Compute with Scientific Notation

E-MAIL Every day, nearly 130 billion spam E-mails are sent worldwide! How many is that each year? The numbers are too large even for your calculator.

1. Express 130 billion in scientific notation.
2. Round 365 to the nearest hundred and express it in scientific notation.
3. Write a multiplication expression using the numbers in Exercises 1 and 2 to find the total number of spam E-mails sent each year.

You can use the Product of Powers and Quotient of Powers properties to multiply and divide numbers written in scientific notation.

**Examples**

**Multiplication and Division with Scientific Notation**

Evaluate each expression. Express the result in scientific notation.

1. \((4.2 \times 10^3)(1.6 \times 10^4)\)
   
   \((4.2 \times 10^3)(1.6 \times 10^4) = (4.2 \times 1.6)(10^3 \times 10^4)\)
   
   \(= (6.72)(10^3 \times 10^4)\)
   
   \(= 6.72 \times 10^{3+4}\)
   
   \(= 6.72 \times 10^7\)

2. \(\frac{1.449 \times 10^6}{2.1 \times 10^3}\)
   
   \(\frac{1.449 \times 10^6}{2.1 \times 10^3} = \left(\frac{1.449}{2.1}\right)\left(\frac{10^6}{10^3}\right)\)
   
   \(= (0.69)\left(\frac{10^6}{10^3}\right)\)
   
   \(= 0.69 \times 10^{6-3}\)
   
   \(= 0.69 \times 10^3\)
   
   \(= 0.69 \times 10^3\)
   
   \(= 6.9 \times 10^2\)

**Check Your Progress**

\[\text{a. } (8.4 \times 10^3)(2.5 \times 10^6)\]
\[\text{b. } \frac{9.72 \times 10^7}{3.6 \times 10^3}\]

Main Idea

Compute with numbers written in scientific notation.
The average distance from Earth to the Sun is \(1.46 \times 10^8\) kilometers. The average distance from Earth to the Moon is \(3.84 \times 10^5\) kilometers. About how many times as great is the distance from Earth to the Sun than to the Moon?

Find \(\frac{1.46 \times 10^8}{3.84 \times 10^5}\).

\[
\begin{align*}
\frac{1.46 \times 10^8}{3.84 \times 10^5} &= \frac{1.46}{3.84} \times \frac{10^8}{10^5} \\
&\approx 0.38 \times 10^3 \\
&= 3.8 \times 10^2
\end{align*}
\]

The distance from Earth to the Sun is about \(3.8 \times 10^2\) or 380 times as great as the distance from Earth to the Moon.

**c. GEOGRAPHY** Refer to the information at the left. About how many times as great is the area covered by Lake Superior than Lake Ontario?

When adding or subtracting decimals in standard form, it is necessary to line up the place values. In scientific notation, the place value is represented by the exponent.

**EXAMPLES**

Evaluate each expression. Express the result in scientific notation.

4. \((6.89 \times 10^4) + (9.24 \times 10^5)\)

\[
\begin{align*}
(6.89 \times 10^4) + (9.24 \times 10^5) &= (6.89 \times 10^4) + (92.4 \times 10^4) \\
&= 6.89 + 92.4 \times 10^4 \\
&= 99.29 \times 10^4 \\
&= 9.929 \times 10^5
\end{align*}
\]

Write \(9.24 \times 10^4\) as \(92.4\) and \(6.89\). Add 6.89 and 92.4.

5. \((7.83 \times 10^8) - (11.61 \times 10^6)\)

\[
\begin{align*}
(7.83 \times 10^8) - (11.61 \times 10^6) &= (783 \times 10^6) - (11.61 \times 10^6) \\
&= 783 - 11.61 \times 10^6 \\
&= 771.39 \times 10^6 \\
&= 7.7139 \times 10^8
\end{align*}
\]

Write \(7.83 \times 10^8\) as \(783 \times 10^6\). Subtract 11.61 from 783.

**CHECK Your Progress**

d. \((8.41 \times 10^3) + (9.71 \times 10^4)\) 

e. \((12.63 \times 10^8) - (15.25 \times 10^6)\)
### Evaluate each expression. Express the result in scientific notation.

