

Topic 8: Exponents and Scientific Notation

for use after **Accentuate the Negative** Investigation 4

Cary is working on a science assignment about comparing sizes. He finds that the Earth is about 1.276×10^7 meters wide and the size of a plant cell is about 1.276×10^{-7} meters wide. These numbers are written in **scientific notation**, a method for expressing very large and very small numbers using powers of 10.

Problem 8.1

- A.** Cary makes the following list to help him understand the different ways to express a number. Use Cary's list to answer questions 1–4.

Standard Form: 648

Expanded Form: $600 + 40 + 8$

Exponential Form: $6 \times 10^2 + 4 \times 10^1 + 8 \times 10^0$

Scientific Notation: 6.48×10^2

1. How does the expanded form of 648 compare to the exponential form of the same number?
 2. How can you determine the place values of the digits using the exponents in the exponential form?
 3. How does the decimal point move from the standard form of 648 to the number expressed in scientific notation, 6.48×10^2 ?
 4. When the decimal is moved in scientific notation, how is the movement seen in the exponent of the power of ten?
- B.** A plant cell is about 1.276×10^{-7} meters wide. This number is very small, with most digits far to the right of the decimal point.
1. When a number is written with a negative exponent, as with 1.276×10^{-7} , which way do you predict that the decimal point moves to show the number in standard form?
 2. How many places would the decimal point move to change 1.276×10^{-7} to standard form?
 3. Write 1.276×10^{-7} in standard form.
 4. Using what you know about moving decimal points, write a rule that explains how to convert scientific notation to standard form.
 5. Write a rule for converting standard form to scientific notation.

- C.**
1. What rule could you write to change a number in standard form to expanded form?
 2. What steps would you take to change a number in standard form to exponential form?
 3. How can you change numbers from expanded form to exponential form?
 4. How do the rules change when you have to change a number back to standard form?

Exercises

Write each number in standard form.

1. 3.901×10^7
2. $(2 \times 10^1) + (0 \times 10^0) + (8 \times 10^{-1}) (7 \times 10^{-2}) + (2 \times 10^{-3})$
3. $40,000 + 3,000 + 80 + 1 + 0.1$

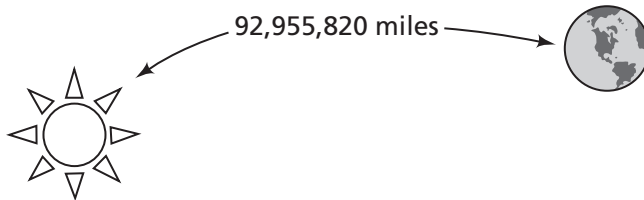
Write each number in scientific notation.

4. 23.0064
5. 325,880
6. 0.00753

Write each number in exponential form.

7. 5,472
8. 102,468.5
9. 0.0993

10. What is the distance from Earth to the Sun in scientific notation?



11. An ant weighs about 0.0003 grams.
 - a. What is this number in scientific notation?
 - b. An ant can lift an object 100 times its weight. How much can an ant lift? Write answer using two forms.
12. Kirby wants to compare the weight of an elephant in pounds to the weight of a mouse in pounds. Which number form should Kirby use? Give reasons for your choice.
13. The Earth travels around the Sun once each year. The speed that the Earth travels is 67,000 miles per hour.
 - a. Write the speed using scientific notation.
 - b. How far does the Earth travel in 100 hours? Solve the question using scientific notation and powers of 10.
 - c. How far does the Earth travel in 1,000 hours?

Topic 8: Exponents and Scientific Notation

PACING 1 day

Mathematical Goals

- Students will develop fluency translating between standard form and exponential form of numbers.
- Students will develop fluency translating between standard form and scientific notation of numbers.

Guided Instruction

Discuss with students the difference in size between a planet and a cell. Explain that such large differences in size are hard to show without having a method to use such as scientific notation. Use the numbers given in the introduction to review how numbers are written using scientific notation. Ask students to recall what they know about using powers of 10. Also review the parts of a power of 10 including the base (10) and the exponent. Explain that the problems in the lesson show how a number can be expressed in several forms and change from one form to another.

