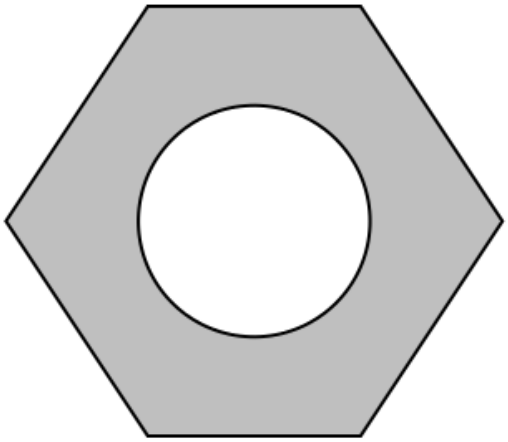
Senior Physics Challenge Task 1 ANSWERS BOOKLET

Part 1: Centre of mass [1 mark]

Mark the position of the centre of mass of the nut.

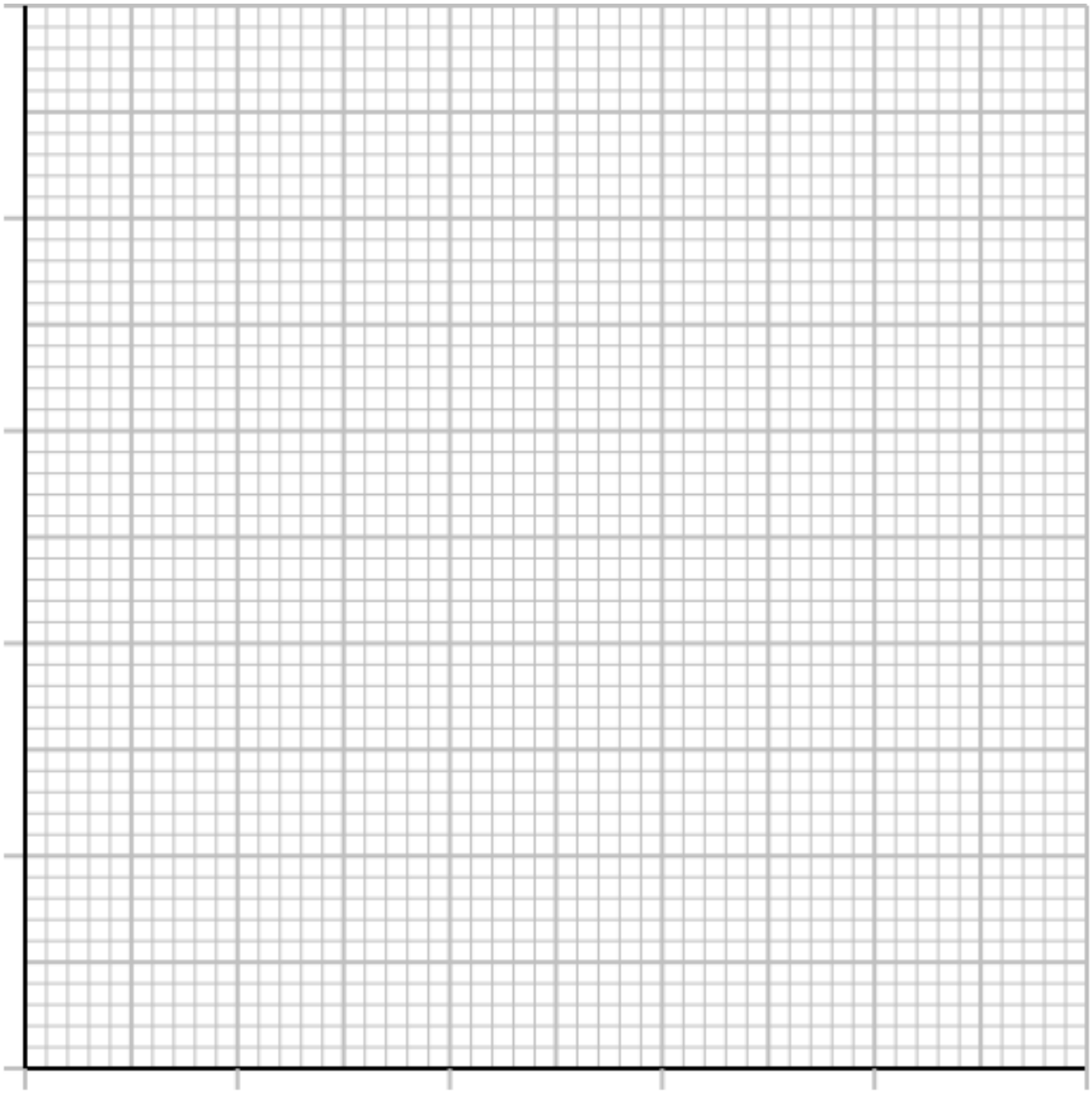


Part 2: Measuring g using a pendulum [8 marks]

Record the results of the pendulum experiment.