<table>
<thead>
<tr>
<th>Example 1 and 2 (p. 306)</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. ((2.6 \times 10^5)(1.9 \times 10^3))</td>
<td>2. ((5.3 \times 10^4)(0.9 \times 10^3))</td>
<td></td>
</tr>
<tr>
<td>3. ((3.7 \times 10^{-2})(1.2 \times 10^3))</td>
<td>4. ((3.3 \times 10^3)(2.1 \times 10^{-5}))</td>
<td></td>
</tr>
<tr>
<td>5. (8.37 \times 10^8)</td>
<td>6. (8.04 \times 10^3)</td>
<td></td>
</tr>
<tr>
<td>2.7 \times 10^5)</td>
<td>6.7 \times 10^2)</td>
<td></td>
</tr>
<tr>
<td>7. (9.72 \times 10^{-9})</td>
<td>8. (4.64 \times 10^{-4})</td>
<td></td>
</tr>
<tr>
<td>1.8 \times 10^5)</td>
<td>2.9 \times 10^{-6})</td>
<td></td>
</tr>
</tbody>
</table>

### Example 3 (p. 307)

#### TEXT MESSAGING
In 2005, \(8.1 \times 10^{10}\) text messages were sent in the United States. By 2007, the number of annual text messages had risen to \(3.63 \times 10^{11}\). About how many times as great was the number of text messages in 2007 than 2005?

### Evaluate each expression. Express the result in scientific notation.

<table>
<thead>
<tr>
<th>Examples 4 and 5 (p. 307)</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>9. ((5.4 \times 10^3) + (6.8 \times 10^5))</td>
<td>10. ((8.9 \times 10^3) + (4.2 \times 10^6))</td>
<td></td>
</tr>
<tr>
<td>11. ((13.5 \times 10^5) - (11.7 \times 10^4))</td>
<td>12. ((9.64 \times 10^8) - (5.29 \times 10^6))</td>
<td></td>
</tr>
</tbody>
</table>

### Practice and Problem Solving

<table>
<thead>
<tr>
<th>Examples 1 and 2 (p. 306)</th>
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</thead>
<tbody>
<tr>
<td>14. ((8.5 \times 10^3)(1.1 \times 10^1))</td>
<td>15. ((3.9 \times 10^5)(2.3 \times 10^6))</td>
<td></td>
</tr>
<tr>
<td>16. ((6.45 \times 10^5)(1.2 \times 10^3))</td>
<td>17. ((4.18 \times 10^{-4})(0.9 \times 10^{-5}))</td>
<td></td>
</tr>
<tr>
<td>18. ((12.6 \times 10^{-8})(0.5 \times 10^6))</td>
<td>19. ((9.75 \times 10^3)(8.4 \times 10^{-4}))</td>
<td></td>
</tr>
<tr>
<td>20. (\frac{8.32 \times 10^7}{1.3 \times 10^5})</td>
<td>21. (\frac{9.45 \times 10^{10}}{1.5 \times 10^6})</td>
<td></td>
</tr>
<tr>
<td>22. (\frac{4.2 \times 10^8}{1.68 \times 10^2})</td>
<td>23. (\frac{9.0 \times 10^{-11}}{2.4 \times 10^8})</td>
<td></td>
</tr>
<tr>
<td>24. (\frac{3.24 \times 10^{-4}}{8.1 \times 10^{-7}})</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example 3 (p. 307)</th>
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</thead>
<tbody>
<tr>
<td>26. <strong>SCIENCE</strong> Neurons are cells in the nervous system that process and transmit information. An average neuron is about (5.0 \times 10^{-6}) meter in diameter. A standard table tennis ball is (4.0 \times 10^{-2}) meter in diameter. About how many times as great is the diameter of a ball than a neuron?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 27. **ASTRONOMY** The Sun burns about \(4.4 \times 10^6\) tons of hydrogen per second. How much hydrogen does the Sun burn in one year? (Hint: one year = \(3.16 \times 10^7\) seconds) |  |  |
Evaluate each expression. Express the result in scientific notation.

Examples 4 and 5 (p. 307)

28. \((7.3 \times 10^5) + (2.4 \times 10^6)\)  
29. \((9.5 \times 10^{11}) + (6.3 \times 10^9)\)

30. \((13.57 \times 10^8) + (5.9 \times 10^5)\)  
31. \((8.64 \times 10^6) + (13.34 \times 10^9)\)

32. \((12.1 \times 10^4) - (9.5 \times 10^3)\)  
33. \((1.03 \times 10^9) - (4.7 \times 10^7)\)

34. \((15.4 \times 10^{11}) - (6.94 \times 10^{10})\)  
35. \((8.71 \times 10^4) - (6.34 \times 10^1)\)

36. **MEASUREMENT** A circular swimming pool holds \(1.22 \times 10^6\) cubic inches of water. It is being filled at a rate of \(1.5 \times 10^3\) cubic inches per minute. About how long will it take to fill the swimming pool?

