ACTIVITY 8

Collecting Experimental Data for Predictions

LABORATORY

v 1.0

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Collecting Experimental Data for Predictions

ACTIVITY SUMMARY

One increasingly challenging source of particulate matter is wildfire smoke, which can travel hundreds or even thousands of miles and affect air quality far from the fire. Students apply their knowledge of scientific uncertainty and probabilistic reasoning to collect experimental data to make predictions about the real world. They conduct an experiment to measure the ignition time and the heat of combustion of different vegetation to model wildfire fuel sources. Students use their laboratory results to make predictions about how fuel sources affect wildfire spread.

ACTIVITY TYPE
LABORATORY

NUMBER OF
40–50 MINUTE
CLASS PERIODS
2

KEY CONCEPTS & PROCESS SKILLS

1. When there is scientific uncertainty in data, probabilistic reasoning is a method for determining the likelihood of different outcomes on which to base a decision.
2. Probabilistic reasoning can be used to identify meaningful patterns in data (*signal*) about a phenomenon being investigated. Variations in the data (*noise*) can increase scientific uncertainty by distorting or hiding the signal.
3. Uncertainty in data is often a result of errors. Scientific errors can be random or systematic and can lead to conclusions that are less likely to be correct.
4. Scientific methods can reduce sources of uncertainty. Techniques to reduce random error include taking repeated measurements and averaging across many samples. Techniques to reduce systematic errors include calibrating equipment more carefully and designing investigations to control for other factors that could influence the results (*confounds*).

CONCEPTUAL TOOLS

PROBABILISTIC REASONING

SIGNAL & NOISE

NEXT GENERATION SCIENCE STANDARDS (NGSS) CONNECTION:
Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (*Science and Engineering Practice: Analyzing and Interpreting Data*)

Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. (*Science and Engineering Practice: Analyzing and Interpreting Data*)

VOCABULARY DEVELOPMENT

calorie
(assumed prior knowledge)
the amount of energy it takes to raise the temperature of 1 gram of water by 1°C

calorimeter
(assumed prior knowledge)
a device used to measure the heat released or absorbed during a chemical reaction or physical change

heat of combustion
(assumed prior knowledge)
amount of energy released as heat when a substance is burned

ignition time
(assumed prior knowledge)
how easily or quickly a material will catch on fire

law of conservation of energy
(assumed prior knowledge)
energy cannot be created or destroyed, so the total amount of energy in a system is constant

TEACHER BACKGROUND INFORMATION

Wildfire Fuel Sources

Fuels are one of three main components that drive wildfires. The other two are terrain and weather (especially wind). Fuels can be split into two classes or components: live and dead. The live component is generally related to the growing season. During the course of the year, there are typically one or two growing periods (e.g., spring and summer) with a dormant period during winter. The dead fuel consists of wood logs and twigs and includes a duff layer, which consists of several years' worth of accumulating tree needles and leaf litter. The drier and deeper the duff layer, as well as the drier the soil, the more susceptible this fuel bed is to lightning strikes. Fire will smolder for days and even weeks within a dry and deep duff layer.

To reduce flammable material—such as dry grass, fallen trees, dense forests, logs, and shrubs—land management agencies strategically remove and reduce fuels on the landscape. Fuel management practices include burning, thinning, pruning, chipping, and mechanically removing fuels to reduce the amount and continuity of burnable vegetation.

