ExamPath

CLASS 9 MATHEMATICS · FBISE · UNIT 1 NOTES

Unit 1: Real Numbers

Short notes on the number system, number line, properties, inequalities, radicals and exponents.

Number systems | Number line | Properties | Inequalities | Radicals | Exponents

1. The number family
2. Rational or irrational
3. The number line
4. Properties
5. Inequalities
6. Radicals
7. Laws of exponents
8. Common mistakes
9. Quick check

1 · THE NUMBER FAMILY

Each set sits inside the next

R Real numbers every point on the number line

Q Rational numbers p/q with q ≠ 0, such as ½ and −¾

Z Integers … −2, −1, 0, 1, 2 …

W Whole numbers 0, 1, 2, 3 …

N Natural numbers 1, 2, 3 …

Q′ Irrational numbers such as $\sqrt{2}$ and π. Together with Q they make up R.

No number is both rational and irrational, so $\mathrm{Q} \cap \mathrm{Q}' = \varnothing$.

2 · RATIONAL OR IRRATIONAL?

The decimal tells you

Rational

Ends, or repeats in a block

$3/8 = 0.375$ | $1/3 = 0.333\ldots$ | $\sqrt{16} = 4$

Irrational

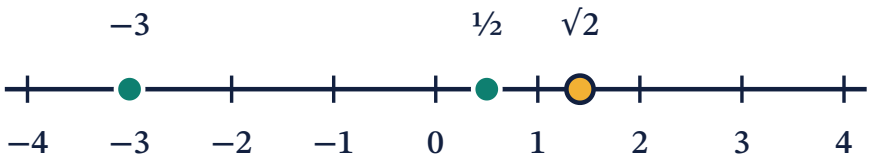
Never ends, never repeats

$\sqrt{2} = 1.41421\ldots$ | $\pi = 3.14159\ldots$ | $0.1010010001\ldots$

Watch out: $\sqrt{16}$ looks like a root, but it equals 4, so it is rational. A root is irrational only when it does not come out as a fraction.

3 · THE NUMBER LINE

Every real number has a place



- Positive numbers lie to the **right** of 0. Negative numbers lie to the **left**.
- Fractions like ½ sit between integers. The teal dots are rational.
- Irrational numbers such as $\sqrt{2} \approx 1.414$ also have exact places. Rational and irrational points together fill the whole line.

4 · PROPERTIES OF REAL NUMBERS

Rules that always hold

Commutative

$a + b = b + a$ $ab = ba$

Associative

$(a+b)+c = a+(b+c)$ $(ab)c = a(bc)$

Identity

$a + 0 = a$ $a \times 1 = a$

Inverse

$a + (-a) = 0$ $a \times 1/a = 1\ (a \neq 0)$

Distributive

$a(b + c) = ab + ac$ $5(x + 2) = 5x + 10$

Why 0 has no multiplicative inverse: a multiplicative inverse must give product 1, but 0 × anything is 0.

5 · ORDER AND INEQUALITIES

When does the sign flip?

Add the same number to both sides
sign stays: $3 < 5 \Rightarrow 5 < 7$ (added 2)

Multiply by a positive number
sign stays: $3 < 5 \Rightarrow 6 < 10$ (times 2)

Multiply by a negative number
sign flips: $2 < 3 \Rightarrow -2 > -3$

Take reciprocals of positive numbers
sign flips: $2 < 5 \Rightarrow \frac{1}{2} > \frac{1}{5}$

On a number line, $x > -4$ uses a **hollow** circle at −4 because −4 is not included. $x \geq -4$ uses a **filled** circle.

6 · RADICALS

The *n*th root

If $a^n = b$, then $a = \sqrt[n]{b} = b^{1/n}$

√ is the **radical sign** | *n* is the **index** | *b* is the **radicand**

Product rule (same index only)
$\sqrt[n]{a} \cdot \sqrt[n]{b} = \sqrt[n]{(ab)}$
$\sqrt{3} \times \sqrt{12} = \sqrt{36} = 6$

Reducing the index ($x > 0$)
$\sqrt[8]{(x^4)} = x^{4/8} = x^{1/2} = \sqrt{x}$

7 · EXPONENTS

Laws of exponents

$a^m \cdot a^n = a^{m+n}$ add powers when multiplying

$a^m \div a^n = a^{m-n}$ subtract powers when dividing

$(a^m)^n = a^{mn}$ multiply powers

$a^{-n} = 1/a^n$ negative power means reciprocal ($a \neq 0$)

Worked example
$(8/27)^{-2/3} = (27/8)^{2/3} = (\sqrt[3]{(27/8)})^2 = (3/2)^2 =$ **9/4**

8 · COMMON MISTAKES

Five traps to avoid

Cancelling a zero. $ac = bc$ gives $a = b$ only if $c \neq 0$. For example $3 \times 0 = 5 \times 0$, but $3 \neq 5$.

Reordering subtraction. $5 - 3 \neq 3 - 5$, so subtraction is not commutative.

Assuming irrational + irrational is irrational. $\sqrt{2} + (-\sqrt{2}) = 0$, which is rational.

Merging different indices. $\sqrt{2} \cdot \sqrt[3]{3}$ cannot use the product rule.

Forgetting to flip. Multiplying $2 < 3$ by -1 gives $-2 > -3$, not $-2 < -3$.

9 · QUICK CHECK

Try these, then check your answers

Simplify $5^4 \div 5^2$

Answer: $5^2 = 25$. Same base, so subtract the powers.

What is $9^{1/2}$?

Answer: 3, because $9^{1/2}$ is the square root of 9.

Is $0.1010010001\ldots$ rational?

Answer: No. It never ends and never repeats a block, so it is irrational.

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