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This activity has been updated since it first appeared in *Math + Science, A Solution*. This is the updated version.

Big Banana Peel

Topic
Mathematical reasoning

Key Question
How much of a banana is edible?

Learning Goal
Students will determine what percentage of a banana is edible.

Guiding Documents

Project 2061 Benchmark

- *Numbers can be written in different forms, depending on how they are being used. How fractions or decimals based on measured quantities should be written depends on how precise the measurements are and how precise an answer is needed.*

NRC Standards

- *Use appropriate tools and techniques to gather, analyze, and interpret data.*
- *Think critically and logically to make the relationships between evidence and explanations.*
- *Use mathematics in all aspects of scientific inquiry.*

*NCTM Standards 2000**

- *Collect data using observations, surveys, and experiments*
- *Represent data using tables and graphs such as line plots, bar graphs, and line graphs*
- *Understand such attributes as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute*
- *Select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles*
- *Work flexibly with fractions, decimals, and percents to solve problems*

Math

Measurement
mass

Estimation

Ratio

Averaging

Writing a formula

Graphing

Integrated Processes

Observing

Collecting and recording data

Comparing and contrasting
Generalizing

Materials

A supply of bananas

Balances

Metric masses

Background Information

This may be the students' first experience in writing a formula. If so, the development of a formula needs to be discussed. In this case, the edible portion of a banana (E in the formula) is to be expressed as a percentage (or fraction) of the total mass of the banana (T in the formula). Thus, if one-half of the banana is edible, the formula would be $E=1/2T$. Most bananas will come very close to fitting the formula $E=.65T$ or $E=2/3T$.

Students may reason that the coefficient of T must be less than one since the *edible* portion has a mass less than the *total*. The best information for determining the formula for this group of bananas is given by the *average percentage*. The function of an average is to help guard against significant error. In this case, the average will be in the neighborhood of 65%, depending on the ripeness of the banana. Percentages are not normally used in such formulas, so 65% is not an appropriate form. It should be converted to a decimal such as .65. The formula becomes $E=.65T$.

This activity provides students with a realistic experience which shows that measurement is always an approximation. They are asked to find the **total mass** (edible part and peel) of the banana. They are then asked to find the separate masses of the **pulp** and the **peel**. The sum of these two may differ by just one gram from the total mass since students are measuring to the nearest gram and therefore rounding.

Fact pages are included that provide information about the science of the banana plant, the nature of banana as a food product, the origin of bananas, and sources of bananas as an agricultural commodity.

Management

1. Before students begin, have them predict and record the edible percentage of the banana. The edible portion must be defined. Here, it is the pulp, not the peel.
2. Students may work in groups of four or five, each group sharing a banana and pooling the results with other groups to find the average percentage.



Procedure

1. Begin by administering the four point true-false quiz to heighten interest and peak curiosity. Students may indicate their responses by showing *thumbs up* for "I think this is a true statement" and *thumbs down* for "I think this is a false statement." (No sideways thumbs!) The four statements are these:
 - a. The banana is a berry. (true)
 - b. Bananas grow on trees. (false)
 - c. Pound for pound, bananas are the most widely sold fruit in the United States. (true)
 - d. Bananas are highly nutritious and easily digestible. (true)(See fact page called *The Truth About Bananas* for complete information.)
2. Distribute a banana to each group. Direct them to find and record the masses of the whole banana, the edible part, and the peel. It is important to make **three** different measures rather than **two** in which case the mass of the peeling would be subtracted from the total to obtain the mass of the edible portion. By completing three massings, students have more experience using the balances and the opportunity for checking accuracy.
3. Have each group share their data for the first three columns of the table. Direct all groups to make the computations to finish the table.

4. After the averages have been computed and recorded, encourage students to construct the bar graphs.
5. Students are asked to write a formula relating the mass of the edible portion (E) to the total mass of the banana (T).