MATERIALS & ADVANCE PREPARATION

FOR EACH GROUP OF FOUR STUDENTS

- METAL SODA CAN OR SOUP CAN
- 50 mL GRADUATED CYLINDER
- RULER WITH CENTIMETERS (cm)
- WATER 50 mL PER SAMPLE
- GLASS THERMOMETER, LONGER THAN 14 cm (5.5 INCHES)
- ALUMINUM FOIL
- WIRE GAUZE MINIMUM ABOUT 7.5 x 7.5 cm (3 X 3 INCHES)
- METAL TONGS
- 2–3 PAPER CLIPS
- RING STAND, WITH CLAMP AND RING SUPPORT (or coat hanger that can hold the can)
- LONG-REACH LIGHTER OR MATCHES
- STOPWATCH OR OTHER TIMER
- ELECTRONIC OR MECHANICAL BALANCE THAT MEASURES TO AT LEAST 0.1 GRAMS
- SAMPLES OF OUTDOOR VEGETATION

FOR EACH STUDENT

- STUDENT SHEET 8.1 "Testing Fuel Sources"
- SAFETY GOGGLES
- LAB COAT (OPTIONAL)
- DISPOSABLE FACE MASK (OPTIONAL)

Gathering Fuel Sources

Select various types of vegetation for groups to test as fuel sources. Depending on your location, you can collect grasses, leaves, shrubs, and twigs from your surrounding area. Results can vary for this lab, based on available materials. In order to facilitate ignition, make sure the following criteria are met:

- Vegetation samples should be less than a pencil width in diameter or thickness and should be collected with enough time in advance of the lab that they can dry out sufficiently.
- To control fire size, all vegetation samples should be trimmed to less than 2 inches long and should weigh no more than 0.5–1.0 grams before burning.

Test materials yourself beforehand to ensure that the samples will ignite as expected and meet the safety requirements as noted in the Safety Notes section. Items that are too thick, too wet, or have certain types of bark may be difficult to ignite. Natural oils, a waxy coating, or other substances will affect how well the materials ignite or how large the flame will be. Avoid placing samples in windy areas or near air drafts that can affect the ignition and burn time of the samples.

While the goal of the lab is to simulate natural fuel sources involved in wildfires, you may find it easier to purchase other materials to test. Some suggestions for alternative fuels are listed in the following table. If you use alternative fuel sources, be sure to help students make analogies to natural fuel sources and think about the effects on a wildfire.

GRASS		DRY VEGETATION		TREES	
NATURAL MATERIALS	NOT AS REALISTIC, BUT EASY TO FIND	NATURAL MATERIALS	NOT AS REALISTIC, BUT EASY TO FIND	NATURAL MATERIALS	NOT AS REALISTIC, BUT EASY TO FIND
Dried grasses: should be long/ tall and dry. May need to fold them into a loose bundle. Dried moss, fine wood shavings (uncolored and not preserved)	Shredded paper or tissue paper Thin strips of crushed paper Food model: marshmallow	Dried leaves Dried pine needles Dried shrubs or herbs	Thin strips of cardboard Toothpicks: loosely bundle several together Food model: popcorn cheese puffs	Dried sticks of wood Dried bark	Wooden craft sticks Wooden paint stirrers Food model: almonds walnuts

Calorimeter Setup

Review the calorimeter setup instructions in Procedure Steps 4–6 in the Student Book, which include a diagram of a ring stand with a clamp from which to hang a soda can by the tab and a ring support with a piece of wire gauze to hold the fuel source. Wire gauze is a wire mesh with a woven ceramic center that provides a surface that can hold the vegetation as it burns. Determine if you need to alter the instructions based on the equipment you have available. In lieu of a ring support and wire gauze, you can build a fuel holder out of various materials such as clay and paper clips. If you don't have access to ring stands and clamps, search online for "high school or home school calorimetry labs" to find a setup that could work with your available equipment.

Safety Notes

Review your school's fire safety plan and ensure your classroom has access to fire safety equipment as needed. Also alert others at the school about the experiment and that they may smell burning materials. Review safety rules and behavioral expectations with students before beginning the lab. Remind students:

- to wear safety eyewear during this investigation.
- that long hair must be tied back and loose sleeves rolled up.
- to clear all items near the test area and be especially careful not to get hair or clothing near the flame. If anything besides the fuel sample begins to burn, get help immediately.
- to keep a cup of water nearby as a fire safety precaution.
- that burning samples can make lab equipment hot to the touch. Use metal tongs to pick up the wire gauze and the burned sample.

