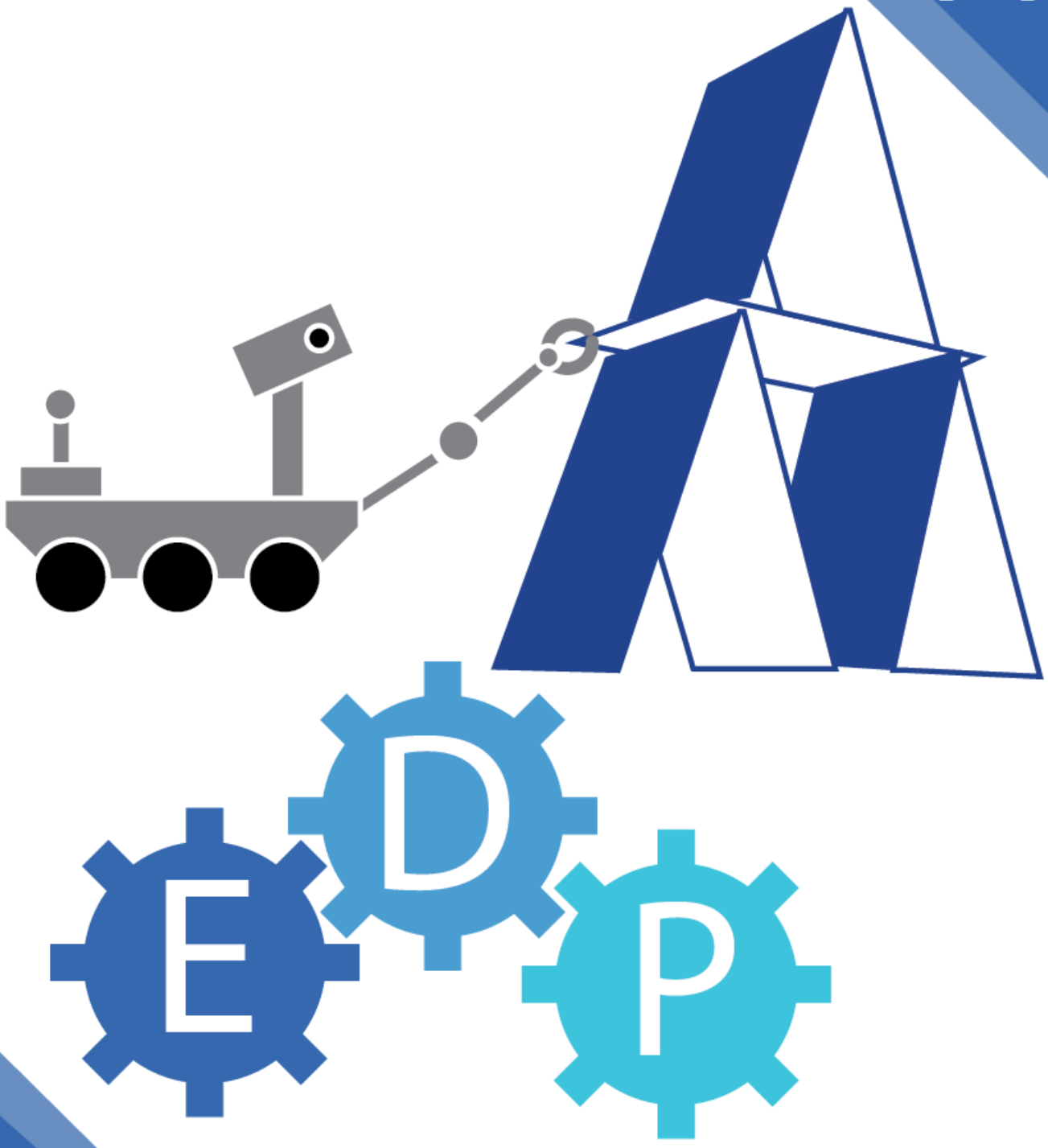
P1



What is Engineering?

Teamwork & Tower

P1 Purpose:

Youth engage in an engineering design challenge using an Engineering Design Process (EDP), criteria, and constraints.

EDP Step:

Plan
Create
Test

Activity Timing

Introduction:	5 min
Identify:	5 min
Create:	20 min
Test & Communicate:	15 min
Reflect:	10 min
Total	55 min

Quick Tips:

- Identify each EDP step used in wrap up
- Criteria:
  - work in groups
  - 1 foot tower
  - support container 10 seconds
- Constraints:
  - 20 minutes
  - given materials
  - scissors & ruler not in towe

Prep Corner

- Post EDP Poster
- Set up Group Materials: 100 index cards, ruler, scissors
- Set up Materials Table: 4 rolls masking tape
- Fill and seal water container

20 min • Guide pg. 9

Did you know?

Use duct tape much? You probably engineer more than you think. Anytime you design a makeshift tool because you don't have exactly what you need, you are engineering.

Key Terms:

- Criteria: Things that you or your design needs to do.
- Constraints: Ways that you or your design are limited.

P2

A	B	C	D
10	10	10	10
20	20	20	20
30	30	30	30

What is Technology?

Trivia & Context Video

P2 Purpose:

Youth consider the definition of technology as any thing or process humans (engineers) design to solve a problem. The Special Report Video sets the context for the entire unit.

EDP Step:

Investigate

Activity Timing

Introduction:	5 min
Investigate:	10 min
Imagine & Improve:	15 min
Video:	10 min
Reflect:	10 min
Total	50 min

Quick Tips:

- Make sure PowerPoint is in Presenter Mode for trivia game
- Low tech Trivia Option, p. 10
- Don't skip the video! It sets the stage for the unit.
- Videos can be subtitled in different languages: Click CC & Settings

Prep Corner

- Post EDP Poster
- Post technology definition
- Set up Special Report Video to view
- Set up and test the Powerpoint game or re-create with sticky notes

