

# Estimating Expressions with Irrational Numbers

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Quick Review

When an expression mixes irrational numbers with ordinary arithmetic, the plan is simple: **estimate each irrational piece first**, then do the adding, subtracting, or multiplying. Replace a square root with a close decimal — for instance  $\sqrt{2} \approx 1.4$  or  $\sqrt{8} \approx 2.8$  — and use  $\pi \approx 3.14$ . Then carry out the operation as usual and round at the end. You can also *compare* two irrational expressions by estimating both. A handy check: a bigger number under the radical always gives a bigger square root, so  $\sqrt{20} > \sqrt{15}$  without any calculation at all.

◇ **Example:** Estimate  $\sqrt{10} + \sqrt{5}$  to the nearest tenth.

⇒ Tackle each root on its own first. For  $\sqrt{10}$ : since  $3.1^2 = 9.61$  and  $3.2^2 = 10.24$ , we get  $\sqrt{10} \approx 3.2$ . For  $\sqrt{5}$ : since  $2.2^2 = 4.84$  and  $2.3^2 = 5.29$ , we get  $\sqrt{5} \approx 2.2$ . Now just add the estimates:  $3.2 + 2.2 = 5.4$ . So the sum is about 5.4 — estimate the parts, then combine!

**Answer:**  $\sqrt{10} + \sqrt{5} \approx 5.4$

## PRACTICE

Estimate each expression, or compare the two values.

- |   |       |  |       |
|---|-------|--|-------|
| 1. $\sqrt{4} + \sqrt{9}$                  | _____ | 11. $2\pi$ (nearest tenth)                       | _____ |
| 2. $\sqrt{16} - \sqrt{1}$                 | _____ | 12. $\sqrt{15} + \sqrt{15}$ (nearest tenth)      | _____ |
| 3. $\sqrt{2} + \sqrt{3}$ (nearest tenth)  | _____ | 13. $\sqrt{50} - \sqrt{2}$ (nearest tenth)       | _____ |
| 4. $\sqrt{8} + \sqrt{2}$ (nearest tenth)  | _____ | 14. $\sqrt{36} + \pi$ (nearest tenth)            | _____ |
| 5. $\sqrt{10} - \sqrt{2}$ (nearest tenth) | _____ | 15. Compare: $\sqrt{20} \square \sqrt{15}$       | _____ |
| 6. $2\sqrt{9}$                            | _____ | 16. Compare: $\sqrt{2} \square 1.5$              | _____ |
| 7. $3\sqrt{16}$                           | _____ | 17. Compare: $\pi \square \sqrt{10}$             | _____ |
| 8. $\sqrt{2} \cdot \sqrt{8}$              | _____ | 18. Compare: $\sqrt{7} + 1 \square \sqrt{7} + 2$ | _____ |
| 9. $\pi + 2$ (nearest tenth)              | _____ | 19. $\sqrt{3} \cdot \sqrt{12}$                   | _____ |
| 10. $\pi - 1$ (nearest tenth)             | _____ | 20. $\frac{\sqrt{49}}{\sqrt{4}}$                 | _____ |

## Word Problems

21. A rectangle has a length of  $\sqrt{20}$  cm and a width of  $\sqrt{5}$  cm. Estimate its perimeter to the nearest tenth of a centimeter.  
\_\_\_\_\_
22. Two square tiles have areas  $18 \text{ in}^2$  and  $8 \text{ in}^2$ . Estimate how much longer one side of the bigger tile is than one side of the smaller tile, to the nearest tenth of an inch. \_\_\_\_\_
23. A circular tabletop has a radius of  $\sqrt{2}$  ft. Using  $\pi \approx 3.14$ , estimate its circumference  $2\pi r$  to the nearest tenth of a foot.  
\_\_\_\_\_
24. Carlos walks  $\sqrt{45}$  blocks and Dana walks 7 blocks. Without a calculator, who walks farther, and how do you know? \_\_\_\_\_



