Mental Math Techniques

Fast Arithmetic for Trading Interviews

Contents

1 Core Philosophy

Key principle: Use standard decompositions and patterns, not "normal" arithmetic.

- **Reduce cognitive load** — apply patterns automatically
- **Avoid carrying/borrowing** — use complements and decompositions
- **Round then adjust** — work with easy numbers first
- **Pair to nice numbers** — look for sums to 10, 100, 1000
- **Practice until automatic** — these must be reflexive under pressure

2 Multiplication Techniques

1. Two-digit × two-digit: Decompose intelligently

General formula: $(a+b)(c+d) = ac + ad + bc + bd$

But choose b and d to be easy (typically multiples of 10).

Example: 47×63

Rewrite as $47 \times (70 - 7)$:

$$\begin{aligned} 47 \times 70 &= 3290 \\ 47 \times 7 &= 329 \\ 47 \times 63 &= 3290 - 329 = \boxed{2961} \end{aligned}$$

Example: 38×24

Rewrite as $(40 - 2) \times 24$:

$$\begin{aligned} 40 \times 24 &= 960 \\ 2 \times 24 &= 48 \\ 38 \times 24 &= 960 - 48 = \boxed{912} \end{aligned}$$

Example: 56×17

Rewrite as $56 \times (20 - 3)$:

$$\begin{aligned} 56 \times 20 &= 1120 \\ 56 \times 3 &= 168 \\ 56 \times 17 &= 1120 - 168 = \boxed{952} \end{aligned}$$

2. Numbers near 100

Formula: $(100 - x)(100 - y) = 10000 - 100(x + y) + xy$

This is extremely fast because you only work with small numbers x and y.

Example: 97×94

Here $x = 3$, $y = 6$:

$$\begin{aligned} 10000 - 100(3+6) + 3 \times 6 &= 10000 - 900 + 18 \\ &= \boxed{9118} \end{aligned}$$

Example: 98×96

Here $x = 2$, $y = 4$:

$$\begin{aligned} 10000 - 100(2+4) + 2 \times 4 &= 10000 - 600 + 8 \\ &= \boxed{9408} \end{aligned}$$

Example: 93×91

Here $x = 7$, $y = 9$:

$$\begin{aligned} 10000 - 100(7+9) + 7 \times 9 &= 10000 - 1600 + 63 \\ &= \boxed{8463} \end{aligned}$$

3. Numbers near 50

Formula: $(50 + x)(50 + y) = 2500 + 50(x + y) + xy$

Example: 53×47

Here $x = 3$, $y = -3$:

$$\begin{aligned} 2500 + 50(3-3) + 3 \times (-3) &= 2500 + 0 - 9 \\ &= \boxed{2491} \end{aligned}$$

Example: 56×54

Here $x = 6$, $y = 4$:

$$\begin{aligned} 2500 + 50(6+4) + 6 \times 4 &= 2500 + 500 + 24 \\ &= \boxed{3024} \end{aligned}$$

Example: 48×52

Here $x = -2$, $y = 2$:

$$\begin{aligned} 2500 + 50(-2+2) + (-2) \times 2 &= 2500 + 0 - 4 \\ &= \boxed{2496} \end{aligned}$$

4. Squaring numbers ending in 5

Formula: $(10a + 5)^2 = 100a(a + 1) + 25$

This is blazing fast.

Example: 35^2

Here $a = 3$:

$$100 \times 3 \times 4 + 25 = 1200 + 25 = \boxed{1225}$$

Example: 65^2

Here $a = 6$:

$$100 \times 6 \times 7 + 25 = 4200 + 25 = \boxed{4225}$$

Example: 85^2

Here $a = 8$:

$$100 \times 8 \times 9 + 25 = 7200 + 25 = \boxed{7225}$$

Example: 125^2

Here $a = 12$:

$$100 \times 12 \times 13 + 25 = 15600 + 25 = \boxed{15625}$$

5. Multiply by 11

Pattern: $\overline{ab} \times 11 = \overline{a(a + b)b}$ (carry if $a + b \geq 10$)