20 min • Guide pg. 9

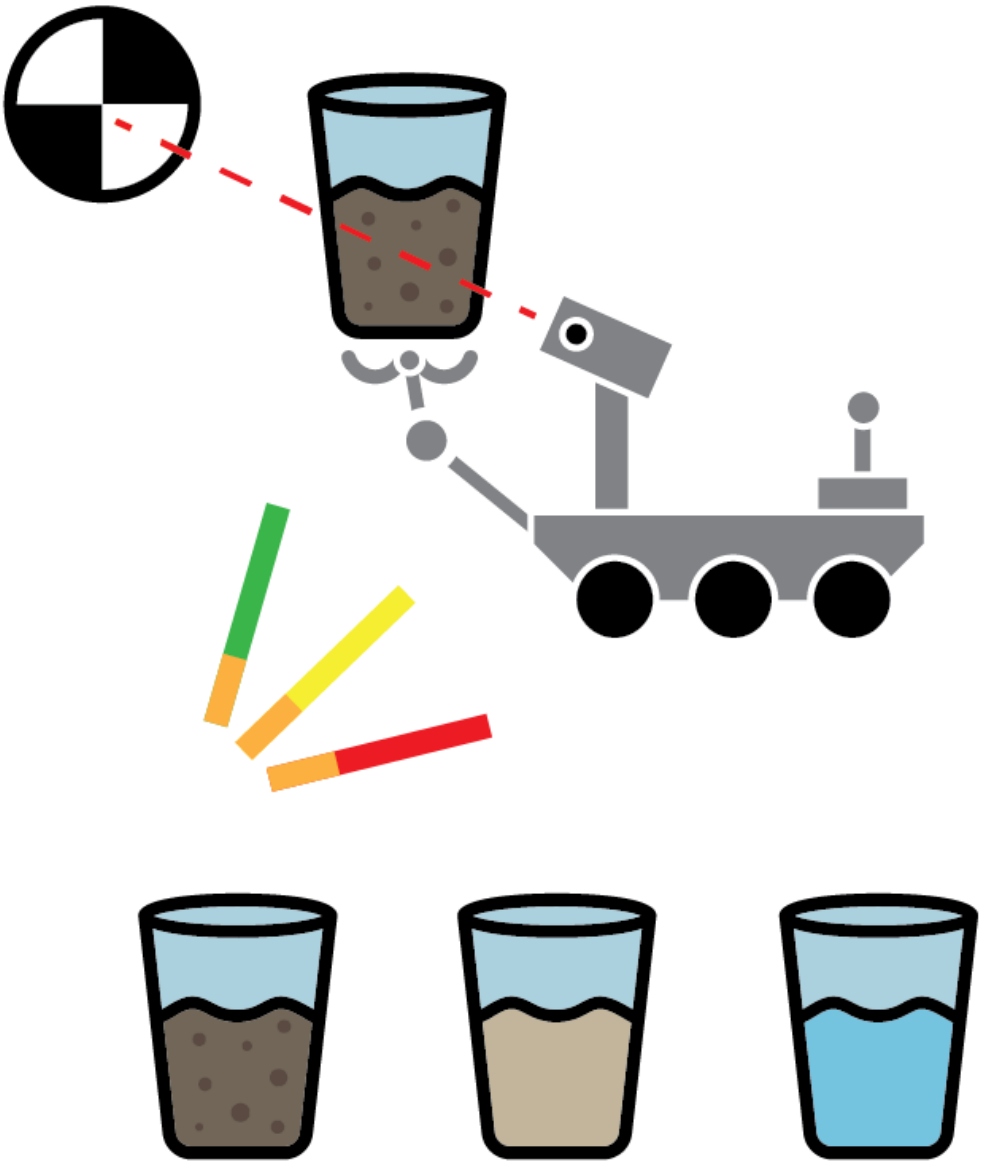
Did you know?

The Earth has a process to purify water naturally: the water cycle. It's not a technology because humans did not design it, even if it does solve a human problem.

Key Terms:

- Process: A series of steps completed in a certain order to solve a problem.
- Technology: Any thing or process designed by people to solve a problem.

A1



A Grey Area

Water Samples & Quality Tests

A1 Purpose:

Youth test the quality of and categorize model water samples using real tools.

EDP Step:

Investigate

Activity Timing

Introduction:	5 min
Modeling:	20 min
Water Quality:	25 min
Reflect:	10 min
Total	60 min

Quick Tips:

- Have paper towels & a sink handy for clean-up
- Set pH strips on paper towels
- Higher water quality scores= higher quality
- Use the Water Categories Cheat Sheet. See additional A1 card

Prep Corner

- Post EDP Poster
- Cut and distribute Water Sample Recipes to groups
- Copy and cut Secchi disks on p. 27
- Review how to test water quality in guide
- Set up materials table: measuring spoons & scissors
- Optional: copy acidity chart on p. 29

15 min · Guide pg. 17

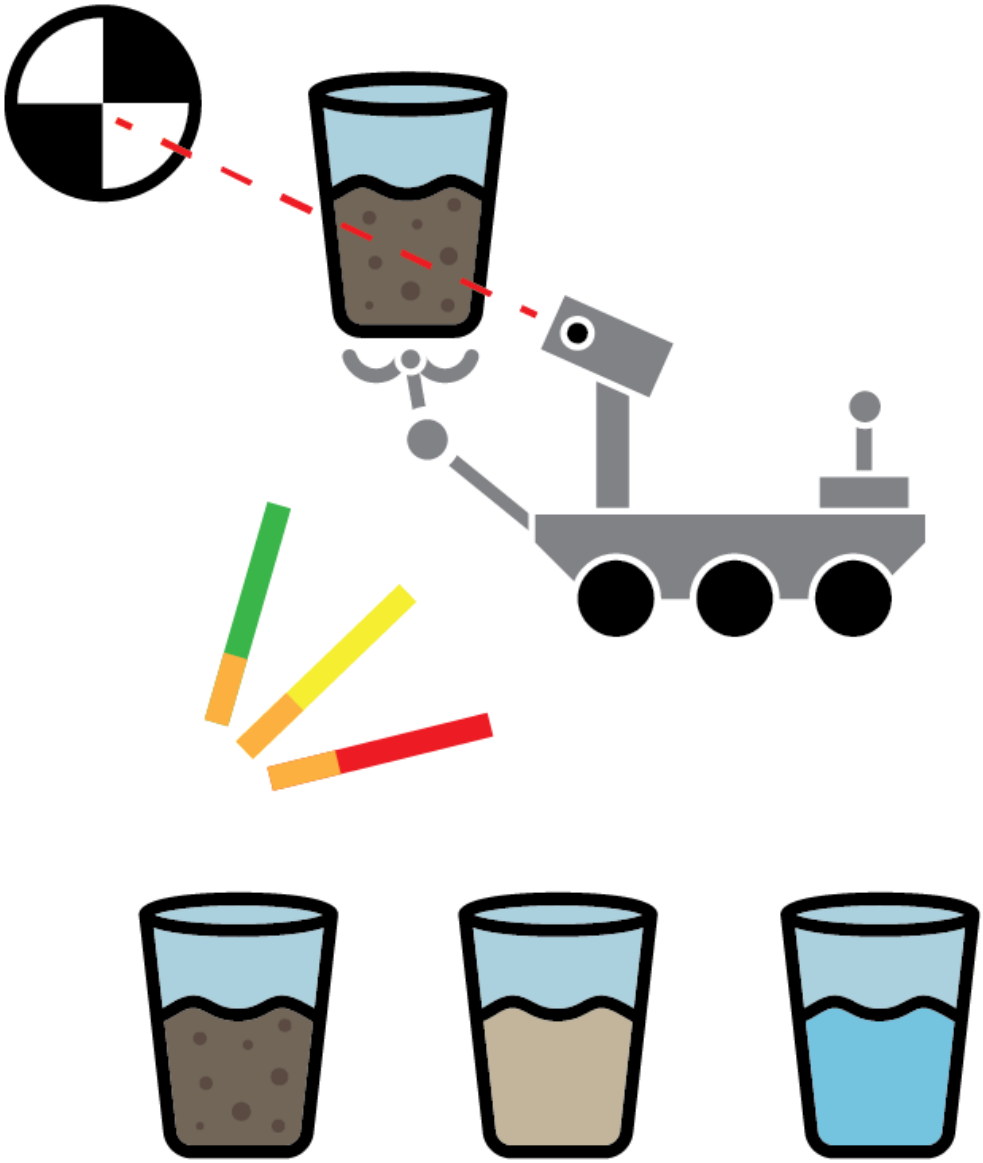
Did you know?

