Lesson 2-4
Evaluate Square Roots and Cube Roots

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I can...
find square roots and cube roots of rational numbers.

Solve & Discuss It!

Matt and his dad are building a tree house. They buy enough flooring material to cover an area of 36 square feet. What are all possible dimensions of the floor?

Look for Relationships
Can different floor dimensions result in the same area?

Focus on math practices

Reasoning Why is there only one set of dimensions for a square floor when there are more sets for a rectangular floor? Are all the dimensions reasonable? Explain.

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Essential Question How do you evaluate cube roots and square roots?

EXAMPLE 1 Evaluate Cube Roots to Solve Problems

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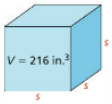
Leah is building a bird house for purple martins, birds that prefer cube-shaped birdhouses. What are the dimensions of each square piece of wood Leah needs to build the 216 cubic-inch birdhouse?

Reasoning What do you know about the length, width, and height of the birdhouse?

Draw and label a cube to represent the birdhouse.



$216 = s \cdot s \cdot s$

$216 = s^3$

A number that is a cube of an integer is a **perfect cube**.
The number 216 is also a perfect cube.

To find the value of s, find the cube root of 216. The **cube root** of a number is a number whose cube is equal to that number.

The symbol $\sqrt[3]{\ }$ means the cube root of a number.

$\sqrt[3]{216} = \sqrt[3]{6 \cdot 6 \cdot 6}$
$= \sqrt[3]{6^3}$
$= 6$

Taking the cube root and cubing a number are inverse operations.

The dimensions of each square piece of wood are 6 inches by 6 inches.

Try It!

A cube-shaped art sculpture has a volume of 64 cubic feet. What is the length of each edge of the cube?

The length of each edge is ☐ feet.

$\sqrt[3]{64} = \sqrt[3]{\square} \cdot \square \cdot \square$

$\sqrt[3]{64} = \sqrt[3]{\square^3}$

$\sqrt[3]{64} = \square$

Convince Me! How can you find the cube root of 64?

EXAMPLE 2 Evaluate Perfect Squares and Perfect Cubes

Evaluate.

A. $\sqrt[3]{64}$

$\sqrt[3]{64} = \sqrt[3]{4 \cdot 4 \cdot 4}$
$= \sqrt[3]{4^3}$
$= 4$

B. $\sqrt{100}$

$\sqrt{100} = \sqrt{10 \cdot 10}$
$= \sqrt{10^2}$
$= 10$

C. $\sqrt{49}$

$\sqrt{49} = \sqrt{7 \cdot 7}$
$= \sqrt{7^2}$
$= 7$

D. $\sqrt[3]{8}$

$\sqrt[3]{8} = \sqrt[3]{2 \cdot 2 \cdot 2}$
$= \sqrt[3]{2^3}$
$= 2$

Try It!

Evaluate.

a. $\sqrt[3]{27}$ b. $\sqrt{25}$ c. $\sqrt{81}$ d. $\sqrt[3]{1}$

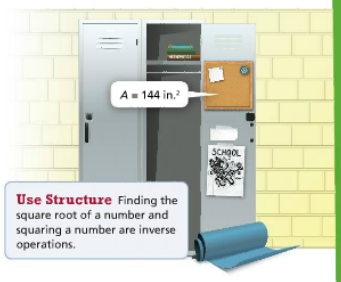
EXAMPLE 3 Evaluate Square Roots to Solve Problems

Sean cuts one sheet of colorful poster paper to cover the bulletin board exactly. What are the dimensions of the poster paper?

Find the square root of the area to find the side lengths of the bulletin board.

$\sqrt{144} = \sqrt{12 \cdot 12}$
$= \sqrt{12^2}$
$= 12$

Each side of the bulletin board measures 12 inches. Sean will need to cut a 12-inch by 12-inch sheet of poster paper.



Use Structure Finding the square root of a number and squaring a number are inverse operations.

Try It!

Emily wants to buy a tablecloth to cover a square card table. She knows the tabletop has an area of 9 square feet. What are the minimum dimensions of the tablecloth Emily needs?

Emily should buy a tablecloth that measures at least ☐ feet by ☐ feet.

$\sqrt{9} = \sqrt{\square \cdot \square}$
$= \sqrt{\square^2}$
$= \square$

Name: _____ Squares and Square Roots Date: _____

n^2 $\sqrt{n}$

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	13.526
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

The cube root of a number is a number whose cube is equal to that number.

$\sqrt[3]{125} = \sqrt[3]{5^3}$
$= 5$

Cubing a number and taking the cube root of the number are inverse operations.

The square root of a number is a number whose square is equal to that number.

