OCR B Physics A-Level

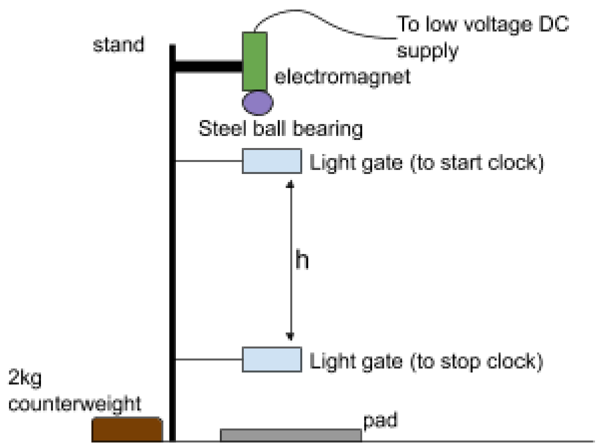
PAG 1.1

Comparing methods of determining g

Using light gates

Equipment

- Clamp stand
- Electromagnet connected to low voltage DC supply
- Steel ball bearing
- Light gates x 2
- Data logger
- Metre ruler
- 2 kg counterweight
- Soft pad for the ball bearing to land on



Method

1. Set up the apparatus as shown in the diagram, connecting the light gates to a data logger and as close to the electromagnet as possible.
2. The position of the lower light gate should be adjusted such that the height (h) is 0.75 m, measured using the metre ruler.
3. Turn on the electromagnet and attach the ball bearing.
4. Switch off the electromagnet, and note the time taken for the bearing to fall between the light gates (t) as recorded by the data logger.
5. Reduce h by 0.05 m by moving the lower light gate upwards and repeat the above two steps, reducing h by 0.05 m each time down to 0.25 m.
6. Repeat the experiment twice more to find mean values of t for each value of h.

Calculations

- Plot a graph of 2h against t^2 and draw a line of best fit. The gradient of the line of best fit will be g. This is derived using one of the constant acceleration formula below:

$$s = ut + \tfrac{1}{2}at^2$$

$$h = \tfrac{1}{2}gt^2$$ As h is distance travelled, g is acceleration, u is 0

$$2h = gt^2$$

$$y = mx$$

Safety

- Use a counterweight or clamp the stand to the table to avoid it toppling over and causing injury.
- The ball bearing is cushioned by a pad at the bottom of the clamp so it does not bounce upwards and cause injury.

Notes

- The distance between the upper light gate and the starting position of the ball bearing must be kept constant so that it reaches the upper light gate with the same speed each time.
- The ball bearing should be dense to help mitigate the effects of air resistance.
- To reduce parallax error in measuring the height, a ruler can be clamped directly next to the light gates.
- You could use the light gates to record the initial velocity (u), final velocity (v), and the time taken for the ball bearing to fall between the gates. This would allow you to use the constant acceleration formula $v = u + at$ to calculate g. Note the values of velocity would be averaged as the bearing is accelerating while moving through the gates.

<u>Using a stopwatch</u>

Equipment

- Tennis ball
- Stopwatch
- Metre ruler
- Soft pad for the ball to land on

Method

1. Using the metre ruler, measure a height (h) of 1.0 m. Place the soft pad at the bottom of the ruler.
2. Hold the tennis ball so the its bottom half is at the 1.0 m mark (it may be useful to work in pairs here, one holding the ruler, one holding the ball).
3. Release the ball and simultaneously switch on the stopwatch and switch it off as soon as the ball hits the soft pad. Note the time taken for the ball to hit the ground (t) as recorded by the stopwatch.
4. Reduce h by 0.05 m and repeat the above two steps, reducing h by 0.05 m each time down to 0.50 m.
5. Repeat the experiment twice more to find mean values of t for each value of h.

Calculations

- Plot a graph of 2h against t^2 and draw a line of best fit. The gradient of the line of best fit will be g. This is derived using one of the constant acceleration formula below:

$$s = ut + \tfrac{1}{2}at^2$$

$$h = \tfrac{1}{2}gt^2$$ As h is distance travelled, g is acceleration, u is 0

$$2h = gt^2$$

y = mx

Safety

- The ball bearing is cushioned by a pad at the bottom of the clamp so it does not bounce upwards and cause injury.

Notes

- The metre ruler must be kept perpendicular to the ground, you could use a set square to make sure this is the case.
- The tennis ball will experience a large amount of air resistance which may affect your calculation of g, therefore the tennis ball can be swapped out for a ball bearing to improve results.
- Reaction times will hugely affect the recorded times (t), making the results less accurate.

Overall Comparison

The second method is easier to carry out and requires less complex equipment, however it will be far less accurate. Therefore, the initial method is better for calculating a more accurate value of g.