

Projectiles and relative motion in a plane

AP Physics 1 (algebra-based) · Lab answers

The model answers use the sample table. Your own measurements will differ a little, but the shapes of the graph and the method of analysis should be the same.

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

Question 1 Fall time

$$2H \div g = 2 \times 0.90 \div 9.81 = 0.1835 \text{ s}^2, \text{ so } t = \mathbf{0.43 \text{ s}}.$$

Question 2 Launch speed

$$v = x \div t = 0.69 \div 0.428 = \mathbf{1.6 \text{ m/s}}.$$

Question 3 Why x^2

$x = vt$ and $t^2 = 2H \div g$, so $x^2 = v^2 t^2 = v^2 \times 2H \div g$. For a rolling ball v^2 is proportional to h , and $2H \div g$ is constant, so x^2 is proportional to h : the graph is a **straight line through the origin**.

Question 4 Gradient

$$\text{Gradient} = (0.706 - 0.240) \div (0.30 - 0.10) = 0.466 \div 0.20 = \mathbf{2.3 \text{ m}}.$$

Question 5 Energy check

$x^2 = (v^2 \div h) \times (2H \div g) \times h$, so $v^2 \div h = \text{gradient} \div 0.1835 = 2.33 \div 0.1835 = 12.7 \text{ m/s}^2$. This is **91 %** of 14.0 m/s^2 ; the shortfall comes from friction at the ramp joint and air resistance, which remove kinetic energy.

Question 6 Uncertainty

Half the spread = $(0.71 - 0.67) \div 2 = 0.02 \text{ m}$. Percentage uncertainty = $0.02 \div 0.69 \times 100 = \mathbf{\text{about } 3 \%}$.

Question 7 Improvement

Use a smoother join between ramp and table so the ball does not bounce; use a photogate or video to measure the speed directly; add more release heights and more trials. Also measure H more precisely with a longer rule. Best single change: **photogate timing at the table edge**.