Depending on your classroom setup, you may wish to light each group's sample yourself (instead of having students do it). You can also design and perform the experiments as a class demonstration or provide students with sample data.

All samples should be tested in a clear area outdoors or in a very well-ventilated classroom to minimize exposure to smoke. Students may wish to wear masks during the ignition procedure. If a sample fails to ignite after 15 seconds of applying the flame from the lighter, students should stop using that sample. Instruct students to take care, as the lighter, sample holder, and sample will be extremely hot.

TEACHING NOTES

Suggestions for **discussion questions** are highlighted in gold.

Strategies for the **equitable inclusion of diverse students** are highlighted in mint.

GETTING STARTED (10 MIN)

1 **Brainstorm ideas about how different types of fuels affect wildfires.**

- Support students in sharing their knowledge about wildfires while remaining sensitive to individual student's experiences. Validate students' points of view by eliciting students' observations, experiences, and knowledge as assets to building understanding. Ask, What are some types of fuel sources that burn in wildfires? Student responses may include descriptions of different types of plants such as trees, grasses, and shrubs. Buildings can also be fuel sources for a wildfire. Students may also have some ideas that are not related to vegetation, such as oil or homes. Follow up with a prediction question. Ask, What ideas do you have about how the type of fuel affects wildfires? Students may already know that vegetation that is really dry can catch fire more easily or be more involved in wildfires. Students might suggest that trees may burn a long time because they are so substantial and provide more fuel.
- Read the Introduction, either as a class or individually. Point out that being able to accurately predict the behavior of wildfires can also help scientists make predictions about wildfire smoke and, therefore, air quality. In this activity, students will investigate fuel sources as one of the factors influencing wildfires, and they will apply their lab results to probabilistic reasoning related to wildfire spread.

PROCEDURE SUPPORT (60 MIN)

2 **Review classroom safety expectations.**

- This lab involves burning various materials, so it is important to review the safety rules and behavioral expectations before students begin the procedure. Remind students to wear lab coats and safety goggles, tie hair back, pull up long sleeves, and follow all other classroom safety rules.
- Point out that the lighters or matches must be used responsibly. Review any additional guidelines you have for their use in the classroom.
- Optionally, students may want to wear masks to protect themselves from any smoke.

3 Prepare students to conduct their experiments.

- As a class, read the fictional scenario in Procedure Step 1. Clarify the purpose of the lab. Explain to students that they will be conducting experiments to find out how different fuel sources affect the heat, speed, and smoke of a fire for the purpose of informing probabilistic reasoning related to wildfire smoke and spread. Groups will choose two different types of vegetation to test, and group members will eventually make predictions about each fuel source's effects on a wildfire.
- Reading the scenario aloud can better support comprehension for many students, including neurodiverse students and emerging multilingual learners who often have more highly developed listening and oral skills than reading comprehension skills.
- Review the terms *ignition time* and *heat of combustio*n defined in Procedure Step 2. Explain to students that they will be measuring both of these values, but they can also observe and record other variables (e.g., how long it takes the fuel source to burn or how much smoke it produces). If needed, review the concepts of combustion, calories, and how a calorimeter works based on the law of conservation of energy from the Science Review in the Student Book.
- Since this is an inquiry-based lab, you may want to use heterogeneous groups to help support the needs of all learners and encourage all students to participate. You may find it useful to assign roles to each group member, as there are many experiment setup and data collection tasks that can be divided up.
- In Procedure Steps 4–6, students refer to Figure 8.1 in the Student Book to set up the calorimeter. Give students any special instructions or modifications related to the available equipment for building the calorimeter and fuel sources to test. It may be useful to demonstrate how to build the holder for the fuel source, prepare the sample, and set up the calorimeter.

