Lesson 2

Energy Flow

Goals

- Choose and create diagrams to help solve problems that involve ratios and non-whole numbers.
- Choose a strategy to solve problems involving rates, and explain (using words and other representations) the solution method.

Lesson Narrative

In this optional lesson, students use ratios and rates to work with large numbers and decimals in an environmental context. Students begin by comparing the water flow of different showers to see which shower uses the most water. Then, students examine different sources of power to determine how much energy came from each source and how long a fan and an air conditioner were used. Students reason abstractly and quantitatively when deciding to use a tape diagram, double number line, or other technique to approach these problems.

Student Learning Goal

Let's compare numbers and rates.

Access for Students with Diverse Abilities

- Action and Expression (Activity 1)

Access for Multilingual Learners

- MLR6: Three Reads (Activity 1)

Instructional Routines

- MLR6: Three Reads

Lesson Timeline

20 min	15 min
Activity 1	Activity 2

Activity 1

Know the Flow

20 min

Activity Narrative

This activity prompts students to apply what they know about equivalent ratios to solve problems about water consumption. Some numbers in the problems are non-whole numbers. Students may decide to use one or more representations previously learned, or reason only numerically, without the use of double number line diagrams or tables. As students compute and compare the different flow rates and interpret the rates in terms of water usage at each house, they reason abstractly and quantitatively.

Launch

Arrange students in groups of 2–4. Use *Three Reads* to support reading comprehension and sense-making about this problem. Display only the first two paragraphs, without revealing Andre's, Lin's, and Kiran's data or the questions.

- For the first read, read the problem aloud and then ask,

"What is this situation about?"

Three students are trying to find out the flow of their shower heads for a science project.

Listen for and clarify any questions about the context.

- After the second read, ask students to list any quantities that can be counted or measured.

The volume of containers and how much time it takes to fill them.

- After the third read, reveal the first question about the shower head with the highest flow rate and ask,

"What are some ways we might get started on this?"

Compare flow rates in the same time period, create a table, create a double number line

Invite students to name some possible starting points, referring to quantities from the second read.

Give students time to complete the rest of the activity, and follow that with a whole-class discussion.

Student Task Statement

Andre, Lin, and Kiran are studying their water usage from showers. They need to find the flow rate of their shower heads, which measures how much water flows out when the shower head is turned to the maximum. Flow rate is measured in gallons per minute.

To collect data, each student turns on the shower head to the maximum and measures the time it takes to fill a container of a known volume.

- Andre fills a 5-gallon container in 2 minutes.
- Lin fills a 3-gallon container in $\frac{3}{4}$ minute.
- Kiran fills a 1.5-gallon container in $\frac{1}{2}$ minute.

For each question, explain or show your reasoning.

Instructional Routines

MLR6: Three Reads

ilclass.com/r/10695568

Please log in to the site before using the QR code or URL.

Access for Multilingual Learners (Activity 1)

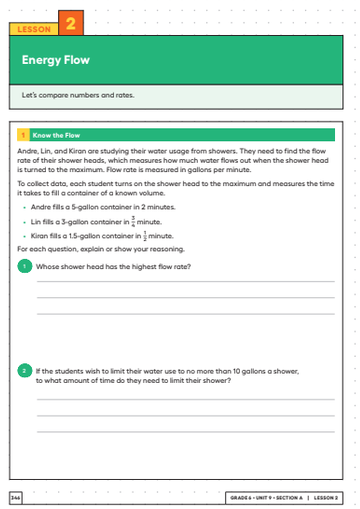
MLR6: Three Reads.
This activity uses the *Three Reads* math language routine to advance reading and representing as students make sense of what is happening in the text.

Access for Students with Diverse Abilities (Activity 1, Student Task)

Action and Expression: Provide Access for Physical Action.
Activate or supply background knowledge. Provide students with access to a blank table or blank double number line diagram to support information processing.

Supports accessibility for: Visual-Spatial Processing, Organization

Student Workbook



LESSON 2

Energy Flow

Let's compare numbers and rates.

1 Know the Flow

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To collect data, each student turns on the shower head to the maximum and measures the time it takes to fill a container of a known volume.

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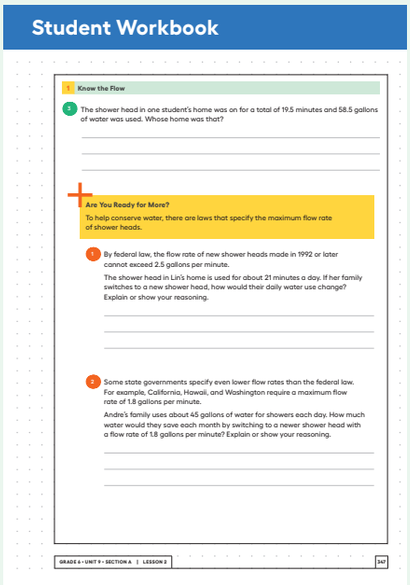
- Kiran fills a 1.5-gallon container in $\frac{1}{2}$ minute.

