**Walton High**

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**Year 12 AS Physics: Making sense of Data**

**Coursework Guide**

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Making sense of data coursework

# Practice Task

(Practice Data Handling Task, 2008)

Below are the results of an experiment about the time period of a pendulum.

|  |  |
| --- | --- |
| **Length (m)** | **Time**  **(s)** |
| 0.02 | 0.284 |
| 0.04 | 0.401 |
| 0.06 | 0.491 |
| 0.08 | 0.567 |
| 0.10 | 0.634 |
| 0.12 | 0.695 |
| 0.14 | 0.750 |
| 0.16 | 0.802 |
| 0.18 | 0.851 |
| 0.20 | 0.897 |
| 0.22 | 0.940 |
| 0.24 | 0.982 |
| 0.26 | 1.02 |
| 0.28 | 1.06 |
| 0.30 | 1.09 |

1. Type these results into Excel and produce a graph with length along the bottom and time up the side. **Print.**
2. The theory of the simple pendulum is that the time for one oscillation (*T*) depends on the length (*l*) of the pendulum and the acceleration due to gravity (*g*)



To see if the experimental results agree with the theory you need to process them to find a straight line graph. If the equation above is correct then a graph of T against √l will be a straight line through (0,0).

To do this, make another column on the spreadsheet for √length. Use a calculator or an equation in Excel to calculate the square root of each of the lengths. [The equation is =(cell with length in it)^0.5]. **Print the sheet.**

1. Now plot the graph of time against √length. You may need to move the columns about to get it with time up the side. Right click the series on the graph and add a trendline **Print**.
2. You should have a trendline that is of the form y=mx+c. According to the theory



is like y = m x (the general equation for a straight line through the origin)

so the gradient of the line m = 2π/√g

so, rearranging, m√g = 2 π

√g = 2 π/m

**g = 4** π**2/m2**

Find m from your trendline equation.

Create a bubble from Autoshapes, copy the equation for **g** into it and work out a value for g.

It should be 9.81N/kg. Comment on the value that you got and write it in the bubble. **Print.**

# Experiment Background

## Introduction

When an object falls through a fluid (such as air or water) there are a number of forces acting upon the object. These forces will in turn affect the rate of fall of the object. Your task will be to gather enough data so you can investigate what happens when objects fall.

The task is designed to test your ability to analyze data, discover trends/relationships, deal with errors and draw qualified conclusions. The whole class will perform the same experiment and gather the same data but it is up to you how you analyze your results and how far you take your analysis.

You will need to use a full range of techniques including but not limited to:

* Research to find physical theories
* Statistics e.g. averaging, curve fitting, gradients, intercepts etc…
* Graphs and tables
* Equations e.g. looking for testable predictions and trends, such as:
* Error analysis e.g. error bars, error calculations

## Measurements, Variables and errors

The experiment will involve dropping ball bearings into a tube of liquid.

You may measure or need to consider some or all of the following:

1. Mass of ball bearing
2. Diameter of ball bearing
3. Distance of fall
4. Time of fall
5. Temperature of Liquid
6. Homogeneity (smoothness) of liquid
7. Density of Liquid
8. Path of fall (close or far from the edge of the tube)
9. Friction

## Stokes’s Law Theory

In 1851, George Gabriel Stokes derived an expression for the frictional force (also called [drag force](http://en.wikipedia.org/wiki/Drag_force)) exerted on spherical objects with very small Reynolds numbers (e.g., very small particles) in a continuous viscous fluid by solving the small fluid-mass limit of the generally unsolvable Navier-Stokes equations (Stokes' Law, 2008).

If the particles are falling in the viscous fluid by their own weight, then a terminal velocity, also known as the settling velocity, is reached when this frictional force combined with the [buoyant upthrust force](http://en.wikipedia.org/wiki/Buoyant_force) exactly balance the [gravitational force](http://en.wikipedia.org/wiki/Gravitational_force). The resulting settling velocity is given by:

V_s = \frac{2}{9}\frac{r^2 g (\rho_p - \rho_f)}{\mu}

where:

* *Vs* is the particles' settling velocity (m/s) (vertically downwards if ρ*p* > ρ*f*, upwards if ρ*p* < ρ*f*),
* *r* is the [Stokes radius](http://en.wikipedia.org/wiki/Stokes_radius) of the particle (m),
* *g* is the [gravitational acceleration](http://en.wikipedia.org/wiki/Gravitational_acceleration) (m/s2),
* *ρp* is the [density](http://en.wikipedia.org/wiki/Density) of the particles (kg/m3),
* *ρf* is the [density](http://en.wikipedia.org/wiki/Density) of the fluid (kg/m3), and
* μ is the (dynamic) fluid [viscosity](http://en.wikipedia.org/wiki/Viscosity) (Pa s).