Rain is slightly acidic. Most rain has a pH of 5.6 to 5.8. This occurs because carbon dioxide (CO_2) from the atmosphere dissolves into rain water. Rain is likely to get more acidic as CO_2 levels rise.

Key Terms:

- Grey water: Water that has been used at least once and can be used again.
- Waste water: Water that is too dirty to be used again.

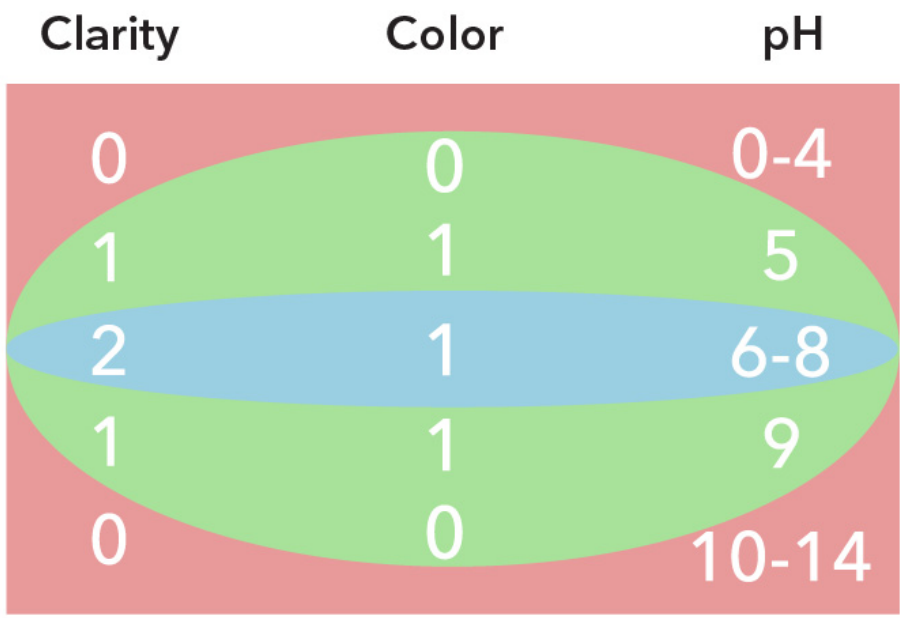
A1+



A Grey Area

Water Quality Cheat Sheet

Water Quality Cheat Sheet



Score Key

- Waste = Any in Red Zone
- Grey = Green & Blue Zones
- Pure = All in Blue Zone

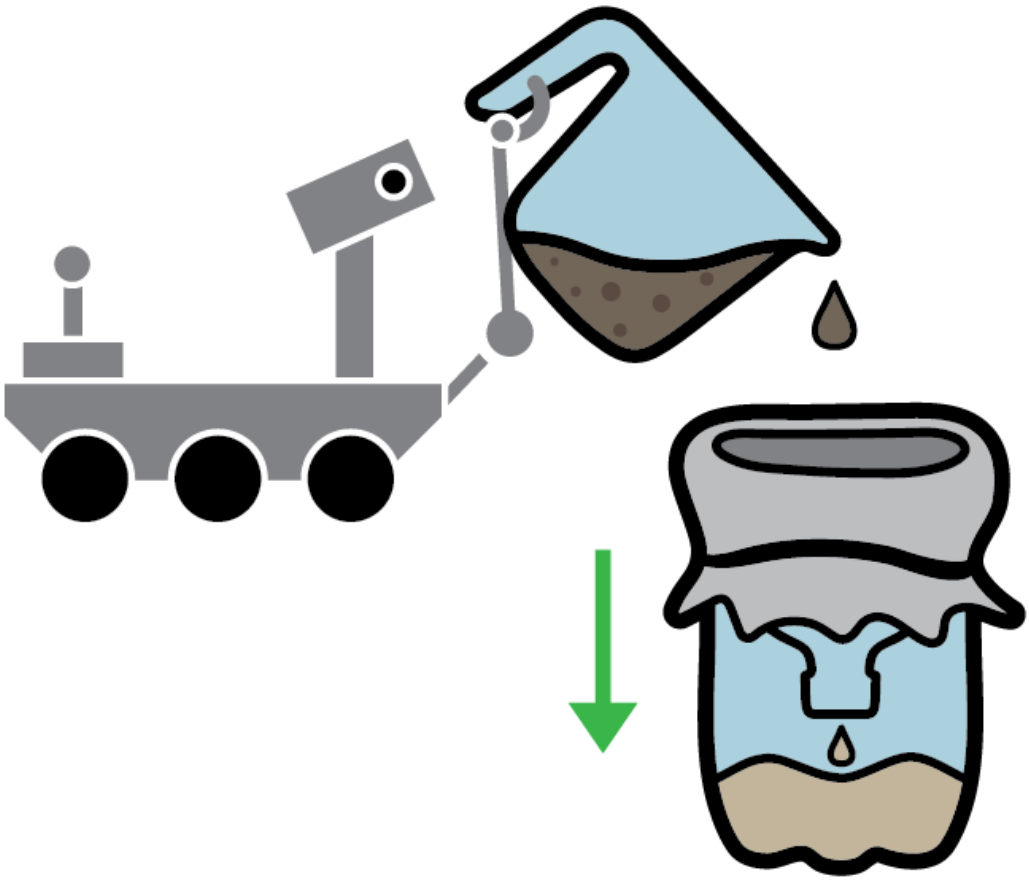
Additional Explanation

In order for water to be classified as pure, all scores must fall in the blue zone. To be classfied as waste water, it hat least one score in the red zone. Water classfied as grey water will have scores that fall in either the blue and green zones or just the green zone.

Tip

None of the samples are "pure" water. Help youth interpret test results more accurately or have youth agree on a fair test procedure.
(e.g. Agree to stir or shake samples before each test.

A2



Investigating Filters

Filter Water Samples

A2 Purpose:

Youth explore how different water filter materials reduce contaminants.

EDP Step:

Investigate

Activity Timing

Introduction:	5 min
Investigate:	40 min
Reflect:	10 min
Total	55 min

Quick Tips:

- Results are subtle: Try photos or side-by-side comparisons on a white background.
- Help youth discover on their own that slowing down the filter improves results.
- Cheat Tip: Sand or cotton balls packed tightly into the nozzle slow the filter rate.
- Help youth interpret test results/decide on fair test procedures like shaking samples.

Prep Corner

- Post EDP Poster
- Make 8 filter bases, p. 37
- Create Investigation chart Chart p. 32
- Set up materials table: filter materials & scissors
- Create charcoal filter and yellow test water, p. 32

40 min • Guide pp. 31-32

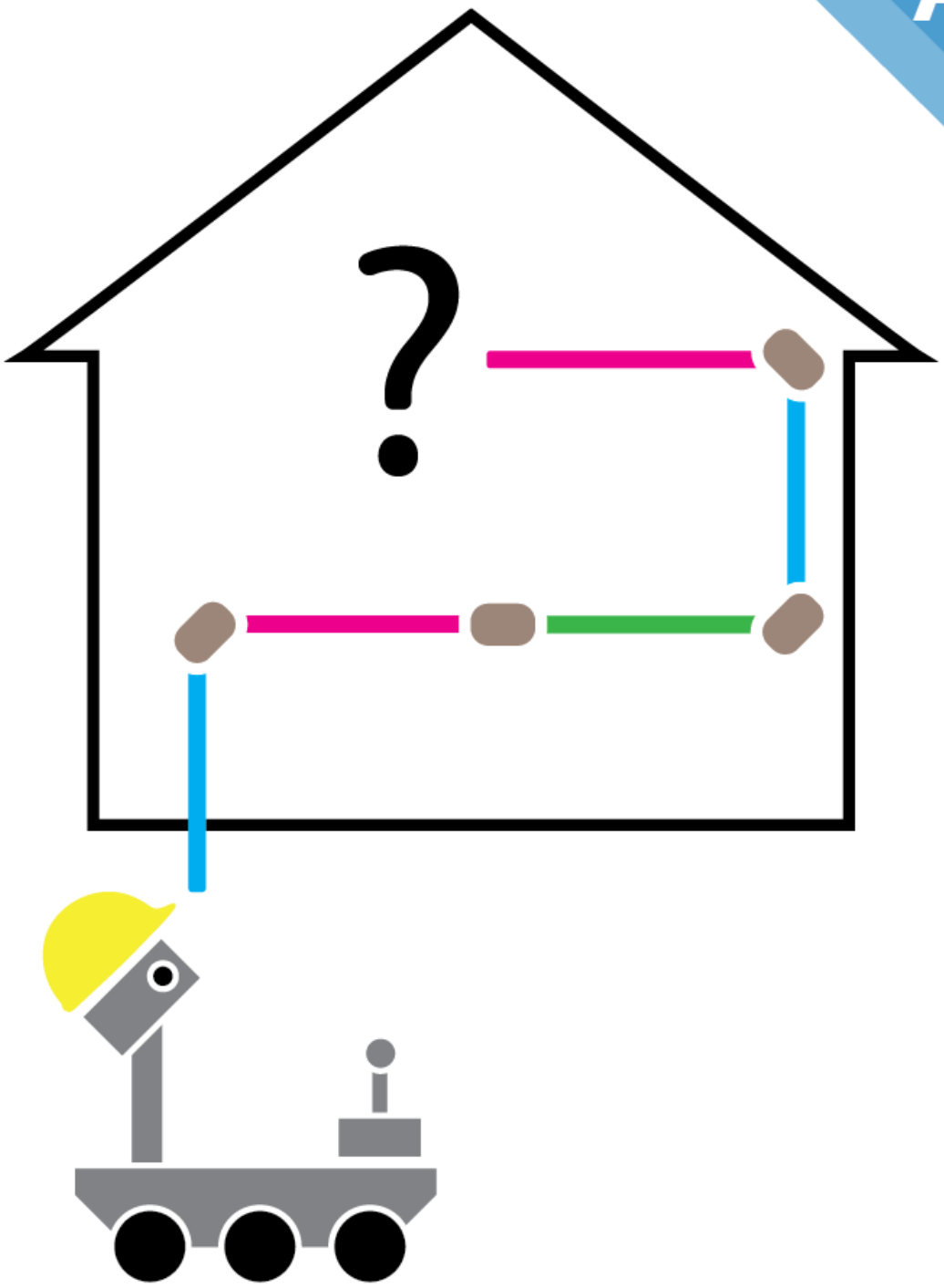
Did you know?

Flint, Michigan gives filters to residents to improve water quality. Lead in pipes dissolves into drinking water and is very harmful to humans. Lead can be removed by filters.

Key Terms:

Water Filter: A technology that improves water quality by removing particles or contaminants as the water passes through.

