

Centripetal acceleration and gravity in orbit

AP Physics 1 (algebra-based) · Lab answers

The sample data follow the theory closely. These model answers show the calculations, the expected graph and the main sources of error for the lab.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 2

Question 1 Completing a row

$F = M g = 0.150 \times 9.81 = 1.47 \text{ N}$. $T = 12.8 \div 20 = 0.640 \text{ s}$. $1/T^2 = 1 \div 0.640^2 = 1 \div 0.4096 = \mathbf{2.44 \text{ s}^{-2}}$.

Question 2 Drawing the graph

The five points lie close to a straight line through the origin. **F is directly proportional to $1/T^2$.**

Question 3 Using the gradient

Using the line through the origin, gradient = $\Sigma F \cdot x \div \Sigma x^2 = \mathbf{0.593 \text{ N s}^2}$. Theory: $4\pi^2 \times 0.025 \times 0.60 = 0.592 \text{ N s}^2$. The difference is +0.1 %, so the data agree with the theory.

Question 4 Timing uncertainty

Percentage uncertainty in the time = $0.3 \div 11.0 = 2.7 \%$. Since $1/T^2$ depends on T squared, double it: **about 5.5 %**.

Question 5 Effect of a sagging string

The tension acts at a small angle above the horizontal, so only its horizontal component provides the centripetal force. Mg then overestimates the real centripetal force, so the plotted F is too large for each period and the gradient comes out **slightly too high**.

Question 6 Radius doubled

Gradient = $4\pi^2 m r$ is proportional to r, so doubling r doubles it: $4\pi^2 \times 0.025 \times 1.20 = \mathbf{1.18 \text{ N s}^2}$.

Question 7 Improvements

Time 30 revolutions and repeat each run three times so the percentage timing uncertainty falls; use a video with a frame-by-frame count to find the period more accurately. **Longer**

timed runs and repeats.