In this experiment, we'll investigate the horizontal and vertical motion of a projectile fired horizontally.

To do this we need:

A ball launcher
A ball
A light gate
A timing plate - these are both attached to a timer.
You will also need a measuring tape.
Set up the ball launcher on a table or bench so that it launches horizontally.

Position the light gate so that the ball will pass through it just after it is launched. Carry out a practice launch to see where the ball lands.

Use a measuring tape to find the range, the horizontal displacement between where the ball is launched and where it lands. Place the timing plate on the floor so that the ball will land on the plate.

Set up the timer to record two times – the time it takes the ball to pass through the light gate and the time of flight, which is the time between launch and hitting the timing plate.

Load the ball into the launcher, start the timer and launch the ball.

Record the times displayed on the timer. In this case, the ball took 7.77 milliseconds to pass through the light gate and the time of flight was 0.482 seconds.

We can use the first time to calculate the horizontal velocity of the ball using the equation.

Vh equals s divided by t, where vh is the horizontal velocity, s is the diameter of the ball, which is 0.025 metres, and t is the time it took the ball to pass through the light gate, 7.77 milliseconds, or 0.00777 seconds.

This gives a horizontal velocity of 3.22 metres per second.

The horizontal velocity of a projectile is constant if we ignore air resistance. So, we can now calculate the range using the equation: S equals vh times t.

Where this time s is the range or horizontal displacement, vh is the horizontal velocity, 3.22 metres per second and t is the time of flight, 0.482 seconds. So, s equals 3.22 times 0. 482.

This gives a range of 1.55 metres, which is very close to where we observed the ball landing before.

The vertical motion of the ball has constant acceleration due to gravity. We can use this and the time of flight to calculate the final vertical velocity.

We can find out the final velocity of the ball using the equation vv equals uv plus at. Where vv is the final vertical velocity, uv is the initial vertical velocity, a is the acceleration due to gravity, and t is the time of flight.

In this case, uv is zero as the ball is fired horizontally, a is 9.8 and t is 0.482. So, vv is 4.72 metres per second, correct to three significant figures.

We can now calculate the height the ball was dropped from using S equals v bar times t.

Where S is the height, V bar is the average vertical velocity and T is the time of flight.

The average velocity is the final velocity (v) minus the initial velocity (u) all divided by two, which is 4.72 minus zero, divided by 2 times the time of flight.

So, s equals 2.36 times 0.482, which equals 1.14 metres.