A3



Order Up!

Design a Water Reuse System

A3 Purpose:

Youth apply what they learned in Activities 1 & 2 to improve water quality at least one level so it can be reused for a different purpose

EDP Step:

Plan

Activity Timing

Introduction:	5 min
A Greywater Process:	35 min
Reflect:	10 min
Total	50 min

Quick Tips:

- Set-up pipe color key prior to design
- There are many correct answers

Criteria:

- work in groups
- in/out for all places
- Greywater reuse
- Clay = filter locations

Constraints:

- 5 straws each color
- filter improves 1 step
- cannot reuse toilet

Prep Corner

- Post EDP Poster
- Fill in chart on Mapping Greywater with student data, pp. 43-45
- Make copies of map and tape together for each group
- Get a head start on prep for Activity 4

30 min • Guide pg. 39

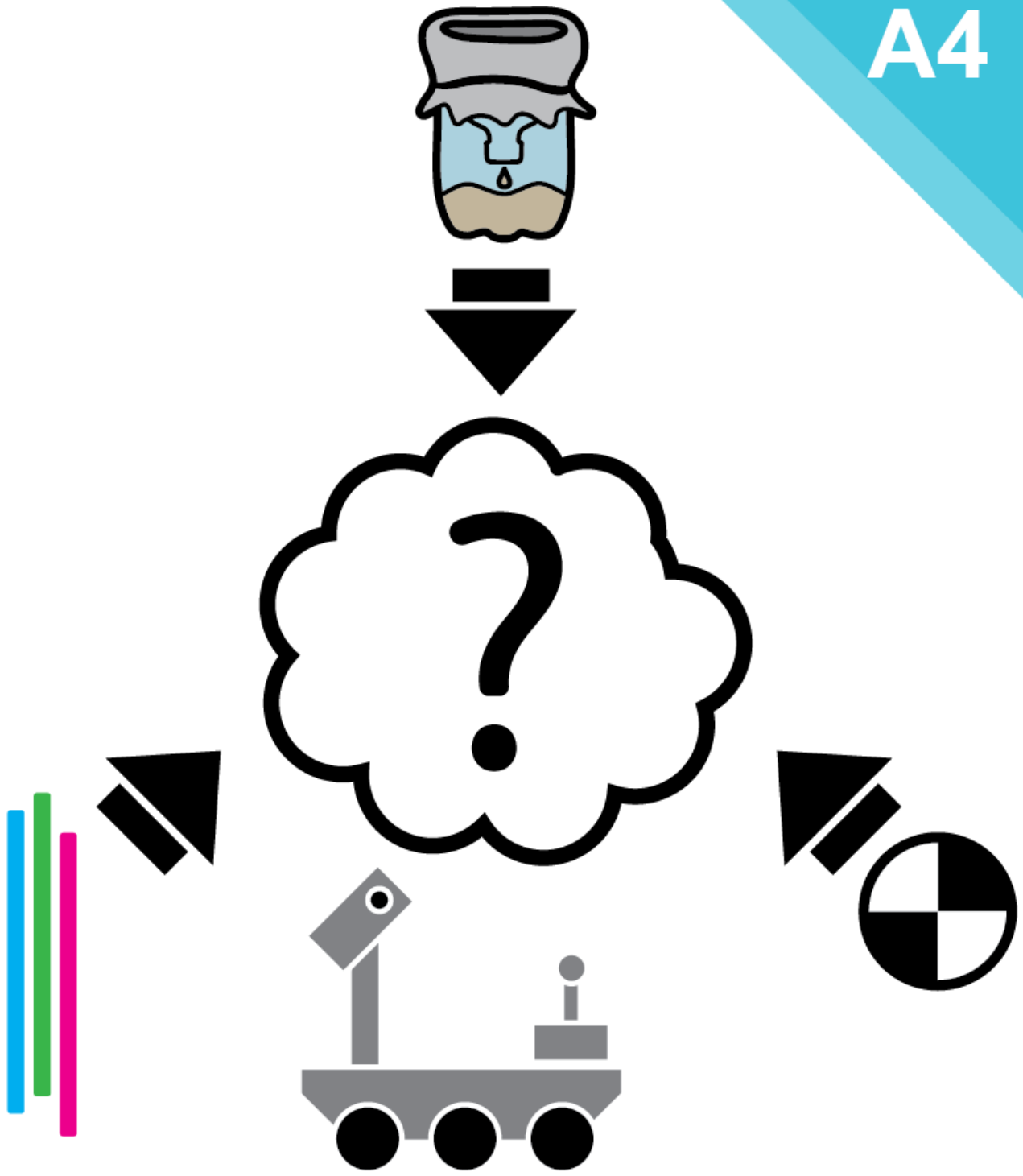
Did you know?

Many buildings around the world are already piped to use reclaimed water in toilets. Reclaimed means that waste water has been treated or filtered for reuse.

Key Terms:

Greywater Process: A process that improves the quality of used water and then uses it again for another purpose.

A4



Create a Process

Plan, Create, Test

A4 Purpose:

Youth apply what they learned in prior activities to design and test a water reuse process using filter materials and home piping reconfiguration.

EDP Step:

Plan
Create
Test

Activity Timing

Introduction:	10 min
Plan:	5 min
Create and Test:	40 min
Reflect:	5 min
Total	60 min

Quick Tips:

- There are multiple correct answers.
- #1 - Mars is a basic challenge
- #3 - ISS is more advanced
- Criteria vary by Extreme Environment
- Same constraints for all: 2 filter bases
- Add materials constraint to conserve for Activity 5

Prep Corner

- Post EDP Poster
- Make 8 more filter bases, p. 37
- Post Investigation Chart, p. 32, & Quality Chart, p.48
- Create model water samples, replace "toilet" with "space toilet"
- Set up materials table: spoons, filter materials, rinsed charcoal
- Copy for each group: Water Reuse Plan, p.53

