How Bob On Ballistics Works

The physics behind the numbers, explained in plain English

This app predicts where a bullet actually goes — not just straight-line guessing, but a real simulation of the forces acting on it from the moment it leaves the barrel to the moment it reaches your target. This document walks through every effect the app accounts for, one at a time, without assuming any background in physics or mathematics. If you've ever wondered what “ballistic coefficient” or “Coriolis effect” actually means in practice, this is for you.

1. The Basic Idea: Gravity and Air Resistance

The key idea: two forces are constantly acting on a bullet in flight, and this app tracks both of them continuously.

The instant a bullet leaves the barrel, two things start happening to it at once. Gravity pulls it downward, exactly the way it pulls everything else downward. And the air around it pushes back against its motion, gradually slowing it down. Neither of these is constant — as the bullet slows down, the air resistance acting on it changes too, and as it travels further, gravity has had more time to pull it lower.

Rather than trying to solve this with one single equation, the app breaks the bullet's flight into thousands of tiny slices of time — a fraction of a millisecond each — and works out the bullet's speed and position at the end of each slice, based on where it was and how fast it was going at the start of that slice. String enough of these tiny slices together and you get an accurate picture of the entire flight, from muzzle to target.

> **IN EVERYDAY TERMS**
>
> *Think of watching a video frame by frame rather than trying to predict the whole scene in one go. Each frame only needs to account for what happens in that split second — a little bit of gravity, a little bit of slowing down — and by the time you've gone through thousands of frames, you've got the full, accurate story of the flight.*

2. Ballistic Coefficient: How “Slippery” Is the Bullet?

The key idea: the ballistic coefficient is a single number describing how well a bullet cuts through air — higher means it slows down less and flies flatter.

Two bullets can weigh exactly the same and leave the barrel at exactly the same speed, and still behave very differently in flight, purely because of their shape. A longer, more pointed, more streamlined bullet slips through the air more easily than a short, blunt one. The ballistic coefficient (usually shortened to “BC”) is a single number that captures this: the higher it is, the better the bullet resists air drag, the more velocity it retains downrange, and the flatter and less wind-affected its path becomes.

The app uses two different reference standards for measuring this, called G1 and G7. G1 is based on an older, flatter-based bullet shape and has been the industry standard for over a century. G7 is based on the long, sleek, “boat-tailed” shape common in modern long-range bullets. A modern bullet's drag pattern actually matches the G7 shape more closely, so using the right one for a given bullet gives a noticeably more accurate prediction, especially at longer range.

> **IN EVERYDAY TERMS**
>
> *Picture pushing your hand through water, palm first, versus knife-edge first. Same hand, same effort, completely different resistance — that's shape doing the work, not strength. Ballistic coefficient is that same idea applied to a bullet moving through air.*

3. Zero and Sight Height: Why Your Scope Isn't Your Barrel

The key idea: the scope sits above the barrel, so the bullet's path and your line of sight cross twice, not once.

A rifle scope sits an inch or two above the centre of the barrel. Because of this small offset, the barrel is actually angled very slightly upward relative to where the scope is pointing. This means that early in its flight, the bullet is rising up through your line of sight, reaches its highest point relative to that line, and then comes back down and crosses it again further out — that second crossing point is what's known as your “zero” range.

This is why a bullet's path relative to your aim point isn't a simple, ever-increasing drop. Close to the muzzle it can actually be slightly above your point of aim, and only starts reading as “below” once it's well past the zero distance. The app accounts for this geometry using your sight height and chosen zero range, so the numbers in the results table reflect what your scope will actually show, not just the bullet's raw physical drop from the bore line.

> **IN EVERYDAY TERMS**
>
> *Imagine a garden hose held slightly above eye level, angled just a touch upward. The water arcs up above your eyeline briefly before curving back down through it and onward — exactly the shape a bullet's path traces against your scope's crosshair.*

4. Wind Drift: Why Wind Pushes Your Bullet Sideways

The key idea: crosswind pushes on the bullet for its entire time in the air, so more time in flight means more sideways push — which is why wind matters so much more at long range.