37. **PARKS** Central Park in New York City is rectangular in shape and measures approximately \(1.37 \times 10^4\) feet by \(2.64 \times 10^2\) feet. If one acre is equal to \(4.356 \times 10^4\) square feet, how many acres does Central Park cover?

**MEASUREMENT** Find the missing measure for each figure.

38. \[\text{A} = \boxed{m^2}\] \(2.5 \times 10^{-3}\) m  
39. \[\text{P} = \boxed{5 \times 10^4\text{ in.}}\] \(8.3 \times 10^{-4}\) m

**H.O.T. Problems**

40. **FIND THE ERROR** Enrique is finding \(6.63 \times 10^{-6}\). Find his mistake and correct it.

\[
\begin{align*}
6.63 \times 10^{-6} & = \frac{6.63}{5.1} \times 10^{-6} \\
& = \frac{6.63}{5.1} \times 10^{-2} \\
& = 1.3 \times 10^{-6} - 2 \\
& = 1.3 \times 10^{-8}
\end{align*}
\]

41. **Which One Doesn’t Belong?** Identify the expression that does not belong with the other three. Explain your reasoning.

\[
14.28 \times 10^9, (3.4 \times 10^6)(4.2 \times 10^3), 1.4 \times 10^9, (3.4)(4.2) \times 10^{(6+3)}
\]

42. **Write Math** Explain how to estimate the sum of \((4.215 \times 10^{-2})\) and \((3.2 \times 10^{-4})\).

---

Lesson 5-2 Scientific Notations
### Practice

43. A music download Web site announced that over $4.0 \times 10^9$ songs were downloaded by $5.0 \times 10^7$ registered users. What is the average number of downloads per user?
   - A. $8.0 \times 10^{-1}$
   - B. $1.25 \times 10^{-2}$
   - C. $1.25 \times 10^2$
   - D. $8.0 \times 10^1$

44. There are approximately 45 hundred species of mammals on Earth and $2.8 \times 10^4$ species of fish. What is the difference in the number of species?
   - F. $6.2 \times 10^0$
   - G. $2.35 \times 10^4$
   - H. $1.6 \times 10^{-1}$
   - I. $3.25 \times 10^4$

45. The rectangle below has an area of $9.14 \times 10^{-7}$ square kilometers.

![Rectangle with area formula](image)

What is the approximate length of the missing side?
   - A. $2.74 \times 10^{-6}$
   - B. $5.52 \times 10^{-4}$
   - C. $1.656 \times 10^{-3}$
   - D. $1.51 \times 10^{11}$

### Spiral Review

46. **LANGUAGES** It is estimated that over 836 million people speak Mandarin Chinese. Write this number in scientific notation. (Lesson 5-2B)

47. Write each expression using a positive exponent. (Lesson 5-2A)
   - 47. $5^{-4}$
   - 48. $6^{-3}$
   - 49. $3^{-5}$
   - 50. $8^{-2}$

51. Four more than a number is at most 12.

52. Seven less than a number is less than 8.

53. **FINANCIAL LITERACY** Jase is saving for an $850 computer. He plans to save $50 each month. The equation $y = 850 - 50x$ represents the amount Jase still needs to save. Graph the equation. What does the slope of the graph represent? (Lesson 3-2A)

54. **MEASUREMENT** The table shows the number of fluid ounces in a cup. (Lesson 2-2B)
   a. Write an expression that can be used to find the number of fluid ounces in $c$ cups.
   b. How many fluid ounces are in 12 cups?

### MEASUREMENT

<table>
<thead>
<tr>
<th>Cups</th>
<th>Fluid Ounces</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>32</td>
</tr>
</tbody>
</table>

55. **GEOMETRY** Find the perimeter of a triangle with sides that measure $33\frac{1}{8}$ feet, $86\frac{1}{8}$ feet, and $79\frac{1}{8}$ feet. (Lesson 1-1B)

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