4 Support students as they test their samples and analyze their data.

- In Procedure Step 4, distribute lab materials (except lighters or matches) to each group and one copy of Student Sheet 8.1, "Testing Fuel Sources," to each student. Before groups begin testing their samples in Procedure Part B, you may want to demonstrate how to properly weigh the samples, safely light and burn the samples, and record data and observations in Table 1 on Student Sheet 8.1. Sample Student Responses for several types of samples are provided at the end of this activity even though students are only expected to test two samples.
- Circulate and assist groups as they test their samples in Part B, if needed.
  - Before lighting vegetation samples, check each group's calorimeter setup for safety.
  - Remind students that they must mass the sample both before and after burning. Depending on the equipment available to you, review how to mass a vegetation sample in order to accurately calculate the change in mass (in Procedure Step 16). Inform students that they may empty and refill their can to help reset the water temperature in between tests. Also remind students to wait until the can is cool to the touch before handling it.

- Students may observe that materials used to represent trees are hard to ignite and often will not remain burning without a constant flame source. In a natural setting, trees are very difficult to ignite, but once ignited, they will burn for a longer period of time. You can help students think about how this plays a role in wildfires, especially in places that have mixed vegetation. (Grasses ignite and spread the flame quickly to other areas, dried vegetation ignites easily and burns for longer, trees can be ignited when there is a lot of nearby dried vegetation that is burning and then burn the longest and hottest of all the fuel sources.)
- Remind students to clean up and safely dispose of their samples before moving on to Procedure Part C.
- In Part C, if you have students who need math support, project Table 2 on Student Sheet 8.1 and model how to complete the calculations described in Procedure Steps 15 and 16, using the data from Table 1.
- In Procedure Step 17, give students instructions for sharing their findings with one or two other groups. You may want to have students record notes from their discussions in their science notebooks.

SYNTHESIS OF IDEAS (20 MIN)

5 **Have students share results.**

- Ask a student from each group to share with the rest of the class their conclusions about the samples they tested and observed. You may want to compile the results on the board so students can compare across groups.
- Ask, Based on everyone's data, which sources will cause a fire to spread most quickly and burn for longer? Student responses may vary depending on the fuel sources they tested. Help the class develop the understanding that drier fuel sources will ignite a lot faster and tend to produce less smoke (burn more cleanly) than fresh fuel sources. Also, grasses (or leaves) will ignite faster and burn more quickly than dry wood. However, since there is generally more mass in a piece of wood than in an equivalent volume of grass (or leaves), wood will produce more heat if it catches fire, though it is more difficult to ignite.
- Follow up by asking, How do you think each of the fuel sources tested will affect the way an actual wildfire behaves? An area with grass will likely cause a fire to spread more quickly than a fuel source area with wood. But wood will be more likely to keep the wildfire burning because it will generate more heat.

6 **Review key concepts from the activity.**

- Ask, What role does probabilistic reasoning play in your prediction of wildfire behavior? Students should recognize that the experiment provided data that could be use for determining the likelihood of wildfire behavior.

- To conclude the activity, evaluate whether your students are able to answer the Guiding Question, *How can you use experimental results to make predictions about the real world?* Use this as a chance to revisit and summarize the key concepts and process skills of the activity by reviewing their answers to Build Understanding items 2, 3, 4 and Connections to Everyday Life item 5. Build Understanding item 2 provides an opportunity for students to use their experiment results from the lab to make a prediction about a wildfire in fictional Koheegee Park. This item also previews the map and fuel sources they will be working with in Activity 9: Probabilistic Modeling. Build Understanding items 3 and 4 give students an opportunity to use real scientific data to make predictions about real wildfires. Connections to Everyday Life item 5 gives students an opportunity to use scientific data to make predictions related to an everyday decision.

EXTENSION (10 MIN)

7 **Use the Extension as an opportunity for advanced learning.**

Students can learn more about fire science, the effects of fires on wildlife, and fire suppression by watching the *Inside the Lab That Starts Fires For Science* video about the Missoula Fire Sciences Lab.

