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 $0.3333\ldots$). An **irrational number** cannot be written as such a fraction — its decimal goes on forever with *no repeating pattern*. Famous examples are π 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 $6.7082\ldots$ 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. $\frac{3}{5}$ ________
2. $\sqrt{49}$ ________
3. $\sqrt{7}$ ________
4. 0.25 ________
5. π ________
6. -8 ________
7. $0.\overline{6}$ ________
8. $\sqrt{16}$ ________
9. $\sqrt{20}$ ________
10. $\frac{0}{9}$ ________
11. $2.\overline{18}$ ________
12. $\sqrt{100}$ ________
13. $-\sqrt{2}$ ________
14. 3.5 ________
15. $\sqrt{64}$ ________
16. $\sqrt{2}+1$ ________
17. $\frac{22}{7}$ ________
18. $0.1010010001\ldots$ ________
19. $\sqrt{81}$ ________
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
2. rational
3. irrational
4. rational
5. irrational
6. rational
7. rational
8. rational
9. irrational
10. rational
11. rational
12. rational
13. irrational
14. rational
15. rational
16. irrational
17. rational
18. irrational
19. rational
20. irrational
21. rational; side $= 6$ ft
22. irrational; side $= \sqrt{30}$ in
23. $0.5 = \frac{1}{2}$ (rational)
24. irrational

Step-by-Step Explanations

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

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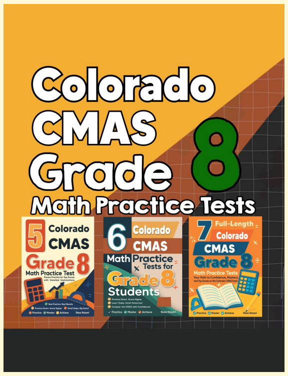

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