The Fitness & Running Math Workout

Printable Toolkit — Seven Cheat Sheets and Seven Planning Sheets

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Math Didn’t Have to Be This Hard: The Workout Series · Book 10

How to Use This Toolkit

This is the printable companion to *The Fitness & Running Math Workout*. It has two parts:

- **Seven cheat sheets**, one for each chapter. Every rule is the one the chapter teaches, with one worked example from Nia's training (or her friends') in the book.
- **Seven planning sheets** to fill in with your own numbers: a pace chart, a weekly log, a 12-week plan sheet, a splits and pace-band sheet, a race-day sheet, a progress chart and a cross-training and gear sheet.

Print as many copies as you like, and do the sums at the table, not halfway through a run.

The numbers in the examples are invented for practice, just as they are in the book, and no watch, app, shoe maker, gym or real race is named. Plans, percent steps, cutback weeks, step lengths and shoe lifetimes are *in this example*: they show the math, not what anyone should run. This toolkit is numbers only. How much and how hard to train is a decision for you and, if you have a health condition or are new to exercise, your doctor or a qualified coach. It is for learning; it is not coaching or medical advice.

The whole set for this book, including seven free calculators:
`mathworkbook.netlify.app/go/book-fitness-running`

1. Pace & Speed

Minutes per mile and miles per hour.

- **60 seconds = 1 minute, 60 minutes = 1 hour.** Seconds = h × 3,600 + m × 60 + s. Decimal minutes = seconds ÷ 60, so 1:30 = 90 s = 1.5 min, and 0.3 min = 18 s.
- **Pace** = time ÷ distance. **Time** = pace × distance. **Distance** = time ÷ pace.
- **Speed (mph)** = miles ÷ hours. **Pace** (minutes per mile) = 60 ÷ mph; **mph** = 60 ÷ pace in minutes.
- **Moving time** = elapsed time − stopped time. A watch that pauses at crossings shows the moving pace.
- **Round at the end:** keep every decimal until the last step, then round to the nearest second. One second off from rounding is fine.

> **Worked example (Chapter 1).** Nia's easy run: 3 miles in 33:00, so 33 ÷ 3 = **11:00 per mile**, and 3 ÷ 0.55 hours = **5.45 mph**. On a treadmill at 5.5 mph: 60 ÷ 5.5 = 10.909 minutes = **10:55 per mile**. Her 5-mile long run took 58:40 on the watch with 2:10 stopped at crossings: moving 56:30 ÷ 5 = **11:18 per mile**; elapsed 58:40 ÷ 5 = **11:44 per mile**.

Your turn. Distance _____ Time _____ Pace _____
Speed (mph) _____ Treadmill setting _____

2. Miles, Kilometers & Laps

Race distances and conversions.

- **1 mile = 1,609.344 m exactly** (5,280 ft × 0.3048 m). 1 mile = 1,760 yd; 1 yd = 0.9144 m.
- **km** = miles × 1.609344. **Miles** = km ÷ 1.609344. **km/h** = mph × 1.609344.
- **Pace per km** = pace per mile ÷ 1.609344. **Pace per mile** = pace per km × 1.609344.
- **Race distances:** 5K = 3.11 mi · 10K = 6.21 mi · half marathon (21.0975 km) = 13.11 mi · marathon (42.195 km) = 26.22 mi.
- **Track:** laps = meters ÷ 400. 1,600 m = 4 laps, 9.344 m short of a mile; a mile = 4.02 laps.
- **Steps per mile** = 5,280 ÷ step length in feet. **Steps a minute** = steps per mile ÷ pace in minutes.

> **Worked example (Chapter 2).** Nia ran her first timed 5K in 30:00: 30 ÷ 5 = **6:00 per km**, and 6.00 × 1.609344 = 9.656 minutes = **9:39 per mile**. Her half marathon is 21.0975 ÷ 1.609344 = **13.11 miles**. With a step of about 3.3 ft (in this example): 5,280 ÷ 3.3 = **1,600 steps per mile**, and at 11:00 a mile, 1,600 ÷ 11 = **145.5 steps a minute**.

Your turn. Km _____ Miles _____ Pace per km _____
Pace per mile _____ Steps per mile _____

3. Splits

Planning every mile.