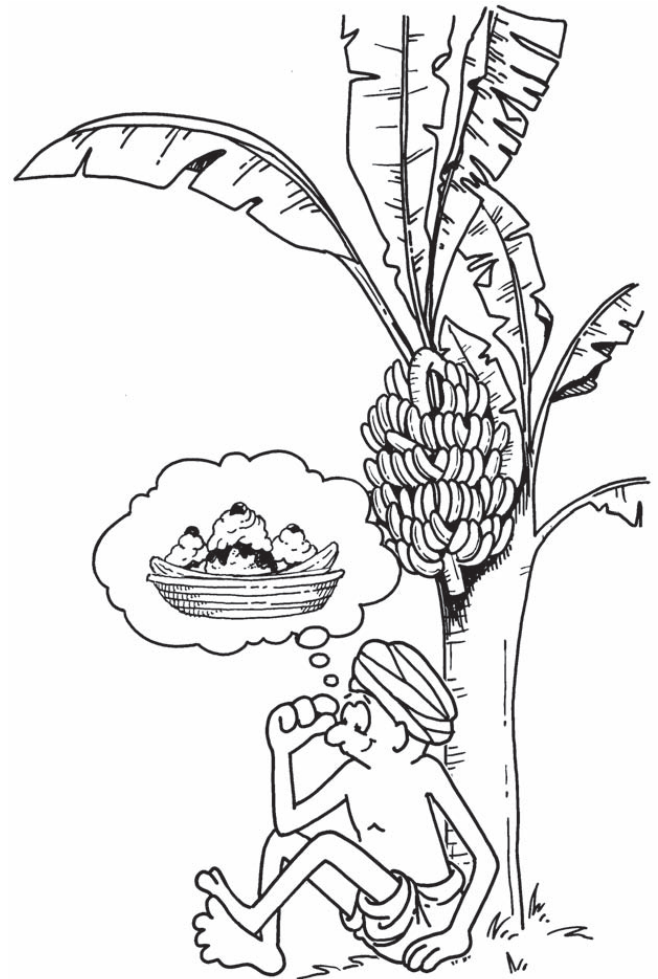
Connecting Learning

1. What percentage of a banana is edible?
2. What factors might affect this result? How? (ripeness, size, variety)
3. If bananas are priced at 49 cents per pound, how much money is wasted on the skin that is thrown away?
4. What other fruits have an inedible peeling? Which fruits have a higher percentage of edible portion?
5. What are you wondering now?

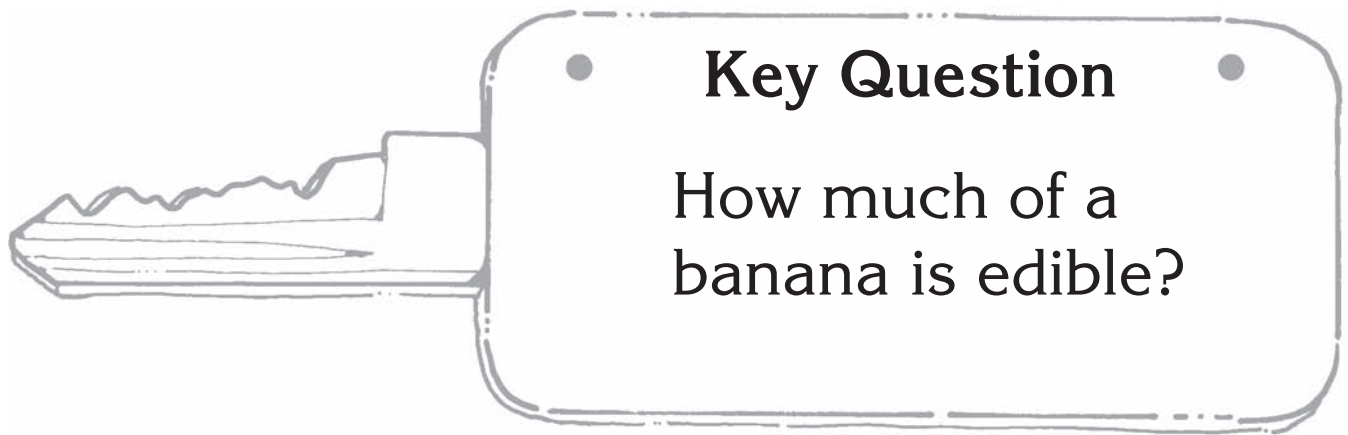
Extensions

1. Try bananas of different sizes and stages of ripeness.
2. See how plantains compare with the bananas.

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The Big Banana Peel!