SAMPLE STUDENT RESPONSES

BUILD UNDERSTANDING

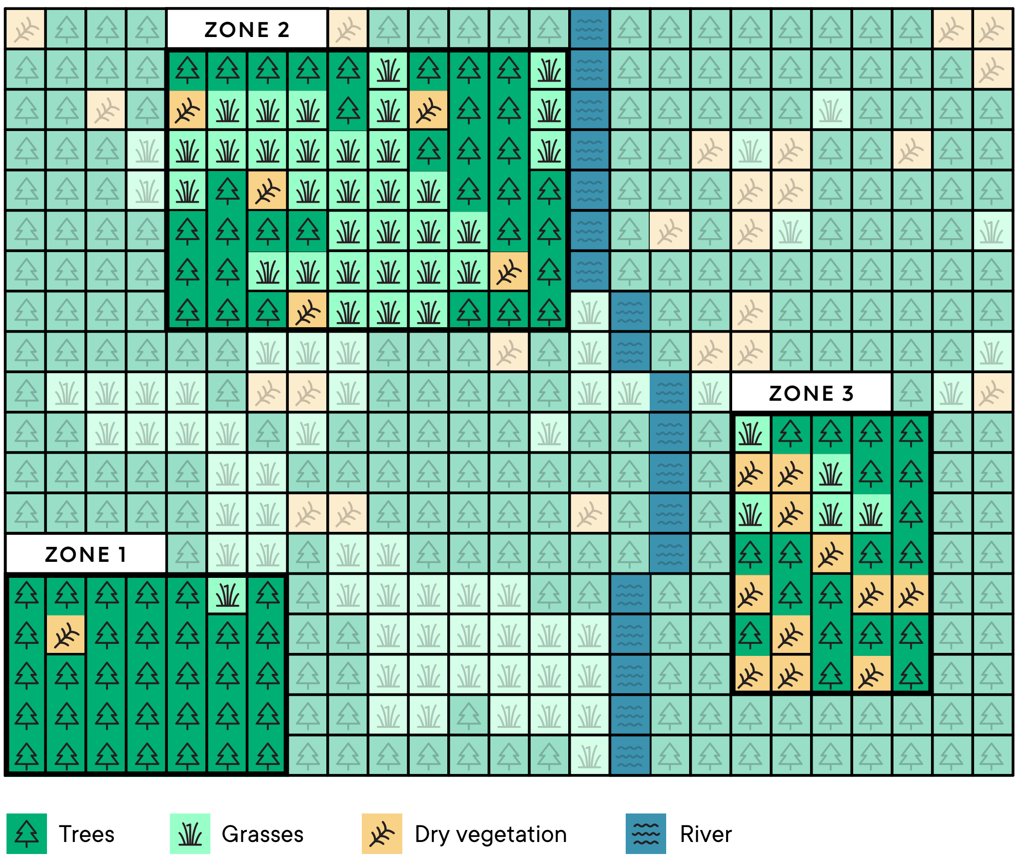
1. **You conducted an experiment to compare two different fuel sources. Which of the fuel sources do you think is more likely to be ignited in a wildfire? Use the results from your experiment as well as probabilistic reasoning to explain your prediction.**

   Responses will vary based on which samples were tested.

   We tested a piece of bark and a bundle of dried grasses. The bark was really difficult to catch on fire, and it wouldn't stay burning, while the grass was very easy to ignite and quickly burned the whole sample. Based on this, I predict that grasses are more likely to be ignited in a wildfire, while trees (which are covered with bark) are less likely to be ignited.

2. **Examine Figure 8.2, which shows a map of a fictional place called Koheegee Park.**

FIGURE 8.2
Map of Koheegee Park with 3 Zones



a **Which of the fuel samples tested by your class would best represent each type of fuel source (trees, grasses, dry vegetation) found in Koheegee Park?**

Grasses: We tested dried lawn grass, and I think this would represent grasses in Koheegee Park because it is similar to other dried grass in nature.