- **Even pace** for a goal = goal time ÷ distance.
- **Clock time at each marker** = pace × distance, rounded to the second. **Each split** = this clock time − the one before. Done this way, the splits always add up to the finish time.
- **The last piece** of a race is short: 0.11 mi at the end of a 5K, 0.11 mi at the end of a half.
- **Negative split:** the second half is faster than the first. **Split difference %** = (first − second) ÷ first × 100.
- A fast start "banks" seconds that usually come back later as a slower finish.
- Courses are measured on the **shortest possible route, plus 0.1%**, so a watch often reads long. The official time and distance are the course's.

> **Worked example (Chapter 3).** Nia's 30:00 5K at an even pace: clock times **9:39, 19:19, 28:58** at miles 1, 2 and 3, finish **30:00**, so the splits are **9:39, 9:40, 9:39** and **1:02** for the last 0.11 mile. Her half plan: halfway is 6.55 miles; first half **1:07:45** (10:20 per mile), second half **1:07:15** (10:16 per mile), a gentle negative split of 30 seconds.

Your turn. Goal time _____ Distance _____ Pace _____
Clock time at mile 1, 2, 3 _____ _____ _____

4. Race Predictions

From one race to the next.

- **Distance ratio** = longer distance ÷ shorter distance (same unit). 10K ÷ 5K = 2; half ÷ 5K = 21.0975 ÷ 5 = 4.2195.
- **Riegel's estimate:** $T2 = T1 \times (D2 \div D1)^{1.06}$. On a phone, use the x^y key (turn the calculator sideways).
- **Going the other way:** $T1 = T2 \div (D2 \div D1)^{1.06}$, the shorter-race time that matches a goal.
- Doubling the distance a little more than doubles the time, because the pace slows.
- It's a well-known estimate, described for efforts of about 3.5 to 230 minutes, and it assumes you've trained for the longer race. Course and weather matter too. Use it as a guide, then choose.
- **Goal vs estimate, in %** = (goal − estimate) ÷ estimate × 100.

> **Worked example (Chapter 4).** From Nia's 28:30 5K: $28.5 \times 4.2195^{1.06} = 131.106$ minutes = **2:11:06** for the half, **10:00 per mile**; the same formula gives **59:25** for a 10K. For her first half, on a hilly course, she picks **2:15:00**: 135 ÷ 131.106 = 1.0297, about **3.0% slower** than the estimate. Goal pace: **10:18 per mile**, **6:24 per km**.

Your turn. Recent time _____ Distance _____ Ratio _____
Estimate _____ My goal _____

5. Training Weeks

Totals, percent steps and cutbacks.

- **Weekly total** = add the week's runs, in miles and in minutes.
- **Percent change** = (new − old) ÷ old × 100.
- **Building by a percent** for k weeks: start × $(1 + p)^k$, which grows on itself. Adding a fixed amount grows in a straight line.
- **Cutback week** = the week before × 0.8; **taper** = peak × 0.7 (both in this example). Compare a new week with the **last full build week**, not with the cutback.
- **Run/walk:** share running = run ÷ (run + walk). Minutes running = share × total.
- **Session load** = effort (0–10) × minutes. **Weekly load** = the sum of the sessions.

> **Worked example (Chapter 5).** Nia's plan (in this example): 12, 13, 14.5, 11.5, 16, 17.5, 19.5, 15.5, 21.5, 23.5, 16.5, 19.1 miles, **200.1 miles** in all. Week 1 to week 2: (13 − 12) ÷ 12 = **+8.3%**. Week 5 is +39.1% on the cutback week but **+10.3%** on week 3, her last full week. Week 1's load: 3 × 33 + 3 × 44 + 4 × 57.5 = 99 + 132 + 230 = **461**.

Your turn. Last week _____ This week _____ Change (%) _____
Minutes _____ Weekly load _____

6. Progress

Logs, averages and charts.

- **Average pace over several runs** = total time ÷ total distance, never the average of the paces.
- **Improvement %** = (old − new) ÷ old × 100. **Rate** = change ÷ weeks.
- **Gains usually get smaller.** Don't stretch a straight line far into the future.
- **Median** = the middle value of a sorted list (the average of the middle two for an even count). One very slow or very fast time moves the mean, not the median.
- **A progress chart** puts time up the side, so faster is lower.
- **Consistency** = runs done ÷ runs planned × 100.