Key Question

How much of a banana is edible?

Learning Goals

Students will:

1. compare the mass of different parts of the banana,
2. find the percentage of the banana that is edible,
3. graph their results, and
4. draw conclusions from the results.



The Truth About Bananas

Scientific Name

Family: Musaceae

Genus: *Musa*

Species: *Musa acuminata* (common banana)

Musa paradisiaca (plantain banana)

Food Value

Water: 75.7%

Protein: 1.1 g

Fat: 0.2 g

Carbohydrates: 22.2 g



Food Energy:

Approximately 1 calorie per gram

Vitamin A: 190 IU

Thiamine (B₁): 0.05 mg

Riboflavin (B₂): 0.06 mg

Phosphorous: 26 mg

Potassium: 370 mg

Vitamin C: 10 mg

Niacin: .7 mg

Calcium: 8 mg

Iron: .7 mg

Sodium: 1 mg

Which of these statements are true?

- The banana is a berry.
- Bananas grow on trees.
- Pound for pound, bananas are the most widely sold fruit in the United States.
- Bananas are highly nutritious and easily digestible.

There are over
100 varieties of
bananas!

The Banana Plant

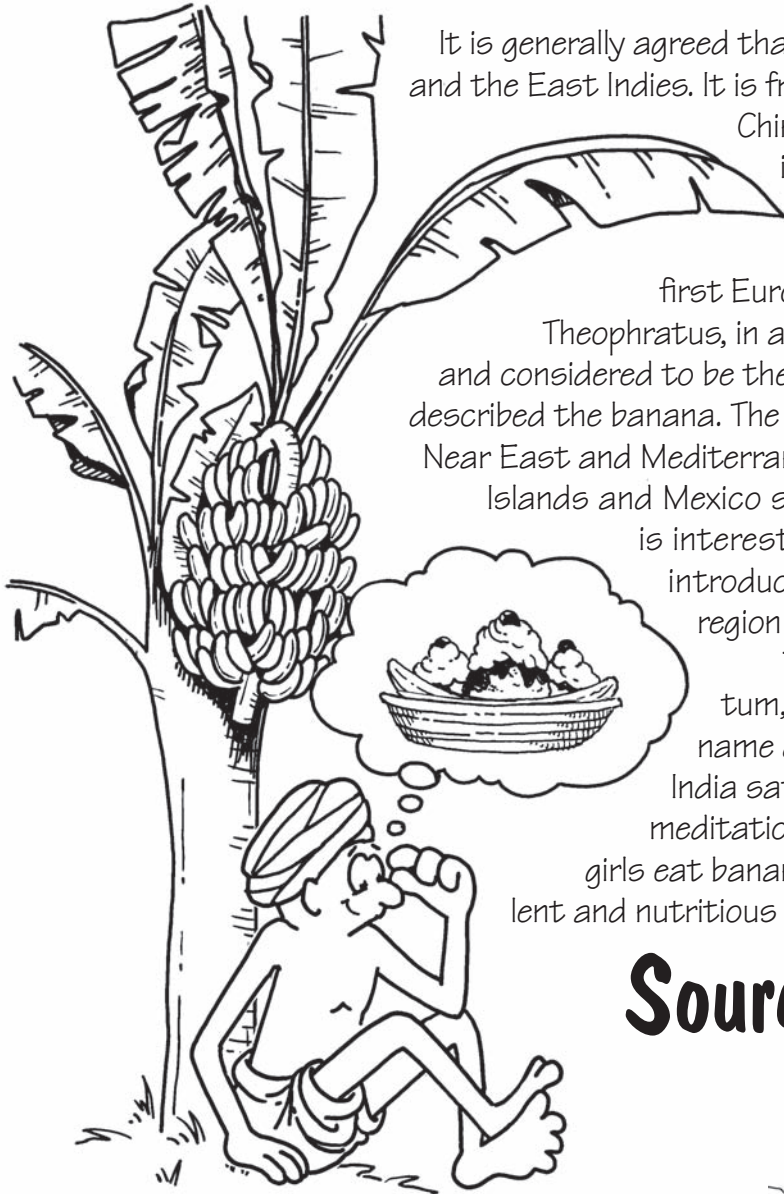
You may be surprised to learn that bananas are berries!