Example: 53×11

Middle digit: $5 + 3 = 8$

$$53 \times 11 = \boxed{583}$$

Example: 67×11

Middle digit: $6 + 7 = 13$ (carry 1)

$$67 \times 11 = (6 + 1)\,3\,7 = \boxed{737}$$

Example: 84×11

Middle digit: $8 + 4 = 12$ (carry 1)

$$84 \times 11 = (8 + 1)\,2\,4 = \boxed{924}$$

Three-digit: $\overline{abc} \times 11 = \overline{a(a + b)(b + c)c}$

Example: 234×11

$$234 \times 11 = 2\,(2 + 3)\,(3 + 4)\,4 = 2574$$

But $3+4=7$, so: $\boxed{2574}$

Example: 578×11

Digits: 5, $(5+7)=12$ (carry), $(7+8)=15$ (carry), 8

$$578 \times 11 = 5\,(12)\,(15)\,8 \to 5\,(13)\,5\,8 \to 6\,3\,5\,8 = \boxed{6358}$$

6. Multiply by 5, 25, 125

Multiply by 5: $\times 10 \div 2$

Example: $87 \times 5 = 870 \div 2 = \boxed{435}$

Example: $124 \times 5 = 1240 \div 2 = \boxed{620}$

Multiply by 25: $\times 100 \div 4$

Example: $36 \times 25 = 3600 \div 4 = \boxed{900}$

Example: $84 \times 25 = 8400 \div 4 = \boxed{2100}$

Multiply by 125: $\times 1000 \div 8$

Example: $16 \times 125 = 16000 \div 8 = \boxed{2000}$

Example: $72 \times 125 = 72000 \div 8 = \boxed{9000}$

7. Divide by 5, 25

Divide by 5: $\times 2 \div 10$

This is huge! Dividing by 5 is hard; multiplying by 2 is trivial.

Example: $347 \div 5 = 694 \div 10 = \boxed{69.4}$

Example: $825 \div 5 = 1650 \div 10 = \boxed{165}$

Divide by 25: $\times 4 \div 100$

Example: $675 \div 25 = 2700 \div 100 = \boxed{27}$

Example: $1250 \div 25 = 5000 \div 100 = \boxed{50}$

8. Approximation + correction

Strategy: Compute via an easy nearby number, then adjust.

This is safer than direct multiplication under pressure.

Example: 79×46

Use 80×46:

$$\begin{aligned} & 80 \times 46 = 3680 \\ \text{subtract } 46: \quad & 79 \times 46 = 3680 - 46 = \boxed{3634} \end{aligned}$$

Example: 68×29

Use 68×30:

$$\begin{aligned} & 68 \times 30 = 2040 \\ \text{subtract } 68: \quad & 68 \times 29 = 2040 - 68 = \boxed{1972} \end{aligned}$$

Example: 103×52

Use 100×52:

$$\begin{aligned} & 100 \times 52 = 5200 \\ \text{add } 3 \times 52: \quad & 103 \times 52 = 5200 + 156 = \boxed{5356} \end{aligned}$$

3 Subtraction: Difference Method

Never borrow! Instead, count up from the smaller number to the larger.

Example: $10000 - 5873$

Ask: $5873 + ? = 10000$

Count up:

$$\begin{aligned} & 5873 \to 6000 \quad (+127) \\ & 6000 \to 10000 \quad (+4000) \\ \text{Total:} \quad & \boxed{4127} \end{aligned}$$

Example: $8000 - 3456$

Count up:

$$\begin{aligned} & 3456 \to 3500 \quad (+44) \\ & 3500 \to 8000 \quad (+4500) \\ \text{Total:} \quad & \boxed{4544} \end{aligned}$$

Example: $5000 - 2738$

Count up:

$$\begin{aligned} & 2738 \to 2800 \quad (+62) \\ & 2800 \to 5000 \quad (+2200) \\ \text{Total:} \quad & \boxed{2262} \end{aligned}$$

Example: $1000 - 647$

Count up:

$$\begin{aligned} 647 \to 650 \quad (+3) \\ 650 \to 1000 \quad (+350) \\ \text{Total:} \quad \boxed{353} \end{aligned}$$

This is **faster and more accurate** under pressure than borrowing.

