**Investigation to compare methods of determining *g***

**Introduction** In this experiment you will be comparing three different methods of determining the acceleration of free fall, the acceleration *g* due to gravity. This will allow you to evaluate the outcome of each experiment and consider the factors involved which give rise to differing values achieved. You are expected to be familiar with the basic formulae involving acceleration : *a =* (*v - u*) */ t* and should be able to use *s= ut + ½ at2* where *s* is distance, *u* is initial velocity, *a* is acceleration and *t* is time.

**Aim:** To determine a value for g using a variety of methods

* To compare the results of the experiments and evaluate each method

**Equipment (per group)**

object to drop, e.g. a piece of plasticine or other non-brittle material

stop clock

data logging system

2 light gates

interrupt card

double interrupt card

**Health and safety** Beware of falling objects.

**Procedure1: Manual timing**

* Drop the object from a known height with measured distance *s*.
* Time the fall of the object from its release until it reaches the ground recording all your results.
* Repeat the experiment to validate the results.
* Calculate the acceleration due to gravity.
* Note how you have dealt with the following;
  + designing your experiment to reduce errors
  + reducing error in how you take each of your measurements
  + the possible effects of terminal velocity

**Procedure 2: Acceleration at A**

1. Set up the data logger with light gate.
2. Test the system to ensure that the interrupt card (or similar) falls easily and doesn’t fall at an angle other than vertical.
3. The logger will require the length of the interrupt card to allow it to calculate time and thus calculate speed at each point from the expression:
4. Set the logger running and drop the interrupt card.
5. Repeat by continuing to drop the card. The logger should record a value for speed through each gate passed during the drop.
6. Set the logger running and record a series of values for *g*.
7. You will require to calculate the velocity of the first leg from measurements of the length of the first blocked out region of the interrupt card and the time it takes to pass through the light gate. Repeat this for the second blocked out region .
8. The acceleration (g) can then be calculated from the difference between the two velocities and the average time between them.

**Procedure 3: Electromagentic Gate**

1. Use the equipment which has been set up for you.
2. Measure the time from the ballbearing being released by the electromagnet to the trapdoor being opened. (This is an automatic start/stop timing system.
3. Decide which SUVAT equation you will use and then take the other appropriate measurements required to calculate a value of g using the equipment.

**Extension Opportunities - Evaluating the Outcome**

1. Make a simple observation of the values obtained by each method.
2. Which method gave the most accurate result compared to the actual value of 9.81 ms-2? Quantify the percentage discrepancy.
3. Which method gives the most instantaneous measure of speed?
4. Why does the logger not require either the distance between sensors or distance across the double interrupt card? (hint *a =* ( *v - u* ) */ t*  )
5. For B and C does it matter at what velocity the card enters the first light gate?

**Recording**

As evidence for the Practical Endorsement you should have the data collected from your group in a clear and logical format. All work should be clearly dated.

In addition, in preparation for the assessment of practical work in the written examinations and to help develop your understanding of physics, you should have used the data collected to calculate a value for g, explaining clearly how you have used the data in each calculation.

You should have calculated the percentage difference between your calculated values and the accepted value.

You should be able to identify sources of uncertainty in each method and link these to an evaluation of each method. **Practical Skills**

* 1.2.1(b) safely and correctly use a range of practical equipment and materials
* 1.2.1(c) follow written instructions
* 1.2.1(d) make and record observations/measurements
* 1.2.1(e) keep appropriate records of experimental activities
* 1.2.1(g) use appropriate software and tools to process data
* 1.2.1(j) use a wide range of experimental and practical instruments, equipment and techniques appropriate to the knowledge and understanding included in the specification
* 1.2.2 (a) use analogue apparatus to measure length
* 1.2.2(c) use methods to increase accuracy such as a plumb line
* 1.2.2(d) use of stopwatch or light gates for timing
* 1.2.2(k) use of data logger with a variety of sensors to collect data