Drinkable Water

Student Material

What's in your water? In 2014, the residents of Flint, Michigan, realized their water contained more than just H_2O; it also contained lead. Although Flint's water crisis was one of the most reported instances of water contamination, it isn't the only occurrence. In 2017, citizens of Pittsburgh, Pennsylvania, were told to boil all water before using it because tests showed the presence of the parasitic microbe *Giardia*.

Young children, infants, and newborns are especially susceptible to the harmful effects of lead poisoning, which can lead to damage of the body's nervous system, hearing loss, learning disabilities, and more. The effects of *Giardia*, which include diarrhea and dehydration, are less severe but still unpleasant.

Water is necessary for human hydration, temperature regulation, and bodily functions. How can you be certain that the water you are drinking is safe? And if it isn't, what could you do to make the water potable? Access to clean water is a global problem. According to UNICEF, in 2020 around 1 in 4 people lacked safely managed drinking water in their homes, and nearly half the world's population lacked safely managed sanitation. In fact, the World Health Organization (WHO) and UNICEF warn that billions of people around the world will be unable to access safely managed household drinking water and sanitation and hygiene services in 2030 unless the rate of progress [the UN 17 Sustainable Goals] quadruples.

You have a chance to be part of the solution to the global water crisis! Explore the causes and effects of unclean drinking water and collaborate with your peers to design an innovative solution to provide clean water for one community.

Drinkable Water *Rubric (Individual Design Journal)*

Student Material

	Novice	**Apprentice**	***Practitioner***	**Expert**
Formulate	includes description of two instances of water contamination meeting the following criteria: • example of contamination by living and nonliving things • explanation of how each type of contamination affects humans • long-term impact if left unsolved	includes description of three to five instances of water contamination meeting the following criteria: • example of contamination by living and nonliving things • explanation of how each type of contamination affects humans • long-term impact if left unsolved	includes description of six or more instances of water contamination meeting the following criteria: • example of contamination by living and nonliving things • explanation of how each type of contamination affects humans • long-term impact if left unsolved	all of *Practitioner* plus: makes personal connection to a water crisis
Explore: Substances	includes: • identification of two or more substances that cause water contamination • physical characteristics and chemical properties of each substance • labeled drawings of one atom found within substance • labeled drawing of water molecule	includes: • descriptions and labeled drawings of three or more substances that cause water contamination • physical characteristics and chemical properties of each substance • labeled drawings of two or more atoms found within substance • labeled drawings of water molecule and one molecule within the substance	includes: • descriptions and labeled drawings of four or more substances that cause water contamination • physical characteristics and chemical properties of each substance • comparison of labeled drawings of three or more atoms found within substance • comparison of labeled drawings of water molecule and one molecule within the substance	all of *Practitioner* plus: explanation of substances as "pure substances" or not

Explore: Microbes	includes: • labeled drawing of two or more microbes that cause water contamination • labeled drawing of cell for one microbe • description of function of each cellular component	includes: • description and labeled drawing of three or more microbes that cause water contamination • labeled drawing of cell for two different types of microbes • description of function of each cellular component • general description of what each type microbe needs to survive and reproduce	includes: • description and labeled drawing of four or more microbes that cause water contamination • labeled drawing/model of cell for three different types of microbes • explanation of how cellular components function as part of overall system • description of what each microbe needs to survive and reproduce	all of *Practitioner* plus: comparison of two or more types of microbes
Explore: Water Testing	• identifies x- and y-variables in methods • identifies starting cost and cost per *x* for graphical representations of methods • identifies arithmetic pattern	• identifies x- and y-variables in methods • constructs x-y table that accurately represents methods • accurately represents methods graphically • mathematically represents arithmetic pattern	• identifies x- and y-variables in methods • constructs x-y table that accurately represents methods and identifies significant values in real-world context • accurately represents methods graphically • mathematically represents arithmetic pattern and methods	all of *Practitioner* plus: provides examples and explanations of mathematical solutions that are not realistic
Ideate	includes two possible solutions to limit water contamination	includes: • three possible solutions to limit water contamination • one possible solution that could be implemented in more than one community	includes: • four or more possible solutions to limit or eliminate water contamination • two possible solutions that could be implemented in more than one community	all of *Practitioner* plus: includes one solution that could be implemented globally