Trees: We tested twigs, and I think those would represent trees because they were the thickest and more woody than the other samples.

Dry vegetation: We tested toothpicks, and I think those would represent dry vegetation because they are thin and snapped easily like dried wood.

b **Which section of the park (Zone 1, 2, or 3) is most at risk from a rapidly spreading wildfire? Explain.**

I think the section of the park that will be most at risk from a rapidly spreading wildfire is Zone 2 because that zone has the most grasses. According to our results, materials like grasses catch fire really quickly and can spread the flame the fastest.

③ ***Fuel load*** **is the amount of combustible material in a given area, measured as weight per unit of area. Examine Table 8.1, which shows the annual fuel load in four different regions by latitude.**

TABLE 8.1
Annual Fuel Load for Four Regions, 2010–2019 (measured in petagrams)

REGION	LIVE FOLIAGE	LIVE WOOD	DEAD FOLIAGE	DEAD WOOD
A (50°N–90°N)	3	76	27	21
B (23.5°N–50°N)	4	61	19	10
C (23.5°S–23.5°N)	9	347	25	34
D (50°S–23.5°S)	1	18	4	5

a **Based on this data and the results from your experiment, which region do you think is most at risk for wildfires? Explain your reasoning.**

Based on our results, I think the region that will be most at risk for wildfires is Region C because it has the most dead vegetation (dead foliage and dead wood, combined). From our experiment, we saw that things that are moist are harder to catch on fire than things that are dry. Live vegetation has more moisture than dead vegetation.

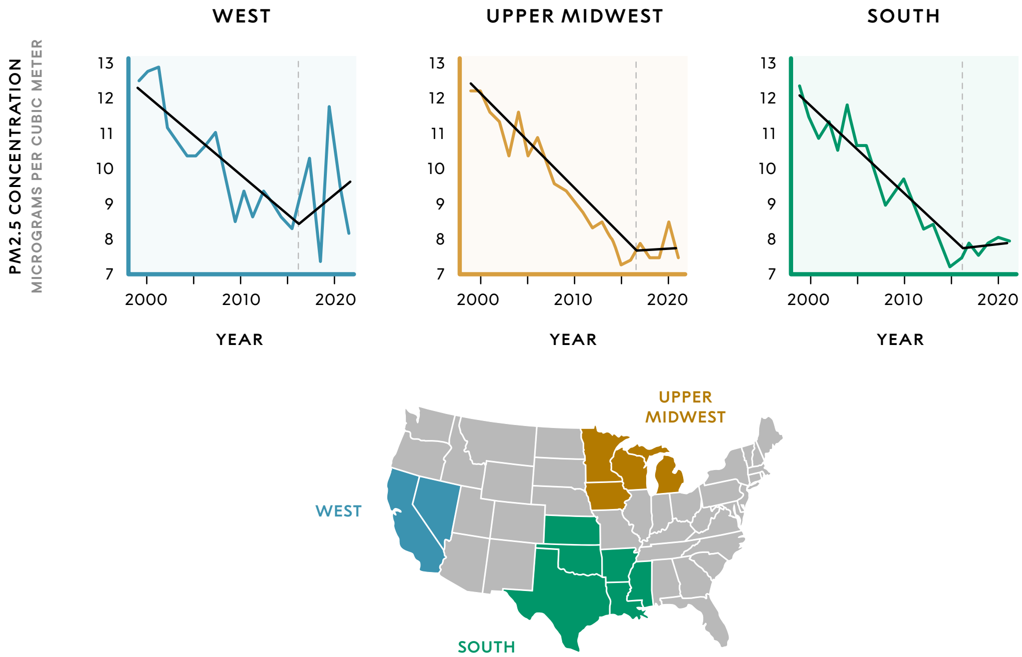
b **What other factors could influence the wildfire risk in each region?**

I think that weather patterns and local features such as lakes and rivers might affect the wildfire risk in each region.

