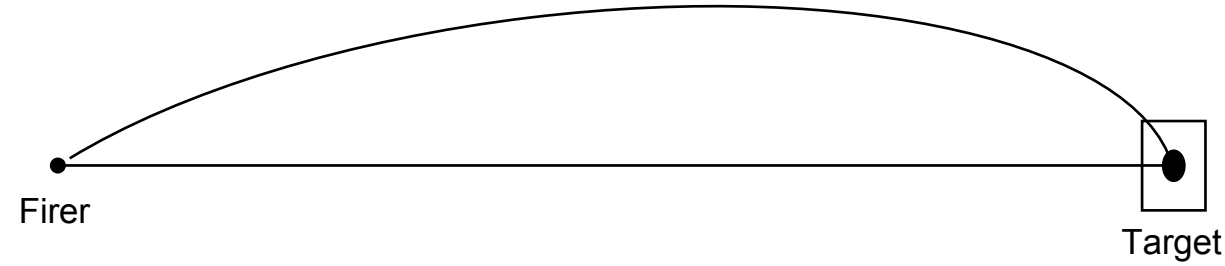
7. FIRING THE SHOT

MARKSMANSHIP PRINCIPLE 3

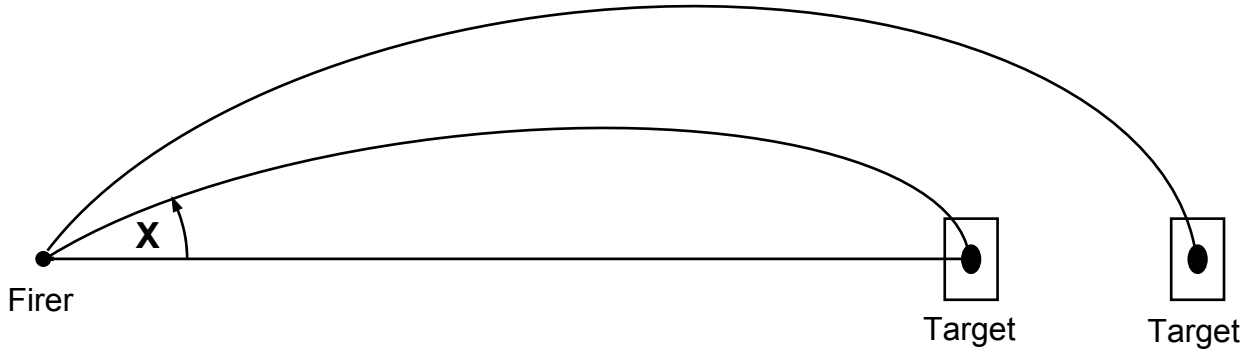
ELEVATION AND TRAJECTORY.

Any object aimed at a distant target has to be propelled upwards, as the force of gravity will attract it downwards again. It therefore follows a curved path, called a trajectory.

Trajectory



The greater the distance between the firer and the target (or the slower the missile), the greater is the initial angle required. This angle is called the 'elevation'. This angle is obvious on artillery guns or mortars but is not so obvious on rifle barrels as the bullet is much faster. However, the further we move back, the more we need to point the rifle upwards. A scale on the rear sight measures the change in the angle of elevation.



The basic measurement of angle is the degree, with 360 degrees in a circle. Degrees are divided into minutes (60 minutes to a degree). The change in elevation needed to move the distances involved in fullbore shooting is small and therefore uses minutes of angle.

As a rough guide, elevating the barrel by 1 minute will change the position of the shot on the target by 1 inch (2.5 cms) on a target 100 yards away. (Changing the weight of the bullet or the speed with which it travels will change this, so it is only a rough guide). Making the same change for a target at 200 yards will change the position of the group by 2 inches (5 cms) and so on.

A good rear sight will be capable of setting both the elevation change and the wind change to ¼ of a minute. Scoring diagrams are marked out in 1-minute squares so that the sight changes needed, can be calculated.

The increase in elevation as the target gets further away is not constant. The farther the bullet travels, the slower it gets so the relatively greater the elevation has to be. At shorter distances it increases by about half a minute for every 100 yards.

