

### Range of Projectiles

In this assignment, my aim is to see how the angle at which an object is fired affects the horizontal distance it travels.

When an object is fired or thrown into the air, it moves both horizontally and vertically. It travels vertically with an acceleration downwards because of gravity and horizontally with a constant speed because gravity doesn't act horizontally.

The distance it travels horizontally is called its range and the range is

$$\text{range} = v \times t ,$$

where  $v$  is the speed it's fired at and  $t$  is the time its in the air.

The velocity it's fired at is split into a vertical and horizontal component

$$v_{\text{horizontal}} = v \cos \theta$$

$$v_{\text{vertical}} = v \sin \theta$$

So if  $\theta$  is big,  $v_{\text{horizontal}}$  is small, and  $v_{\text{vertical}}$  is big so it's in the air a long time.

If  $\theta$  is small,  $v_{\text{horizontal}}$  is big, and  $v_{\text{vertical}}$  is small so it's in the air a short time.

So it's difficult to see what the best for the range – a big velocity for a short time or a small velocity for a long time because  $\text{range} = v \times t$

I fired a ball bearing using a spring loaded projectile apparatus from the edge of the top of a bench at various angles for a number of angles of launch, and measured how big the range of the ballbearing was.

#### Results

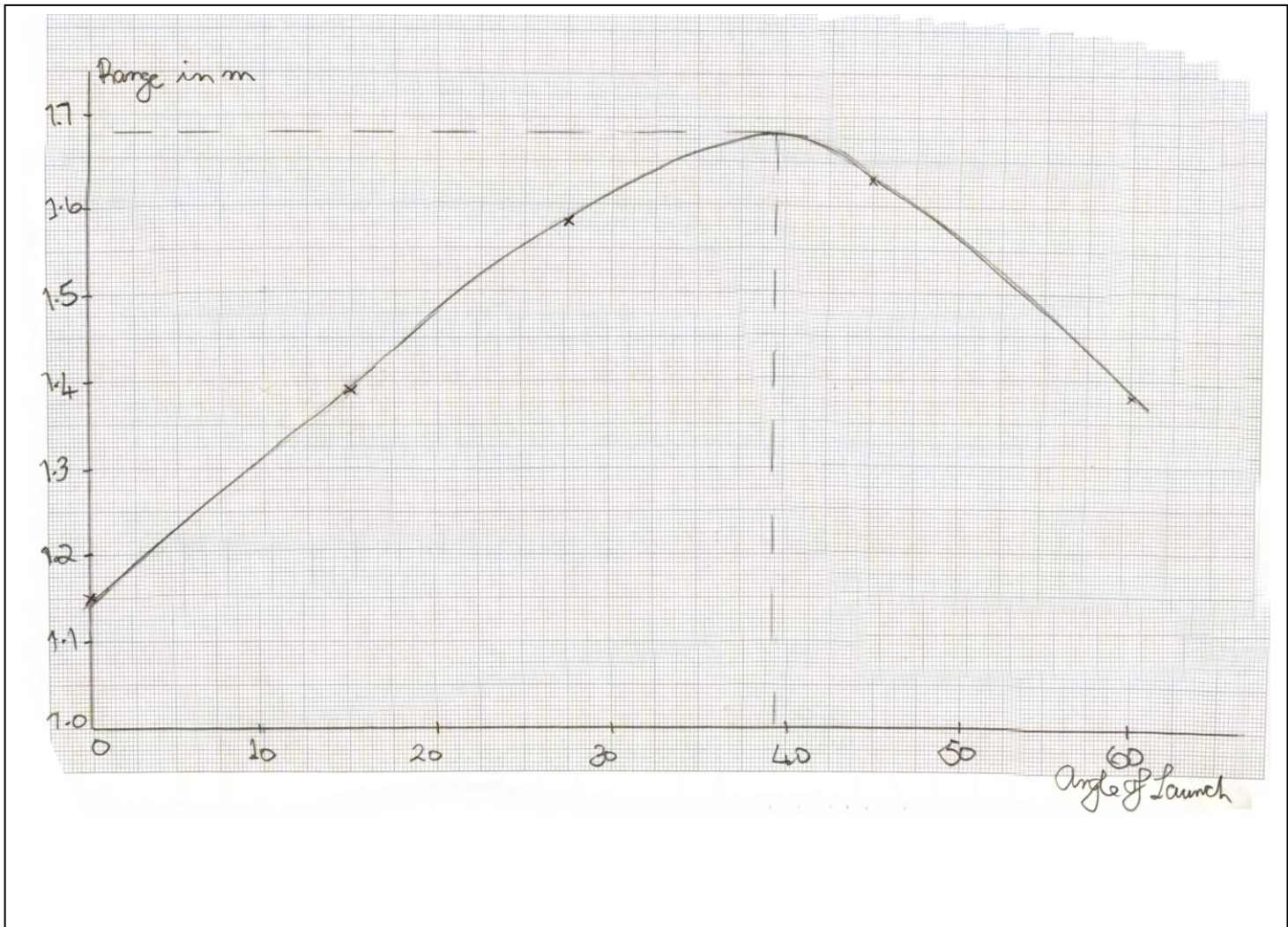
Angle of Launch(°)	Metres			
	First try	Second try	Third Try	Average
0	1.02	1.22	1.21	1.15
15	1.31	1.38	1.49	1.39
30	1.55	1.56	1.63	1.58
45	1.68	1.52	1.62	1.63
60	1.43	1.32	1.38	1.38

