

TAP 206- 3: Measuring the acceleration of free fall

Getting as close to g as possible

In this activity you are required to measure the acceleration of free fall as accurately as possible, given the limitations of the apparatus used. You should also estimate the degree of uncertainty in your final result.

You will need

- ✓ access to a reasonably large 'drop', e.g. a stair well.
- ✓ ball bearing
- ✓ cardboard box with cloths, or some other arrangement, to ensure a soft, safe landing
- ✓ tape measure
- ✓ stopwatch reading to at least 0.1 s
- Plus – if available (and there is enough time to use it)
- ✓ an electronic timing system, data-logging device, video camera or computer-aided system for measuring the time of fall through a measured distance
- ✓

What to do

1. Start with the simplest possible equipment listed above and use it to time the fall of a small metal sphere through a measured height. Calculate the value of the sphere's acceleration – hopefully close enough to be labelled g – using the formula:

$$s = \frac{1}{2}gt^2 \quad \text{where } t \text{ is the time of fall and } s \text{ the distance fallen.}$$

2. Repeat the readings 10 times and consider the results. Decide if any are too different from the others to be considered unreliable. If you have a reason why a result is wrong (e.g. you know you started the stopwatch too late) then discard it and take enough extra, reliable measurements to make up the total to 10.
3. Take the mean of these as your measurement of g .
4. Estimate the possible spread of values in each of your measurements.
5. Now use these estimates to calculate the worst possible cases. What are the largest and smallest values of g that your measurements and uncertainties could allow? (Hint – perform two separate calculations.)
6. Now estimate how precisely you have measured the value of g .
7. Think about whether there could be bias in your experiment, giving a value which is systematically too high to too low.

Extra

You might have the time and interest to try to make a more reliable estimate of g . A number of electronic and other types of equipment have been designed for this. Check with your teacher whether or not such equipment to measure g is available and worth using. After all, the best way to find out the value of g is to look it up in a book of physical constants.

Points to learn from this:

1. One or two ways for measuring the acceleration of free fall.

2. How to estimate the reliability of a measurement and quantities calculated from measurements.

Practical advice

This activity is somewhat open-ended, allowing students to engage in simple measurements and then think about what to improve, and how.

Alternative approaches

The same procedure may be used with a digital stop clock or timer instead of the computer and interface. The data could be entered into a spreadsheet and manipulated to calculate speeds and plot graphs. The method described removes the hassle of entering much of the data.

External references

This activity is taken from Advancing Physics Chapter 9, 120E