45 min · Guide pg. 48

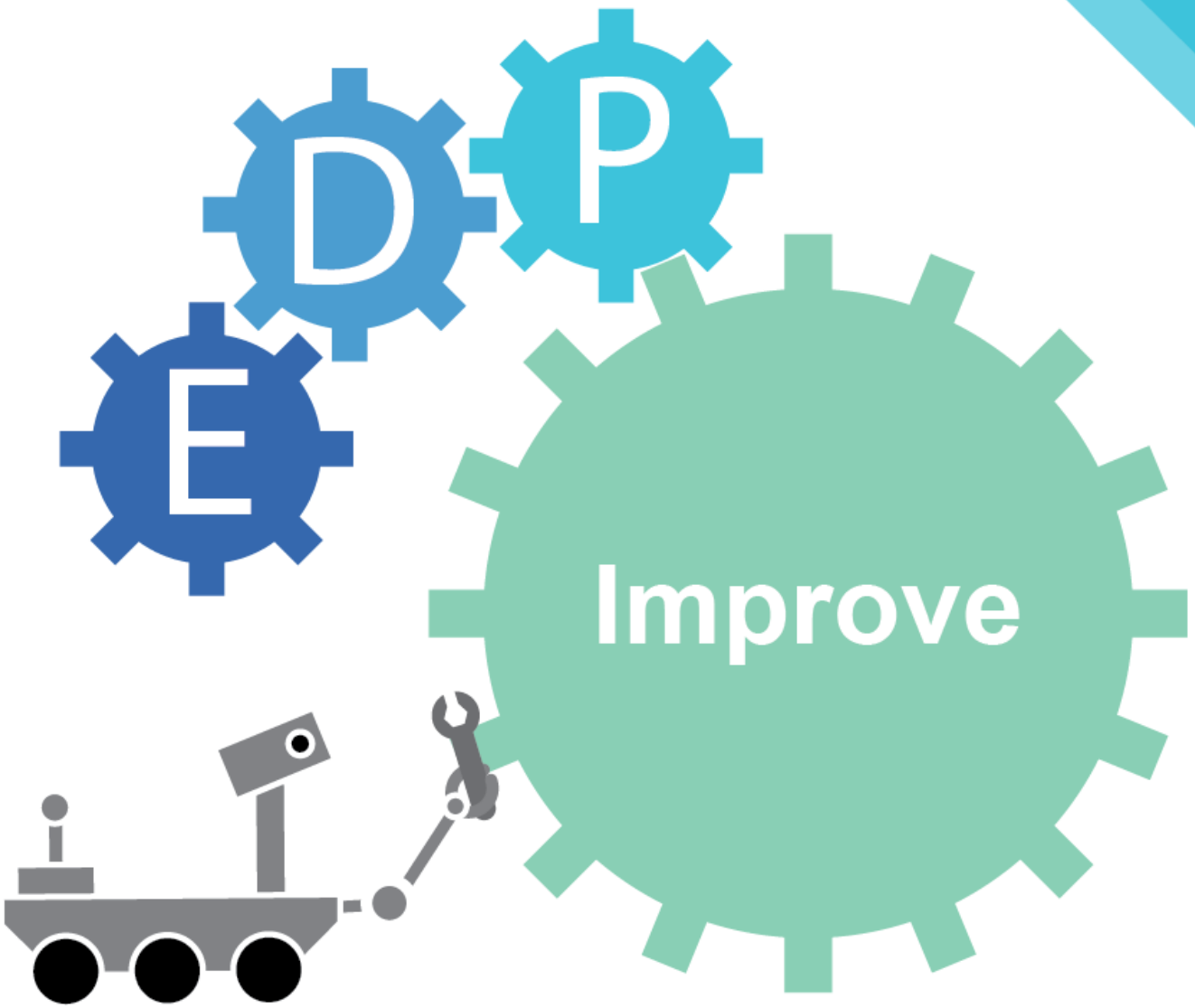
Did you know?

Failure is a big part of the engineering design process. Engineers sometimes make mistakes on purpose so they can learn how to avoid them later when it's more crucial to get it right.

Key Terms:

Extreme Environment: A place where it is difficult for people to survive

A5



Improve

Improve a Process

A5 Purpose:

Youth improve their process to better meet the criteria of their extreme environment.

EDP Step:

Improve

Activity Timing

Introduction:	5 min
Plan:	5 min
Improve:	35 min
Reflect:	10 min
Total	55 min

Quick Tips:

- If groups struggled in Activity 4, use this as additional time to meet criteria.
- If groups accomplished criteria in Activity 4, use budget contraints to improve the process.

Prep Corner

- Post EDP Poster
- Post Extreme Environments Quality Chart, p.48
- Create a Materials Store with remaining filter materials
- Copy and distribute Engineering Showcase Invitations, p. 59
- If needed, replenish samples & copy new reuse plan cards, p. 53