To work out the average I added the three ranges and divided by 3

$$1.02+1.22+1.21=3.45$$

$$3.45 \div 3 = 1.15$$

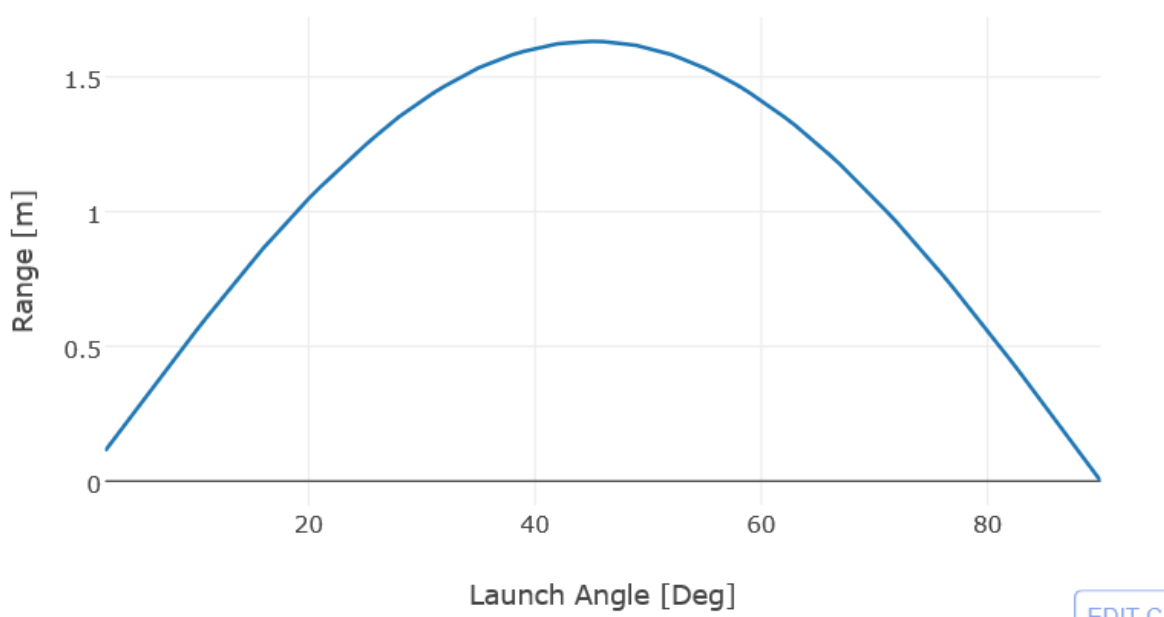
The graph of my results is below.



From the website below I found another graph of range against launch angle.

[www.wired.com/2015/03/determining-maximum-projectile-range-numerical-model/](http://www.wired.com/2015/03/determining-maximum-projectile-range-numerical-model/)

### Projectile Range (4 m/s launch speed on flat ground)



This graph gets a maximum range at a launch angle of about  $45^\circ$ .

Both graphs have the same shape with the range getting bigger then smaller. My graph shows a maximum range at launch angle about  $39^\circ$  which is close to the same as the graph from the internet.

So both my experiment and information from the internet show that you get a smaller range at both small and large launch angles, with the best angle for a bigger range being about  $39-45^\circ$ .

In my experiment it was difficult at first to measure exactly the range of the ball bearings because you couldn't see exactly where they landed and it was difficult to judge where to measure to. What I did to make this better was to put some paper on the floor with some carbon paper on top so that the ballbearing left a dot on the paper to show where it landed exact. I measured the distance from the foot of the bench to the dot. This made the measuring more accurate.