For each question, explain or show your reasoning.

1. Whose shower head has the highest flow rate?

2. If the students wish to limit their water use to no more than 10 gallons a shower, to what amount of time do they need to limit their shower?

Student Workbook



1 Know the Flow

3 The shower head in one student's home was on for a total of 19.5 minutes and 58.5 gallons of water was used. Whose home was that?

Are You Ready for More?

To help conserve water, there are laws that specify the maximum flow rate of shower heads.

1 By federal law, the flow rate of new shower heads made in 1992 or later cannot exceed 2.5 gallons per minute.

The shower head in Lin's home is used for about 21 minutes a day. If her family switches to a new shower head, how would their daily water use change? Explain or show your reasoning.

2 Some state governments specify even lower flow rates than the federal law. For example, California, Hawaii, and Washington require a maximum flow rate of 1.8 gallons per minute.

Andre's family uses about 45 gallons of water for showers each day. How much water would they save each month by switching to a newer shower head with a flow rate of 1.8 gallons per minute? Explain or show your reasoning.

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1. Whose shower head has the highest flow rate?

Lin's shower head. Sample reasoning:

- Andre's shower head lets out 2.5 gallons per minute, because $5 \div 2 = 2.5$. Kiran's shower head lets out at 3 gallons a minute, because $1.5 \cdot 2 = 3$. Lin's shower head lets out 3 gallons in 45 seconds, so more than 3 gallons would flow in 1 minute.
- Andre:

volume of container (gallons)	time to fill container (minutes)
5	2
2	1

- Lin:

volume of container (gallons)	time to fill container (minutes)
3	0.75
1	0.25
4	1

- Kiran:

volume of container (gallons)	time to fill container (minutes)
1.5	0.5
3	1

2. If the students wish to limit their water use to no more than 10 gallons a shower, to what amount of time do they need to limit their shower?

4 minutes for Andre, 2.5 minutes for Lin, and 3 minutes and 20 seconds for Kiran
Sample reasoning:

- Andre: $10 \div 2.5 = 4$
- Lin: $10 \div 4 = 2.5$
- Kiran: $10 \div 3 = 3\frac{1}{3}$ and $\frac{1}{3}$ of a minute is 20 seconds

3. The shower head in one student's home was on for a total of 19.5 minutes and 58.5 gallons of water was used. Whose home was that?

Kiran's home
Sample reasoning: $(19.5) \cdot 3 = 58.5$.

Are You Ready for More?

To help conserve water, there are laws that specify the maximum flow rate of shower heads.

1. By federal law, the flow rate of new shower heads made in 1992 or later cannot exceed 2.5 gallons per minute.

   The shower head in Lin's home is used for about 21 minutes a day. If her family switches to a new shower head, how would their daily water use change? Explain or show your reasoning.

   Sample responses:

   - Lin's family would save at least 31.5 gallons a day. Switching from a flow rate of 4 gallons per minute to 2.5 gallons per minute saves 1.5 gallons per minute. This means saving $21 \cdot (1.5)$ or 31.5 gallons a day.
   - Lin's family would use at most 52.5 gallons of water for showers ($21 \cdot (2.5) = 52.5$) instead of 84 gallons ($21.4 = 84$) each day.

2. Some state governments specify even lower flow rates than the federal law. For example, California, Hawaii, and Washington require a maximum flow rate of 1.8 gallons per minute.

   Andre's family uses about 45 gallons of water for showers each day. How much water would they save each month by switching to a newer shower head with a flow rate of 1.8 gallons per minute? Explain or show your reasoning.

   Sample response: 336 gallons a month. Andre's family runs the shower head for 18 minutes each day ($45 \div 2.5 = 18$). Switching from a flow rate of 2.5 to 1.8 gallons per minute means reducing water use by 0.7 gallon per minute. $18 \cdot (0.7) = 12.6$, so that's a saving of 12.6 gallons a day. In a 30-day month, that's a savings of $30 \cdot (12.6)$ or 378 gallons.

Activity Synthesis

Invite students who use different reasoning strategies to share their responses. Highlight connections across strategies, in particular, between those that made use of flow rate per minute and those that did not. For example, to find the maximum shower time on Andre's shower head so as to not exceed 10 gallons, some students may double the 2 minutes in the given ratio (5 gallons of water in 2 minutes). Others may divide 10 by the flow rate of 2.5 gallons per minute.