Length (L) of pendulum in metres	1st time recorded for 20 swings in seconds	2nd time recorded for 20 swings in seconds	3rd time recorded for 20 swings in seconds	Average time for 20 swings in seconds	Average time for 1 swing (T) in seconds	Average time squared (T^2) for 1 swing in seconds squared

Plot a graph of T^2 on the y-axis against length, L, on the x-axis.



Calculate the gradient of the graph.

……

……

……

……

Gradient of graph = ……

Calculate the acceleration due to gravity from the results of the pendulum experiment.

……

……

……

……

Acceleration due to gravity = ……

Part 3: Testing the pendulum equation [8 marks]

Independent variable(s) would be ……..

Dependent variable(s) would be ……..

Control variable(s) would be ……..

Method.

……

……

……

……

……

……

……

……

Results.

Conclusion.

……

……

……

……

Part 4: Large angle pendulums [8 marks]

Results for a small angle.

1st time recorded for 20 swings in seconds	2nd time recorded for 20 swings in seconds	3rd time recorded for 20 swings in seconds	Average time for 20 swings in seconds	Average time for 1 swing (T) in seconds

Method to release the pendulum from an angle of 40°.

……

……

……

……

……

……

……

……

Results for an angle of 40°.

1st time recorded for 20 swings in seconds	2nd time recorded for 20 swings in seconds	3rd time recorded for 20 swings in seconds	Average time for 20 swings in seconds	Average time for 1 swing (T) in seconds

Percentage difference between the time period for a small angle pendulum and the time period for a pendulum released at an angle of 40°.

……

……

……

……

……

Estimate of the percentage uncertainty on the time period for each pendulum.

……

……

……

……

……

Conclusion.

……

……

……

……

Part 5: Pendulum clocks [5 marks]

Explanation - why a pendulum of a pendulum clock loses energy over time.

……

……

……

……

Calculation of the maximum energy required **per swing**.

……

……

……

……

……

……

Reasons why pendulum clocks were not suitable for use on board early sailing ships.

……

……

……

……

……

……

……

……

Senior Physics Challenge Task 2 ANSWERS BOOKLET

Part 1: Measuring the speed of water waves

Determining the depth of the water in the shallow tray

Record appropriate dimensions of the plastic box and the shallow tray.

Explain how you will determine the depth of the water in the shallow tray.

……

……

……

……

……

……

……

……

Determining the speed of the water wave

Explain how you will determine the speed of the water wave.

……

……

……

……

……

Record your results.

Part 2: Graphical Analysis [8 marks]

State what graph you will plot.

……

……

……

……

Include a sketch.

Explain how you will determined the acceleration due to gravity using your graph.

