Lesson 2-10
Operations with Numbers in Scientific Notation

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I can...
perform operations with numbers in scientific notation.

Solve & Discuss It!

ACTIVITY

The homecoming committee wants to fly an aerial banner over the football game. The banner is 1,280 inches long and 780 inches tall. How many different ways can the area of the banner be expressed?

Focus on math practices

Be Precise Which of the solutions is easiest to manipulate?

Essential Question How does using scientific notation help when computing with very large or very small numbers?

EXAMPLE 1 Add or Subtract Numbers in Scientific Notation

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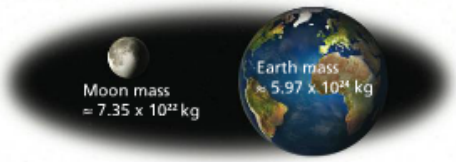
The mass of Earth and the mass of the Moon are shown. How much greater is the mass of Earth than that of the Moon?



Use Structure What does the exponent tell you about the magnitude of the number?

ONE WAY Write the masses in standard form and then subtract.

$5.97 \times 10^{24} = 5{,}970{,}000{,}000{,}000{,}000{,}000{,}000{,}000$

$7.35 \times 10^{22} = 73{,}500{,}000{,}000{,}000{,}000{,}000{,}000$

$$\begin{array}{r} 5{,}970{,}000{,}000{,}000{,}000{,}000{,}000{,}000 \\ -\ 73{,}500{,}000{,}000{,}000{,}000{,}000{,}000 \\ \hline 5{,}896{,}500{,}000{,}000{,}000{,}000{,}000{,}000 \end{array}$$

The difference is about 5.8965×10^{24} kilograms.

ANOTHER WAY Write the masses using the same power of 10. Then subtract.

5.97×10^{24}

$= (5.97 \times 10^{2}) \times 10^{22}$

$= 597 \times 10^{22}$

Use a property of exponents to write 10^{24} as $10^{2} \times 10^{22}$.

$(597 \times 10^{22}) - (7.35 \times 10^{22})$

$= (597 - 7.35) \times 10^{22}$

$= 589.65 \times 10^{22}$

$= 5.8965 \times 10^{24}$

Remember, the first factor must be greater than or equal to 1 and less than 10.

The difference is about 5.8965×10^{24} kilograms.

Try It!

The planet Venus is on average 2.5×10^{7} kilometers from Earth. The planet Mars is on average 2.25×10^{8} kilometers from Earth. When Venus, Earth, and Mars are aligned, what is the average distance from Venus to Mars?

$2.25 \times 10^{8} = (2.25 \times \square \times \square)$

$= \square \times 10^{7}$

$2.5 \times 10^{7} + \square \times 10^{7} = (2.5 + \square) \times 10^{7}$

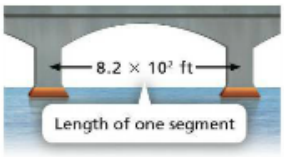
$= \square \times 10^{7}$

$= \square \times \square$

Convince Me! In Example 1 and the Try It, why did you move the decimal point to get the final answer?

EXAMPLE 2 Multiply Numbers in Scientific Notation

The Confederation Bridge connects New Brunswick to Prince Edward Island. The main part of the bridge rests on piers that form 43 segments. What is the approximate length of the main part of the bridge? Express your answer in scientific notation.



STEP 1 Write an expression to represent the problem situation.

$(8.2 \times 10^2) \times 43$

$= (8.2 \times 10^2) \times (4.3 \times 10^1)$ — Express both numbers in scientific notation.

STEP 2 Multiply.

$(8.2 \times 10^2) \times (4.3 \times 10^1)$

$= (8.2 \times 4.3) \times (10^2 \times 10^1)$ — Remember: The Product of Powers Property states that when multiplying powers with the same base, you add the exponents.

$= 35.26 \times (10)^{2+1}$

$= 35.26 \times 10^3$

$= 3.526 \times 10^4$ — The first factor must be less than 10 and greater than or equal to 1.

The length of the main part of the bridge is approximately 3.5×10^4 feet.

EXAMPLE 3 Divide Numbers in Scientific Notation

A queen ant lays 1.83×10^6 eggs over a period of 30 days. Assuming she lays the same number of eggs each day, about how many eggs does she lay in one day? Express your answer in scientific notation.

First, write 30 in scientific notation: 3.0×10^1

Then, divide.

$(1.83 \times 10^6) \div (3.0 \times 10^1)$

$\frac{1.83 \times 10^6}{3.0 \times 10^1}$

$\frac{1.83}{3.0} \times \frac{10^6}{10^1}$

$(1.83 \div 3.0) \times (10^6 \div 10^1)$ — The Quotient of Powers Property states that when dividing powers with the same base, you subtract the exponents.

0.61×10^5

6.1×10^4

The queen ant lays about 6.1×10^4 eggs per day.

Try It!