A sideways wind doesn't shove a bullet off course all at once — it pushes on it gently and continuously for as long as the bullet is in the air. A bullet that only takes a third of a second to reach its target barely has time to be pushed anywhere. The same bullet at a distance where it takes a full two seconds to arrive has six times as long for that same wind to nudge it sideways, which is exactly why wind drift grows so much faster than distance alone would suggest.

The app takes a wind speed and a compass-style direction — which way the wind is blowing from. A wind coming from directly ahead or directly behind contributes nothing sideways at all, since it's pushing along the bullet's path rather than across it. A wind from directly left or right gives the full sideways push. Anything in between gives a proportional share of that push, which is a bit of simple geometry the app works out automatically from the direction you enter.

> **IN EVERYDAY TERMS**
>
> *Picture walking across a windy car park with a large, light umbrella. A gust from behind you does nothing to push you sideways. The same gust hitting the umbrella from the side shoves you noticeably off your line — and the longer you're out there walking, the further off course you end up drifting.*

5. Spin Drift: The Gyroscope Effect

The key idea: a spinning bullet very slightly resists tipping downward the way a spinning top resists falling over, and that resistance shows up as a small sideways drift.

Rifling inside the barrel makes a bullet spin extremely fast — often over 200,000 revolutions per minute. That spin is what keeps the bullet flying straight and point-forward rather than tumbling. But it has a side effect: as the bullet's path gradually curves downward under gravity, the spinning bullet behaves a little like a gyroscope being tipped, and gyroscopes don't simply tip the way you push them — they respond slightly sideways to that push instead. Over a long flight, this adds up to a real, measurable drift, always in the same direction the barrel's rifling twists.

This effect is genuinely tiny at short range — often less than the width of a coin at 200 yards — but grows steadily with distance and time of flight, becoming a real factor worth correcting for by around 600 yards and beyond. The app calculates it from your bullet's weight and dimensions and your barrel's twist rate, using a well-established formula (originally developed by Don Miller) that's been checked and used across the shooting industry for decades.

> **IN EVERYDAY TERMS**
>
> *Try tipping a fast-spinning bicycle wheel held by its axle. Rather than simply falling in the direction you pushed, it swings sideways in a way that feels almost like it's resisting you — that odd sideways swing is the same underlying physics as spin drift.*

6. The Coriolis Effect: When the Earth Itself Gets Involved

The key idea: the Earth keeps spinning underneath a bullet during its flight, and over several seconds that shows up as a small apparent sideways and vertical shift.

This is the strangest-sounding effect in the app, but the underlying idea is fairly simple. The Earth is constantly rotating. A bullet in flight isn't attached to the ground — for the second or two (sometimes longer) that it's in the air, the ground beneath it, and the target it's aimed at, have both moved very slightly due to that rotation. From the shooter's point of view, standing on that same moving ground, this shows up as the bullet appearing to drift slightly off course, even though nothing actually pushed it.

Because this depends on the bullet spending real time in the air, it's completely negligible for anything under roughly 800 yards, and only becomes worth correcting for at genuinely long range. It also depends on which compass direction you're firing and how far north or south of the equator you are, which is why the app asks for your latitude and the direction you're pointing before applying this correction — and why it's the one effect that uses your phone's own GPS and compass, since typing those in accurately by hand would be impractical.

> **IN EVERYDAY TERMS**
>
> *Imagine throwing a ball across a spinning merry-go-round to someone standing on the far side. By the time the ball arrives, they've rotated slightly away from where they were when you threw it — the ball didn't curve, but it looks like it did from your point of view. A very long rifle shot experiences a much smaller version of exactly that.*

7. Weather and Altitude: Why the Same Shot Behaves Differently on Different Days

The key idea: hot, high-altitude, low-pressure air is thinner and lets a bullet fly flatter; cold, low-altitude, high-pressure air is denser and slows it down more.

Air isn't always the same thickness. Heat makes air molecules spread further apart, so hot air is thinner than cold air. Altitude has a similar effect — there's simply less atmosphere pressing down at higher elevation, so mountain air is thinner than sea-level air. Barometric pressure captures day-to-day changes in that same thickness, even at a fixed location and temperature. Since all of these change how much the air resists the bullet, they all change how much the bullet slows down and drops over a given distance.

