material's properties that becomes evident during, or after, a chemical reaction; that is, any quality that can be established only by changing a substance's chemical identity.
- **Homogenous mixtures:** a solid, liquid or gaseous mixture that has the same proportions of its components throughout any given sample.
- **Heterogeneous mixtures:** consists of two or more phases. When oil and water are combined, they do not mix evenly, but instead form two separate layers. Each of the layers is called a phase. Oil and water do not mix, instead forming two distinct layers called phases.

It may also be helpful to the student to have a previous lesson on early history of Mesopotamia and the city design. Students will need to know where it is located on the map and the surrounding resources, like the Tigris and Euphrates rivers.

Students should be aware of the engineering design cycle prior to this lesson. These steps include the following; Define the Problem, Collect Information, Brainstorm Solutions, Develop a Solution, Build a Prototype, Present Your Ideas to Others for Feedback, Test and Redesign. The process is never really complete, as there can always be additional redesign. Students also need to be aware of the safety precautions in using some of the makerspace materials. It is advisable that the teacher does not introduce new tools in this lesson, but instead uses only the tools students are familiar with already, as a safety precaution.



<https://i2.wp.com/media.premiumtimesng.com/wp-content/files/sites/2/2017/02/Engineering-Design-Process.png>



Materials

- *Matter Terms* worksheet
- *Filter Blueprint* worksheet
- Pencil
- Access to Discovery Education
- Sand
- Gold glitter
- Silver glitter
- Rocks
- Tape
- Trash bag
- Craft stick
- Legos
- Pasta pieces
- Thin foam
- Magnets
- Straws
- Paper towels
- Plastic wrap
- Paper plate
- Fake money
- Notebook
- Water
- Seashells
- Salt
- Small gems
- Popsicle sticks
- Scissors
- Colored tape
- Glue stick
- String
- Gauze
- Water bottle
- Skewers
- Dental floss
- Cotton balls
- Styrofoam cup
- *Physical and Chemical Properties* worksheet
- pH indicators

Instruction

Introduction

- The teacher will begin the lesson by showing the students a short [video](#) over ancient water purification to have students begin thinking about filtering and distributing water.
- After watching the video, the class will take 2-3 minutes to discuss what they noticed and learned.
- After the short discussion, the teacher will explain the water filtration project.

Activity

Day 1 and 2

- Step 1: Students will research and record information on different terms given in the *Matter Terms* worksheet.
 - Terms include: matter, mass, physical properties, chemical properties, homogenous mixtures, heterogeneous mixtures and different ways to separate mixtures.
- Step 2: Students will use various online resources to look up the physical and chemical properties of the items that will be found in the “water.” These terms will be recorded on their *Physical and Chemical Properties* worksheet.
 - Terms include: gold, silver, copper, carnelian rocks, seashells, salt, and sand.



Day 3 and 4

- Step 3: Once the students have finished their research, each student will begin drawing a working water filter system blueprint by using the guidelines illustrated in the *Filter Blueprint* worksheet.
 - Blueprint will be constructed with the provided materials list that provides a detailed and labeled description of their project.
 - The students will need to provide a written description as to why they think their proposed materials will work to filter out the big and small items mixed within the water.
 - The students will need to include a budget list on the side to make sure they don't spend over \$20.

Day 5 and 6

- Step 4: The teacher will look over the blueprint and provides each group their \$20 in fake money. Then, they are free to "buy" from the store and start building and testing.
- Teacher will prepare a bucket of water with all materials mixed in.
 - Bucket will include: water, salt, sand, gold and silver glitter, carnelian rocks, crushed bitumen and seashells.
- Students can decide if they would like to test and record the unfiltered water's pH (found in the bucket).
- Students will take a sample of the unfiltered water found in the bucket and run it through their built filtration system.
 - Students are required to test until they get a pH level of 7.0.

Closure

- Students will complete a *STEM Reflection Sheet* in which they discuss what they learned, what they would do differently, what parts worked, what parts "failed," etc.