For Problem 8.1 A, ask:

- *Why is it important to know about place value when talking about expanded form?* (Expanded form shows the values of each place value in a number.)
- *How are the place values of a base ten number related to the powers of 10 in exponential form?* (Each place value is represented by a power of 10. For example, the hundreds place is 10 to the power of 2, or 10^2 .)
- *What does it mean to say that the decimal moves in a number?* (The decimal changes position. When the change takes place, the exponent in the power of 10 changes also. Sample: 123.5×10^2 is the same as 1.235×10^4 .)

For Problem 8.1 B, ask:

- *Why would a small number have most of the digits to the far right of the decimal?* (Numbers to the right of the decimal are less than one. The farther away from the decimal a digit is, the smaller the value.)
- *Find the value of 2.5×10^{-1} .* (0.25)

For Problem 8.1 C, Review all student examples in questions 1- 4, then ask:

- *How do you expand a number with decimal place values?* (Expanded numbers with decimal place values use negative exponents.)

You will find additional work on exponents in the grade 8 unit *Growing, Growing, Growing*.

Vocabulary

- scientific notation

Assignment Guide for Topic 8

Core 1–13

Answers to Topic 8

Problem 8.1

- A.**
1. Answers may vary. Sample: The expanded form of 648 is the sum of all of the values in each place value. The exponential form is the sum of each place value written with powers of 10.
 2. The hundreds place has 2 zeros which is the number of the exponent, the tens place has 1 zero which is the same as the number of the exponent and the ones place has no zeros making the place value a single digit place.
 3. The decimal point moves two places to the left.
 4. The exponent of the power of ten is the same as the number of places that the decimal point moves to the left or right.
- B.**
1. Answers may vary. Sample: Because the standard form is a very small number, one might predict that the decimal would move to the left.
 2. The decimal would move 7 places to the left.
 3. 0.0000001276
 4. Answers may vary. Sample: To convert numbers written in scientific notation, move the decimal point the same number of place values as indicated by the value of the exponent. When positive exponents are used, the decimal moves to the right, when negative exponents are used, the decimal moves to the left.
 5. To convert numbers written in standard form, move the decimal point until one factor is greater than 1 and less than 10. The other factor is a power of 10 with an exponent value that is the same as the number of places that the decimal moved. When positive exponents are used, the decimal moves to the left, when negative exponents are used, the decimal moves to the right.
- C.**
1. Write the standard form number as the sum of the values in each place value.
 2. Write the standard form number as the sum of the values in each place value. Write each value as the product of the digit in the place times the power of 10 that represents the place value.
 3. Write each value as the product of the digit in the place times the power of 10 that represents the place value.
 4. Add to find the total which is the standard form of the number.

Exercises

1. 39,010,000
2. 20.872
3. 43,081.1
4. 2.30064×10^1
5. 3.25880×10^5
6. 7.53×10^{-3}
7. $(5 \times 10^3) + (4 \times 10^2) + (7 \times 10) (2 \times 10^0)$
8. $(1 \times 10^5) + (0 \times 10^4) + (2 \times 10^3) + (4 \times 10^2) + (6 \times 10^1) + (8 \times 10^0) + (5 \times 10^{-1})$
9. $(0 \times 10^{-1}) + (9 \times 10^{-2}) + (9 \times 10^{-3}) + (3 \times 10^{-4})$
10. 9.295582×10^7
11. **a.** 3×10^{-4}
b. 0.03 grams or 3×10^{-2}
12. scientific notation – reasons may vary.
13. **a.** 6.7×10^4
b. $6.7 \times 10^4 \times 10^2 = 6.7 \times 10^6 = 6,700,000$
c. $6.7 \times 10^4 \times 10^3 = 6.7 \times 10^7 = 67,000,000$