4. **Researchers examined the contribution of wildfire smoke to average annual PM2.5 concentrations in different regions of the United States by using a combination of ground-based and satellite-based air pollution data from 2000 to 2022. Examine their results, which are shown in Figure 8.3.**

FIGURE 8.3

Regional Trends in the United States of PM2.5 Concentrations, 2000–2022



a **For each graph, describe the patterns you see in the data both before and after 2016, the year indicated by the dashed vertical line.**

West: The amount of PM2.5 generally decreases until 2016. After 2016, the PM2.5 level increased sharply.

Upper Midwest: The amount of PM2.5 generally decreases until 2016. After 2016, the PM2.5 level stayed the same.

South: The amount of PM2.5 generally decreases until 2016. After 2016, the PM2.5 level increased a little bit.

b **Based on this data, which part of the United States is most likely to have PM2.5 levels that are influenced by wildfire? Explain your reasoning.**

I think that the western region is most likely to have PM2.5 levels that are influenced by wildfire because the PM2.5 levels have increased since 2016. I heard on the news that there are lots of wildfires in the west. Wildfires can result in increased levels of PM2.5 because the burning and smoke can release small particles into the air.

c **Explain how the trend line on the graph helps you differentiate the signal from the noise.**

The trend line helps differentiate the signal from the noise because of all the fluctuations in the data. The noise makes it hard to see the longer-term pattern in the data. The trend line shows the general pattern and also makes it easier to compare the date from one location to another.

CONNECTIONS TO EVERYDAY LIFE

⑤ **Imagine you have been saving to go on a trip to an outdoor amusement park during a school break. A ticket costs $100. If you buy your ticket one month in advance, you will get a 20% discount. So far, the weather has been mild and warm with little rain and no snow. Table 8.2 shows local weather data for the last 5 years for the month you plan to go.**

TABLE 8.2
Five-Year Average of Local Weather Data during Annual School Break

YEAR	MINIMUM TEMPERATURE	MAXIMUM TEMPERATURE	TOTAL PRECIPITATION
2020	-1.1°C (30°F)	5.6°C (42°F)	0.1 cm (0.04 in)
2021	3.9°C (39°F)	10.0°C (50°F)	0.2 cm (0.08 in)
2022	0.6°C (33°F)	9.4°C (49°F)	1.0 cm (0.4 in)
2023	11.6°C (53°F)	19.4°C (67°F)	0.0 cm (0.0 in)
2024	5.0°C (41°F)	14.4°C (58°F)	3.0 cm (1.2 in)

a **Use probabilistic reasoning to explain whether or not you would buy a ticket in advance.**

I would not buy a ticket in advance right now. The data from the previous 5 years shows that the temperatures and precipitation are unpredictable from year to year. The weather forecast is only useful a few days out. More than a few days, you are taking a big chance. Even though I would save $20, if it is wet or very cold on that day, I would either not go and lose my money or go and be miserable.

b **What information would reduce the uncertainty in your decision?**

It would help to look at data from more than just the weeks of the school break. That could give a better sense of what the range of weather is like during this time of year. I also want to know more about what conditions would cause some of the rides to be shut down and whether or not I can get a refund if we decide not to go due to bad weather.

REFERENCES

Burke, M., Childs, M. L., de la Cuesta, B., *et al*. (September 20, 2023). The contribution of wildfire to PM2.5 trends in the USA. *Nature, 622*, 761–766. https://doi.org/10.1038/s41586-023-06522-6

McNorton, J. R., & Di Giuseppe, F. (2024). A global fuel characteristic model and dataset for wildfire prediction. European Geoscience Union: *Biogeosci-ence*, *21*(1), 279–300. https://doi.org/10.5194/bg-21-279-2024