Differentiation

- Students can work in groups or on their own for this project.
- Google translate and speech to text is available online and may be utilized for ELL or special needs students.
 - Make sure to check translations before so there is no miscommunication between student and teacher on exact definitions.
- Students may choose to create their blueprint on websites like Smart Draw or the sketch option in Microsoft Word.
- Time (an extra day) may be extended for Step 1 and 2.
- For ELL, student could be provided a vocab sheet with key vocabulary defined and translated to their native language.



Assessment:

Formative Assessment

- Throughout the lesson, the teacher can use basic scaffolding questions like, “Can you explain to me your process and why your group is doing that idea?” or “What are ways your group can improve your design?”
- Teacher can have short discussions over the student’s answers to the worksheets to check for understanding.
- Teacher can have students fill out an exit ticket asking what they learned, what they want to learn more about, and what the students design plan is for the next day.

Summative Assessment:

- The focus of this lesson is problem solving with the engineering design process via creating a filtration system. Due to this, the students’ complete project should be grades on things like problem solving, the quality of their notes, participation, and ability to use their notes.
- Example Rubric:

| Project Rubric | | |
|------------------------|-------------------------|--------------------|
| | Student's Points | Max. Points |
| Problem Solving | | 25 |
| Note's quality | | 25 |
| Participation | | 25 |
| Usage of Notes | | 13 |
| pH level of 7.0 | | 12 |
| Total Points | | 100 |

Name:

Date:

Matter Terms

In the boxes below, provide the definition, important information/explanation, and URL to resource used for each term .

**Physical
Properties**

**Chemical
Properties**

Matter

Mixtures

**Homogeneous
Mixtures**

**Heterogeneous
Mixtures**



Four ways to separate different mixtures

Filter Blueprint

Directions: Use all of your notes to plan a water filter system that will separate all mixtures found in the water. Your blueprint will be titled "Filter Blueprint."

Challenge: Build a "working" water filter system to separate the following items: sand, salt, silt, gold, silver, copper, bitumen, seashells, and carnelian rocks.

Criteria:

- Your blueprint should be labeled with materials and costs.
- Include with your blueprint a written description as to why you think your proposed materials will work to filter out the big and small items mixed within the water.
- You must test it once before the final project is due.
- Filtered water should reach a pH of 7.

Constraints:

- You need a teacher signature on your blueprint before you can begin building.
- You have \$20 to build.
- Money will be taken away for teacher cleaning expenses.

Cost of Items:

- | | |
|---|---|
| • "Wood" | • \$2 for 2 pieces |
| • Tape | • \$2 per day |
| • Scissors | • \$1 per day |
| • Trash Bag | • \$6 per bag |
| • Colored Tape | • \$5 for the project |
| • Craft Sticks | • \$5 for 5 |
| • Glue Stick | • \$3 for usage |
| • Legos | • \$2 per foot |
| • String | • \$2 for 10 pieces |
| • Pasta Pieces | • \$5 per square foot |
| • Gauze | • \$4 per piece |
| • Thin Foam | • 2 free bottles |
| • Water Bottle | • \$6 for 3 |
| • Magnets | • \$2 for 1 |
| • Skewers | • \$1 per straw |
| • Straws | • \$2 for 2 feet |
| • Dental Floss | • \$3 per sheet |
| • Paper Towel Sheet | • \$5 for 10 |
| • Cotton Balls | • \$4 for 1 square foot |
| • Plastic Wrap | • \$8 for 1 |
| • Styrofoam Cup | • \$4 for 1 plate |
| • Paper Plate | • \$3 for 6 pieces (the Legos must be reusable) |
| • You can bring in ONE item of your choosing for ENGINEERING- get it approved by your teacher | |



Name:
Date:

WHAT DID I LEARN?



WHAT PARTS WORKED WELL?



WHAT PARTS OF THE DESIGN DID NOT WORK?



WHAT WOULD I DO DIFFERENTLY?

