

# Rational and Irrational Numbers

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

## Quick Review

A **rational number** is any number you can write as a fraction  $\frac{a}{b}$  of two integers (with  $b \neq 0$ ). When you write a rational number as a decimal, it always either *stops* (like 0.75) or *repeats* a pattern forever (like 0.3333...). An **irrational number** cannot be written as such a fraction — its decimal goes on forever with *no repeating pattern*. Famous examples are  $\pi$  and most square roots, such as  $\sqrt{2}$  and  $\sqrt{10}$ . A quick test:  $\sqrt{n}$  is rational only when  $n$  is a **perfect square** (like  $\sqrt{49} = 7$ ); otherwise it is irrational.

◊ **Example:** Tell whether  $\sqrt{45}$  is rational or irrational.

⇒ Start by asking the key question: is 45 a perfect square? The perfect squares near it are  $36 = 6^2$  and  $49 = 7^2$ , and 45 is stuck *between* them — it is not a perfect square. That means  $\sqrt{45}$  is not a whole number, and in fact its decimal 6.7082... never stops and never repeats. So  $\sqrt{45}$  cannot be written as a fraction of integers — it is **irrational**.

**Answer:**  $\sqrt{45}$  is irrational

## PRACTICE

Classify each number as rational or irrational.

- |                     |       |                       |       |
|---------------------|-------|-----------------------|-------|
| 1. $\frac{3}{5}$    | _____ | 11. $2.\overline{18}$ | _____ |
| 2. $\sqrt{49}$      | _____ | 12. $\sqrt{100}$      | _____ |
| 3. $\sqrt{7}$       | _____ | 13. $-\sqrt{2}$       | _____ |
| 4. 0.25             | _____ | 14. 3.5               | _____ |
| 5. $\pi$            | _____ | 15. $\sqrt{64}$       | _____ |
| 6. -8               | _____ | 16. $\sqrt{2} + 1$    | _____ |
| 7. $0.\overline{6}$ | _____ | 17. $\frac{22}{7}$    | _____ |
| 8. $\sqrt{16}$      | _____ | 18. 0.1010010001...   | _____ |
| 9. $\sqrt{20}$      | _____ | 19. $\sqrt{81}$       | _____ |
| 10. $\frac{0}{9}$   | _____ | 20. $\sqrt{50}$       | _____ |

## Word Problems

21. A square garden has an area of 36 square feet. Is the side length a rational or an irrational number? Explain. \_\_\_\_\_
22. A different square tile has an area of 30 square inches. Is its side length rational or irrational? \_\_\_\_\_
23. Maria says every number that has a decimal point is irrational. Give one example that shows she is wrong. \_\_\_\_\_
24. A circle has a radius of 4 cm. Its circumference is  $2\pi r = 8\pi$  cm. Is the exact circumference rational or irrational? \_\_\_\_\_



## Answer Keys

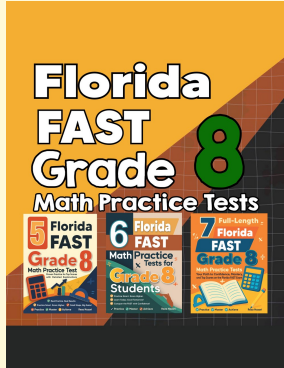
- |               |                                       |
|---------------|---------------------------------------|
| 1. rational   | 13. irrational                        |
| 2. rational   | 14. rational                          |
| 3. irrational | 15. rational                          |
| 4. rational   | 16. irrational                        |
| 5. irrational | 17. rational                          |
| 6. rational   | 18. irrational                        |
| 7. rational   | 19. rational                          |
| 8. rational   | 20. irrational                        |
| 9. irrational | 21. rational; side = 6 ft             |
| 10. rational  | 22. irrational; side = $\sqrt{30}$ in |
| 11. rational  | 23. $0.5 = \frac{1}{2}$ (rational)    |
| 12. rational  | 24. irrational                        |

### Step-by-Step Explanations

- |   |  |
|---|--|
| <p>1. It is already a fraction of two integers, so it is rational by definition.</p> <p>2. <math>49 = 7^2</math> is a perfect square, so <math>\sqrt{49} = 7</math>, a whole number — rational.</p> <p>3. 7 is between the perfect squares 4 and 9, so <math>\sqrt{7}</math> is not a whole number and does not repeat — irrational.</p> <p>4. This decimal stops, and <math>0.25 = \frac{1}{4}</math>, so it is rational.</p> <p>5. <math>\pi = 3.14159\dots</math> goes on forever with no repeating pattern, so it is irrational.</p> <p>6. Every integer is rational: <math>-8 = \frac{-8}{1}</math>.</p> <p>7. A repeating decimal is rational; in fact <math>0.\overline{6} = \frac{2}{3}</math>.</p> <p>8. <math>16 = 4^2</math> is a perfect square, so <math>\sqrt{16} = 4</math> — rational.</p> <p>9. 20 sits between 16 and 25, so it is not a perfect square and <math>\sqrt{20}</math> is irrational.</p> <p>10. <math>\frac{0}{9} = 0</math>, and 0 is an integer, so it is rational.</p> <p>11. The block 18 repeats forever, and any repeating decimal can be written as a fraction — rational.</p> <p>12. <math>100 = 10^2</math>, so <math>\sqrt{100} = 10</math>, a whole number — rational.</p> <p>13. <math>\sqrt{2}</math> is irrational, and negating an irrational number keeps it irrational.</p> <p>14. This decimal stops: <math>3.5 = \frac{7}{2}</math>, so it is rational.</p> | <p>15. <math>64 = 8^2</math>, so <math>\sqrt{64} = 8</math> — a perfect square root is rational.</p> <p>16. Adding the rational number 1 to the irrational <math>\sqrt{2}</math> still gives an irrational number.</p> <p>17. It is a ratio of two integers — rational. (It is a famous <i>approximation</i> of <math>\pi</math>, but not equal to <math>\pi</math>.)</p> <p>18. The decimal grows forever but the digits never settle into a repeating block, so it is irrational.</p> <p>19. <math>81 = 9^2</math>, so <math>\sqrt{81} = 9</math> — rational.</p> <p>20. 50 lies between 49 and 64, so it is not a perfect square and <math>\sqrt{50}</math> is irrational.</p> <p>21. The side length is <math>\sqrt{36}</math>, and <math>36 = 6^2</math> is a perfect square, so <math>\sqrt{36} = 6</math> ft — a whole number, which is rational.</p> <p>22. The side is <math>\sqrt{30}</math>. Since 30 is between the perfect squares 25 and 36, it is not a perfect square, so <math>\sqrt{30}</math> is irrational.</p> <p>23. A decimal that stops or repeats is rational. For example 0.5 has a decimal point but equals <math>\frac{1}{2}</math>, so Maria's rule is false.</p> <p>24. The circumference is <math>8\pi</math>. Since <math>\pi</math> is irrational, multiplying it by the nonzero rational number 8 keeps the result irrational.</p> |
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