A berry is a simple fruit having a skin surrounding one or more seeds in a fleshy pulp. Botanists classify grapes, tomatoes, currants, and bananas as berries.

Bananas grow on a tropical plant that is not a tree—it has no trunk. Bananas are gigantic herbs that spring from underground stems. What appears to be the trunk is a false stem formed by tightly wrapped leaf sheaths that grows to a height of three or more meters. From the top, 10-20 large oblong to elliptical-shaped leaves fan out. It takes 5-18 months to grow the one stalk of bananas it bears. Bananas on the stalk point upward. After harvesting, the plant is cut down and the underground rootstock produces new shoots for the next plant.



The HISTORY of Bananas



It is generally agreed that the banana originated in Malaysia and the East Indies. It is frequently referred to in ancient Hindu, Chinese, Greek, and Roman literature and in sacred texts of Oriental cultures. It is said that the armies of Alexander the Great fighting in India were the first Europeans to learn about bananas.

Theophrastus, in a book written in the 4th century B.C. and considered to be the first scientific botanical work known, described the banana. The Arabs introduced bananas to the Near East and Mediterranean. They came to the Caribbean Islands and Mexico shortly after Columbus' voyages. It is interesting to note that the Polynesians introduced bananas throughout the Pacific region during their migration.

The name of one species, *Musa sapientum*, means "fruit of the wise men." This name derives from the legend that sages in India sat under banana plants during times of meditation. Today wise men, women, boys and girls eat bananas because they are such an excellent and nutritious food.

Sources of Supply

In the Western Hemisphere:
 Ecuador (largest exporter)
 Honduras (chief export)
 Panama (chief export)
 Costa Rica
 Guatemala

Mexico
 Dominican Republic
 Brazil
 Columbia

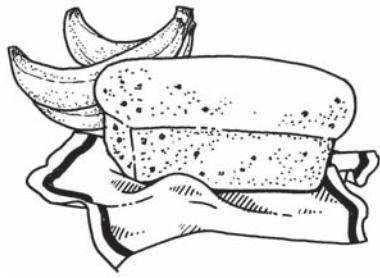


In Asia:
 Taiwan

In Africa:
 Canary Islands
 Ethiopia
 Cameroon
 Guinea
 Nigeria

Next time you are in a store, carefully examine the label on a bunch of bananas. Generally, the source country is named on it in small type. See how many different source countries you can find on banana labels!!

The Banana as Food



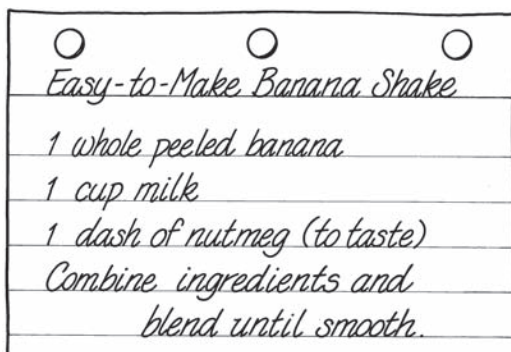
Pound for pound, bananas are the most widely sold fruit in the United States. They are the most important of all commercial fruits, close to the combined production of all citrus fruits.

