

Free-body diagrams and net force problems

AP Physics 1 (algebra-based) · Lab answers

The model answers use the sample table. Your own values will differ a little, but the line should be straight with a gradient close to $1 \div M$ and a small intercept on the force axis.

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

Question 1 Acceleration

From $d = \frac{1}{2}at^2$ with $u = 0$, $a = 2d \div t^2$. For 0.060 kg: $a = 2.00 \div 1.48^2 = 2.00 \div 2.19 = \mathbf{0.91 \text{ m/s}^2}$.

Question 2 The graph

Gradient = $(1.57 - 0.26) \div (0.981 - 0.196) = 1.31 \div 0.785 = \mathbf{1.7 \text{ m/s}^2 \text{ per N}}$.

Question 3 System mass

Gradient = $1 \div M$, so $M = 1 \div 1.67 = \mathbf{0.60 \text{ kg}}$, in agreement with the value found with the balance.

Question 4 The intercept

Extend the line: $a = 0$ when $F = 0.196 - 0.26 \div 1.67 = \mathbf{0.04 \text{ N}}$. This is the friction force opposing the motion; only the force beyond 0.04 N accelerates the system.

Question 5 Constant total mass

Keeping M constant means that a changes only because F changes; adding mass to the hanger alone would raise F and M together, so a would not be proportional to F . Keeping M fixed at $\mathbf{0.600 \text{ kg}}$ makes the graph a straight line.

Question 6 String tension

For the hanger, $mg - T = ma$, so $T = 0.100 \times (9.81 - 1.57) = \mathbf{0.82 \text{ N}}$. This is smaller than the weight of 0.98 N because the hanger accelerates downward.

Question 7 Improvement

Use a low-friction track or an air track and a light pulley; use two photogates or a video to time the motion more precisely; time over a longer distance; repeat more times. The most effective change is **photogate timing**.