STUDENT SHEET 8.1	TESTING FUEL SOURCES	NAME

TABLE 1: OBSERVATIONS AND MEASUREMENTS

SAMPLE	MASS OF WATER (g)	SAMPLE MASS INITIAL (g)	SAMPLE MASS FINAL (g)	WATER TEMPERATURE INITIAL (°C)	WATER TEMPERATURE FINAL (°C)	IGNITION TIME (seconds)
	BURN OBSERVATIONS					
	BURN OBSERVATIONS					

TABLE 2: CALCULATIONS

SAMPLE	Energy released by the sample (calories) = mass of water (g) X temperature change of water (°C)			Heat of combustion (calories/gram) = $\frac{\text{energy released by the sample (cal)}}{\text{change in mass of sample (g)}}$	
	MASS OF WATER IN CAN (g)	TEMPERATURE CHANGE OF WATER (°C)	ENERGY RELEASED BY SAMPLE (cal)	CHANGE IN MASS OF SAMPLE (g)	HEAT OF COMBUSTION (cal/g)

 SAMPLE STUDENT RESPONSE

TABLE 1: OBSERVATIONS AND MEASUREMENTS

SAMPLE	MASS OF WATER (g)	SAMPLE MASS INITIAL (g)	SAMPLE MASS FINAL (g)	WATER TEMPERATURE INITIAL (°C)	WATER TEMPERATURE FINAL (°C)	IGNITION TIME (seconds)
dry wooden stick broken into 4 short pieces	50	0.54	0.40	18	28	10
	BURN OBSERVATIONS: *Had a medium flame at first, but the flame quickly grew smaller and then went out. Had to relight, and then it burned for about 30 seconds, smoldered for about 15 seconds before going out all the way. Medium amount of smoke.*					
pile of wood shavings	50	0.35	0.01	58	64	2
	BURN OBSERVATIONS: *Lit quickly, stayed burning. Very large flame burned consistently. Flame spread quickly through the sample, burned quickly and all the way. Burned 10–20 seconds, light smoke.*					
4 toothpicks	50	0.54	0.14	24	40	2
	BURN OBSERVATIONS: *Lit quickly, stayed burning. Toothpicks burned consistently until they were burned all the way through. Burned for more than 30 seconds. Not a lot of smoke until the flames went out, then smoked.*					
pile of crinkled paper strips	50	0.94	0.10	40	60	2
	BURN OBSERVATIONS: *Lit quickly, burned consistently and evenly, spreading quickly from where it was lit to the rest of the pile. Burned about 20 seconds. Flame height was large. Light smoke.*					

* Students are only expected to test two samples. Additional responses are provided for teacher reference.

STUDENT SHEET 8.1 | TESTING FUEL SOURCES | NAME SAMPLE STUDENT RESPONSE

CONTINUED

TABLE 2: CALCULATIONS

SAMPLE	Energy released by the sample (calories) = mass of water (g) X temperature change of water (°C)			Heat of combustion (calories/gram) = energy released by the sample (cal) / change in mass of sample (g)	
	MASS OF WATER IN CAN (g)	TEMPERATURE CHANGE OF WATER (°C)	ENERGY RELEASED BY SAMPLE (cal)	CHANGE IN MASS OF SAMPLE (g)	HEAT OF COMBUSTION (cal/g)
dry wooden stick	*50*	*28 – 18 = 10*	*50 x 10 = 500*	*0.54 - 0.40 = 0.14*	*500 /0.14 = 3,571*
wood shavings	*50*	*64 – 58 = 6*	*50 x 6 = 300*	*0.35 - 0.01 = 0.34*	*300/0.34 = 882*
toothpicks	*50*	*40 – 24 = 16*	*50 x 16 = 800*	*0.54 - 0.14 = 0.40*	*800/0.40 = 2,000*
paper strips	*50*	*60 – 40 = 20*	*50 x 20 = 1,000*	*0.9 - 0.1 = 0.8*	*1,000/0.8 = 1,250*

* Students are only expected to test two samples. Additional responses are provided for teacher reference.