$\sqrt{4} = \sqrt{2^2}$
$= 2$

Squaring a number and taking the square root of the number are inverse operations.

Do You Understand?

1. **Essential Question** How do you evaluate cube roots and square roots?

2. **Generalize** A certain number is both a perfect square and a perfect cube. Will its square root and its cube root always be different numbers? Explain.

3. **Critique Reasoning** A cube-shaped box has a volume of 27 cubic inches. Bethany says each side of the cube measures 9 inches because $9 \times 3 = 27$. Is Bethany correct? Explain your reasoning.

Do You Know How?

4. A cube has a volume of 8 cubic inches. What is the length of each edge of the cube?

$2 \cdot 2 \cdot 2$
The length of each edge of the cube is 2 inches.

$8 = 2 \cdot 4$
$4 = 2 \cdot 2$

5. Below is a model of the infield of a baseball stadium. How long is each side of the infield?

$l \cdot w = 81 \text{ in}^2$
$l \cdot l = 81 \text{ in}^2$
$\sqrt{l^2} = \sqrt{81 \text{ in}^2}$
$l = 9$ in.

Each side of the infield is 9 in long.

$81 = 9 \cdot 9$

6. Julio cubes a number and then takes the cube root of the result. He ends up with 20. What number did Julio start with?

Name: _____

Practice & Problem Solving

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Leveled Practice In 7 and 8, evaluate the cube root or square root.

7. Relate the volume of the cube to the length of each edge.

Edge length Edge length Edge length

☐ cm × ☐ cm × ☐ cm

$\sqrt[3]{8} = \square$

8. Relate the area of the square to the length of each side.

Side length Side length

☐ cm × ☐ cm

$\sqrt{16} = \square$

9. Would you classify the number 169 as a perfect square, a perfect cube, both, or neither? Explain.

10. The volume of a cube is 512 cubic inches. What is the length of each side of the cube?

The length of each side of the cube is 8 in.

$512 = 2 \cdot 256$
$256 = 2 \cdot 128$
$128 = 2 \cdot 64$
$64 = 8 \cdot 8$
$8 = 2 \cdot 4$
$4 = 2 \cdot 2$

$(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)$
$8 \cdot 8 \cdot 8$

11. A square technology chip has an area of 25 square centimeters. How long is each side of the chip?

12. Would you classify the number 200 as a perfect square, a perfect cube, both, or neither? Explain.

13. A company is making building blocks. What is the length of each side of the block?

14. Mrs. Drew wants to build a square sandbox with an area of 121 square feet. What is the total length of wood Mrs. Drew needs to make the sides of the sandbox?

15. Construct Arguments Diego says that if you cube the number 4 and then take the cube root of the result, you end up with 8. Is Diego correct? Explain.

16. Higher Order Thinking Talia is packing a moving box. She has a square-framed poster with an area of 9 square feet. The cube-shaped box has a volume of 30 cubic feet. Will the poster lie flat in the box? Explain.

$A = 9\,ft^2$

$\ell^2 = 9\,ft^2$

$\ell = 3\,ft$

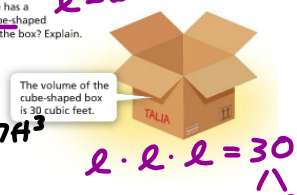
$w = 3\,ft$

$h = 3\,ft$

$V = 3 \cdot 3 \cdot 3 = 27\,ft^3$

poster

$\ell = w = h$



$\ell \cdot \ell \cdot \ell = 30\,ft^3$ ✓

$3 \cdot 10$

2.5

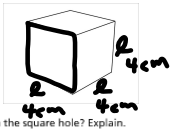
Assessment Practice

17. Which statements are true? Select all that apply.

- ☐ 49 is a perfect square.
- ☐ 9 is a perfect cube.
- ☐ 27 is a perfect cube.
- ☐ 14 is neither a perfect square nor a perfect cube.
- ☐ 1,000 is both a perfect square and a perfect cube.

18. A toy has various shaped objects that a child can push through matching holes. The area of the square hole is 8 square centimeters. The volume of a cube-shaped block is 64 cubic centimeters.

cube block $V = 64\,cm^3$



square hole $A = 8\,cm^2$ ✓

PART A

Which edge length can you find? Explain.

64

$8 \cdot 8$

$4 \cdot 2 \quad 4 \cdot 2$

$2 \cdot 2 \quad 2 \cdot 2$

$(2 \cdot 2)(2 \cdot 2)(2 \cdot 2)$

$4 \cdot 4 \cdot 4$

PART B

Will the block fit in the square hole? Explain.

$A_{block} = 4\,cm \cdot 4\,cm$

$16\,cm^2$

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