……

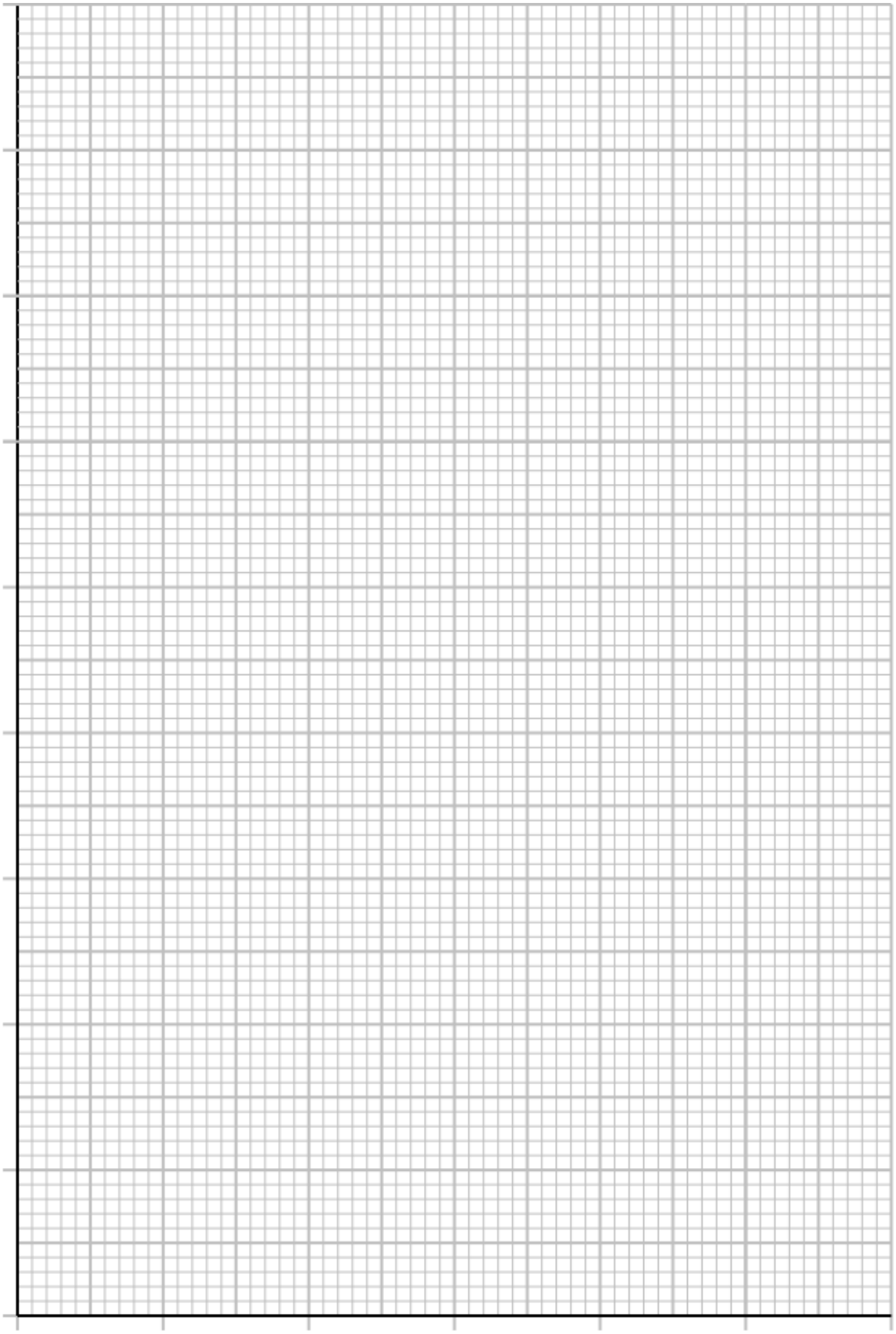
……

……

……

……

Plot a graph of your results.



Part 3: Conclusion [6 marks]

Determine the acceleration due to gravity.

……

……

……

……

……

……

……

……

Values of acceleration due to gravity

Pendulum experiment g = ……

Water waves experiment g = ……

Percentage difference

Calculate the percentage difference between your two values for the acceleration due to gravity.

……

……

……

……

……

……

Which result is more reliable?

State which value you think is more reliable or whether you consider both results to be equally reliable.

……

……

……

……

Explanation 1

……

……

……

……

Explanation 2

……

……

……

……

Part 4: Refraction [8 marks]

Describe the relationship between the speed of the water waves (ripples) and the depth of the water.

……

……

……

……

Calculate the speed of the ripples (v) in the shallower water.