Bananas are an excellent food source of potassium, vitamins A & C, and quick energy. They are low in protein and fat. They are an excellent between-meal snack and one of the most easily digested and nutritious natural foods. A medium-size banana has about 125-130 calories, or about one calorie per gram. Bananas are recommended for low-fat, low-sodium diets.

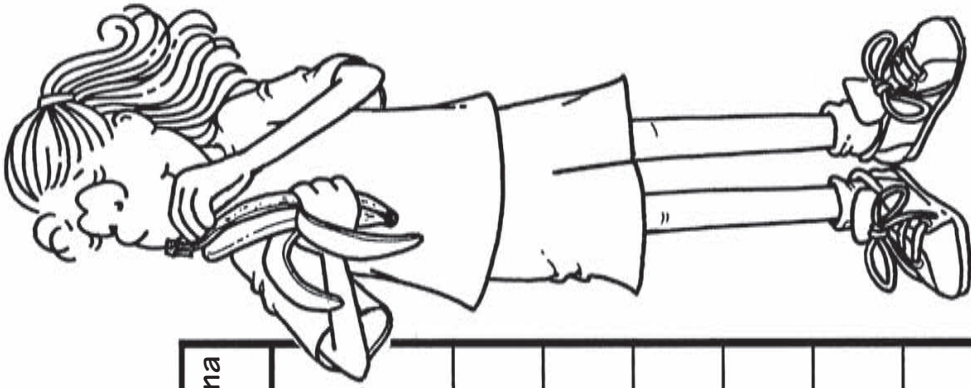
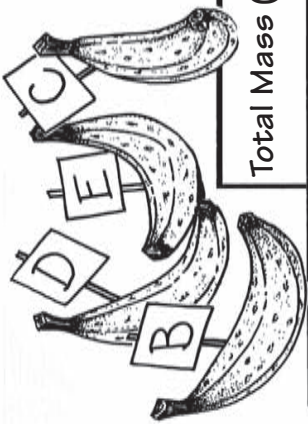
Bananas come with their own wrapping, ready to go into lunch boxes. They are tasty sliced on breakfast cereals, in fruit salads, and gelatin desserts. Bananas are used in the preparation of flavoring. Vacuum dehydration yields banana crystals, a light-brown powder used in ice cream, bakery products and milk-based beverages.

“Tree-ripened” would not make good advertising for bananas. If allowed to ripen on the plant they are starchy, mealy, or rotten and therefore inedible. They are sent to market green and are ripened in air-tight rooms with controlled humidity and temperature. These conditions permit nearly all of the starch to be converted into sugar for good taste. The banana is at its best eating condition when the bright yellow peeling is flecked with brown specks, known as “sugar specks.” Look for plump, well-filled fruit.

A plantain is a cooking variety of banana that is larger than our common banana. It is a staple food in the tropics. Plantains are starchy when green and take the place of potatoes. Plantain chips are the Latin-American equivalent of our potato chips!



The Big Banana Peel!