Humidity has a smaller, slightly counter-intuitive effect: humid air is actually very slightly thinner than dry air at the same temperature and pressure, because a water vapour molecule is lighter than the nitrogen and oxygen molecules it displaces. The effect is small compared to temperature or altitude, but the app accounts for it anyway, along with all the others, by combining them into a single “density ratio” that scales the air resistance used in every calculation.

> **IN EVERYDAY TERMS**
>
> *Swimming through a warm swimming pool feels different to wading through thick, cold porridge — same basic motion, very different resistance. Air works the same way, just on a much subtler scale: change the temperature, altitude, or pressure, and you've changed how much the air pushes back on the bullet.*

8. Truing: Teaching the Calculator From a Real Shot

The key idea: if a real shot doesn't quite match the prediction, the app can work backwards from what actually happened to correct itself for every shot after that.

Every number that goes into this calculator — the ballistic coefficient on the box, the muzzle velocity on the label — was measured under specific test conditions that may not exactly match your particular rifle, barrel length, or batch of ammunition. Small differences are completely normal and expected. Rather than just hoping the box numbers are close enough, the app lets you enter a real, observed result — "I aimed correctly for this distance and the shot landed this far off" — and it works backwards from that single real data point to figure out what the true ballistic coefficient or muzzle velocity must actually be for your specific setup.

Once corrected this way, every other distance in the results table benefits from that same adjustment, since the underlying numbers driving the whole calculation have been improved, not just the one distance you tested at.

> **IN EVERYDAY TERMS**
>
> *It's a bit like recalibrating a kitchen scale using a single object of known weight. Once you know the scale reads two grams heavy, you don't need to keep correcting for it every single time — you fix the scale itself, and everything you weigh afterward comes out right automatically.*

9. Elevation Trim: A Quick Manual Adjustment

The key idea: elevation trim is a simple, constant correction you can dial in yourself, for whenever your actual zero has quietly shifted from what the maths predicts.

Sometimes, for all sorts of small real-world reasons — a scope that's settled slightly, a mount that's been retorqued, conditions the calculator can't fully capture — the point of impact you actually see at the range doesn't quite match the prediction, even after everything else in this document has been accounted for. Elevation trim is a deliberately simple tool for that situation: a flat correction, in the same units your scope's own turret uses, applied equally at every distance in the table.

It's the same effect as turning the scope's elevation turret itself, without actually needing to touch it — useful when you want to compensate for something you've confirmed at the range without permanently moving your zero.

10. The Sound Barrier: Why Long-Range Accuracy Gets Trickier

The key idea: as a bullet slows down and crosses the speed of sound, turbulent airflow briefly forms around it, which can make its flight noticeably less predictable.

Sound travels through air at a specific speed — roughly 1,120 feet per second at typical conditions, though it varies a little with temperature. A bullet fired at typical rifle velocities starts out well above that speed, but as it flies further and slows down, it eventually crosses it. Right around that crossing point, called the transonic region, the airflow around the bullet becomes genuinely turbulent and unstable in a way it isn't at speeds clearly above or clearly below the speed of sound.

This turbulence can make a bullet's flight noticeably less consistent through that zone, which is exactly why the app highlights it directly in the results table — an amber warning as the bullet approaches this region, and a red one once it's crossed fully into subsonic flight — so it's clear at a glance which distances still have solid, trustworthy data behind them, and which are past the point where accuracy reasonably starts to suffer.

> **IN EVERYDAY TERMS**
>
> *It's similar to a boat crossing from calm open water into a choppy, turbulent wake left by another vessel. The boat handles predictably on either side of that wake — it's only the crossing itself that gets rough and harder to control.*

11. Shooting Uphill or Downhill: Why Both Need Less Correction, Not More

The key idea: gravity only ever pulls straight down, but only the part of that pull acting along your tilted line of sight actually matters for drop — and that part shrinks the steeper the angle gets, uphill or downhill alike.

Every calculation up to this point has assumed a level shot. Shooting at a real uphill or downhill angle changes something subtle but important: gravity still pulls straight down, exactly as it always does, but the target is no longer at the same height as the rifle. Only the portion of gravity's pull acting along the tilted line between shooter and target contributes to how far the bullet drops relative to that line — the rest of gravity's pull is, in a sense, wasted pulling the bullet away from a line it was never travelling along in the first place.

