LESSON 3.3.3

Drawing Conclusions

and Evaluating Methods

A conclusion answers the investigation question. An evaluation explains how much confidence to place in that answer and how the method could be improved.

1. CLAIM

Name the relationship or state the measured result.

2. EVIDENCE

Use numbers, units and the graph to support it.

3. LIMIT

State the tested range and relevant uncertainty.

WORKED EXAMPLE: DOES A SPRING OBEY HOOKE'S LAW?

Illustrative analysis: six loads from 0.50 N to 3.00 N give extensions from about 0.010 m to 0.060 m. The force-extension graph is straight with an intercept consistent with zero.

$$F = kx \qquad k = \frac{\Delta F}{\Delta x} \approx 50 \text{ N m}^{-1}$$

Conclusion: the data supports force being directly proportional to extension over the tested range. The gradient gives a spring constant of about 50 N/m.

Do not claim that the spring obeys this law at every load. A straight line alone is not enough for direct proportionality: the intercept must also be consistent with zero.

Say what the evidence supports, not what the experiment has "proved".

1 Judge agreement using uncertainty

Two illustrative measurements of g are compared with a reference value of 9.81 m/s².

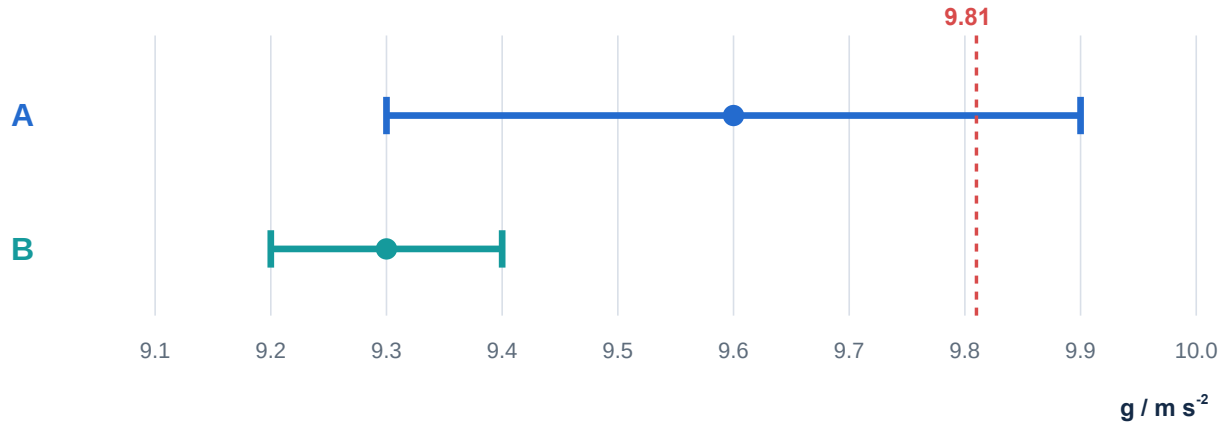
RESULT A: THE REFERENCE IS INSIDE THE INTERVAL

$$g = (9.6 \pm 0.3)\ m\ s^{-2}$$

Minimum: 9.6 - 0.3 = 9.3 **Maximum: 9.6 + 0.3 = 9.9**

Since 9.81 lies between 9.3 and 9.9, the result is consistent with the reference within the stated uncertainty. This does not mean the central value is exact.

COMPARE THE INTERVALS ON ONE SCALE



RESULT B: SMALLER UNCERTAINTY

B is 9.3 ± 0.1 m/s², so its interval is 9.2 to 9.4 m/s². It does not include 9.81. A narrower interval does not automatically mean better agreement.

DISAGREEMENT NEEDS INVESTIGATION

Check calibration, assumptions and overlooked uncertainties. Do not widen an uncertainty just to include the reference. If the reference has uncertainty, consider that too.

Intervals are supplied here; this example does not require combining uncertainties.

2 Make every improvement specific

Connect a named limitation to its effect on the result, then explain how the change addresses it.

LIMITATION	EFFECT ON THE DATA	TARGETED IMPROVEMENT
Spring pointer read from varying eye positions.	Parallax changes the apparent scale reading; repeated readings may scatter.	Keep the pointer close to the rule and view at its level, perpendicular to the scale.
Very short travel time measured by hand.	Reaction-time variation is a large fraction of the measured interval.	Use light gates and an electronic timer with suitable resolution; align the gates.
A force sensor reads +0.10 N with no load.	Every force reading has a positive offset; repeating does not remove it.	Tare the sensor before loading and verify zero. Correct existing data by the measured offset.
Wire heats during a current-voltage test.	Changing temperature changes resistance, confounding the intended comparison.	Use low currents, switch off between readings and let the wire cool to a consistent temperature.

MORE READINGS: CHOOSE THE PURPOSE

Repeats at each setting reveal scatter and improve a mean. More settings across a safe range test the shape of the relationship. Neither fixes a shared zero error.

PRIORITISE THE MAIN LIMITATION

Target the largest uncertainty or strongest bias first. "Be more careful" and "use better equipment" need a named action and a physical reason.

Source: Pearson IAL Physics, Unit 3 pp. 25-26 and Appendix 10 pp. 76, 80-81.

Lesson numbering follows the Jimlaoshi course sequence. Examples are illustrative.