Prediction: What part of a banana is edible? _____ %

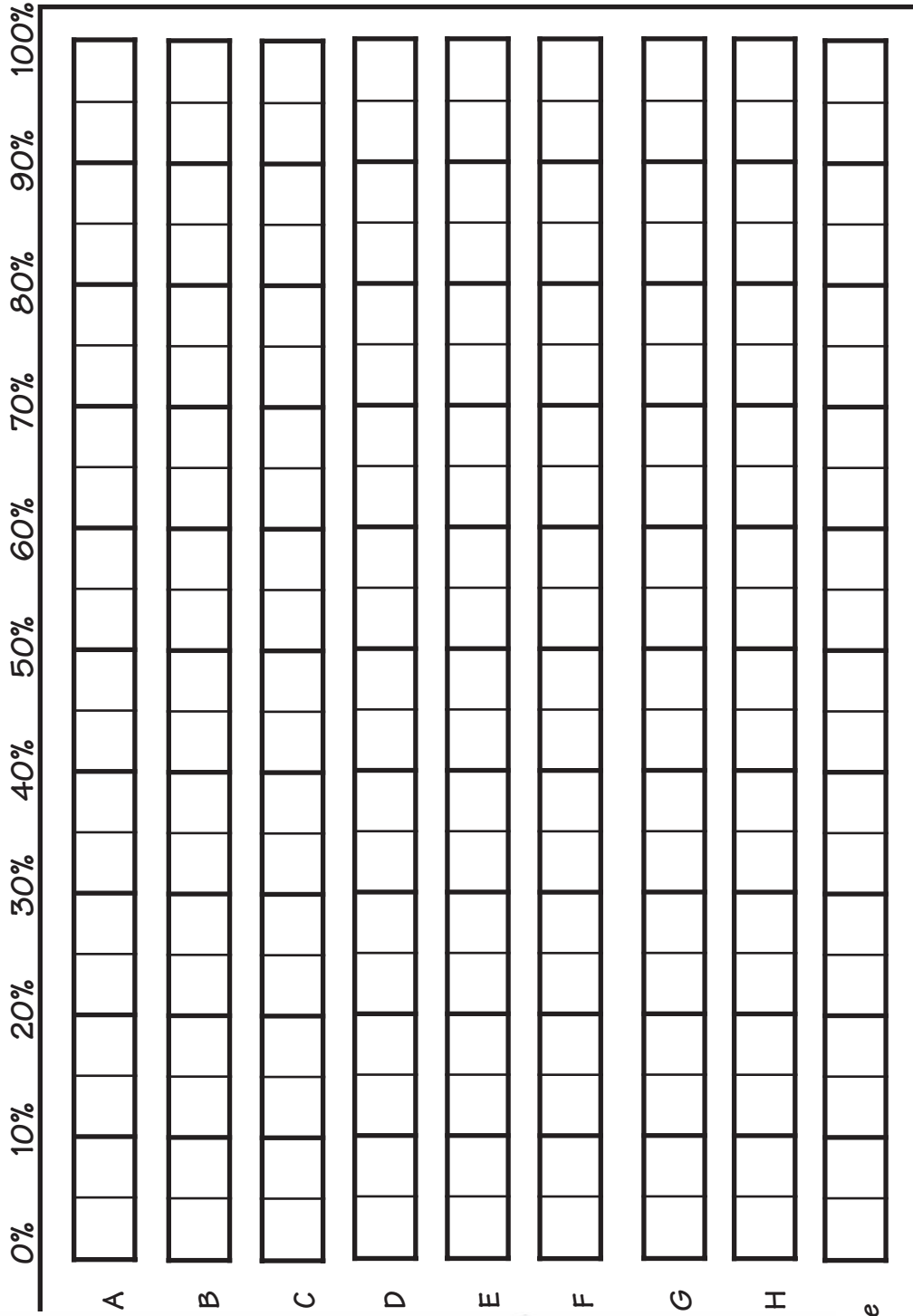
Complete the table.

| | Total Mass (g) | Mass of Peeling (g) | Mass of Edible Part (g) | $\frac{\text{Ratio of Edible (g)}}{\text{Total Mass (g)}}$ | Percent of Banana that is Edible |
|----------|----------------|---------------------|-------------------------|--|----------------------------------|
| Banana A | | | | | |
| Banana B | | | | | |
| Banana C | | | | | |
| Banana D | | | | | |
| Banana E | | | | | |
| Banana F | | | | | |
| Banana G | | | | | |
| Banana H | | | | | |
| Sum | | | | | |
| Average | | | | | |

From this data, write three things you now know about these bananas.

The Big Banana Peel!