CHANGE (yards)	RISE (minutes)
100 - 200	2.0
200 – 300	2.5
300 – 400	3.0
400 – 500	3.5

etc

A rough set of tables can be made, to assist with setting sights of an unfamiliar rifle to approximately the correct elevation, once they have been zeroed. Thereafter, the firer will use previous values for that rifle at each distance to set the sights.

Elevation Table

RISE TO FROM	**300 yds**	**500 yds**	**600 yds**	**800 yds**	**900 yds**	**1000 yds**
200 yds	2.5 min	9 min	13 min	22 min	28.5 min	35.5 min
300 yds		6.5 min	10.5 min	19.5 min	26 min	33 min
500 yds			4 min	13 min	19.5 min	26.5 min
600 yds				9 min	15.5 min	22.5 min
800 yds					5.5 min	12.5 min
900 yds						7 min

Factors Affecting Elevation

1. AMMUNITION

Different bullet weights and muzzle velocities will need different elevations.

2. TEMPERATURE

Change of temperature changes the density of the air. In hot weather, less elevation will be needed. There may therefore be a slight difference in winter and summer settings. It is also not advisable to keep an unfired round in a hot chamber for a long time e.g. if there is a delay on the target. A 'cooked' round may go a little low. It is best (and safest) to close the bolt just as the target begins to rise.

3. ALTITUDE

Similarly, at higher altitude the air is less dense so less elevation is needed. However, only shooters visiting e.g. South Africa need be concerned with this – their range is at about 8000 ft..

4. WET AND DIRT

Oil, water or dirt in the chamber decreases the grip of the bullet on the chamber walls, increases the chamber pressure and gives high shots. Proper cleaning and maintenance

is essential. Even stainless steel barrels, which do not need cleaning as often, should have the chamber cleaned with a breech stick and flannelette at least once a day.

5. VARIATION IN SIGHT PICTURE

Variations in sight picture will cause elevation changes. This may be caused by inconsistent head position or by variations in firing point contours – some ranges have flat firing points, some have the older sloped version.

Factors Affecting The Rise Between Ranges

1, 2 and 3 above will also change the rise needed between ranges, as will the sight base (the distance between front and rear sights). All other things being equal, the longer the sight base, the greater the rise necessary.

After a rifle has been used by its firer a few times, a set of elevations for given distances will be known and should be used instead of elevation tables. However if you have a set of elevations for one rifle, they are not likely to apply to a different rifle.

Sight picture.

Target rifles have what is referred to as 'iron sights' i.e. not telescopic sights. Most have 'ring sights' i.e. circular apertures at both front and rear in which the target is centred. Usually, the diameter of both front and rear can be changed. (The usual rule for choosing the diameter is to have as large as possible in the front and as small as possible at the rear. A good starting point from which to experiment is to have a 3.6mm sight in the front and a 1mm at the rear (for an iris) or the third hole of a six hole aperture.

A typical sight picture would be:

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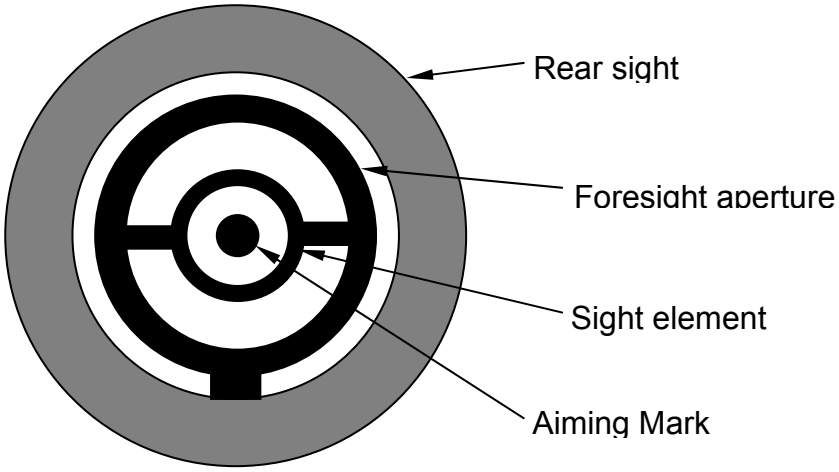
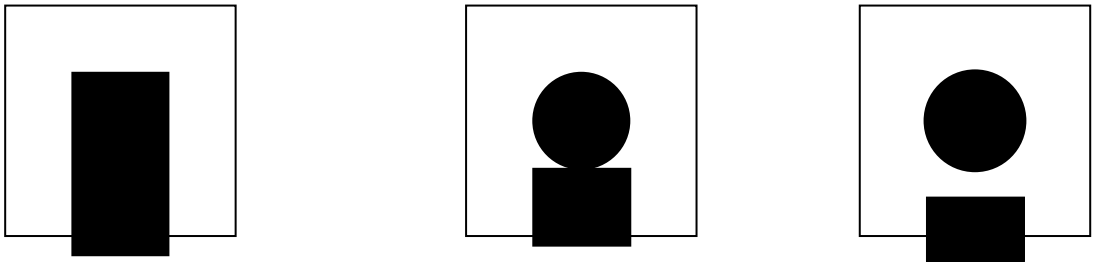