> **Worked example (Chapter 6).** Nia's week 1: 134.5 minutes ÷ 12 miles = 11.208 minutes = **11:13 per mile** (the average of her three paces, 11:10, is not her average pace). Her 5K time trials in weeks 0, 3, 6 and 9: 30:00, 29:25, 28:55, 28:30. The gains are **35, 30 and 25 seconds**, smaller each time. In all, 90 ÷ 1,800 = **5.0% faster**, and 28:30 is **9:10 per mile**, **5:42 per km**.

Your turn. Old time _____ New time _____ Change (s) _____
Improvement (%) _____ Weeks between _____

7. Beyond the Run

Walking, cycling, swimming, strength and gear.

- **U.S. guidelines for adults:** 150–300 minutes a week of moderate activity, or 75–150 of vigorous, or a mix. 1 vigorous minute counts as 2 moderate. **Moderate-equivalent** = moderate + 2 × vigorous. Muscle-strengthening on 2 or more days.
- **Cycling:** time = distance ÷ speed. Inches per pedal turn = (front teeth ÷ rear teeth) × wheel circumference in inches; mph = inches per turn × cadence × 60 ÷ 63,360.
- **Swimming:** lengths = distance ÷ pool length (25 yd, 25 m or 50 m). Pace per 100 = time ÷ (distance ÷ 100).
- **Strength:** volume = sets × reps × load. Plates per side = (target − bar) ÷ 2, largest plates first.
- **Cost per use** = price ÷ uses. **Cost per mile** = price ÷ miles. **Break-even visits** = monthly price ÷ price per visit.

> **Worked example (Chapter 7).** Nia's week-1 running is 134.5 vigorous minutes, so 134.5 × 2 = **269 moderate-equivalent minutes**. Her Sunday ride: 10 miles at 12 mph = **50 minutes**. Her shoes cost $120 and she plans to retire them at 400 miles (in this example): $120 ÷ 400 = **$0.30 a mile**. They had 220 miles at the start of the plan, so they reach 400 in **week 11**. Bea's 135 lb lift is a 45 lb bar + **45 lb a side**; 3 sets × 8 reps × 135 = **3,240 lb** of volume.

Your turn. Moderate minutes _____ Vigorous minutes _____
Moderate-equivalent _____ Shoe price _____ Cost a mile _____

Planning Sheet 1: Pace Chart

Write a pace in the first column, then fill across. Time = pace × miles, rounded to the second at the end.

Per mile	Per km	mph	1 mile	5K (3.11 mi)	10K (6.21 mi)	Half (13.11 mi)	Marathon (26.22 mi)

Pace per km = pace per mile ÷ 1.609344. mph = 60 ÷ pace in minutes.

My easy pace _____ · my 5K pace _____ · my goal pace _____

Planning Sheet 2: Weekly Log

One row per session. The week's average pace is total time ÷ total miles.

Day	What I did	Miles	Time	Pace	Effort (0–10)	Load	Notes
Mon							
Tue							
Wed							
Thu							
Fri							
Sat							
Sun							
Week							

Week totals	This week	Last week
Total miles		
Total minutes		
Average pace (total time ÷ total miles)		
Weekly load (effort × minutes, added up)		
Long run, and its share of the week		
Change in miles from last week (%)		

Planning Sheet 3: 12-Week Plan

Plan first, then log the actual miles. Compare each build week with the last full build week.

Week	Planned miles	Build, cutback or taper	% vs last build week	Long run	Actual miles	Total so far
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
Total						

Start _____ miles · build step _____% (start × $(1 + \text{step})^{k}$) · cutback _____% of the week before · taper _____% of the peak

Planning Sheet 4: Splits & Pace Band

Goal time _____ ÷ distance _____ = goal pace _____ per mile (_____ per km)

Marker (mi)	Planned clock time	Planned split	Actual clock time	Actual split	Ahead (–) / behind (+)
Finish					

Clock time = goal pace × miles, rounded to the second. Split = this clock time – the one before.