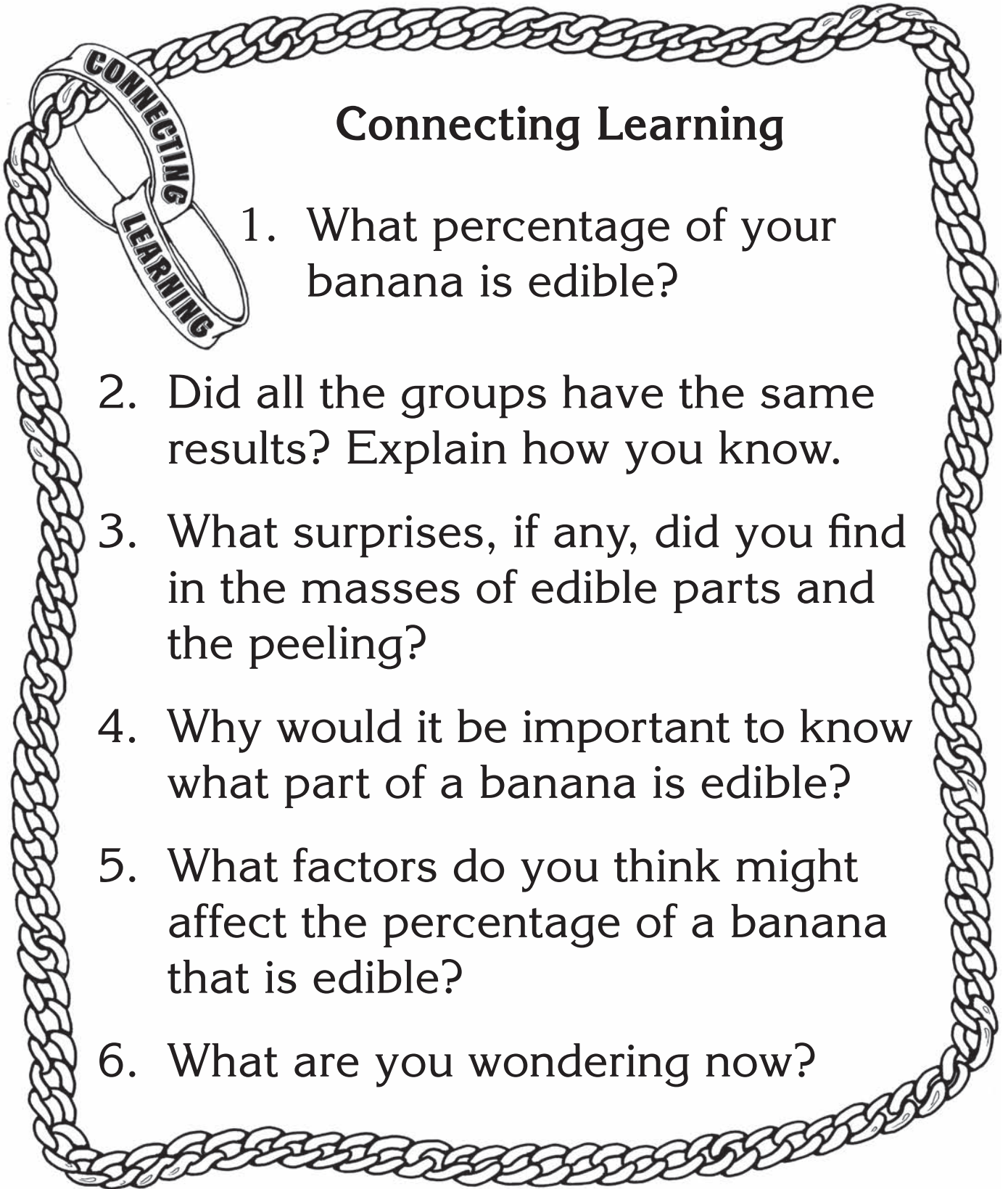
Construct a bar graph showing the percent of each banana that is edible.



Write a formula to show the amount of the edible portion.

Let E stand for Edible and T for the total. $E = \frac{\quad}{\quad} T$

The Big Banana Peel!



Connecting Learning

1. What percentage of your banana is edible?
2. Did all the groups have the same results? Explain how you know.
3. What surprises, if any, did you find in the masses of edible parts and the peeling?
4. Why would it be important to know what part of a banana is edible?
5. What factors do you think might affect the percentage of a banana that is edible?
6. What are you wondering now?