Sight Adjustment

Target rifle sights can be finely adjusted. They usually have what is described as 'quarter minute sights'.

1 minute of angle is approximately the angle subtended by 1 inch at 100 yds (or approximately 2.5 cm at 100m). It takes four clicks of the screw on you sights to move the shot by one minute, so each click is ¼ of a minute. If you were firing at 100 yds and fired one shot, then moved the sights by one minute (four clicks), the next shot should (theoretically!) land 1 inch (2.5 cm) away. At 200 yds it would land 2 inches away, at 300 yds it would land 3 inches away etc.
Score diagrams have 1 minute squares drawn on them to assist with deciding sight adjustment.
On most fullbore sights, clockwise on the top screw moves shots up the target, clockwise on the side screw moves shots too the right, and vice versa.
Some shooters use blade foresights. The following are choices of sight picture with a blade.



In the first one, the whole target is being used as the aiming mark, with equal borders of white around it.

Vernier scales
To be sure of getting the correct setting on the sights at each distance, target shooters must be able to read the vernier scales on the sight. .
A Vernier scale is a way of accurately reading a scale, which would have divisions too small to be easily read by the naked eye.

How Does It Work?
Since the change in elevation needed on rifle sights is a very small angle, any measurement on a sight would be difficult to read. The smallest graduations which could be easily read would be about 5 minutes, but we need to be able to read to ¼ of a minute.
A vernier scale has two components – a moving scale and a fixed scale. The moving scale has five divisions on it, to every four on the main scale.

Reading The Elevation Vernier
Diagram 1
This shows the elevation vernier reading zero – both ‘0’’s are aligned.

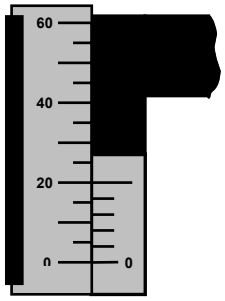


Diagram 2
If the top screw is turned clockwise four clicks (1 minute), the ‘0’ on the Vernier scale is no longer aligned with another mark but the next line up is aligned with one on the main scale – i.e. the reading is 0 + 1, or 1 minute.

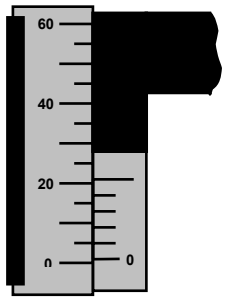


Diagram 3
If the top screw is turned another four clicks clockwise (another 1 minute), we will have to count to the second line above zero on the vernier to find two aligned, giving a reading of 0 + 2, or 2 minutes.

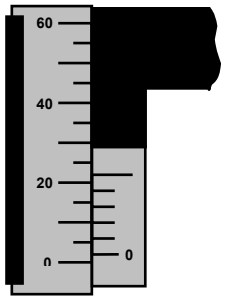


Diagram 4
The ‘0’ on the vernier is aligned with ‘5’ on the main scale, giving a reading of 5 minutes.

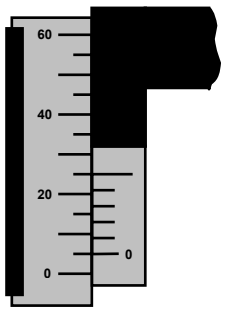


Diagram 5
Here the alignment comes above ‘5’ on the main scale and one up from the ‘0’ on the vernier scale, giving a reading of ‘5 + 1’, or 6 minutes.