You should be able to work out a simple relationship(s) that you can test when analyzing your experimental data

# Assessment Criteria

(Advancing Physics Specification, 2002)

## Initiative and independence:

Planning and use of resources

Your teacher should work closely with you. You should show initiative, personal involvement and interest in the task. The task may require the use of ICT resources if available. Marks are awarded at the following levels:

Planning

1. You needed considerable advice and help in making calculations and in constructing plots. You performed some analysis.

3. You formulated some questions and conclusions independently, perhaps modifying your ideas after discussion. You needed some help to identify the essentials of the experiment. You made calculations and plots independently, after some advice or direction.

5. You carried out the analysis and report writing independently. You identified and described the essentials of the experiment and decided what questions to ask and what conclusions to draw. You considered and explored alternatives. You made constructive use of any advice.

Use of resources

1. You used simple resources and perhaps used ICT but with little thought.

3. You used some of the available resources effectively.

5. You used the available ICT and other resources well.

## Use of knowledge, skill and understanding of physics

In completing the task you will need to use your understanding of physics you have studied to understand the experiment, to look for the important relationships in the data and to account for difficulties or discrepancies. Marks are awarded as follows:

Devising a strategy

1. Your approach was largely mechanical, with little planning ahead.

3. You anticipated straightforward relationships, you tried to link the data to the physics.

5. You used your knowledge of physics and your initial graphs and calculations to guide the progress of the work.

Experiment

1. You described the experiment and its purpose without basic errors in physics. The link between the physics of the experiment and the results of the data analysis was weak.

3. You described the experiment correctly, and some aspects of the physics underlying it were clear. You discussed some aspect of the experiment in explaining the results.

5. Your report demonstrates your understanding of the experiment. You discussed the essential physics behind the experiment clearly. You described the experiment clearly but briefly, drawing attention to aspects likely to be important in understanding the results.

## Quality of communication

You must produce a written report. You should move beyond descriptive reporting to show evidence of critical and connected thought about your work. Marks are awarded as follows:

The content of the report

1. You provided a report which contained some basic material: a description of experiment, the recorded data and some conclusions. The description of the experiment was basic. The data tables may have lacked significant details.

3. Your report made some attempt at all the important features: account of the experiment and the physics behind it; records of data; some processing of data; some display of relationships in graphs or tables; some conclusions supported by the data.

5. Your report was guided by a concern to make sense of data from the experiment. The outcome of your analysis was clear. You used graphs or tables well to display their message effectively, for example through good choices of scale. The captions to graphs or tables communicated the meaning to be drawn from them.

The presentation of the report

1. Your work may have been untidy or disorganised, with muddled arguments. You gave little thought to the impact of the report. Your graphs were constructed without thought for their appearance. Your English was adequate to express simple ideas clearly.

3. Your work was generally neat and orderly. Your graphs were basic, but neat and without distracting elements. Your English was adequate to express some more complex ideas.

5. Your report was concise, interesting to read and presented results with impact and clarity. You used available ICT and other resources for report writing and graphics thoughtfully. Your English was good.

## Analysis:

Mathematical skill and care

The data-handling task provides an opportunity for you to demonstrate appropriate and skilful use of mathematics and of forms of representation of data (e.g. graphs and tables) to support the analysis and extract meaning from the results. Marks are awarded as follows:

Graphs and tables

1. You provided some labelled graphs or tables relevant to the experiment. You used the quantities direct from the measurements. You did not make much of the possible errors.

3. You tried to choose the most appropriate plots or quantities to tabulate, usually correctly labelled with quantities and units. You made some correct calculations of relevant derived quantities. You mentioned the possible errors.

5. You chose sensible graphical plots and carried them out well. You interpreted graphs using the gradient, intercept or area under a curve. You used appropriate mathematical relationships correctly. You used orders of magnitude of quantities to check results. You thought about the magnitudes of possible errors and represented them on plots.

Analysis

1. You presented the data in a raw form. You drew some conclusions relevant to the data.

3. You used tables and graphs to show significant relationships, and provided some interpretation. You noticed any anomalies or discrepancies. Your conclusions were consistent with the data and with basic physical ideas.

5. Your knowledge and understanding was brought to bear in accounting for anomalies or discrepancies. Your graphs and tables were interpreted in terms of the relevant physics, using your knowledge and understanding to develop a model or make predictions. Your analysis revealed correctly the underlying mechanisms at work. The relationships you proposed were consistent with the evidence and with basic physical ideas.

# References

*Advancing Physics Specification.* (2002). Retrieved September 1, 2007, from OCR: http://www.ocr.org.uk/qualifications/as\_alevelgce/physics\_b\_advancing\_physics/index.html

*Practice Data Handling Task.* (2008). Retrieved February 9, 2008, from Gosford Hill: http://www.gosford-hill.oxon.sch.uk/physics/html/helpforstudents.html

*Stokes' Law*. (2008). Retrieved February 8, 2008, from Wikipedia: http://en.wikipedia.org/wiki/Stokes'\_law