This is why a well-known rule among long-range shooters holds true: both uphill and downhill shots need less elevation correction than a level shot to the same slant distance, not more for one and less for the other. Whether the angle is positive or negative, that same reduction applies, because it depends only on how steep the angle is, not which direction it tilts. The app handles this by properly rotating the entire trajectory calculation to match the tilted line of sight, rather than using a rougher shortcut some calculators rely on — and it treats the range you enter as slant range, exactly what a rangefinder shows, since that's what a shooter actually has to work with in the field.

The angle itself can be typed in directly, or read live from the phone's own tilt sensor — held flat against the top of the scope or rail, pointed downrange, the same principle a bubble-level or clinometer app uses, rather than trying to judge the angle from a camera image.

> **IN EVERYDAY TERMS**
>
> *Picture rolling a ball down a ramp instead of dropping it straight down. It speeds up more slowly on the ramp, because only part of gravity's pull acts along the slope — the rest simply presses the ball into the ramp's surface and does nothing to move it forward. A bullet fired at a steep angle experiences something similar: only part of gravity's downward pull acts along the tilted line to the target, which is exactly why less correction is needed than the raw distance alone would suggest.*

A closing note: truing and incline together

If the validation feature from section 8 is used to correct a ballistic coefficient or muzzle velocity, and the shot being validated against was actually taken at a real incline rather than on level ground, it matters that the app knows about that incline at the moment it works out the correction. Ballistic coefficient and muzzle velocity are meant to be pure properties of the bullet itself — true regardless of what angle it happens to be fired at. If the incline isn't accounted for during that particular calculation, its effect on the observed result gets folded into the bullet's numbers instead, producing a corrected value that isn't really measuring the bullet on its own anymore — and that same result would then give a wrong answer the next time it's used for a level shot.

The app avoids this by using whatever incline is currently set whenever it solves for a correction, so validating at a genuine incline produces a correct result rather than a silently compromised one. That said, a level shot remains the cleaner choice to validate against when one's available — it measures the bullet's properties without any angle mixed into the picture at all.

> **IN EVERYDAY TERMS**
>
> *Picture measuring someone's height while they happen to be wearing thick-soled boots, without realising it. The number recorded isn't exactly wrong — it's just measuring the boots along with the person. Use that number later to have a coat properly fitted, and it'll be wrong, even though nothing seemed off when it was first measured.*

Bringing It All Together

None of these effects are calculated in isolation. For every single row in the results table, the app runs the full simulation described in section one, continuously factoring in air resistance shaped by your bullet's ballistic coefficient, the density of the air on the day, wind pushing from the side, spin drift building with distance, and — for genuinely long shots — the Earth's own rotation, all at once. Change any single input and every number in the table updates to reflect it.

That said, no calculation, however thorough, replaces confirming your actual data at the range. Wind calls, atmospheric quirks, and the small individual character of a specific rifle and barrel are always worth checking against reality — which is exactly what the truing feature in section eight is there for.

Appendix: The Actual Formulas

For anyone who'd rather see the real mathematics behind each section above. Numbered to match the sections in the main document, so "A4" here is the precise version of section 4's plain-English explanation.

A1 — A2. Trajectory Integration and Drag Deceleration (Sections 1–2)

The trajectory isn't solved with one closed-form equation — it's stepped forward in very small slices of time (0.0005 seconds each), updating velocity and position at every step:

FORMULA

$$v(t+dt) = v(t) + a(t) \times dt$$

$$x(t+dt) = x(t) + v(t) \times dt$$

v = velocity
x = position
dt = time step (0.0005s)
a(t) = total acceleration at time t: gravity plus drag, below

Drag deceleration at each step:

FORMULA

$$a_{drag} = PIR \times \rho_{ratio} \times C_d(Mach) \times v^2 / BC$$

PIR = 2.08551×10^{-4}, a standard exterior-ballistics constant
ρ_**ratio** = air density ratio, see A3
C_d(Mach) = drag coefficient read from the G1 or G7 reference table at the current Mach number
BC = ballistic coefficient
v = current velocity, fps

