

Equations of motion for constant acceleration

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab answers

With the sample data the acceleration is close to 0.79 m/s^2 , slightly below the frictionless value of 0.82 m/s^2 . Your own ramp will give a different value, but a straight line through the origin confirms constant acceleration.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.4, IB A.1

Question 1 Shape of the graph

From $s = \frac{1}{2}at^2$ the graph is a **straight line through the origin** with gradient $\frac{1}{2}a$.

Question 2 Gradient

Gradient = $(1.00 - 0) \div (2.53 - 0) = \mathbf{0.395 \text{ m/s}^2}$.

Question 3 Acceleration

$a = 2 \times \text{gradient} = 2 \times 0.395 = \mathbf{0.79 \text{ m/s}^2}$.

Question 4 Speed at the bottom

$v = at = 0.79 \times 1.59 = \mathbf{1.26 \text{ m/s}}$. Check: $v^2 = 2as = 2 \times 0.79 \times 1.00 = 1.58$, so $v = 1.26 \text{ m/s}$.

Question 5 Theory comparison

Ideal $a = 9.81 \times (0.10 \div 1.20) = 0.818 \text{ m/s}^2$. Difference = $(0.818 - 0.79) \div 0.818 = \mathbf{3.4 \%}$ **lower than ideal**, which is explained by friction and rolling resistance.

Question 6 Timing uncertainty

$0.03 \div 1.59 = 1.9 \%$. Squaring doubles it: **3.8 % in t^2** .

Question 7 Improvement

Use a light gate or frame-by-frame video to improve timing, and **repeat each timing more times** to average out random errors. Keep the starting release identical each time.

Question 8 Hypothesis check

From 0.20 m to 0.40 m the time rose from 0.71 s to 1.02 s, a factor of 1.4, not 2. **The claim**

is false: time is proportional to $\sqrt{s}$, since $s \propto t^2$.