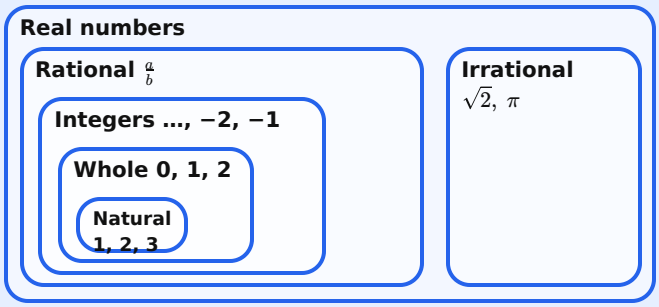
Unit 1 · Real Numbers and Exponents Cheat Sheet

Unit 1 focus: rational and irrational numbers, square and cube roots

1 KEY VOCABULARY

rational	Can be written as $\frac{a}{b}$ ($b \neq 0$); decimal ends or repeats.	$-3,\ 0.75,\ 0.\overline{6}$
irrational	Decimal never ends and never repeats.	$\sqrt{2},\ \pi$
perfect square	A whole number squared.	1, 4, 9, 16, 25, …
square root	$\sqrt{n}$: the positive number whose square is n.	$\sqrt{49} = 7$
cube root	$\sqrt[3]{n}$: the number whose cube is n.	$\sqrt[3]{-8} = -2$

2 THE REAL NUMBER SYSTEM



Every rational number is a fraction $\frac{a}{b}$ (or a decimal that ends or repeats). Irrational decimals never end or repeat.

3 FRACTIONS AND DECIMALS

Fraction → decimal: divide. A repeating decimal → fraction: let x be the decimal, multiply by 10 (or 100), subtract.

Example: Write $0.\overline{4}$ as a fraction.
Let $x = 0.444\ldots$, so $10x = 4.444\ldots$
Subtract: $9x = 4$
Answer: $x = \frac{4}{9}$

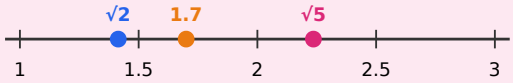
4 SQUARE AND CUBE ROOTS

Solve or estimate	Answer
$x^2 = 64$	$x = \pm 8$ (two solutions)
$x^3 = -27$	$x = -3$ (one solution)
$\sqrt{40}$ lies between	$\sqrt{36} = 6$ and $\sqrt{49} = 7$, closer to 6: ≈ 6.3
$\sqrt{\frac{9}{16}}$	$\frac{3}{4}$

5 COMPARING AND ORDERING

Estimate each irrational number with nearby perfect squares, then place it on a number line.

Example: Order $\sqrt{5},\ 1.7,\ \sqrt{2}$ from least to greatest.
Estimate: $\sqrt{2} \approx 1.41$, $\sqrt{5} \approx 2.24$
Answer: $\sqrt{2},\ 1.7,\ \sqrt{5}$



6 QUICK REMINDERS & COMMON MISTAKES

✔ Do remember

- Every integer and every terminating or repeating decimal is rational.
- $\sqrt{n}$ is irrational unless n is a perfect square.
- Rational + irrational is irrational.

✘ Common mistakes

- $x^2 = 25 \Rightarrow x = 5$ only: also $x = -5$
- Calling $\pi = 3.14$ rational: 3.14 is only an estimate
- $\sqrt{-9} = -3$: no real square root

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More practice: negative exponents, exponent rules and scientific notation

1 EXPONENT RULES

Rule	Example
$a^m \cdot a^n = a^{m+n}$	$2^3 \cdot 2^4 = 2^7$
$\frac{a^m}{a^n} = a^{m-n}$	$\frac{5^6}{5^2} = 5^4$
$(a^m)^n = a^{mn}$	$(3^2)^3 = 3^6$
$(ab)^n = a^n b^n$	$(2x)^3 = 8x^3$
$a^0 = 1$	$7^0 = 1$
$a^{-n} = \frac{1}{a^n}$	$4^{-2} = \frac{1}{16}$

2 NEGATIVE EXPONENTS

A negative exponent means "reciprocal": move the factor across the fraction bar and make the exponent positive.

Example: Simplify $\frac{x^{-3}y^2}{x^2}$.
Subtract exponents: $x^{-3-2} = x^{-5}$
Rewrite: $x^{-5}y^2 = \frac{y^2}{x^5}$

Answer: $\frac{y^2}{x^5}$

3 SCIENTIFIC NOTATION

Standard form	Scientific notation
4,500,000	4.5×10^6
0.00072	7.2×10^{-4}
602,000,000,000,000,000,000,000	6.02×10^{23}

Form $a \times 10^n$ with $1 \le a < 10$. Big numbers: positive n. Small numbers: negative n.

4 MULTIPLY AND DIVIDE

Multiply (or divide) the decimals, then use the exponent rules on the powers of 10. Fix a if it is not between 1 and 10.

Example: $(3 \times 10^5)(4 \times 10^{-2})$
Multiply: 12×10^3
Adjust: 1.2×10^4

Answer: 1.2×10^4 **(12,000)**

5 ADD AND SUBTRACT

Rewrite so both numbers have the same power of 10, then add or subtract the decimals.

Example: $(5.1 \times 10^4) + (3 \times 10^3)$
Match powers: $5.1 \times 10^4 + 0.3 \times 10^4$
Add: 5.4×10^4

Answer: 5.4×10^4

6 CHECK YOURSELF

- Is a at least 1 and less than 10?
- Did I add exponents when multiplying and subtract when dividing?
- Did I rewrite negative exponents as positive in my final answer?
- Does the size make sense? 10^{-4} is a small number; 10^6 is a million.