There are 1×10^{14} good bacteria in the human body. There are 2.6×10^{18} good bacteria among the spectators in a soccer stadium. About how many spectators are in the stadium? Express your answer in scientific notation.

Name: _____ Squares and Square Roots Date: _____

n	Squared² n^2	Square Root √n
1	1	1.000
2	4	1.414
3	9	1.732
4	16	2.000
5	25	2.236
6	36	2.449
7	49	2.646
8	64	2.828
9	81	3.000
10	100	3.162
11	121	3.317
12	144	3.464
13	169	3.606
14	196	3.742
15	225	3.873
16	256	4.000
17	289	4.123
18	324	4.243
19	361	4.359
20	400	4.472
21	441	4.583
22	484	4.690
23	529	4.796
24	576	4.899
25	625	5.000
26	676	5.099
27	729	5.196
28	784	5.292
29	841	5.385
30	900	5.477
31	961	5.568
32	1024	5.657
33	1089	5.745
34	1156	5.831
35	1225	5.916
36	1296	6.000
37	1369	6.083
38	1444	6.164
39	1521	6.245
40	1600	6.325
41	1681	6.403
42	1764	6.481
43	1849	6.557
44	1936	6.633
45	2025	6.708
46	2116	6.782
47	2209	6.856
48	2304	6.928
49	2401	7.000
50	2500	7.071

n	Squared² n^2	Square Root √n
51	2601	7.141
52	2704	7.211
53	2809	7.280
54	2916	7.348
55	3025	7.416
56	3136	7.483
57	3249	7.550
58	3364	7.616
59	3481	7.681
60	3600	7.746
61	3721	7.810
62	3844	7.874
63	3969	7.937
64	4096	8.000
65	4225	8.062
66	4356	8.124
67	4489	8.185
68	4624	8.246
69	4761	8.307
70	4900	8.367
71	5041	8.426
72	5184	8.485
73	5329	8.544
74	5476	8.602
75	5625	8.660
76	5776	8.718
77	5929	8.775
78	6084	8.832
79	6241	8.888
80	6400	8.944
81	6561	9.000
82	6724	9.055
83	6889	9.110
84	7056	9.165
85	7225	9.220
86	7396	9.274
87	7569	9.327
88	7744	9.381
89	7921	9.434
90	8100	9.487
91	8281	9.539
92	8464	9.592
93	8649	9.644
94	8836	9.695
95	9025	9.747
96	9216	9.798
97	9409	9.849
98	9604	9.899
99	9801	9.950
100	10000	10.000

n	Square Root √n
101	10.050
102	10.100
103	10.149
104	10.198
105	10.247
106	10.296
107	10.344
108	10.392
109	10.440
110	10.488
111	10.536
112	10.583
113	10.630
114	10.677
115	10.724
116	10.770
117	10.817
118	10.863
119	10.909
120	10.954
121	11.000
122	11.045
123	11.091
124	11.136
125	11.180
126	11.225
127	11.269
128	11.314
129	11.358
130	11.402
131	11.446
132	11.489
133	11.533
134	11.576
135	11.619
136	11.662
137	11.705
138	11.747
139	11.790
140	11.832
141	11.874
142	11.916
143	11.958
144	12.000
145	12.042
146	12.083
147	12.124
148	12.166
149	12.207
150	12.247

n	Square Root √n
151	12.288
152	12.329
153	12.369
154	12.410
155	12.450
156	12.490
157	12.530
158	12.570
159	12.610
160	12.649
161	12.689
162	12.728
163	12.767
164	12.806
165	12.845
166	12.884
167	12.923
168	12.961
169	13.000
170	13.038
171	13.077
172	13.115
173	13.153
174	13.191
175	13.229
176	13.266
177	13.304
178	13.342
179	13.379
180	13.416
181	13.454
182	13.491
183	13.528
184	13.565
185	13.601
186	13.638
187	13.675
188	13.711
189	13.748
190	13.784
191	13.820
192	13.856
193	13.892
194	13.928
195	13.964
196	14.000
197	14.036
198	14.071
199	14.107
200	14.142

n	Square Root √n
201	14.177
202	14.213
203	14.248
204	14.283
205	14.318
206	14.353
207	14.387
208	14.422
209	14.457
210	14.491
211	14.526
212	14.560
213	14.595
214	14.629
215	14.663
216	14.697
217	14.731
218	14.765
219	14.799
220	14.832
221	14.866
222	14.900
223	14.933
224	14.967
225	15.000
226	15.033
227	15.067
228	15.100
229	15.133
230	15.166
231	15.199
232	15.232
233	15.264
234	15.297
235	15.330
236	15.362
237	15.395
238	15.427
239	15.460
240	15.492
241	15.524
242	15.556
243	15.588
244	15.620
245	15.652
246	15.684
247	15.716
248	15.748
249	15.780
250	15.811

KEY CONCEPT

Operations with very large or very small numbers can be carried out more efficiently using scientific notation. The properties of exponents apply when carrying out operations.