4 Addition: Chunking Strategy

Always scan for complements to 10, 100, 1000 before adding left-to-right.

Example: $487 + 596 + 213 + 404$

Pair to 1000s:

$$\begin{aligned} (487 + \underline{513}) &= 1000 \quad \text{but we have 596, so:} \\ 487 + 596 &= 1083 \\ 213 + 404 &= 617 \\ \text{Total:} \quad 1083 + 617 &= \boxed{1700} \end{aligned}$$

Better approach:

$$\begin{aligned} (596 + 404) &= 1000 \\ (487 + 213) &= 700 \\ \text{Total:} \quad &= \boxed{1700} \end{aligned}$$

Example: $38 + 67 + 62 + 33$

Pair to 100:

$$\begin{aligned} (38 + 62) &= 100 \\ (67 + 33) &= 100 \\ \text{Total:} \quad &= \boxed{200} \end{aligned}$$

Example: $145 + 387 + 255 + 613$

Pair smartly:

$$\begin{aligned} (145 + 255) &= 400 \\ (387 + 613) &= 1000 \\ \text{Total:} \quad &= \boxed{1400} \end{aligned}$$

Example: $19 + 47 + 81 + 53$

Pair to even 100s:

$$\begin{aligned}(19+81) &= 100\\ (47+53) &= 100\\ \text{Total:} \quad &= \boxed{200}\end{aligned}$$

5 Division Shortcuts

1. Dividing by 9

Pattern: $n \div 9 \approx n \times 0.111\ldots$

Better: use the fact that $9 \times 11 = 99 \approx 100$

Example: $456 \div 9$

Think: $456 \div 9 = 456 \times \frac{11}{99} = \frac{5016}{99} \approx \frac{5000}{100} = 50$

Exact: $456 = 9 \times 50 + 6$, so $456 \div 9 = 50.666\ldots = \boxed{50\frac{2}{3}}$

2. Dividing by 15

Strategy: $\div 15 = \div 3 \div 5 = \div 3 \times 2 \div 10$

Example: $450 \div 15$

$$\begin{aligned}450 \div 3 &= 150\\ 150 \div 5 &= 150 \times 2 \div 10 = 30\\ \text{Answer:} \quad &\boxed{30}\end{aligned}$$

3. Dividing by 12

Strategy: $\div 12 = \div 4 \div 3$ or $\div 3 \div 4$

Example: $288 \div 12$

$$\begin{aligned}288 \div 4 &= 72\\ 72 \div 3 &= 24\\ \text{Answer:} \quad &\boxed{24}\end{aligned}$$

6 Percentages

Quick percentage calculations

Key insight: $a\%$ of $b = b\%$ of a

Example: 16% of 25

Instead compute 25% of $16 = 4$

So 16% of $25 = \boxed{4}$

Example: 8% of 75

Instead compute 75% of $8 = 6$

So 8% of $75 = \boxed{6}$

Example: 12% of 50

$12\% = \frac{12}{100}$, so 12% of $50 = \frac{12 \times 50}{100} = \frac{600}{100} = \boxed{6}$

Or: 50% of $12 = 6$

Common percentages to memorize

Percentage	Fraction/Decimal
10%	0.1
12.5%	$\frac{1}{8} = 0.125$
16.666 . . . %	$\frac{1}{6} \approx 0.167$
20%	$\frac{1}{5} = 0.2$
25%	$\frac{1}{4} = 0.25$
33.333 . . . %	$\frac{1}{3} \approx 0.333$
37.5%	$\frac{3}{8} = 0.375$
40%	$\frac{2}{5} = 0.4$
50%	$\frac{1}{2} = 0.5$
62.5%	$\frac{5}{8} = 0.625$
66.666 . . . %	$\frac{2}{3} \approx 0.667$
75%	$\frac{3}{4} = 0.75$
80%	$\frac{4}{5} = 0.8$
87.5%	$\frac{7}{8} = 0.875$