Drinkable Water *Rubric (Group Design Solution)*

Student Material

	Novice	**Apprentice**	***Practitioner***	**Expert**
Sift	includes: • pros and cons of each group member's proposed solution • identification of specific water crisis to solve	includes: • pros and cons of each group member's proposed solution • description of feasibility of each proposed solution • identification of specific water crisis to solve	includes: • pros and cons of each group member's proposed solution • description of feasibility of each proposed solution • comparison of unintended consequences of proposed solutions • explanation of why specific water crisis was chosen	all of *Practitioner* plus: explanation of why final solution was chosen
Simulate	labeled drawing of proposed solution	labeled model of proposed solution	testable, labeled model of proposed solution	all of *Practitioner* plus: redesigned solution based on feedback from others
Advocate: Supporting Document	• introduces solution • provides appropriately cited background information about substance(s) and/or microbe(s) • provides appropriately cited information about how solution provides clean water • includes transitions, scientific vocabulary, and conclusion	• introduces solution and organization of document • includes headings, graphics, etc. • provides appropriately cited background information about substance(s) and/or microbe(s) • provides appropriately cited information about how solution provides clean water • includes transitions, scientific vocabulary, and conclusion	• introduces solution and organization of document • includes headings, graphics, etc., as needed to support reader understanding of solution • provides background information about substance(s) and/or microbe(s) with appropriately cited facts, definitions, examples, etc. • explains how prototype will limit or eliminate water with appropriately cited facts, definitions, examples, etc. • includes transitions to create cohesion and flow of text • includes scientific vocabulary • concludes with logical connection to text	all of *Practitioner* plus: includes link to video demonstration of solution

Drinkable Water *Scaffold for Learning*

Teacher Material

Benchmark Video and Discussions
- Unit launch to create felt need
- The IDE Design Process
- Linear functions
- What are elements?

Instructional Activities: Learning

Instructional Texts/Websites
- Identify functions from data tables and graphs (I, P)
- Determine y-intercept (I, P)
- Determine slope-intercept equation from graph (I, P)
- Determine central idea of article (I)
- Write unbiased summary (I, HW)
- Understand atomic structure (I)
- Understand the Periodic Table (I, P, SG)
- Using the vertical line test (I, P)
- Point of view (IV)
- Research (I)
- Cite sources (I, P)

Instructional Videos
- Identify functions from data tables and graphs (I, P)
- Determine y-intercept (I, P)
- Determine slope-intercept equation from graph (I, P)
- Determine central idea of article (I)
- Write unbiased summary (I, HW)
- Understand atomic structure (I)
- Understand the Periodic Table (I, P, SG)
- Using the vertical line test (I, P)
- Point of view (IV)
- Research (I, P)
- Cite sources (I, P)

How-to Sheets
- Set up Design Journal
- Design an investigation
- Determine x- and y-variables
- Find y-intercept
- Find slope
- Write a linear equation from graph
- Determine reliability of a source

Interactive Websites
- Graphing Linear Equations (SG)
- Atomic Models (P, SG)
- Graphing software (I, P, SG)
- Khan Academy (I, HW)
- Freerice (I, HW)
- IXL (I)

Learning Centers
- Compare data tables: function or not? (P, SG)
- Match linear equation with corresponding graph (I, P)
- Compare sources: reliable or not? (I, P, SG)
- Categorize summaries: biased and unbiased (P, SG)
- Explore models of atoms (I, P)

Small-Group Mini-Lessons
- Identify functions from data tables and graphs
- Determine y-intercept
- Determine slope-intercept equation from graph
- Determine central idea of article
- How to write unbiased summary
- Understand atomic structure
- Understand the Periodic Table
- Using the vertical line test
- Point of view
- Research
- Cite sources

Instructional Activities: Additional

Practice
- **Identify function data tables/graphs (I)**
- **Determine central idea: Flint crisis (I, HW)**
- **Write unbiased summary: Flint crisis (I)**
- **Label atomic model (I, HW)**
- **Identify objects made of pure substances (I)**
- **Match linear equation — graph (I, HW)**
- **Differentiate function/nonfunction (I, HW)**
- **Writing in slope-intercept form (IV)**

Application
- **Graph input/output from data tables (I, P)**
- **Create data table from graph (I)**
- **Analyze point of view: Flint crisis (I)**
- **Research contaminated water histories (I)**
- **Write linear equations from graphs (I, P)**
- **Connect atomic model to Periodic Table (I, P)**
- **Recognize bias language within text (I, P)**

Assessment
- **Self-assess functions (I)**
- **Self-assess Periodic Table (I)**
- **Self-assess atomic model (I)**
- **Use rubric to peer edit task (P)**
- **Use rubric to self-assess task (I)**

Reflection
Reflect:
- **Share thoughts about places like Flint, Michigan.**
- **Thoughts about clean water for all?**
- **What can you still do after this unit is over?**
- **What were the most "doable" solutions presented, why? (I, P, SG)**

Key: Individual **(I)**, Pairs **(P)**, Small Groups **(SG)**, Activities suitable for homework **(HW)**, Insights Video **(IV)**

EDQUIDDITY
EDUCATION FOR YOUR WHATNESS

Drinkable Water *Content Facilitation Grid (Week 1 Sample)*

Teacher Material

	Math						ELA						Science							
Student	Defines *function*	Determines if input and output represent a function	Uses vertical line test to determine if graph represents a function	Corrects graphs domain & range	Locates y-intercept on graph	Writes linear equation when given graph	Determines reliability of sources	Determines central idea of text	Writes unbiased summary	Determines point of view of author	Connects point of view with purpose of text	Identifies relationship between language used and point of view	Understands smallest unit of element is an atom	Labels protons in atomic model	Labels electrons in atomic model	Labels neutrons in atomic model	Identifies nucleus of atom	Connects information of Periodic Table to atomic model	Identifies protons as positively charged	Identifies electrons as negatively charged