Addition or Subtraction	Multiplication	Division
$(2.3 \times 10^6) + (1.6 \times 10^9)$	$(2.3 \times 10^6) \times (1.6 \times 10^9)$	$(2.3 \times 10^6) \div (1.6 \times 10^9)$
$(2.3 \times 10^6) + (1.6 \times 10^3) \times 10^6$	$(2.3 \times 1.6) \times (10^6 \times 10^9)$	$(2.3 \div 1.6) \times (10^6 \div 10^9)$
$(2.3 \times 10^6) + (1,600 \times 10^6)$	$3.68 \times 10^{6+9}$	$1.4375 \times 10^{6-9}$
$(2.3 + 1,600) \times 10^6$	3.68×10^{15}	1.4375×10^{-3}
$1,602.3 \times 10^6$		
1.6023×10^9		

Use the Product of Powers Property.

Use the Product of Powers Property.

Use the Quotient of Powers Property.

Do You Understand?

1. **Essential Question** How does using scientific notation help when computing with very small or very large numbers?

2. **Use Structure** When multiplying and dividing two numbers in scientific notation, why do you sometimes have to rewrite one factor?

3. **Use Structure** For the sum of (5.2×10^4) and (6.95×10^4) in scientific notation, why will the power of 10 be 10^5?

Do You Know How?

4. A bacteriologist estimates that there are 5.2×10^4 bacteria growing in each of 20 petri dishes. About how many bacteria in total are growing in the petri dishes? Express your answer in scientific notation.

5. The distance from Earth to the Moon is approximately 1.2×10^9 feet. The Apollo 11 spacecraft was approximately 360 feet long. About how many spacecraft of that length would fit end to end from Earth to the Moon? Express your answer in scientific notation.

6. The mass of Mars is 6.42×10^{23} kilograms. The mass of Mercury is 3.3×10^{23} kilograms.
   a. What is the combined mass of Mars and Mercury expressed in scientific notation?
   b. What is the difference in the mass of the two planets expressed in scientific notation?

Name: _____

Practice & Problem Solving

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Leveled Practice In **7** and **8**, perform the operation and express your answer in scientific notation.

7. $(7 \times 10^{-6})(7 \times 10^{-6})$

(☐ · ☐) × (10☐ · 10☐)

☐ × 10☐

4.9×10☐

8. $(3.76 \times 10^{5}) + (7.44 \times 10^{5})$

(☐ + ☐) × (10☐)

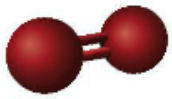
☐ × ☐

1.12×10☐

9. What is the value of n in the equation $1.9 \times 10^{7} = (1 \times 10^{5})(1.9 \times 10^{n})$?

10. Find $(5.3 \times 10^{3}) - (8 \times 10^{2})$. Express your answer in scientific notation.

11. What is the mass of 30,000 molecules? Express your answer in scientific notation.



Mass of one molecule of oxygen = 5.3×10^{-23} gram

12. Critique Reasoning Your friend says that the product of 4.8×10^{8} and 2×10^{-3} is 9.6×10^{-5}. Is this answer correct? Explain.

13. Find $\frac{7.2 \times 10^{-8}}{3 \times 10^{-2}}$. Write your answer in scientific notation.

14. A certain star is 4.3×10^{2} light years from Earth. One light year is about 5.9×10^{12} miles. How far from Earth (in miles) is the star? Express your answer in scientific notation.

15. The total consumption of fruit juice in a particular country in 2006 was about 2.28×10^9 gallons. The population of that country that year was 3×10^8. What was the average number of gallons consumed per person in the country in 2006?

16. The greatest distance between the Sun and Jupiter is about 8.166×10^8 kilometers. The greatest distance between the Sun and Saturn is about 1.515×10^9 kilometers. What is the difference between these two distances?

17. What was the approximate number of pounds of garbage produced per person in the country in one year? Express your answer in scientific notation.

Garbage generated in country:
6.958×10^{10} pounds
Population of country:
4.57×10^6 people

18. Higher Order Thinking

a. What is the value of n in the equation $1.5 \times 10^{12} = (5 \times 10^5)(3 \times 10^n)$?

b. Explain why the exponent on the left side of the equation is not equal to the sum of the exponents on the right side.

Assessment Practice

19. Find $(2.2 \times 10^5) \div (4.4 \times 10^{-3})$. When you regroup the factors, what do you notice about the quotient of the decimal factors? How does this affect the exponent of the quotient?

20. Which equation(s) are true? Select all that apply.

- ☐ $(4.7 \times 10^4) + (8 \times 10^4) = 1.27 \times 10^5$
- ☐ $(7.08 \times 10^3) + (2.21 \times 10^3) = 9.29 \times 10^6$
- ☐ $(5.43 \times 10^8) - (2.33 \times 10^8) = 3.1 \times 10^4$
- ☐ $(9.35 \times 10^6) - (6.7 \times 10^6) = 2.65 \times 10^6$