

# Transporting Hazardous Materials

## Activity Overview

Now that students know the hazards that the simulated waste poses, they must think about transporting the material safely. Students read about a highway accident involving hazardous materials and examine hazardous materials transportation data from the federal government. Students select a mode of transportation by analyzing the data and creating a graph to support their recommendation.

### CONCEPTS, PROCESSES, AND ISSUES

(with NSE 5–8 Content Standards Correlation)

1. Hazardous materials are substances that pose a danger to the health and safety of living organisms. (*PhysSci: 1*)
2. Hazardous materials must be identified before being treated, moved, or disposed of. (*Perspectives: 4*)
3. Analysis of data can aid in the assessment of options, risk, and trade-offs and facilitate decision making related to transportation of hazardous materials. (*Inquiry: 1; SciTech: 1*)
4. Graphing data can reveal information not immediately apparent from data tables. (*Inquiry: 1*)

### TEACHING SUMMARY

#### Step 1.

Introduce the role of the National Transportation Safety Board (NTSB).

#### Step 2.

Read and discuss data.

#### Step 3. (Assessment)

Recommend a mode of transportation for transporting the barrel.

#### Step 4.

Prepare a graph of data that supports the preferred mode of transportation. (Optional)

### MATERIALS

#### For the teacher

- \* 1 overhead projector
- 1 Transparency 1.4, “Feedback Form: Analyzing Data” (optional)
- 1 Transparency 1.5, “Scoring Guide: Analyzing Data” (optional)
- 1 Transparency 7.1, “Percentage of Accidents by Transportation Mode (Scale 1)”
- 1 Transparency 7.2, “Percentage of Injuries by Transportation Mode”
- 1 Transparency 7.3, “Percentage of Accidents by Transportation Mode (Scale 2)”

#### For each student

- \* 1 calculator
- \* 1 sheet of graph paper (optional)
- \* 1 ruler (optional)
- \* 1 computer with graphing software (optional)
- 1 paper copy of Transparency 1.4, “Feedback Form: Analyzing Data” (optional)
- 1 paper copy of Transparency 1.5, “Scoring Guide: Analyzing Data” (optional)

\*not supplied in kit

### REFERENCES

- National Transportation Safety Board. 2001. *Hazardous Materials Accident Report (PB2002-917003): Release and Ignition of Hydrogen Following Collision of a Tractor-Semitrailer with Horizontally Mounted Cylinders and a Pickup Truck near Ramona, Oklahoma*. Washington, D.C.: National Transportation Safety Board.
- Research and Special Programs Administration (RSPA). September 2001. *Hazardous Materials Information System*. Washington, D.C.: U.S.

Department of Transportation. (retrieved on Jan. 27, 2003). *hazmat.dot.gov/spills.htm*

## Teaching Suggestions

### GETTING STARTED

#### Step 1. Introduce the role of the National Transportation Safety Board (NTSB).

Remind students that the Hazardous Materials Transportation Act of 1975 requires the labeling of hazardous materials during transport. Reports must be filled out any time a hazardous materials accident or spill occurs. Ask students if they remember hearing about or witnessing any type of hazardous materials spill. Have them share what they recall. Have them discuss ideas about how such accidents could be prevented. Students may bring up the idea of having rules and regulations about handling and transporting hazardous materials. Tell them that the National Transportation Safety Board (NTSB), which is a different federal agency from the Department of Transportation (DOT), investigates air, rail, highway, marine, and pipeline accidents in the United States. Every accident involving hazardous materials must be reported to the government; this data is then compiled so the NTSB can issue safety recommendations aimed at preventing future accidents.

Inform students that in this activity, they will analyze data that was collected from accident reports from the year 2000. (To check the availability of more recent data, refer to the RSPA reference listed in the Activity Overview.)

### INVESTIGATING

#### Step 2. Read and discuss data.

Distribute Investigation 7, “Planes, Trains, and More.” The story that introduces Investigation 7 describes an actual hazardous materials accident that occurred in Ramona, Oklahoma, on May 1, 2001. Have students read the story. Encourage them to pay particular attention to the information provided in the tables.