Drinkable Water *Facilitation Questions*

Teacher Material

COMPREHENSION: *Ask questions that ensure students understand content and skills needed to solve the problem.*	• What is an atom? • What is an element? • What is a microbe? • What is slope-intercept form? • What is a proportional relationship?
APPLICATION: *Ask questions that ensure the ability of students to apply learning to new situations.*	• How are substances and microbes different? How are they the same? • How can you determine if a graph represents a linear function? • What types of relationships can you represent using functions? • What is the relationship between atoms and molecules? • How would you model sodium chloride? • What language in the text provides insight to the author's bias about the topic?
CONNECTION: *Ask questions that ensure the ability of students to apply learning to their lives.*	• How might you react if you realized the water you had been drinking was contaminated with lead? • How could you use the Design Process to solve other problems in your community?
SYNTHESIS: *Ask questions that encourage students to create new information from existing data.*	• Describe a situation in which the graphs of your water test results would not represent a function. • What were some of the unintended consequences of the solutions you did not choose? Why would they have occurred? Would there have been a way to control for them?
METACOGNITION: *Ask questions that prompt students to think about their own thinking process.*	• What was the most difficult part of this task? • How would you evaluate your group's ability to work together? • How did your team analyze possible solutions to select just one to simulate?

Drinkable Water *Transfer Task*

Student Material

According to the U.S. Food and Drug Administration (FDA), water is not the only place where you might find concentrations of lead. Both industrial and environmental uses of lead can contaminate the soil, causing contamination of plants that we eat. That's not all! Animals that we use for food (e.g., cows for beef and milk) may eat contaminated plants and pass on the lead to us as well.

Knowing what you do about microbes and substances, examine the following:

This plant is suffering from bacterial wilt. Unfortunately, the farmer also used lead arsenate to control the pests that spread the bacteria.

Describe the bacteria by providing the following:

- A labeled drawing
- An explanation of how five or more cellular components function within the system
- A description of reproductive and survival needs

Research lead arsenate and describe it by providing the following:

- An explanation for why it can or why it cannot be classified as a pure substance
- A description of two or more physical characteristics
- A description of two or more chemical properties

Drinkable Water *Teacher Notes*

Teacher Material

Unit Overview	
Access to clean drinking water is something that many people take for granted. However, 2.1 billion people around the world lack this basic need for human survival. Using the IDE Design Process, students explore instances of water contamination and select one to solve with an innovative solution. In the process, students gain empathy for those others as well as an enhanced perspective of the world.	
Enduring Understandings	**Essential Questions**
• Functions are a mathematical way to describe relationships between two quantities. • Functions can be represented in a variety of ways. • The Design Process is useful for identifying, working through, and solving real-world problems. • Atoms form molecules and are the basis for substances. • Pure substances have specific physical and chemical properties.	• What real-world scenarios can be represented as linear functions? • What is a substance? • What environmental and humanmade factors lead to water contamination? • How can text features be used in informative writing to support a reader's understanding of the topic?
Common Core State Standards Addressed	
CCSS.ELA-LITERACY.RST.6-8.1; CCSS.ELA-LITERACY.RST.6-8.2; CCSS.ELA-LITERACY.RST.6-8.4; CCSS.ELA-LITERACY.RST.6-8.7; CCSS.ELA-LITERACY.RST.6-8.9 CCSS.ELA-LITERACY.WHST.6-8.2; CCSS.ELA-LITERACY.WHST.6-8.4; CCSS.ELA-LITERACY.WHST.6-8.7; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.ELA-LITERACY.WHST.6-8.9 CCSS.MATH.CONTENT.8.EE.C.8a; CCSS.MATH.CONTENT.8.EE.C.8b; CCSS.MATH.CONTENT.8.EE.C.8c CCSS.MATH.CONTENT.8.F.A.1; CCSS.MATH.CONTENT.8.F.A.2; CCSS.MATH.CONTENT.8.F.A.3; CCSS.MATH.CONTENT.8.F.B.4; CCSS.MATH.CONTENT.8.F.B.5	
Other National Standards Addressed	
MS-PS1-1; MS-PS1-2; MS-PS1-5 MS-LS1-1; MS-LS1-2; MS-LS1-5	

21st Century Skills Addressed	
Core Content and Interdisciplinary Themes • Subject-Area Mastery • Health Literacy • Environmental Literacy	*Information and Media Literacy* • Information Literacy • Media Literacy
Learning and Innovation • Critical Thinking and Problem Solving • Creativity and Innovation • Communication and Collaboration	*Life and Career* • Flexibility and Adaptability • Initiative and Self-Direction • Social and Cross-Cultural Skills • Productivity and Accountability • Leadership and Responsibility