

Making Paper

Goals

- Choose and create diagrams to help solve problems that involve ratios and a total amount.
- Explain a method to solve ratio problems involving large numbers.

Lesson Narrative

In this optional lesson, students compare the energy used to make paper from two different sources: tree fiber or recycled material. This lesson begins with a *Warm-up* meant to familiarize students with vocabulary related to energy consumption and carbon dioxide emission. This promotes students' making sense of the problem and their perseverance in solving it. They then analyze the current consumption and emission of two paper mills and construct arguments regarding whether or not one of the paper mills should change the material used to create paper.

Student Learning Goal

Let's decide what material to make paper from.

Access for Students with Diverse Abilities

- Engagement (Activity 1)

Access for Multilingual Learners

- MLR1: Stronger and Clearer Each Time (Activity 1)

Instructional Routines

- MLR1: Stronger and Clearer Each Time

Lesson Timeline

10
min

Warm-up

30
min

Activity 1

Student Workbook

LESSON 3

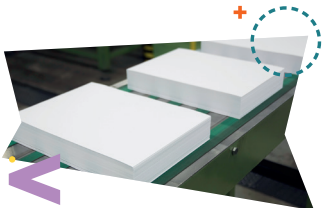
Making Paper

Let's decide what material to make paper from.

Warm-up Notice and Wonder: Paper Sources

What do you notice? What do you wonder?

| | tree fiber | recycled material |
|---|------------|-------------------|
| energy consumption (kWh) | 4 | 2 |
| carbon dioxide (CO ₂) emission (lb) | 9 | 4 |



GRADE 6 • UNIT 9 • SECTION A | LESSON 3

Warm-up

Notice and Wonder: Paper Sources

10 min

Activity Narrative

The purpose of this *Warm-up* is to familiarize students with the energy consumption involved in creating paper, which will be useful when students compare materials for making paper in a later activity. While students may notice and wonder many things about this table, understanding the vocabulary and seeing the difference between each paper source are the important discussion points.

This *Warm-up* prompts students to make sense of a problem before solving it by familiarizing themselves with a context and the mathematics that might be involved.

Launch

Arrange students in groups of 2. Display the table for all to see. Ask students to think of at least one thing they notice and at least one thing they wonder. Give students 1 minute of quiet think time, and then 1 minute to discuss with their partner the things they notice and wonder.

Student Task Statement

What do you notice? What do you wonder?

| | tree fiber | recycled material |
|---|------------|-------------------|
| energy consumption (kWh) | 4 | 2 |
| carbon dioxide (CO ₂) emission (lb) | 9 | 4 |

Students may notice:

- There are two materials used to make paper.
- Using both materials consumes energy.
- Using both materials emits carbon dioxide.
- The numbers associated with tree fiber are greater than the numbers associated with recycled material.

Students may wonder:

- What kinds of trees are used?
- What recycled materials are used?
- Why are the numbers for tree fiber approximately twice the numbers for recycled materials?
- What does “kWh” mean?

Activity Synthesis

Ask students to share the things they noticed and wondered. Record and display their responses without editing or commentary. If possible, record the relevant reasoning on or near the table. Next, ask students,

“Is there anything on this list that you are wondering about now?”

Encourage students to observe what is on display and to respectfully ask for clarification, point out contradicting information, or voice any disagreement.

Introduce the context to students. Explain that the production of everyday goods has an effect on the environment. One reason is that it requires energy, usually from burning fuel. (Remind students that kilowatt-hours (kWh) is a unit of energy.) Burning fuel in turn produces carbon dioxide, the same gas that we exhale. If present excessively in the atmosphere, it can trap heat and cause temperatures on earth to rise.

Tell students that in this lesson they will solve some problems about the environmental effect of paper production.

Activity 1

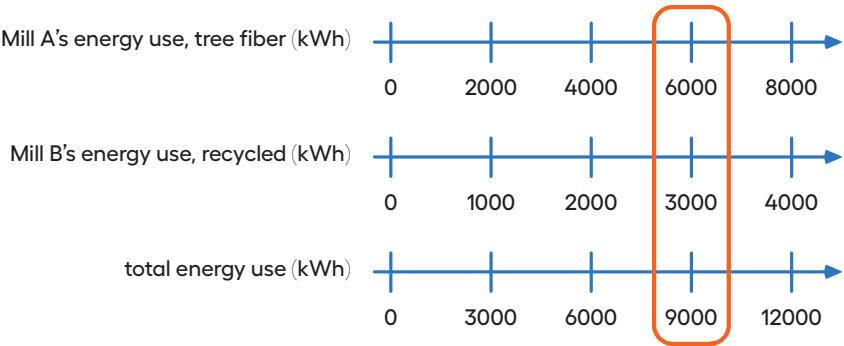
Sources of Paper Products

30 min

Activity Narrative

This activity offers students an opportunity to apply different strategies to solve part-part-whole ratio problems. Because of the large numbers involved, students need to reason flexibly and choose representations strategically. For example, for the first problem, students may choose to:

- Use a double or triple number line diagram, but showing energy use for increments of 500 pounds (instead of 1 pound) of paper.



Instructional Routines

MLR1: Stronger and Clearer Each Time
ilclass.com/r/10695479



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Access for Multilingual Learners (Activity 1)

MLR1: Stronger and Clearer Each Time.
This activity uses the *Stronger and Clearer Each Time* math language routine to advance writing, speaking, and listening as students refine mathematical language and ideas.