After students have completed the reading, have groups discuss Questions 1 and 2. Note that Question 3 requires students to calculate percentages. Depending on your students’ skills with percentages, you may want to review the concept of percent and the process

of calculating percentages. Question 3e provides a good opportunity to discuss risk and data analysis: that is, why do percentages allow a more accurate comparison of risk than numbers alone?

#### QUESTION 1

*Would you describe hydrogen gas as an extremely hazardous material? Why or why not?*

Most students will consider hydrogen extremely hazardous because it is flammable. Flammability is a category of hazard that students investigated in this module and is recognized by the DOT placarding system. In the accident described in the reading, the burning hydrogen required the evacuation of the neighborhood and the closure of the highway, indicating the seriousness of the hazard.

#### QUESTION 2

*Do you think that hazardous materials should be banned from being transported long distances? Explain your reasoning.*

Some students will want to ban the transportation of hazardous materials because they pose a public danger. The story of the truck accident highlights this situation. Other students will point out that the data shows that the number of injuries and deaths relative to the estimated number of shipments is relatively small. If the hazardous materials are not transported away from a site with a high density of people nearby, they may pose a greater risk of injury or death to a greater number of people. In addition, if the materials are not transported long distances, they may have to be produced and transported locally to meet consumer needs. Gasoline is one obvious example of a hazardous substance that must be transported long distances and that most people would not want to ban.

#### QUESTION 3

*Look at and then copy the following table [on student pages].*

- a. *How is most hazardous material transported? Why do you think that this mode of transportation is the most commonly used?*

More hazardous waste in the United States is transported by highway than by any other mode of transportation. This could be because there are more roads than railroads or waterways connecting different parts of the United States.

- b. Complete the table by calculating the percentage of shipments that resulted in accidents in 2000. Hint: To calculate a percentage, you divide one number by another and then multiply by 100.

See response in table below.

- c. Which mode of transportation has the highest number of accidents?

The highest number of accidents occurred on the highway.

- d. Which mode of transportation has the highest percentage of accidents?

The highest percentage of accidents occurred on the railways.

- e. Which mode of transportation do you think is the safest? Explain your reasoning.

Some students likely will consider water transportation to be the safest, simply because the fewest number of accidents occurred on waterways in 2000. Other students likely will select highways as the safest because they had the lowest percentage of accidents in 2000. Encourage students' understanding of the importance of using percentage to make a fair comparison of the four modes of transporting hazardous materials.

## SYNTHESIZING

### Step 3. (Assessment) Recommend a mode of transportation for transporting the barrel.

Before assigning Question 4, explain to students that they now need to reflect on what they've learned about hazardous materials accidents and choose what they consider to be the safest mode of transport for the barrel. Then have them respond to Question 4 in writing.

### QUESTION 4 (Assessment)

What mode of transportation would you recommend for transporting your hazardous waste to a disposal site? Support your answer with evidence.

Although student responses will vary, guide students to support their answers with evidence. A complete and correct Level 3 response is shown here.

I recommend using the highway. It had the lowest percentage of accidents in 2000. The highway had 1.2% accidents compared to 2.1% on the water. This means that if there were 100 shipments by water, there might be two accidents. If there were 100 shipments by highway, there might be only one accident. So even though transportation by water had the fewest number of accidents, it was not likely to be safer. It would help to have data from other years to make sure that this is true every year.

### Step 4. Prepare a graph of data that supports the preferred mode of transportation. (Optional)

Encourage students to consider which data tables seemed easier or more difficult to read and why. Point out that graphs often show patterns in data

## Response to Question 3b

Mode of Transportation	Number of Hazardous Materials Accidents in 2000	Estimated Number of Shipments	Percentage of Shipments That Resulted in Accidents
Air	1,420	88,000	1.6%
Highway	14,943	1,200,000	1.2%
Railway	1,053	13,000	8.1%
Water	15	700	2.1%

more clearly than do tables or charts containing large amounts of data, and thus graphs can be helpful tools for making decisions. Tell students that they will need to choose one set of data that clearly supports their recommendation and prepare a graph of that data.

