LESSON 3.3.1

Tables, Graphs,

Gradients and Intercepts

Organise the readings, reveal the relationship and extract quantities from the line. Each stage should preserve the units and the evidence.

ILLUSTRATIVE SPRING DATA: FORCE AND EXTENSION

Force F / N	Reading 1 / mm	Reading 2 / mm	Mean x / m
0.50	9.8	10.2	0.0100
1.00	19.8	20.2	0.0200
1.50	29.7	30.1	0.0299
2.00	39.9	40.3	0.0401
2.50	49.8	50.2	0.0500
3.00	59.8	60.2	0.0600

Two repeats are shown to illustrate the table, not as a fixed requirement. Record suitable repeats at every setting and keep the original readings.

HEADINGS AND PRECISION

Put the quantity and unit in each heading. Keep raw decimal places consistent with the instrument; show repeat readings separately.

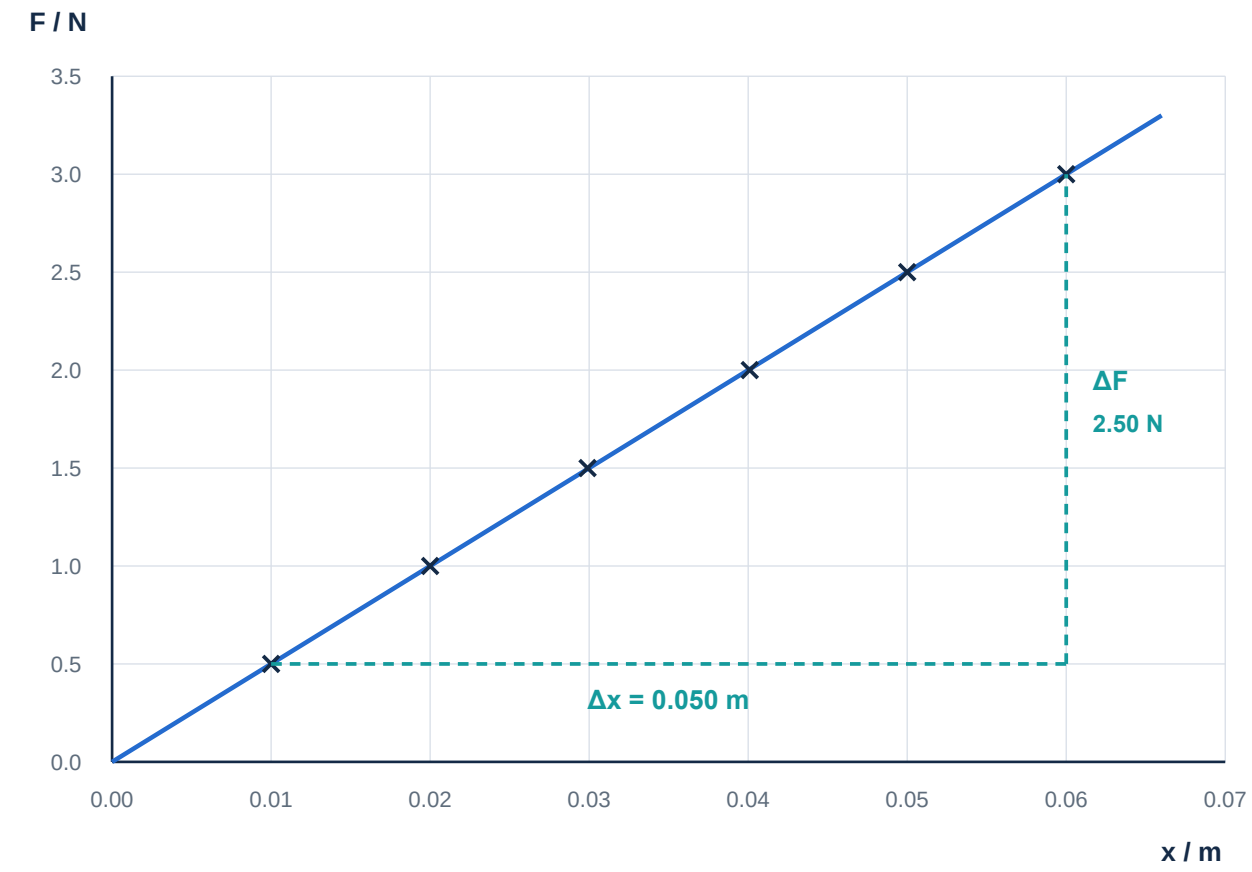
PROCESS WITHOUT LOSING UNITS

Average the extensions, then convert mm to m by dividing by 1000. Tabulate the exact quantities that will be plotted.

A table is the record; a graph is a model-based view of that record.

1 Plot the relationship clearly

Plot F against mean extension x so the gradient can be compared directly with the spring constant.



Crosses: readings Blue: illustrative best-fit line Dashed: gradient triangle

CHOOSE READABLE SCALES

Label both axes with quantities and units. Use simple equal intervals and spread the data over at least half the grid in each direction.

FIT THE TREND

Use a straight line only where the data supports one. Balance the scatter around the line; do not join neighbouring data points.

The large triangle uses two widely separated positions on the fitted line. They need not be measured points. Read coordinate differences from the axes, not distances on the paper.

The line is consistent with zero here; do not force an origin intercept in general.

2 Turn the line into quantities

For a straight line, compare the plotted variables with y = mx + c before interpreting the numbers.

GRADIENT OF THE FORCE-EXTENSION GRAPH

$$k = \frac{\Delta F}{\Delta x} = \frac{3.00 - 0.50}{0.060 - 0.010} = 50\ \text{N m}^{-1}$$

The gradient unit is the vertical-axis unit divided by the horizontal-axis unit. A steeper F-x line means a larger spring constant.

Use differences between two line coordinates. F/x at one point is only a valid shortcut if the fitted intercept is zero.

INTERCEPT: THE VERTICAL VALUE WHEN x = 0

$$F = kx + b \qquad b = F - kx$$

Using (x, F) = (0.020 m, 1.00 N): b = 1.00 - 50 × 0.020 = 0 N

The intercept b has units of force, not units of gradient.

LINEAR IS NOT ALWAYS PROPORTIONAL

A straight line with a non-zero intercept is linear. Direct proportionality also requires an intercept consistent with zero, allowing for uncertainty.

INTERPRET, THEN CHECK

An unexpected intercept may suggest an offset, missing load or model limitation. Check the setup and uncertainty before assigning a cause.

Source: Pearson IAL Physics, Unit 3 p. 26; Student Practical Guide pp. 9-10.

Lesson numbering follows the Jimlaoshi course sequence.