How does the firing angle effect the range of a projectile

Ben Cheetham & Lucas Tripodi

Introduction

Aim:

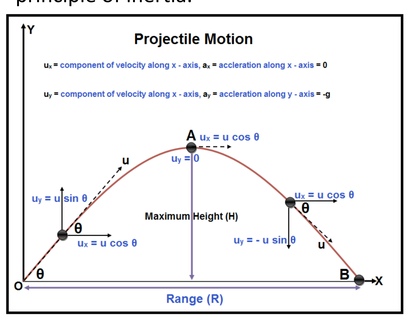
The aim of this practical is to find the effect that different angles have one the horizontal range of a nerf bullet

Hypothesis:

It is expected that the range will be at its maximum when the angle is at 45 degrees.

Background Physics:

Galileo was the first to acknowledge that a projectile shot from a cannon was influenced by two motions and not one. The first motion being a vertical one due to gravity that pulls down a projectile with a force of 9.8N. As well as this he recognised that while the object may be falling the projectile is still moving forward horizontally, this motion is recognised as uniform and constant according to the principle of inertia.



Variables:

Dependent- The range of the bullet

Independent- Bullet mass

- Firing angle

Controlled-

- The Nerf gun used (same spring system)
- The environment of which we shoot the bullet in (Air temp & wind)
- The Nerf bullet used (same projectile)

Materials

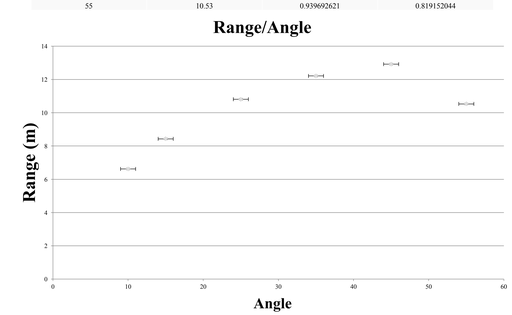
- Long measuring tape
- Nerf gun
- Nerf bullets
- Tape
- Angle stand
- Protractor

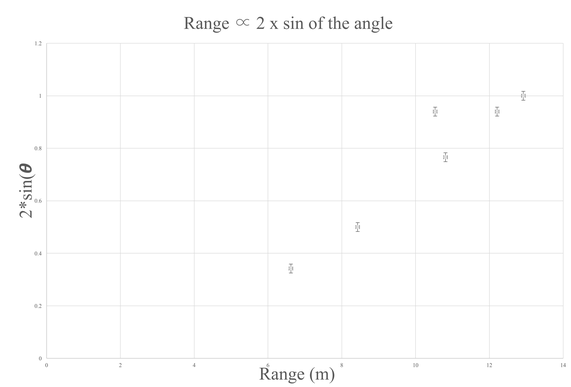
Method

1. Collect all materials required and find a large open space (preferably a gymnasium)
2. Tape the nerf gun to the angle stand ensuring that it is stable
3. Set up a measuring tape 20-30 metres long
4. Set up the nerf gun with an angle of 10° and fire the gun 3 times measuring the landing space as accurately as possible
5. Repeat step 4 at angles 15, 25, 35, 45 and 55 ensuring that 3 trials are completed for each angle to gain accurate results

Results

Angle	range	sin 2 x angle	sin angle
10	6.62	0.342020143	0.173648178
15	8.43	0.5	0.258819045
25	10.81	0.766044443	0.422618262
35	12.21	0.939692621	0.573576436
45	12.92	1	0.707106781
55	10.53	0.939692621	0.819152044





Discussion

Prior to experiment it was hypothesised that 45 degrees would be the optimum angle for the best range. This conclusion was based of the equation $\frac{U2*Sin(2*\theta}{g}$ as 45 degrees gives Sin(2*45 which provides the answer of 1, any number above or below 45 would change this and therefore decrease the overall range according to this equation. This hypothesis was proved by the results as the graph comparing the angle and range showed a parabolic shape peaking at 45 degrees showing that the angle of 45 degrees does give the largest range.

The controlled environment used ensured that the air resistance and the wind effect was as low as possible, having little impacts on the projectile.

The graph showing the relationship between range and 2*Sin($\boldsymbol{\theta}$ produced an outlier. The outlier represented the bullets shot at an angle of 55 degrees. This outlier could be a result of the gun misfiring as the spring system may not be as reliable as we would want.

If more time was available more trials could be completed allowing for multiple angles and masses to be tested. As well as this we were limited as the gun didn't allow us to add too much mas to the bullets as they wouldn't fit in the gun otherwise. If more time was available better weights could have been created that didn't have as much of an effect on the bullets centre of mass. To improve a method of creating a more accurate method of taking the measurements such as putting chalk on the end of the bullet to mark the landing spot accurately.

Conclusion

To conclude the data shows that the angle of 45 degrees is ideal for attempting to find the optimum range. As well as this the results support the hypothesis that 45 degrees will provide the best range.

Acknowledgments

http://www.mcm.edu/academic/galileo/ars/arshtml/mathofmotion2.html MCM 20/9/18

https://byjus.com/physics/projectile-motion/ BYJU's learning app 20/8/18

.