……

……

……

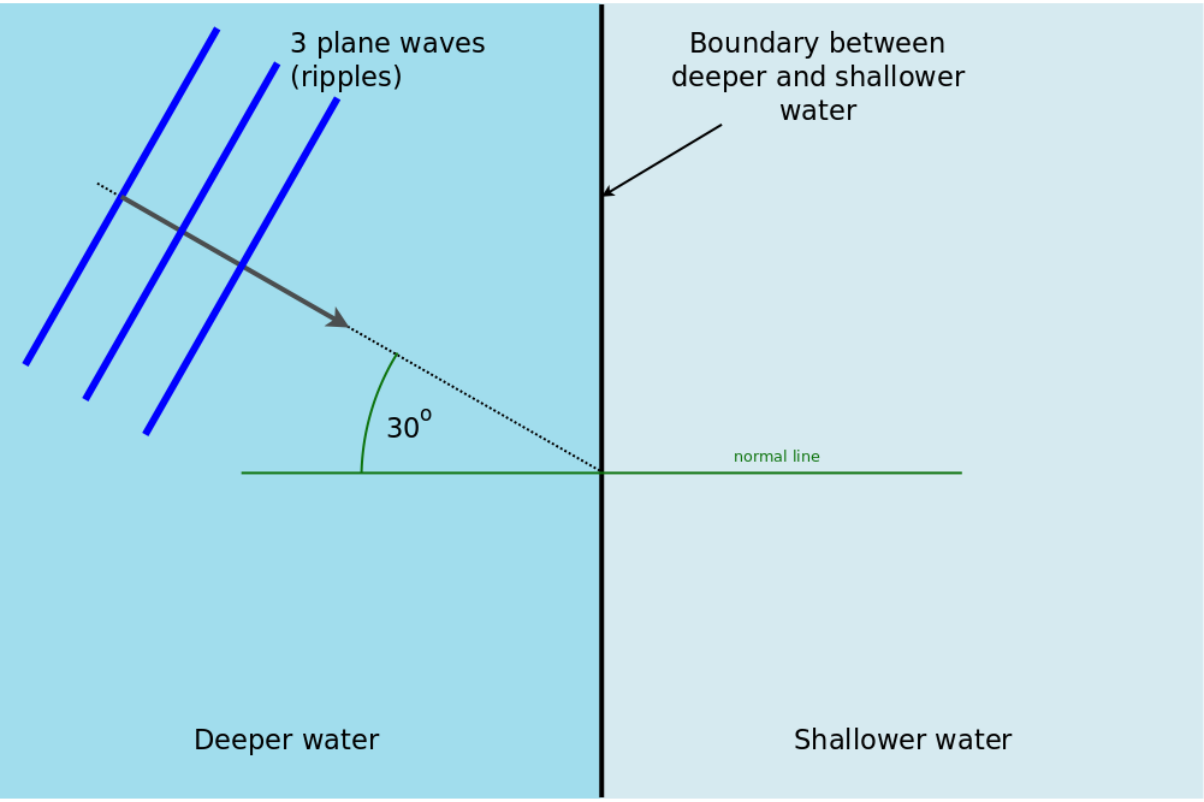
……

……

……

Add to the diagram.

Show what happens to the ripples as they approach and cross the boundary.



Calculate the direction that the ripples travel in the shallower water.

……

……

……

……

Explain why ocean waves often arrive at a sandy beach parallel to the shore line.

……

……

……

……

……

Senior Physics Challenge Task 3 ANSWERS BOOKLET

Part 1: Measuring Density [15 marks]

Centre of mass of the ruler

Position of the centre of mass of the ruler ……..