7 Fraction Arithmetic

Adding fractions with different denominators

Strategy: Cross-multiply for numerator, multiply denominators

$$\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$$

Example: $\frac{2}{3} + \frac{3}{5}$

$$\frac{2 \times 5 + 3 \times 3}{3 \times 5} = \frac{10 + 9}{15} = \frac{19}{15} = 1\frac{4}{15}$$

Multiplying fractions

Cancel before multiplying!

Example: $\frac{15}{28} \times \frac{14}{25}$

Cancel: $\frac{15}{25} = \frac{3}{5}$ and $\frac{14}{28} = \frac{1}{2}$

$$\frac{15}{28} \times \frac{14}{25} = \frac{3}{5} \times \frac{1}{2} = \frac{3}{10}$$

Dividing fractions

Multiply by reciprocal: $\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$

Example: $\frac{5}{8} \div \frac{3}{4}$

$$\frac{5}{8} \times \frac{4}{3} = \frac{5 \times 4}{8 \times 3} = \frac{20}{24} = \frac{5}{6}$$

8 Powers and Roots

Powers of 2 (memorize these!)

Power	Value
2^5	32
2^6	64
2^7	128
2^8	256
2^9	512
2^{10}	1024
2^{11}	2048
2^{12}	4096
2^{15}	32768
2^{16}	65536
2^{20}	$1048576 \approx 10^6$

Square roots via Newton's method (one iteration)

Formula: $\sqrt{n} \approx \frac{1}{2}\left(x + \frac{n}{x}\right)$ where x is initial guess

Example: $\sqrt{50}$

Guess $x = 7$ (since $7^2 = 49$):

$$\sqrt{50} \approx \frac{1}{2}\left(7 + \frac{50}{7}\right) = \frac{1}{2}(7 + 7.14) = \boxed{7.07}$$

True value: $7.071\ldots$

Example: $\sqrt{80}$

Guess $x = 9$ (since $9^2 = 81$):

$$\sqrt{80} \approx \frac{1}{2}\left(9 + \frac{80}{9}\right) = \frac{1}{2}(9 + 8.89) = \boxed{8.94}$$

True value: $8.944\ldots$

9 Practice Drills

Multiplication drills (do these daily)

1. 47×23
2. 96×98

3. 53×47
4. 125^2
5. 67×11
6. 84×25
7. 78×19
8. 94×96

Subtraction drills

1. $10000 - 6842$
2. $5000 - 2963$
3. $8000 - 4157$
4. $7500 - 3278$

Addition drills (look for pairs)

1. $237 + 763 + 491 + 509$
2. $88 + 67 + 12 + 33$
3. $456 + 789 + 544 + 211$

Division drills

1. $735 \div 5$
2. $1250 \div 25$
3. $456 \div 12$
4. $675 \div 15$

10 Interview Strategy

During mental math sections

- **Talk through your method** — let them see your process
- **Use patterns, not brute force** — show you have systematic techniques
- **Round and adjust** — demonstrate strategic thinking
- **Write intermediate steps** — reduces errors, shows clarity
- **Check reasonableness** — does $97 \times 94 \approx 9000$? Yes.
- **Practice under time pressure** — set 30-second timers

What interviewers are evaluating

1. **Speed** — Can you compute quickly?
2. **Accuracy** — Do you make careless errors?
3. **Method** — Do you use smart techniques or struggle?
4. **Composure** — Do you panic or stay calm under pressure?

*These techniques are **learnable skills**, not innate talent.*
Practice 15 minutes daily for 2 weeks and they become automatic.