A3. Air Density Ratio (Section 7)

FORMULA

$$P = P_0 \times (1 - 6.8756\times10^{-6} \times Alt)^{5.2559}$$

$$\rho_{ratio} = (P/P_0) \times (T_0/T) \times (P - 0.378\times P_v)/P$$

P = station pressure at altitude (inHg)
P0 = standard sea-level pressure, 29.92 inHg
Alt = altitude, feet
T, T0 = actual and standard temperature, degrees Rankine
Pv = water vapour pressure from relative humidity, via the Buck equation

A4. Wind Drift (Section 4)

FORMULA

$$Crosswind = -WindSpeed \times \sin(Direction)$$

$$Windage = Crosswind_{fps} \times LagTime \times 12$$

$$LagTime = TimeOfFlight - (Range / MuzzleVelocity)$$

Direction = compass direction wind is from, 0°=headwind
LagTime = extra time the bullet spent in the air versus a no-drag reference shot — this “extra time” is what the crosswind acts on

A5. Spin Drift (Section 5)

FORMULA

$$S_g = (30\times W) / (T^2\times D^3\times L\times(1+L^2)) \times (V/2800)^{1/3} \times ((F+460)/519) \times (29.92/P)$$

$$SpinDrift\ (inches) = 1.25 \times (S_g + 1.2) \times TOF^{1.83}$$

Sg = gyroscopic stability factor (Miller's formula)
W = bullet weight, grains
T = twist rate, calibers per turn
D = bullet diameter, inches
L = bullet length, calibers
V = muzzle velocity, fps
F = temperature, °F
P = station pressure, inHg
TOF = time of flight to that range, seconds

A6. Coriolis Effect (Section 6)

FORMULA

$$\text{Horizontal (in)} = \Omega \times \text{Range}_{ft} \times \sin(\text{Latitude}) \times \text{TOF} \times 12$$

$$\text{Vertical (in)} = \Omega \times V \times \cos(\text{Latitude}) \times \sin(\text{Azimuth}) \times \text{TOF}^2 \times 12$$

Ω = Earth's angular velocity, 7.2921×10^{-5} rad/s
Range_ft = downrange distance at that point, feet
Azimuth = compass direction of fire, 0°=North
V = muzzle velocity, fps

A7. Elevation Trim (Section 9)

FORMULA

$$\text{Drop}_{adjusted} = \text{Drop} - (\text{TrimMOA} \times 1.047 \times (\text{Range}/100))$$

TrimMOA = the flat correction entered by the shooter
1.047 = inches subtended by 1 MOA at 100 yards

A8. Incline and Decline Shooting (Section 11)

The zero angle is always solved on a level range — it's a fixed mechanical offset between barrel and sight line that doesn't change with incline. For an inclined shot, that same offset carries through, with the incline angle added on top:

FORMULA

$$\text{LaunchAngle} = \text{ZeroAngle} + \text{Incline}$$

ZeroAngle = barrel angle relative to the sight line, solved on a level range (Section 3)
Incline = incline angle, positive = uphill, negative = downhill

The trajectory itself is still stepped forward exactly as in A1, in true horizontal/vertical coordinates. What changes is how range and drop are read back out of it — rotated into the tilted line-of-sight frame rather than read straight off the horizontal and vertical axes:

FORMULA

$$\text{Range}_{alongsight} = x \times \cos(\text{Incline}) + y \times \sin(\text{Incline})$$

$$\text{Drop} = (-x \times \sin(\text{Incline}) + y \times \cos(\text{Incline})) \times 12$$

x, y = the bullet's true horizontal and vertical position at each step, from A1
Range_alongsight = distance travelled along the tilted sight line — this is what's compared against the slant range you entered, to decide which row of the table this point belongs to

At zero incline, cos(Incline)=1 and sin(Incline)=0, so both formulas reduce exactly to the original level-fire versions — this is a genuine generalisation of the original calculation, not a separate approximation bolted on alongside it.

All formulas above were checked against published worked examples before being used in the app — the Miller stability and Litz spin drift formulas in particular were verified against independently-published reference calculations rather than implemented from memory alone.