

# Straight-line motion with graphs and equations

AP Physics 1 (algebra-based) · Lab answers

The model answers use the sample data in the results table. Your own values will differ slightly, but the straight-line shape of the graph and the slope method must be the same. Quote results with the number of significant figures the timing allows.

**Level:** AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 1

## Question 1 Why plot against $t^2$

For constant acceleration from rest,  $\Delta x = \frac{1}{2}at^2$ , so  $\Delta x$  against  $t^2$  is a straight line through the origin. A straight line is easy to judge by eye and its slope gives  $a$  directly, while  $\Delta x$  against  $t$  is a curve that cannot be checked as easily. **Slope =  $a/2$ .**

## Question 2 A check on the table

Mean =  $(1.22 + 1.19 + 1.22)/3 = 3.63/3 = 1.21$  s. Then  $t^2 = 1.21^2 = \mathbf{1.464\ s^2}$ , which matches the table.

## Question 3 Finding the acceleration

Slope =  $(1.00 - 0.20)/(2.465 - 0.504) = 0.80/1.961 = 0.408\ \text{m/s}^2$ . Since slope =  $a/2$ ,  $a = 2 \times 0.408 = \mathbf{0.82\ m/s^2}$ .

## Question 4 Timing uncertainty

Half the range is  $(0.72 - 0.70)/2 = 0.01$  s. Percentage uncertainty =  $0.01/0.71 \times 100 = \mathbf{1.4\ \%}$ . Squaring doubles it, so  $t^2$  has about **2.8 %** uncertainty.

## Question 5 Prediction

$t = \sqrt{(2\Delta x/a)} = \sqrt{(2 \times 1.50 / 0.82)} = \sqrt{3.66} = \mathbf{1.9\ s}$ .

## Question 6 An intercept

A positive  $t^2$  intercept means the measured time is shorter than expected for a given distance, as if the clock started late or the ball had a small initial push. The ball was not released exactly from rest at the start line, or the stopwatch was started after release.

**Systematic timing or release error.**

### Question 7 Improving the method

Use two light gates connected to a timer instead of a stopwatch to remove reaction time, and use more repeats with a longer ramp so the times are larger. Either change lowers the percentage uncertainty. **Light gates and longer distances.**