Depending on the students' level of comfort with graphs and their graphing abilities, you may need to review different types of graphs and their uses. You may want to demonstrate how to create a bar graph using data from one of the tables. Transparencies 7.1, "Percentage of Accidents by Transportation Mode (Scale 1)," and 7.2, "Percentage of Injuries by Transportation Mode," show sample graphs for the data from Investigation 7, "Planes, Trains, and More." Some students may graph the percentage of hazardous materials shipments that resulted in accidents (Transparency 7.1) to support their recommendation that highway transport is the safest. Other students may graph the percentage of hazardous materials shipments that resulted in injuries (Transparency 7.2) to support their recommendation that water transport is the safest.

Discuss how the selection of the scale on the y-axis can influence the perception of the data. Choosing a scale that is limited to the values being graphed (as was done on Transparencies 7.1 and 7.2) exaggerates the differences among the values. For example, the percentage of shipments that resulted in accidents (Transparency 7.2) is less than one for each mode of transportation. Choosing a scale that covers the range of possible values (for example, 0–100 in the case of percentages) minimizes these differences while highlighting the meaning of each value. Display Transparency 7.3, "Percentage of Accidents by Transportation Mode (Scale 2)." The bar graph is identical to the one on Transparency 7.1, except that it uses a different scale.

**Teacher's Note**

*This activity is an excellent opportunity for students to use graphing software, such as Excel, to create their graphs. However, students should have a solid understanding of how to create graphs before they are introduced to this software.*

## Planes, Trains, and More

### ••••► CHALLENGE

#### How will you transport the simulated hazardous waste?

What is the safest way to transport hazardous waste? Use data presented in the following reading to determine the safest way to move the barrel to a disposal site hundreds of miles away.

#### MATERIALS

*For each student*

1 calculator

### ••••► READING

At 2:15 p.m. on May 1, a tractor-trailer hit a pickup truck that pulled in front of it on U.S. Highway 75. The tractor-trailer flipped over, but continued to slide forward. It went off the road and slid 300 more feet before it stopped. The trailer contained hydrogen, a flammable gas. During the accident, the trailer was damaged, and hydrogen was released. The hydrogen caught fire, and the trailer began to burn. The pickup truck also went off the road. It stopped 52 feet from the tractor-trailer. The pickup truck's fuel line broke, and the pickup truck also caught fire.

The driver of the tractor-trailer died, and the driver of the pickup truck was seriously injured. People living in five homes near the accident site had to evacuate, and the highway was closed for more than 12 hours. The financial cost of the damage and cleanup was estimated at \$155,000.

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Every year, millions of tons of hazardous materials are transported from one part of the country to another. These materials may be used by industries to produce new goods (such as circuit boards) or to provide services (such as dry cleaning). Some hazardous materials are sold directly to consumers for purposes such as cleaning (bleach, for example) or to run other products (cars require motor oil, for example).

When such hazardous materials are accidentally released into the environment in large quantities, they can cause serious problems. How common are such accidents? It depends on the mode of transportation. Some materials are transported by trucks on highways, while other materials are transported by airplanes, trains, or ships. The table on the left shows the number of accidents involving hazardous materials by each mode of transportation. Not all of these accidents were fatal. The table on the right shows the number of injuries and deaths from each of mode of transportation.

Hazardous Materials Accidents in 2000

Mode of Transportation	No. of Hazardous Materials Accidents
Air	1,420
Highway	14,943
Railway	1,053
Water	15

Hazardous Materials Injuries and Deaths in 2000

Mode of Transportation	Injuries	Deaths
Air	5	0
Highway	156	12
Railway	82	1
Water	0	0

### ••••► ANALYSIS

#### Group

1. Would you describe hydrogen gas as an extremely hazardous material? Why or why not?
2. Do you think that hazardous materials should be banned from being transported long distances? Explain your reasoning.

#### Individual

3. Look at and then copy the table on the top of the next page.
  - a. How is most hazardous material transported? Why do you think that this mode of transportation is the most commonly used?
  - b. Complete the table by calculating the percentage of shipments that resulted in accidents in 2000.