Halfway _____ mi · first half _____ · second half _____ · split difference _____% ((first – second) ÷ first × 100)

Planning Sheet 5: Race-Day Sheet

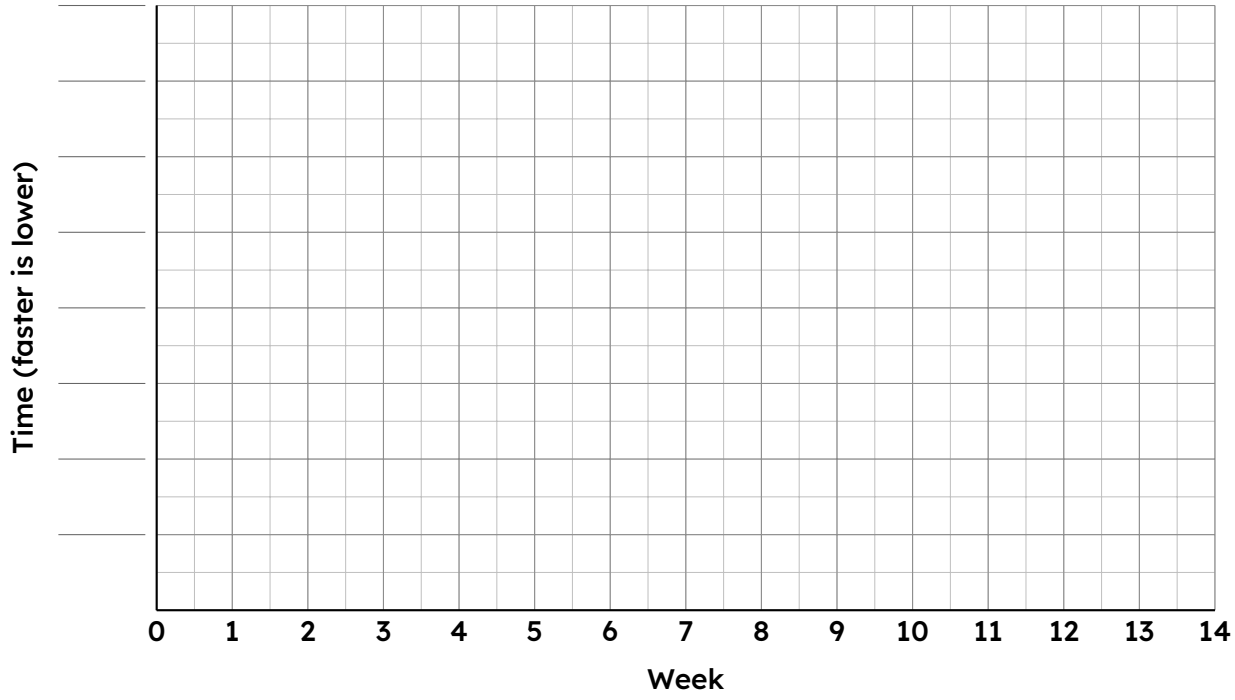
Top half the week before; bottom half after the finish line.

Before the race	**Mine**
Race and date	
Distance in miles and in km	
Recent race or time trial (time, distance)	
Estimate: $T1 \times (D2 \div D1)^{1.06}$	
Goal time (my choice), and % vs the estimate	
Goal pace per mile and per km	
Plan: first half and second half	
Start time on the clock	
Goal finish on the clock (start + goal time)	
Entry fee, and cost per mile (fee ÷ miles)	

After the race	**Mine**
Official finish time	
Actual first half and second half	
Split difference (%)	
Ahead of or behind my goal (seconds)	
Faster or slower than the estimate (%)	
What I'd keep, and what I'd change	

Planning Sheet 6: Progress Chart

Plot each time trial over the same distance. Write your own times up the side, slowest at the top, so **faster is lower**.



Week	Date	Distance	Time	Pace	Change (s)	Change (%)

Improvement % = (old − new) ÷ old × 100. Rate a week = change ÷ weeks between trials.

Planning Sheet 7: Cross-Training & Gear

Count the whole week, then what your gear costs per use. Fill it in for every training block: the numbers show the trade, and you decide.

Day	Activity	Minutes	Moderate or vigorous	Moderate-equivalent (vigorous × 2)	Strength day?
Mon					
Tue					
Wed					
Thu					
Fri					
Sat					
Sun					
Week					

Gear or membership	Price	Miles or uses I expect	Cost per mile or use	Used so far
Running shoes				
Gym: monthly price ÷ price per visit = break-even visits				

Shoe miles: at the start _____ + plan so far _____ = _____ of the _____ I chose.