## Answer Keys

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| <ol style="list-style-type: none"> <li>1. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">5</span></li> <li>2. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">3</span></li> <li>3. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">3.1</span></li> <li>4. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">4.2</span></li> <li>5. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">1.7</span></li> <li>6. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">6</span></li> <li>7. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">12</span></li> <li>8. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">4</span></li> <li>9. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">5.1</span></li> <li>10. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">2.1</span></li> <li>11. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">6.3</span></li> <li>12. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">7.7</span></li> </ol> | <ol style="list-style-type: none"> <li>13. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">5.7</span></li> <li>14. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">9.1</span></li> <li>15. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;"><math>\sqrt{20} &gt; \sqrt{15}</math></span></li> <li>16. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;"><math>\sqrt{2} &lt; 1.5</math></span></li> <li>17. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;"><math>\pi &lt; \sqrt{10}</math></span></li> <li>18. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;"><math>\sqrt{7} + 1 &lt; \sqrt{7} + 2</math></span></li> <li>19. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">6</span></li> <li>20. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;"><math>\frac{7}{2}</math></span></li> <li>21. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">about 13.4 cm</span></li> <li>22. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">about 1.4 in</span></li> <li>23. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">about 8.8 ft</span></li> <li>24. <span style="border: 1px solid black; border-radius: 5px; padding: 2px 5px;">Dana walks farther</span></li> </ol> |
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### Step-by-Step Explanations

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| <ol style="list-style-type: none"> <li>1. Both are perfect squares: <math>\sqrt{4} = 2</math> and <math>\sqrt{9} = 3</math>, so the sum is exactly 5.</li> <li>2. <math>\sqrt{16} = 4</math> and <math>\sqrt{1} = 1</math>, so <math>4 - 1 = 3</math>.</li> <li>3. <math>\sqrt{2} \approx 1.4</math> and <math>\sqrt{3} \approx 1.7</math>, so the sum is about <math>1.4 + 1.7 = 3.1</math>.</li> <li>4. <math>\sqrt{8} \approx 2.8</math> and <math>\sqrt{2} \approx 1.4</math>, so <math>2.8 + 1.4 = 4.2</math>.</li> <li>5. <math>\sqrt{10} \approx 3.16</math> and <math>\sqrt{2} \approx 1.41</math>, so <math>3.16 - 1.41 \approx 1.7</math>.</li> <li>6. <math>\sqrt{9} = 3</math>, so <math>2 \times 3 = 6</math>.</li> <li>7. <math>\sqrt{16} = 4</math>, so <math>3 \times 4 = 12</math>.</li> <li>8. Multiplying under one radical, <math>\sqrt{2} \cdot \sqrt{8} = \sqrt{16} = 4</math> exactly.</li> <li>9. Using <math>\pi \approx 3.1</math>, we get <math>3.1 + 2 = 5.1</math>.</li> <li>10. With <math>\pi \approx 3.1</math>, <math>3.1 - 1 = 2.1</math>.</li> <li>11. <math>2 \times 3.14 = 6.28</math>, which rounds to 6.3.</li> <li>12. <math>\sqrt{15} \approx 3.87</math>, so <math>3.87 + 3.87 \approx 7.7</math>.</li> <li>13. <math>\sqrt{50} \approx 7.1</math> and <math>\sqrt{2} \approx 1.4</math>, so <math>7.1 - 1.4 = 5.7</math>.</li> <li>14. <math>\sqrt{36} = 6</math> and <math>\pi \approx 3.1</math>, so <math>6 + 3.1 = 9.1</math>.</li> </ol> | <ol style="list-style-type: none"> <li>15. A larger number under the radical gives a larger root, and <math>20 &gt; 15</math>, so <math>\sqrt{20} &gt; \sqrt{15}</math>.</li> <li>16. <math>1.5^2 = 2.25</math>, which is more than 2, so <math>1.5 &gt; \sqrt{2}</math>.</li> <li>17. <math>\pi \approx 3.14</math> and <math>\sqrt{10} \approx 3.16</math>, so <math>\pi</math> is slightly less than <math>\sqrt{10}</math>.</li> <li>18. Both share <math>\sqrt{7}</math>, so the one with the larger added number is bigger.</li> <li>19. <math>\sqrt{3} \cdot \sqrt{12} = \sqrt{36} = 6</math> exactly.</li> <li>20. <math>\sqrt{49} = 7</math> and <math>\sqrt{4} = 2</math>, so the quotient is <math>\frac{7}{2}</math>.</li> <li>21. <math>\sqrt{20} \approx 4.5</math> and <math>\sqrt{5} \approx 2.2</math>. The perimeter is <math>2(4.5) + 2(2.2) = 9.0 + 4.4 = 13.4</math> cm.</li> <li>22. The sides are <math>\sqrt{18} \approx 4.2</math> in and <math>\sqrt{8} \approx 2.8</math> in. The difference is <math>4.2 - 2.8 = 1.4</math> in.</li> <li>23. With <math>\sqrt{2} \approx 1.4</math>, the circumference is <math>2 \times 3.14 \times 1.4 \approx 8.8</math> ft.</li> <li>24. <math>7 = \sqrt{49}</math>, and <math>45 &lt; 49</math>, so <math>\sqrt{45} &lt; 7</math>. That means Carlos walks less than Dana.</li> </ol> |
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