20 min · Guide pp. 55-56

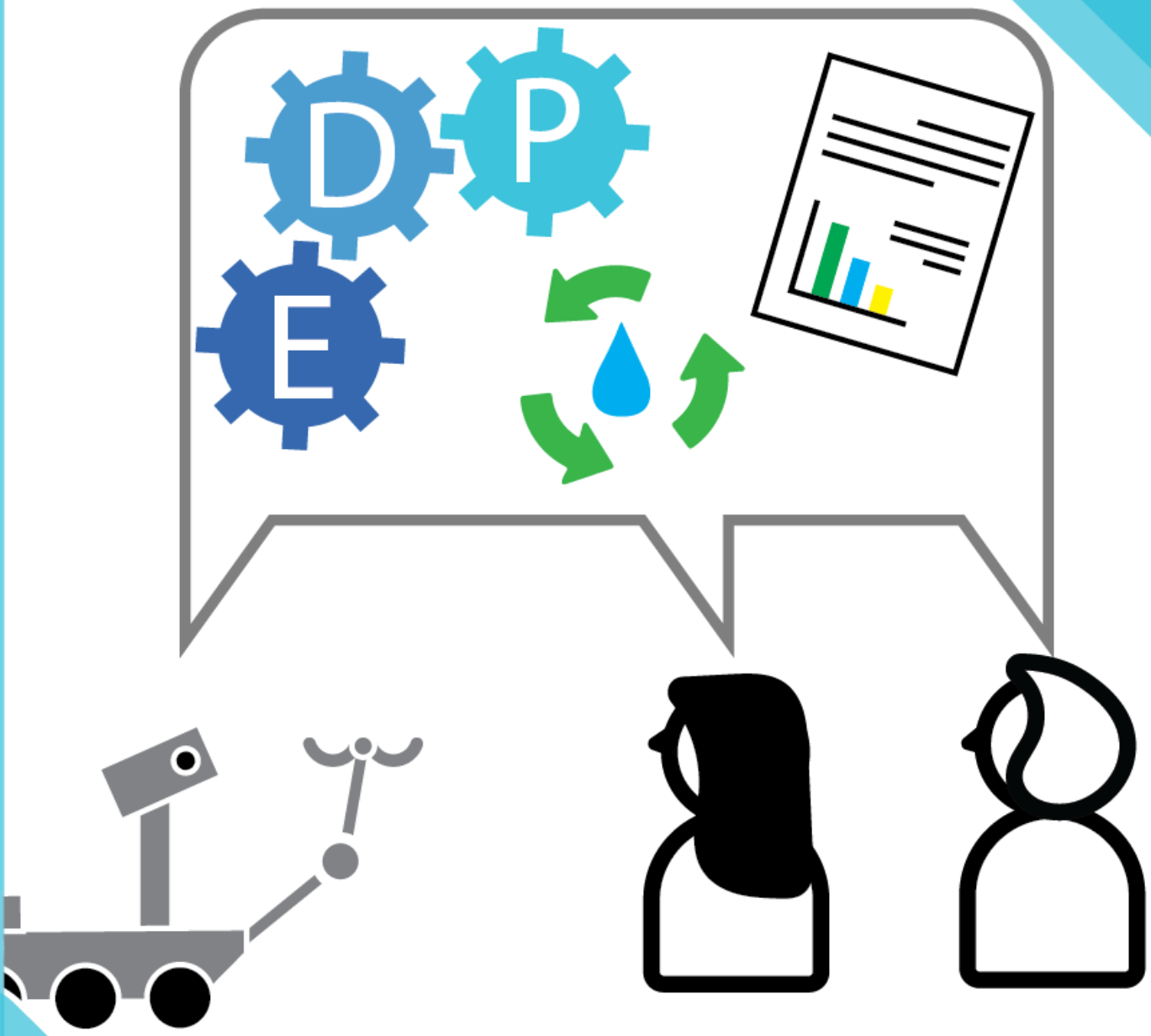
Did you know?

The International Space Station filters and treats every drop of water used on board so it can be used again the next day. To learn more, check out this cool NASA video linked through: www.planets-stem.org/water-in-extreme-environments/

Key Terms:

Improve (in engineering):To make a process better than the first design. Examples include something being cheaper, easier, better at producing results, etc.

A6



Engineering Showcase

Communicate Results

A6 Purpose:

Youth prepare presentations to communicate their water reuse process to others.

EDP Step:

Communicate

Activity Timing

Introduction:	5 min
Preparing:	15 min
Showcase:	30 min
Reflect:	10 min
Total	60 min

Quick Tips:

- An authentic audience inspires more thought in presentations. Pull in random members of your organization, if needed.
- Consider again if using a different room:
  - » Have paper towels & a sink handy
  - » To avoid stains, set pH strips on paper towels

Prep Corner

- Post EDP Poster
- Set-up the Materials Table with remaining materials
- If needed, replenish samples & copy new reuse plan cards, p. 53
- Invite community, including youth's family & friends to Showcase

15 min • Guide pg. 61

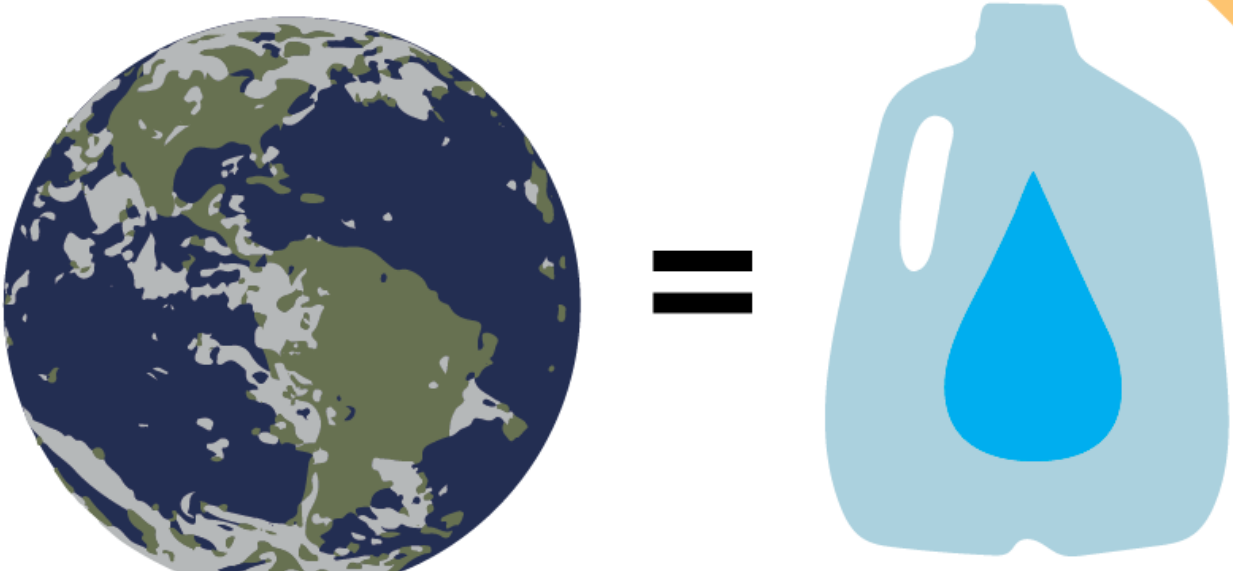
Did you know?

Engineers and Scientists present their discoveries and inventions all the time at professional conferences around the world. In academia, this is called scholarship.

Key Terms:

Communicate (in engineering): To share information, data, or ideas in order to improve designs or inspire new designs.

S1



Earth's Water

Experiment & Videos

S1 Purpose:

Youth explore the concept of water availability, accessibility, and usability on Earth.

