**Comparing methods of determining *g***

**Introduction**

This experiment should be carried out when learners are familiar with the basic formula for acceleration. An understanding of the suvat equations is useful, but not essential as learners can work from the formulae given.

**Aim and skills covered**

* To compare three different methods of determining the acceleration of free fall (the acceleration due to gravity), allowing them to evaluate the outcome of each experiment and consider the factors involved which give rise to differing values achieved.
* Use of appropriate analogue apparatus to measure distance
* Use of a stopwatch and light gates for timing
* Use of a data logger to collect and process data
* Use of methods to increase accuracy such as a set square or plumb line

**Intended class time**

* 90 to 120 minutes

**Links to Specifications**

**Physics A**

* 3.1.1 (a) displacement, instantaneous speed, average speed, velocity and acceleration
* 3.1.2 (a) the equations of motion for constant acceleration in a straight line, including motion of bodies falling in a uniform gravitational field without air resistance
* 3.1.2 (b) acceleration *g* of free fall and its experimental determination using a falling object

**Physics B Advancing Physics**

* 4.2 a(vii) measurement of displacement, velocity and acceleration
* 4.2 c(iii) the kinematic equations for constant acceleration
* 4.2 d(ii) determining the acceleration of free fall, using trapdoor and electromagnetic arrangement, light gates or video technique

**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

**CPAC** (section 5g Table 2)

1. Follows written procedures

(3) Safely uses a range of practical equipment and materials

(4) Makes and records observations

**Mathematical skills**

* M0.1 Recognise and make use of appropriate units in calculations
* M0.2 Recognise and use expressions in standard form
* M0.3 Calculate percentage uncertainties
* M1.1 Use an appropriate number of significant figures
* M1.2 Find arithmetic means
* M2.2 Change the subject of an equation
* M2.3 Substitute numerical values into algebraic equations using appropriate units
* M2.4 Solve algebraic equations, including quadratic equations
* M3.7 Distinguish between instantaneous and average rate of change

**Equipment**

Teachers will need to ensure learners are familiar with the apparatus below in order to demonstrate these Practical Skills.

* object to drop – piece of plasticine or other non-brittle material
* stop clock
* data logging system
* 2 light gates
* interrupt card
* double interrupt card

The method described is based on the use of Data-Harvest EasySense data-loggers, or similar, which has options for determining acceleration from A to B or acceleration at A, capturing the time of each change of state as the object passes through the light gate.

Other systems may simply indicate velocity at A and B, requiring the distance between sensors to be measured to calculate acceleration *a* from *v*2 *= u*2 *+* 2*as.*

**Health & Safety**

Materials being dropped should not be likely to break or shatter. Care should also be taken to avoid possible injury from dropped materials.

These experiments are referred to in the “Mainly Physics” section of the CLEAPSS Laboratory Handbook, section 12.4 Dynamics.

Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.

**Notes**

* These practical activities are not controlled assessments, should not be carried out in exam conditions and can be adapted by the centre. Students can collaborate during the activities which should take place as part of the normal teaching sequence. They are intended to be formative with students acquiring and practising skills throughout the course.
* To achieve a pass in the Practical Endorsement each student is required to demonstrate competence in all the skills, apparatus and techniques listed in section 1.2 of the specification and assessed against the Ofqual Common Practical Assessment Criteria (CPAC) at the end of the course.
* The skills, apparatus and techniques can be demonstrated during any practical work undertaken during the A Level course whether an OCR practical activity or not.
* OCR recommends that this experiment is trialled by the teacher in advance of giving it to the students to ensure familiarity with the data logging equipment and the suitability of the worksheet for the data loggers being used.

**Recording**

* Learners should not need to re-draft their work but rather keep all their notes as a continuing record of Practical Activity.
* As evidence for the Practical Endorsement learners should have evidence of the data collected from their group in a clear and logical format.

In addition, to support the assessment of practical work in the written examinations:

* They should have used the data collected to calculate a value for g, explaining clearly how they have used the data in each calculation.
* They should calculate the percentage difference between your calculated values and the accepted value.
* They should identify sources of uncertainty in each method and link these to an evaluation of each method.