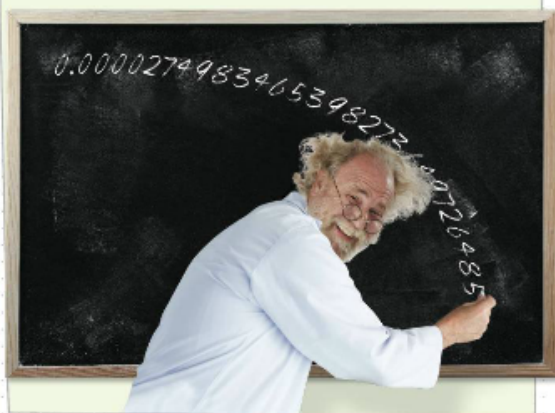


Solve & Discuss It!



Scientists often write very large or very small numbers using exponents. How might a scientist write the number shown using exponents?



Lesson 2-9
Understand Scientific Notation

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I can...
use scientific notation to write very large or very small quantities.

Use Structure How can you use your knowledge of powers of 10 to rewrite the number?

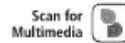
Focus on math practices

Look for Relationships What does the exponent in 10^{15} tell you about the value of the number?

Essential Question What is scientific notation and why is it used?



EXAMPLE 1 Write Large Numbers in Scientific Notation



Louisa is researching the approximate distance between Earth and the Sun. Her father told her that the distance is 9.296×10^7 miles. In an astronomy book, she found the following.
Which distance is correct?



Louisa's father used **scientific notation** to express the approximate distance because the distance is so great. Numbers in scientific notation have two factors.

$$9.296 \times 10^7$$

The first factor is always a number greater than or equal to 1 and less than 10.

The second factor is always a power of 10.

Write the number in standard form in scientific notation.

Place the decimal point after the first nonzero digit.

$$92,960,000$$

$$9.296 \times 10^7$$

Count the number of digits after the decimal point to determine the power of 10.

The two numbers represent the same distance.

Try It!

The height of Angel Falls, the tallest waterfall in the world, is 3,212 feet. How do you write this number in scientific notation?

$$\square . \square \square \square \times 10^\square$$

Convince Me! Why do very large numbers have positive exponents when written in scientific notation? Explain.

EXAMPLE 2 Write Small Numbers in Scientific Notation

What is the width of a red blood cell written in scientific notation?

Write the number as the product of two factors.

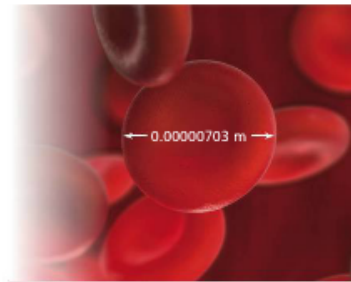
Place the decimal after the first nonzero digit.

Count the number of digits before the decimal point to determine the power of 10.

$$0.00000703 \times 10^{-6} = 7.03 \times 10^{-6}$$

6 digits

The width of the red blood cell, expressed in scientific notation, is 7.03×10^{-6} meter.



Try It!

A common mechanical pencil lead measures about 0.005 meter in diameter. How can you express this measurement using scientific notation?

EXAMPLE 3 Convert Scientific Notation to Standard Form

A. Kelly used a calculator to multiply large numbers. How can she write the number on her calculator screen in standard form?

$$3.5 \times 10^{15} = 3,500,000,000,000,000$$

The exponent is positive so move the decimal point to the right.



B. How can Charlie write the number on the calculator screen in standard form?

$$8 \times 10^{-9} = 0.000000008$$

The exponent is negative so move the decimal point to the left.



Use Appropriate Tools Certain calculators may display scientific notation using the symbol EE or E. The number that follows is the power of 10.

Try It!

Write the numbers in standard form.

a. 9.225×10^{18}

b. 6.3×10^{-8}

Name: _____

Squares and Square Roots

Date: _____

n	Squared ² n ²	Square Root \sqrt{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	Squared ² n ²	Square Root \sqrt{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 \sqrt{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 \sqrt{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 \sqrt{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



KEY CONCEPT

Scientific notation is a way to write very large numbers or very small numbers. Scientists use scientific notation as a more efficient and convenient way of writing such numbers.

A number in scientific notation is the product of two factors. The first factor must be greater than or equal to 1 and less than 10. The second factor is a power of 10.

Count the number of digits **after** the decimal point. The exponent is positive.

7 digits

$6,500,000 \rightarrow 6.5 \times 10^7$

Place the decimal point after the first nonzero digit.

Count the number of digits **before** the decimal point. The exponent is negative.

5 digits

$0.00009.87 \rightarrow 9.87 \times 10^{-5}$

Place the decimal point after the first nonzero digit.

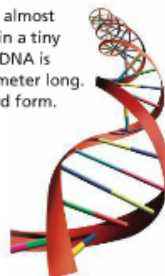
To write a number in scientific notation in standard form, multiply the decimal number by the power of 10.

Do You Understand?

- Essential Question** What is scientific notation and why is it used?
- Critique Reasoning** Taylor states that 2,800,000 in scientific notation is 2.8×10^{-6} because the number has six places to the right of the 2. Is Taylor's reasoning correct?
- Construct Arguments** Sam will write 0.000032 in scientific notation. Sam thinks that the exponent of 10 will be positive. Do you agree? Construct an argument to support your response.

Do You Know How?

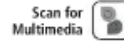
- Express 586,400,000 in scientific notation.
- The genetic information of almost every living thing is stored in a tiny strand called DNA. Human DNA is 3 nanometers or 3×10^{-9} meter long. Write the length in standard form.
- The largest virus known to man is the Megavirus, which measures 0.00000044 meter across. Express this number in scientific notation.
- How would you write the number displayed on the calculator screen in standard form?



Name: _____



Practice & Problem Solving



Leveled Practice In 8 and 9, write the numbers in the correct format.

8. The Sun is 1.5×10^8 kilometers from Earth.

1.5×10^8 is written as in standard form.

9. Brenna wants an easier way to write 0.00000000000000000587.

0.00000000000000000587 is written as $\times 10^{\text{$ in scientific notation.

10. Is 23×10^{-8} written in scientific notation?
Justify your response.

11. Is 8.6×10^7 written in scientific notation?
Justify your response.

12. Simone evaluates an expression using her calculator. The calculator display is shown at the right. Express the number in standard form.



13. Express the number 0.00001038 in scientific notation.

14. Express the number 80,000 in scientific notation.

15. Peter evaluates an expression using his calculator. The calculator display is shown at the right. Express the number in standard form.



16. a. What should you do first to write 5.871×10^{-7} in standard form?
 b. Express the number in standard form.

17. Express 2.58×10^{-2} in standard form.

18. At a certain point, the Grand Canyon is approximately 1,600,000 centimeters across. Express this number in scientific notation.



19. The length of a bacterial cell is 5.2×10^{-6} meter. Express the length of the cell in standard form.

20. **Higher Order Thinking** Express the distance 4,300,000 meters using scientific notation in meters, and then in millimeters.

Assessment Practice

21. Which of the following numbers is written in scientific notation?

- A 12×10^6
- B 12
- C 6.89×10^6
- D 6.89

22. Jeana's calculator display shows the number to the right.

PART A

Express this number in scientific notation.



PART B

Express this number in standard form.