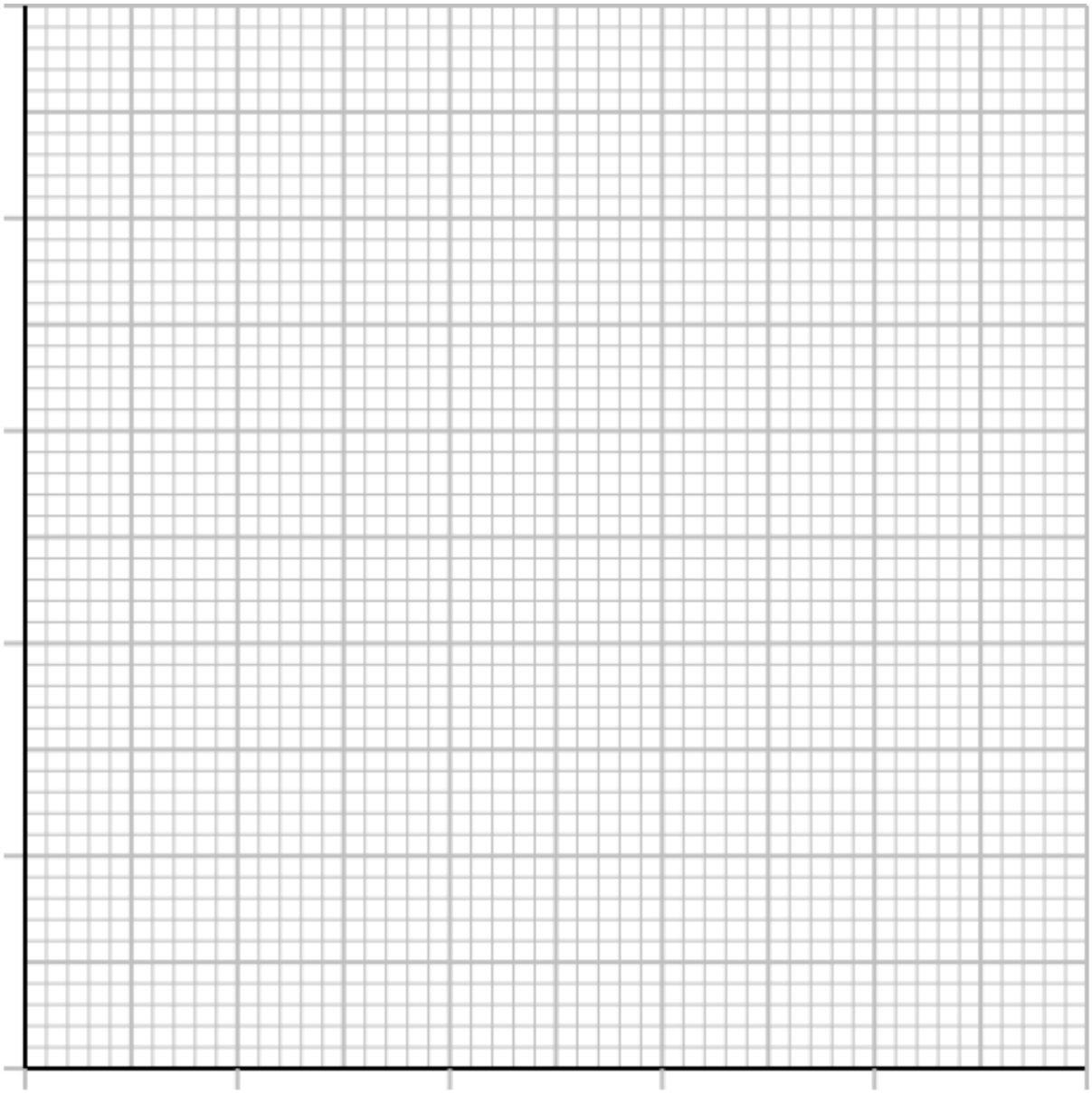
Mass of the empty plastic box

Mass of the bolt (from the printed card) ……..

Record your results in the table

Distance from dowel to centre of mass of the empty box (x) in cm	Distance from dowel to the centre of mass of the bolt (y) in cm

Use the graph paper on the next page to plot the required graph



Calculate the gradient of the best fit straight line

……

……

……

Calculate the mass of the empty box

……

……

……

Mass of the ruler

Mass of one nut (from the printed card) ……..

Record your results in the table

Distance from dowel to centre of mass of the ruler (x) in cm	Distance from dowel to the centre of mass of the nut (y) in cm

