A PHYSICS PROFESSOR'S VIEW OF BALLISTICS
by Bert Blanton

There is a lot of discussion among hunters and firearm enthusiasts about bullet "ballistics". The following is a short discussion from the laws of physics point of view:

SOME FACTS OF PHYSICS:
1. The instant the bullet leaves the barrel it begins to fall toward the center of the earth due to the force of gravity. If you point the barrel upward at 45 degrees the bullet still begins falling from the "bore line" immediately. (More on that later).
2. All bullets regardless of weight (mass) fall at the same rate. If you drop two lead balls of different weights from a tower, they will both hit the ground at the same time. [If you drop a feather and a lead ball of the same weights they will not because the feather is greatly affected by the air and the lead ball is minimally affected by the air.] Here we will assume the air does not affect the falling of a rifle bullet.
3. How much a bullet drops in its journey downrange to a fixed target is totally determined by its time in flight. The longer it is in flight, the faster and farther it falls from its initial flight path.
4. Its time in flight is determined by its beginning muzzle velocity AND its wind DRAG in the horizontal direction. All bullets have some wind drag. Some have more than others. If it tumbles it is worse.
5. Faster bullets have less "drop" on their way to the target because they are not in flight as long. Read on.

CARTRIDGE GRAPHS:
Lets look at the first graph below: This graph is for a 22 LR bullet which has the barrel of the gun raised such that the bullet falls just enough to hit a target level with the sight line (1.5" above the muzzle) at 50 yds. If you did not raise the muzzle of the gun, the bullet would hit about 2" below the target at 50 yards. It would be about 7.5" low at 100 yards etc. There is a 1.5" confusion factor here due to the sights/scope being 1.5" above the barrel.

From the Federal website, this 22LR bullet is traveling 1200 ft/sec (not bad for 22LR but very slow for most rifles) out of the muzzle and has slowed to 1075 ft/sec at 50 yds and to 991 ft/sec at 100 yds and to 928 ft/sec at 150 yds. We could calculate its time in flight in seconds at 100 yds and then using the formula for gravity to find how far it falls. We don't need to. Federal has already done that and tested the rounds for us.

Looking closely at the graph, the bullet leaves the muzzle 1.5" below the sight line at 1200 ft/sec and its beginning path is pointed upward (the sight line and the barrel are NOT parallel. The scope is horizontal to the earth's surface in this test while the barrel is inclined slightly upward.) The bullet travels upward in a tilted falling curve and intersects the sight line at about 20 yards downrange. It continues upward in its curving flight and peaks out at about 0.5" above sight line at about 40 yards downrange and then passes through the sight line again at 50 yards (our target). It continues falling after that until it hits the dirt. We don't care about that because it hit our target on the way.

You can see from the shape of the graph that it falls faster and faster because it is slowing down due to wind drag and its time in flight is getting rapidly longer.
A 22LR (muzzle velocity=1200 ft/sec) zeroed at 50 yards.

Now if you wish to raise the muzzle a little more you can do so such that the bullet passes through our target at 100 yards (100 yd zero) instead of at 50 yards. It looks like the graph below (Caution: the scale on the graph changes from 50 to 100 yd zero).

Notice how much steeper you must point the barrel to accomplish this. Again the bullet leaves the muzzle at 1200 ft/sec 1.5" below our sight line, travels steeply upward and intersects our sight line at about 10 yds, peaks out at about 3" above sight line at about 55 yds and then passes through our target at 100 yds. If you shoot at something at 50 yds you will be 3" high if you place the sights on the object. A 22LR zeroed at 100 yds will be 3" high at 50 yds and 2" high at 30 yds and 2" high again at 85 yds and right on at 100 yds.
HUNTING ANALYSIS:
Assume you are going hunt with a 22LR and you feel you must be within + or - 1.5 inches to kill your game. If you zero at 50 yards (from the graph above) your bullet will be no more than 1.5” above or below your sight line from 0 to almost 70 yards. So tell your child or spouse to put the sights right on the rabbit anywhere from 0 out to 70 yards. Beyond that distance will require another plan. Read on.

Notice from the table below that the faster the round is, the less drop it has on its way to 200 yds if zeroed at 100 yds. If you wish to be very accurate at various and longer distances, you MUST use a faster round OR USE A "BDC" SCOPE (another topic) or be a practiced up marksman (or all 3)!

<table>
<thead>
<tr>
<th>Speed</th>
<th>Example round</th>
<th>25</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
<th>500</th>
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<tr>
<td>1990</td>
<td>Fed 30 Carbine</td>
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<td>+0.3</td>
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<td>-13.0</td>
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<td>2570</td>
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<td>0</td>
<td>0</td>
<td>-4.9</td>
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<tr>
<td>2720</td>
<td></td>
<td>-1.1</td>
<td>-0.1</td>
<td>0</td>
<td>-4.2</td>
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<tr>
<td>2950</td>
<td>Fed GM223M or P270A1</td>
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</table>

Check the faster .223 zeroed at 200 yds. It is good for about 2” from 0 out to about 235 yds. Anything faster than about 2950 ft/sec (223, 243, 270 etc) needs to be zeroed at 200 yards.

![Trajectory graphs](image)
A few more graphs of popular hunting rifles:

270 Win-3060 ft/sec:

7mm Magnum-3150 ft/sec

204 Ruger-4030 ft/sec