Access for Students with Diverse Abilities (Activity 1, Launch)

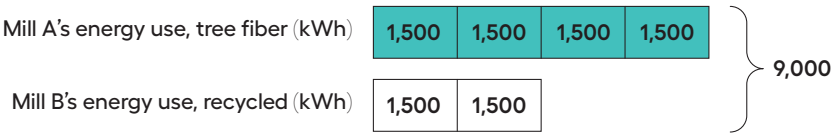
Engagement: Provide Access by Recruiting Interest.
Invite students to share their experience with different types of paper. If possible, show students examples of different types of paper made from different sources. Consider discussing the differences between paper made from different sources and if there are advantages or disadvantages to any source.

Supports accessibility for: Conceptual Processing, Memory

- Use a table and multiply 6 by different factors to get to 9,000.

| paper produced (lb) | energy use, paper mill A, tree fiber (kWh) | energy use, paper mill B, recycled material (kWh) | energy use, total (kWh) |
|---------------------|--|---|-------------------------|
| 1 | 4 | 2 | 6 |
| 100 | 400 | 200 | 600 |
| 500 | 2,000 | 1,000 | 3,000 |
| 1,500 | 6,000 | 3,000 | 9,000 |

- Draw a tape diagram showing 4 units for one quantity and 2 for the other. They may then experiment with different values for each unit that would add up to 9,000, or divide 9,000 by 6 units.



In this partner activity, students take turns sharing their initial ideas and first drafts. As students trade roles explaining their thinking and listening, they have opportunities to explain their reasoning and critique the reasoning of others.

Launch

Explain to students that paper can be made from different raw materials. Paper mills may use tree fiber, recycled material, or a combination of the two to make paper products. The material used affects how much energy is needed for production and how much carbon dioxide (CO₂) is emitted. Tell students that they will now compare the impacts of two paper mills that use different raw materials.

Arrange students in groups of 2. Give students 10 minutes of partner work time to complete the problems. Follow with a whole-class discussion.

Student Task Statement

The table shows the environmental effect of making one pound of plain paper using only tree fiber compared to using only recycled material.

| | tree fiber | recycled material |
|---|------------|-------------------|
| energy consumption (kWh) | 4 | 2 |
| carbon dioxide (CO ₂) emission (lb) | 9 | 4 |

A paper company has two mills that produce the same amount of paper. Mill A uses only tree fiber. Mill B uses only recycled material. Each day, the two mills used a total of 9,000 kWh of energy for their paper production.



1. How many pounds of paper did each mill produce? How many pounds did they produce in total?

Each mill produced 1,500 pounds. They produced 3,000 pounds in total.
Sample reasoning: It takes 6 kWh of energy for each mill to make 1 pound of paper. $9,000 \div 6 = 1,500$.

2. How much carbon dioxide did the two mills emit in total?

19,500 pounds of carbon dioxide
Sample reasoning: Mill A emitted $1,500 \cdot 9$ or 13,500 lb. Mill B emitted $1,500 \cdot 4$ or 6,000 lb. In total, they emitted $13,500 + 6,000$ or 19,500 lb.

3. Suppose Mill A is converted to use only recycled material.

a. If the mills still produce the same amount of paper as before, how would their total energy use change?

They would use 3,000 kWh less energy.
Sample reasoning: Papermill A would use 2 kWh less for every pound of paper it makes or 3,000 less for the 1,500 pounds of paper it makes.

b. How would their carbon dioxide emission change?

The emission would decrease by 7,500 pounds.
Sample reasoning: Making one pound of paper from recycled material instead of tree fiber would cut emission by 5 pounds ($9 - 4 = 5$) and $1,500 \cdot 5 = 7,500$.

c. Should Mill A change to only recycled materials? Explain your reasoning.

Sample response: Yes, Mill A should change to using recycled materials. They can produce the same amount of paper while using less energy and creating less carbon dioxide.

Student Workbook

Sources of Paper Products

The table shows the environmental effect of making one pound of plain paper using only tree fiber compared to using only recycled material.

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A paper company has two mills that produce the same amount of paper. Mill A uses only tree fiber. Mill B uses only recycled material. Each day, the two mills used a total of 9,000 kWh of energy for their paper production.

1

How many pounds of paper did each mill produce? How many pounds did they produce in total?

2

How much carbon dioxide did the two mills emit in total?

Student Workbook

Sources of Paper Products

Suppose Mill A is converted to use only recycled material.

a

If the mills still produce the same amount of paper as before, how would their total energy use change?

b

How would their carbon dioxide emission change?

c

Should Mill A change to only recycled materials? Explain your reasoning.

Activity Synthesis

Use *Stronger and Clearer Each Time* to give students an opportunity to revise and refine their response to “Should Mill A change to only recycled materials? Explain your reasoning.” In this structured pairing strategy, students bring their first draft response into conversations with 2–3 different partners. They take turns being the speaker and the listener. As the speaker, students share their initial ideas and read their first draft. As the listener, students ask questions and give feedback that will help their partner clarify and strengthen their ideas and writing.

If time allows, display these prompts for feedback:

- “_____ makes sense, but what do you mean when you say ...?”
- “Can you describe that another way?”
- “How do you know ...? What else do you know is true?”

Close the partner conversations, and give students 3–5 minutes to revise their first draft. Encourage students to incorporate any good ideas and words they got from their partners to make their next draft stronger and clearer.

After *Stronger and Clearer Each Time*, invite students to share their responses and reasoning. Then, focus the discussion on whether or how the larger numbers in the problems affect the strategies or representations that students chose to use in solving the problems.