# Experiment: Projectile Motion Time allocated: 40 min

**Aim**

To experimentally determine the value of the acceleration due to gravity () using the motion of a projectile.

**Background**

In the absence of air resistance, the only force acting on a projectile is gravity. This makes predicting the motion of a projectile fairly simple. For example, the range of a projectile which returns to the same starting height it was launched from can be calculated using:

where

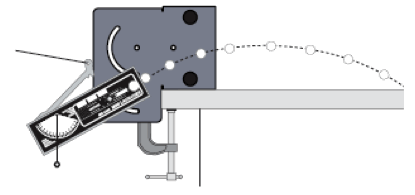
* is the horizontal range
* is the launch velocity
* is the gravitational acceleration
* is the angle the projectile is launched at

This relationship between horizontal range and launch angle will be used to determine the gravitational acceleration.

**Equipment**

1. Projectile launcher
2. Ball
3. Metre ruler

**Diagram of Setup**



Ball

Projectile Launcher

**Procedure**

1. Align the end of the projectile launcher such that the ball exits in line with the table surface and clamp the launcher to the table.
2. Record the launch angle of the projectile from the protractor on the projectile launcher.
3. Launch the ball and watch where the ball first hits the table. Record the horizontal range as the distance from the launch edge of the table to this point. Repeat for 3 trials.
4. Adjust the launch angle and repeat steps 2-3 over different launch angles.

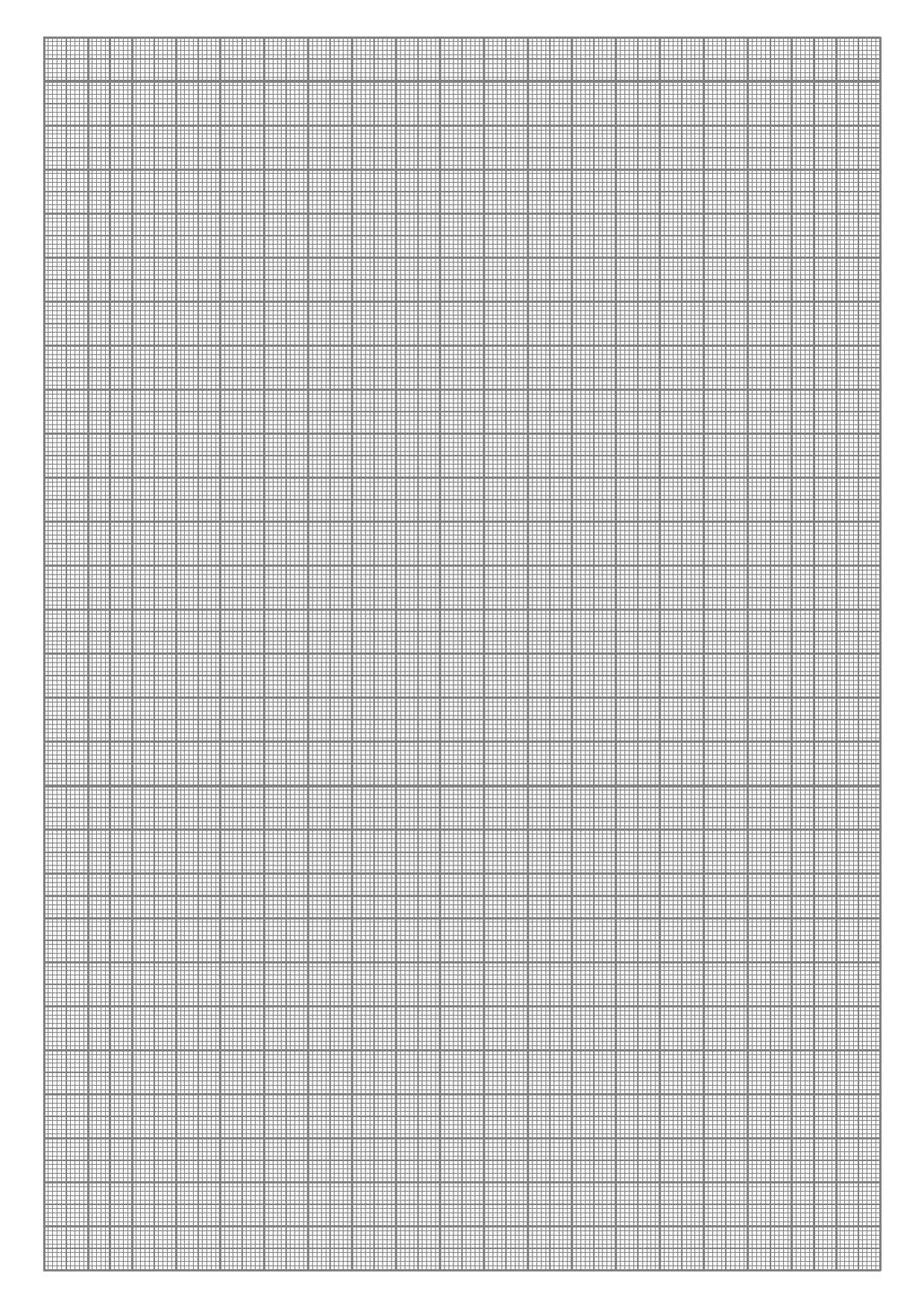
**Results**

Launch Velocity: 1.5 m s-1

|  |  |  |  |
| --- | --- | --- | --- |
| Launch angle (degrees) |  | Average Horizontal Range (m) |  |
| 10 |  | 0.08 |  |
| 15 |  | 0.12 |  |
| 25 |  | 0.19 |  |
| 35 |  | 0.23 |  |
| 45 |  | 0.24 |  |

1. Using the equipment list, procedure and table of results as a guide, estimate the size of the **absolute** uncertainty of the horizontal range measurements. Justify your choice. [3 marks]
2. Produce a **linear** graph to show the relationship between launch angle and the horizontal range of the projectile. Use the formula in the background information to help guide you to produce a **linear** graph. Include error bars for both axes – you may assume your horizontal axis values have an uncertainty of ±10%. Extra columns are provided in the table to assist you, but are not required to be used.

[6 marks]



1. Determine the gradient of the graph. Include units. [3 marks]
2. **Using the gradient**, determine the experimental value for the acceleration due to gravity ().

[2 marks]

1. Determine the percentage difference between your experimentally determined value of the acceleration due to gravity and the accepted value of the acceleration due to gravity near the Earth’s surface.

[1 mark]

1. Your gravitational acceleration is either too high or too low compared to the accepted value.
   1. By considering the range of the error bars in your graph,
      1. produce a new line of best fit that may achieve a gravitational acceleration closer to the accepted value. Draw in the new line of best fit and clearly label the lines of best fit as “original” and “adjusted”. [1 marks]
      2. Calculate the gravitational acceleration from this new line of best fit. [2 marks]
   2. Based on your findings to part (a), comment on whether this experiment has confirmed that the gravitational acceleration could be 9.8 m s-2. [2 marks]