**Hint:** To calculate a percentage, you divide one number by another and then multiply by 100.

## Analyzing Hazardous Materials Accidents

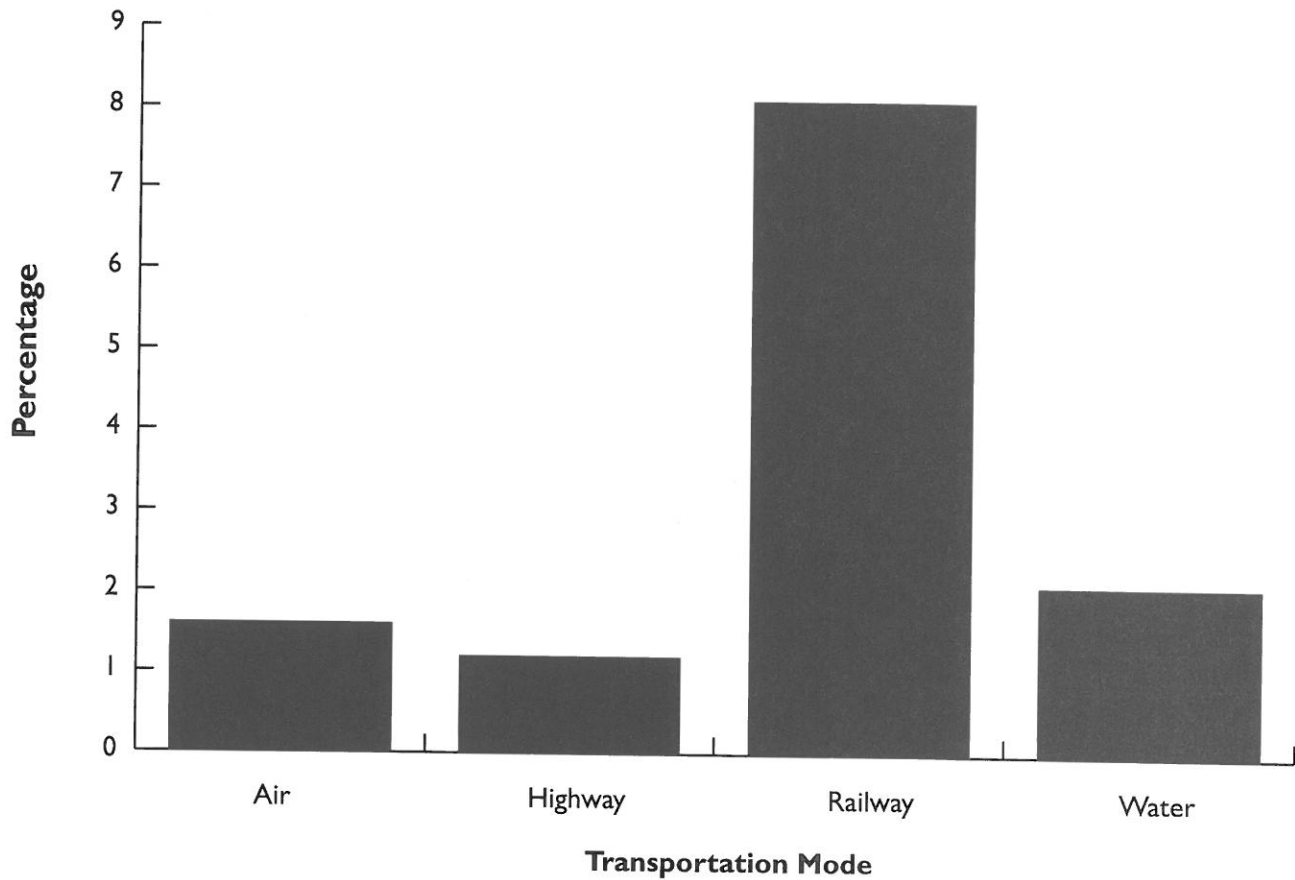
Mode of Transportation	Number of Hazardous Materials Accidents in 2000	Estimated Number of Shipments	Percentage of Shipments That Resulted in Accidents
Air	1,420	88,000	
Highway	14,943	1,200,000	
Railway	1,053	13,000	
Water	15	700	

- c. Which mode of transportation has the highest number of accidents?
  - d. Which mode of transportation has the highest percentage of accidents?
  - e. Which mode of transportation do you think is the safest? Explain your reasoning.
4. What mode of transportation would you recommend for transporting your hazardous waste to a disposal site? Support your answer with evidence.