Use the graph paper on the next page to plot the required graph

Calculate the mass of the ruler

……

……

……

……

……

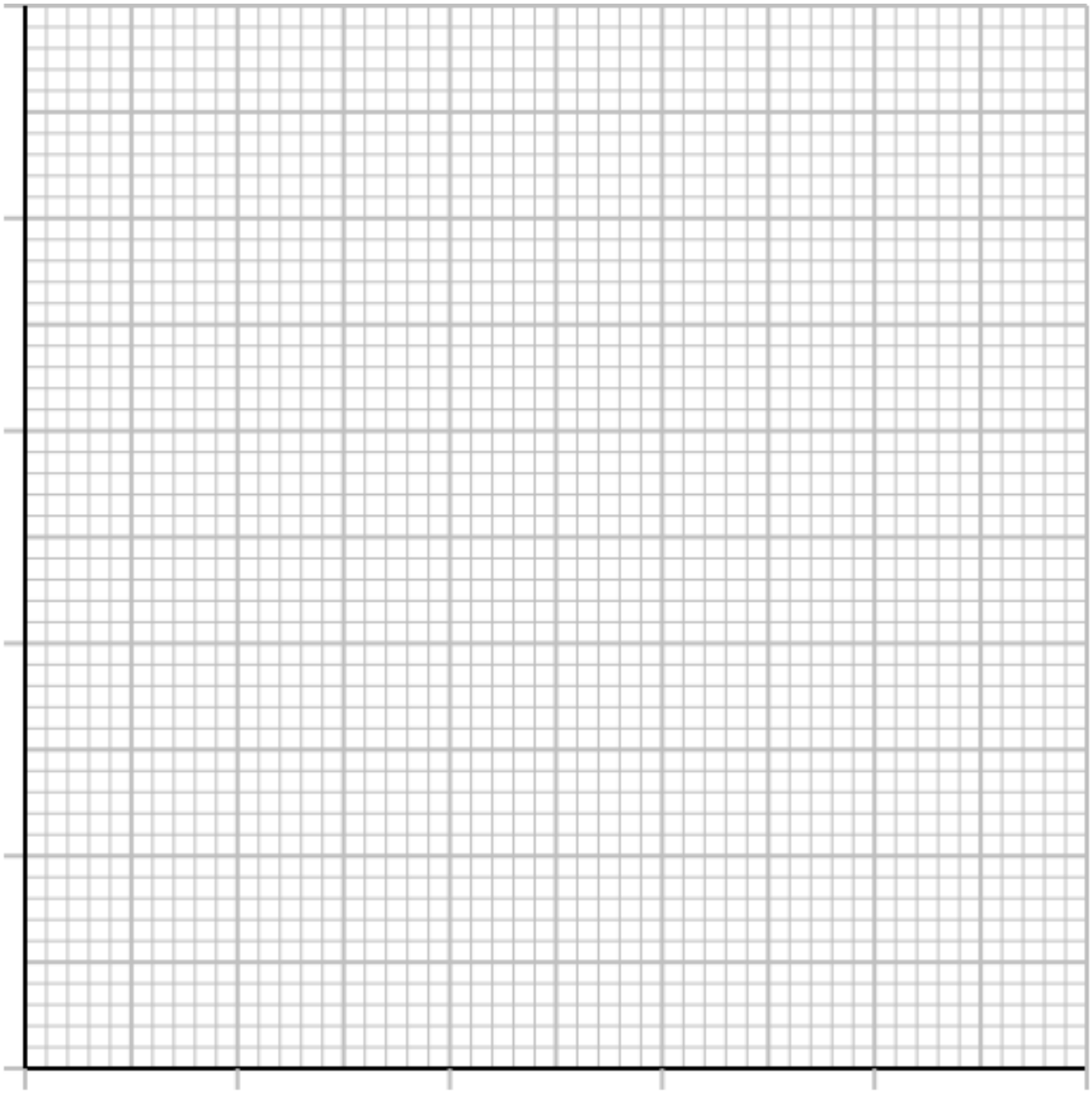
……

……

……

Mass of ruler ……

Graph to determine the mass of the ruler



Volume of gravel in the box

Depth of gravel in the box …….

Length of box …….

Width of box …….

Volume of gravel in the box …….

Mass of gravel in the box

Diagram of the arrangement with the **bolt and 5 nuts**

Calculate the mass of the plastic box and gravel

……

……

……

Diagram of the arrangement with the **bolt and 3 nuts**

Calculate the mass of the plastic box and gravel

……

……

……

Diagram of the arrangement with the **bolt and 1 nut**

Calculate the mass of the plastic box and gravel

……

……

……

Calculate the average mass of the plastic box and the gravel

……

……

……

Calculate the mass of just the gravel in the box

……

……

……

Density of the gravel

Calculate the density of the gravel

……

……

……

Advantage of using a large amount of gravel

……

……

……

……

Advantage of using a small amount of gravel

……

……

……

……

Part 2: A different way to measure density [5 marks]

Change of water level in the bottle ……

Measured diameter of bottle ……

How did you measure the diameter of the bottle? Draw a diagram

……

……

……

Calculate the volume of water displaced

……

……

……

Volume = ……

Calculate the density of the gravel

……

……

……

Density = ……

Part 3: Radius of Earth [10 marks]

Chosen value of acceleration due to gravity g = ……

Explanation: ……

……

……

Chosen value of density ρ = ……

Explanation: ……

……

……

Average density of Earth

Calculate the average density of Earth

……

……

……

……

……

……

……

……

……

Radius of Earth and journey to the equator

Calculate the radius of Earth

……

……

……

……

……

……

Calculate the distance to the equator

……

……

……

……

Calculate the number of days taken to reach the equator

……

……

……

……