

Work as an integral and potential energy curves

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

Model answers based on the sample data. The gradient should come out near 25 N/m and the measured drop extension a few per cent below the prediction. If your own spring differs, check that your units are in metres and newtons before comparing.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:M Unit 3

Question 1 Spring constant

Points lie on a straight line through the origin. Gradient = $2.45/0.098 = \mathbf{25\text{ N/m}}$, and Hooke's law holds over this range.

Question 2 Area under the graph

Triangle area = $\frac{1}{2} \times 2.45 \times 0.098 = 0.120\text{ J}$, and $\frac{1}{2}kx^2 = \frac{1}{2} \times 25 \times (0.098)^2 = 0.120\text{ J}$, so they agree: **0.12 J**.

Question 3 Predicted drop

$mgx = \frac{1}{2}kx^2$ gives $x = 2mg/k = 2 \times 0.100 \times 9.81/25 = 0.0785\text{ m}$, so the predicted extension is **7.8 cm**.

Question 4 Measured against predicted

Mean = $(7.7 + 7.5 + 7.6)/3 = 7.6\text{ cm}$. Difference = $(7.85 - 7.6)/7.85 = \mathbf{3.2\% \text{ lower}}$ than predicted.

Question 5 Energy accounting

Gravitational energy lost = $mgx = 0.981 \times 0.076 = 0.0746\text{ J}$. Elastic energy = $\frac{1}{2} \times 25 \times (0.076)^2 = 0.0722\text{ J}$. Missing energy = **0.0024 J**, about 3 % of the loss.

Question 6 Uncertainty

$0.001/0.020 = 5\%$, so the 50 g point carries **5 %** uncertainty. Larger loads have smaller percentage uncertainty, so the best-fit gradient is dominated by the larger loads.

Question 7 Evaluation

Air resistance and internal friction in the spring remove a little energy, and the spring's own mass was ignored. Using a higher frame-rate video reduces the reading error: **smaller than predicted because of energy losses.**