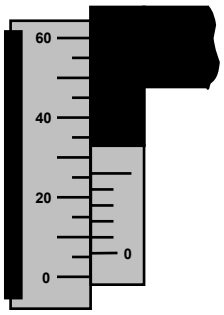


Diagram 6
It should now be easy to read this as 7 minutes.

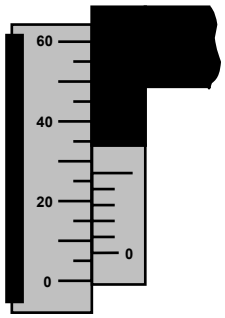
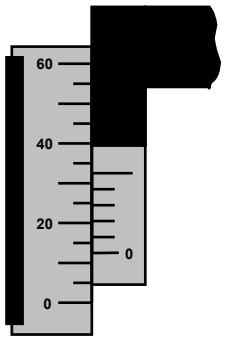


Diagram 7
Here, there are no alignments, but a pair of lines on the vernier scale are between two on the main scale. In this case, the reading is above 10 and it is the the second and third which are between alignments i.e. '10 + 2.5', or 12.5 minutes.
If the exact reading was difficult to see, the sight could be clicked to see how many it took to bring it to the nearest whole number. For half a minute it will take two clicks
Quarters are best judged by the clicking method, remembering to click back once the reading is obtained.



The Wind Vernier
Reading the wind vernier is similar except that wind can be both left and right.

Diagram 1
This shows zero wind

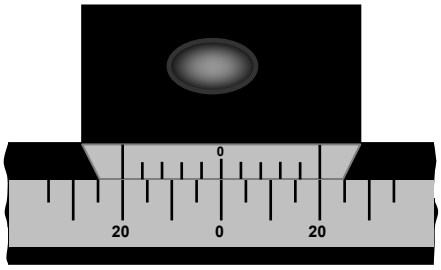
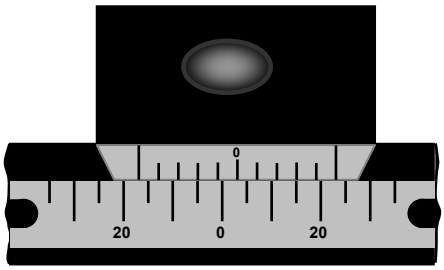
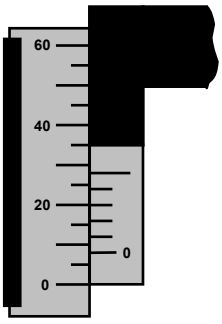


Diagram 2
This shows 3 minutes of right wind

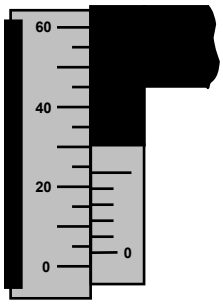


Exercises

1. Read the following elevations



1



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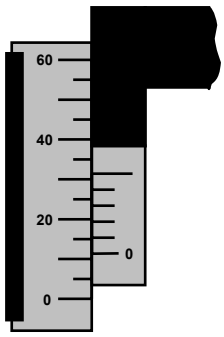

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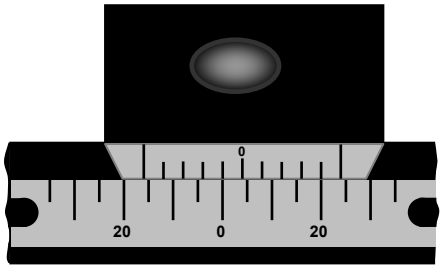
2. Read the following winds



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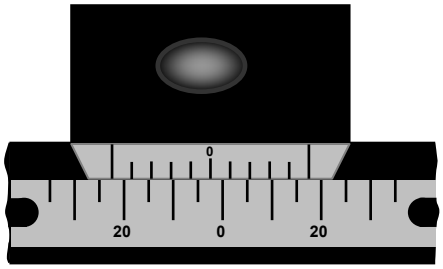

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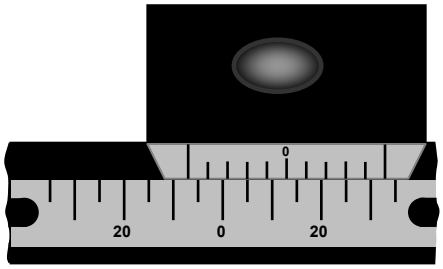

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