Here are some questions for discussion:

- *"Why does the amount of water used matter?"*

  Water is a limited resource.

- *"Other than the shower, what are some ways you use water?"*

  drinking, cooking, brushing teeth, cleaning, doing laundry, washing dishes

- *"What could you do to be more aware of your water usage?"*

  Time showers. Turn off water when not using it.

If desired, the activity can be extended to include students' actual water usage. Consider inviting students to collect data on the flow rate of their shower heads, the length of their showers, and the amount of water used for showers. Their results can be used to reflect on their water consumption and possible ways to conserve water.

Activity 2

Power Sources, Power Uses

15 min

Activity Narrative

This activity gives students a chance to apply the different strategies they have learned to solve part-part-whole ratio problems. It is also an opportunity to decide on methods that would make the most sense in given situations.

Each problem may lend itself better to a particular representation than to others. For example:

- The problem about power sources can be well represented by all three representations because it involves small numbers and simple multiplication.
- The problem about power used for cooling might be inefficient to represent with a number line diagram, since it would require marking 8 increments of 4.25 to find the total of 34. Using a tape diagram or a table with more straightforward multiplication would be more efficient.

The time needed to solve the problems may depend on the representation students choose to use.

Launch

Tell students that they will use some of the strategies that they have learned—number lines, tables, and tape diagrams—to solve ratio problems.

To introduce the context, ask students where the electricity that powers our buildings might come from. If not mentioned by students, note that some buildings are powered by a combination of solar energy (collected by solar panels, usually installed on the roof) and energy from power plants (distributed by energy companies). The electricity in those sources are then used to power appliances, light fixtures, and more. Explain that kilowatt-hour (kWh) is a unit of energy. (With 1 kilowatt-hour we can, for instance, toast 160 slices of bread or keep cool for 30 hours with a ceiling fan.)

Provide access to graph paper and rulers. Arrange students in groups of 2.

Student Task Statement

For each question, explain or show your reasoning. Organize it so it can be followed by others. If you get stuck, consider drawing a double number line diagram, table, or tape diagram.

1. A small building gets its electricity from two sources: solar panels and a power company. The ratio of electricity from solar panels to the electricity from the power company is 4 to 3.

In a typical week, the building uses 42 kilowatt-hours (kWh) of electricity. How many kWh of electricity is from solar panels

24 kWh from the solar panels
Sample reasoning:

- If 7 parts of electricity equal 42 kWh, then each part is 42 ÷ 7 or 6 kWh. 4 × 6 = 24
- Use a tape diagram:

2. The building has two rooms: One is cooled with a ceiling fan and the other with an air conditioner. Both appliances are turned on and off at the same time. It takes 0.2 kWh to power the fan for 6 hours and 4 kWh to power the air conditioner for 6 hours.

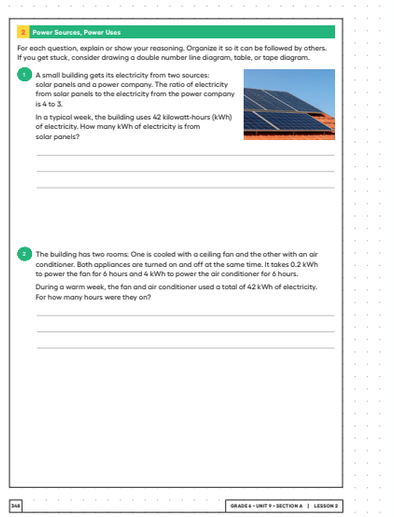
During a warm week, the fan and air conditioner used a total of 42 kWh of electricity. For how many hours were they on?

60 hours
Sample reasoning:

- It takes 4.2 kWh to power both appliances for 6 hours, or 8.4 kWh for 12 hours. I know that 5 · (8.4) = 42, so the appliances were used for 5 · 12 or 60 hours.
- Use a table and multiply 4.2 by different factors to get 42.

ceiling fan (kWh)	air conditioner (kWh)	total (kWh)	time used (hours)
0.2	4	4.2	6
1	20	21	30
2	40	42	60

Student Workbook


2 Power Sources, Power Uses

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Activity Synthesis

Solicit or share the solutions to the problems, and ask students about their choice(s) of representations. Here are some questions for discussion:

- *"Is there a particular representation you tend to try first?"*
- *"Does one seem more efficient than the others?"*
- *"Did the situation in a problem affect your choice? If so, what features of a problem might steer you toward or away from a particular strategy?"*
- *"A family wants their home to be comfortable in the summer while also minimizing their energy use. What recommendations would you make to them?"*

  Ceiling fans use less energy than air conditioners use. Some homes or rooms in homes do not have ceiling fans, so a combination of fans and air conditioners would be better than just air conditioners.