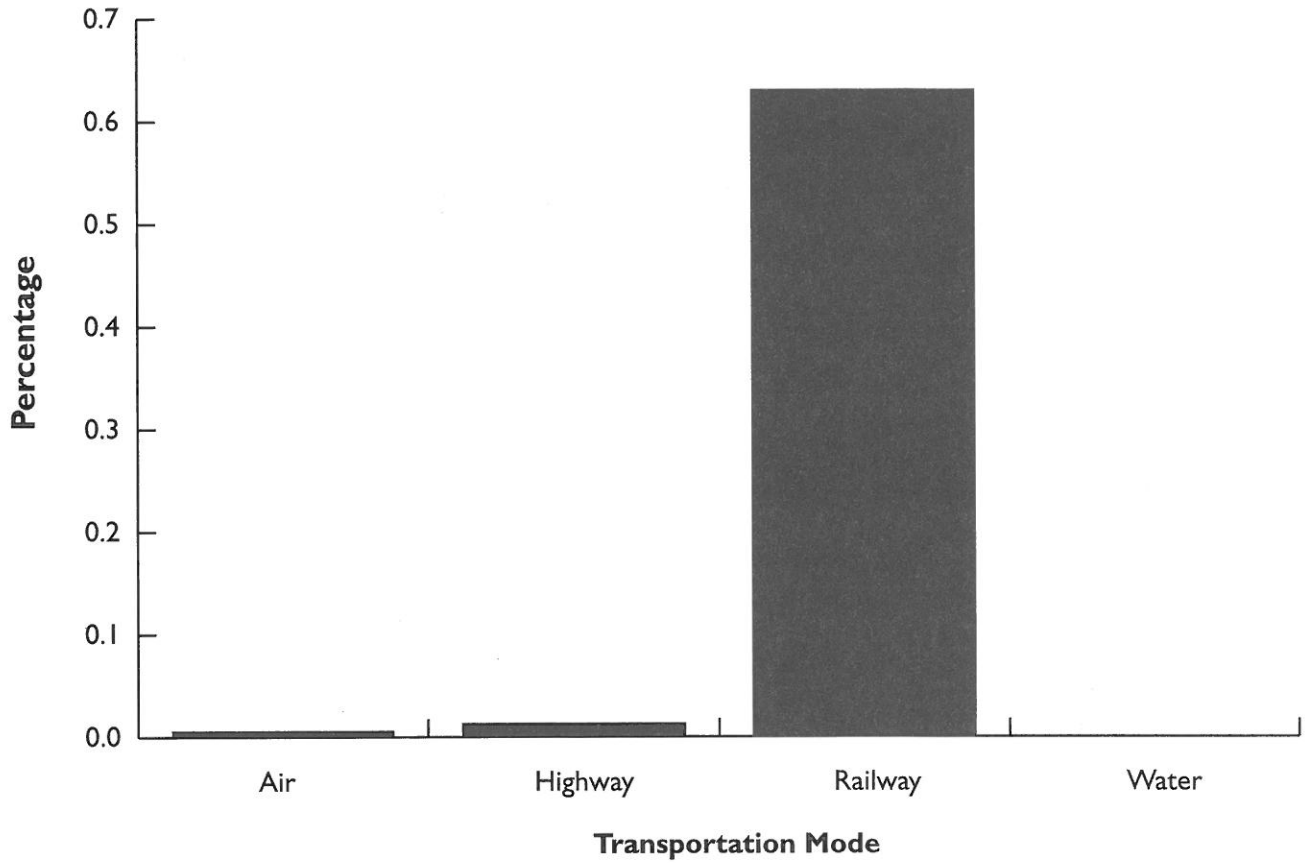




## Percentage of Accidents by Transportation Mode (Scale 1)



# Percentage of Injuries by Transportation Mode



# Percentage of Accidents by Transportation Mode (Scale 2)