Activity Timing

Introduction:	5 min
Water on Earth:	10 min
Dissolved Contaminants:	20 min
Habitability:	15 min
Wrap Up:	10 min
Total	60 min

Quick Tips:

- If you don't have a potato on hand, use an apple
- Turn Earth's Water video into an activity: you'll need a gallon of water, measuring spoons, and cups labeled for each reservoir

Prep Corner

- Read Science Series guide
- Test video links
- Print & copy Science Notebooks for each youth, p. 43
- Slice a potato
- Consider printing tables (pp. 26-29) & cards for S2, p. 50

1-2 hrs

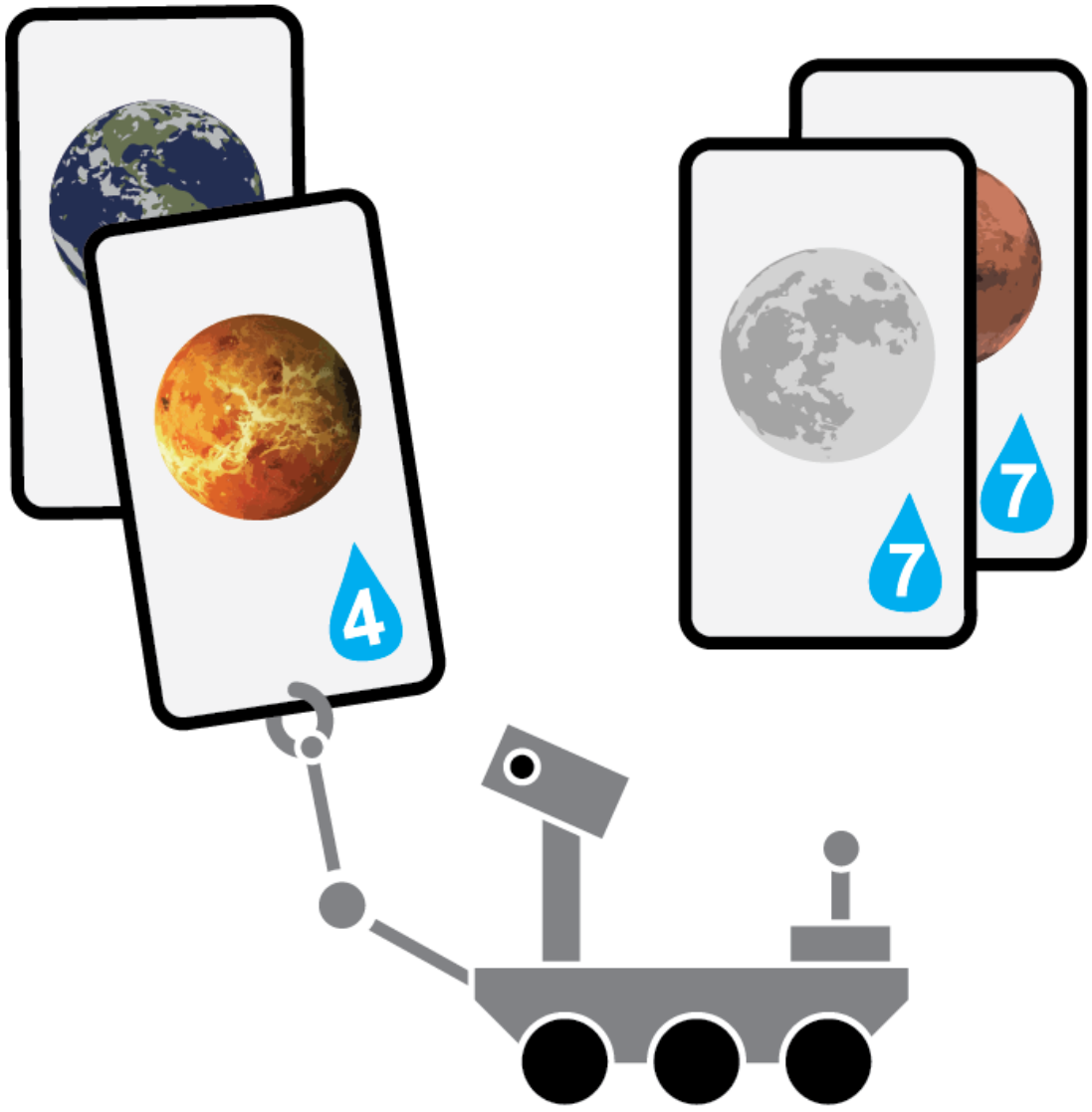
Did you know?

Salt in the oceans comes from the land. Groundwater dissolves small amounts of salt in rocks, which rivers carry to the ocean. As water evaporates and leaves the salt, the salinity of the ocean increases.

Key Terms:

- Availability: is water present?
- Accessibility: how easy is it to get?
- Usability: is it clean enough for humans to use?
- Habitability: can organisms live in the water?

S2



Water in the Solar System

PLANETS cards

S2 Purpose:

Youth explore where water is available in the solar system and begin to consider its accessibility and usability.

Activity Timing

Introduction:	5 min
Explore:	15 min
Investigate Water:	25 min
Wrap Up:	10 min
Total	55 min

Quick Tips:

- The math behind the water droplet values is available on: www.planets-stem.org
- Distribute cards for investigating water in the solar system in groups or shuffle and deal randomly, p. 25

Prep Corner

- Print & post tables around the room, pp. 26-29
- Print and cut cards, p. 50
- Optional: laminate cards for future use

40 min

Did you know?

We drink water molecules that dinosaurs drank. Earth's water has been around for billions of years, check out video 6: Water in the Solar System on: www.planets-stem.org/water-in-extreme-environments/

Key Terms:

Reservoir: A place where something is stored (in this case, water)

S3

Exploration Potential

Choose a Water Reservoir & Share

S3 Purpose:

Youth propose a planetary body to explore based on the availability, accessibility and usability of water and present their choice.

Activity Timing

Introduction:	5 min
Make a Choice:	15 min
Prepare:	15 min
Present:	25 min
Wrap Up:	5 min
Total	65 min

Quick Tips:

- Consider showing the whole play-list of background content videos on our website, or just video 7 - Water and Habitability
- When we don't have sufficient evidence for something its called scientific uncertainty.

Cheat Sheet for Potential Answers

Although arguments can be made for other states, liquid water is generally more usable & habitable. Cards that have liquid water: Earth surface, and the subsurface of Earth, Europa, Uranus, Titania, Ganymede, Callisto, Pluto, Titan, Triton, Enceladus, & Dione.

No prep for this activity

Did you know?

We don't actually know if water is usable on other planets. If it's mixed with other substances or appears rocky, then at least we know its not pure.

Did you know?

Amino acids are organic compounds that form the building blocks of life. Scientists have found evidence for them in space - on meteorites, comets, and in deep space.