

Independent horizontal and vertical motion of projectiles

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

With $H = 0.85$ m the time of fall is 0.416 s for every release. The launch speeds 1.49, 2.02 and 2.47 m/s follow from the ranges. Your values will differ, but the time of fall must be the same for all releases.

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

Question 1 Time of fall

$$t = \sqrt{2H \div g} = \sqrt{(1.70 \div 9.81)} = \sqrt{0.1733} = \mathbf{0.416 \text{ s.}}$$

Question 2 Launch speeds

$$v = x \div t: \text{low } 0.62 \div 0.416 = \mathbf{1.49 \text{ m/s}}; \text{medium } 0.84 \div 0.416 = \mathbf{2.02 \text{ m/s}}; \text{high } 1.03 \div 0.416 = \mathbf{2.47 \text{ m/s.}}$$

Question 3 Same time of fall

The vertical motion starts with zero vertical velocity each time and depends only on H and g .
The horizontal velocity does not affect the time.

Question 4 Percentage uncertainty

$$\text{Low: } 0.01 \div 0.62 = 1.6 \%. \text{ High: } 0.01 \div 1.03 = 0.97 \%. \mathbf{1.6 \% \text{ and } 1.0 \%}.$$

Question 5 Prediction

$$t = \sqrt{(2.40 \div 9.81)} = 0.4946 \text{ s. } x = 1.49 \times 0.4946 = \mathbf{0.74 \text{ m.}}$$

Question 6 Impact speed

$$v_y = gt = 9.81 \times 0.416 = 4.08 \text{ m/s. } v = \sqrt{(2.47^2 + 4.08^2)} = \sqrt{(6.10 + 16.65)} = \mathbf{4.77 \text{ m/s.}}$$

Question 7 Sources of error

Air resistance reduces the horizontal speed, and **the marble may leave the table with a slight downward angle or spin**. Measuring from the wrong point of the marble also changes x .

Question 8 Improvement

Take more landings per release and use their mean, or **use a camera to measure the speed at the table edge directly** for comparison.