

Centre of mass, impulse and momentum with calculus

AP Physics C (Mechanics and E&M, calculus-based) · Lab answers

Calculated values use masses in kilograms and positions in centimetres. Your own differences will vary, but they should be a few tenths of a centimetre and close to the reading uncertainty. Compare your explanation with the model answers below.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:M Unit 4

Question 1 Calculated position

$x_{\text{cm}} = (0.100 \times 50.0 + 0.050 \times 90.0)/(0.150) = 9.5/0.150 = \mathbf{63.3 \text{ cm}}$, compared with 63.0 cm measured.

Question 2 Complete the table

Trial 2: $9.0/0.300 = 30.0 \text{ cm}$. Trial 3: $(5.0 + 8.0 + 1.0)/0.300 = 46.7 \text{ cm}$. Trial 4: $(5.0 + 10.5)/0.250 = 62.0 \text{ cm}$. Trial 5: $(5.0 + 7.5)/0.350 = \mathbf{35.7 \text{ cm}}$.

Question 3 Differences

Measured minus calculated: $-0.3, +0.3, -0.2, +0.2, -0.2 \text{ cm}$, which are 0.5 %, 1.0 %, 0.4 %, 0.3 % and 0.6 % of the calculated positions. The largest is **1.0 %**.

Question 4 Pattern of errors

The differences have mixed signs and no trend, so they are **random scatter** rather than a systematic error.

Question 5 Why balancing works

The weight acts as if at the centre of mass. With the support there, the weight and the support force have no turning effect, so the rule stays **horizontal**.

Question 6 Uncertainty

The largest difference is 0.3 cm, which is equal to the $\pm 0.3 \text{ cm}$ reading uncertainty. The results are **consistent with the formula within error**.

Question 7 Better precision

Mark the rule with a thin pencil line and use a very narrow support, or find the balance point three times and average. **Repeat and average.**