



The lab report, written so that **another student could repeat it.**

A laboratory report is not an essay with numbers in it. It is a record that lets a reader judge what you did, decide whether they believe it, and repeat it themselves. This document sets out the nine parts, then works one experiment through completely — including the uncertainty statement — and closes with a marking checklist.

1 Why the standard shape exists — and why it is not an essay

The shape has an origin you can point to. Sollaci and Pereira surveyed medical journals across five decades and found that the familiar order took hold in the middle of the last century: "The IMRAD structure, in those journals, began to be used in the 1940s." It spread because it answers, in the order a sceptical reader asks them, four questions: what was asked, how it was done, what happened, and what it means.

A LABORATORY REPORT

- **Reader:** someone who wants to check or repeat the work.
- **Purpose:** to record what was observed, and how.
- **Dominant tense:** past tense for what you did; present for established theory.
- **Voice:** the passive ("the bob was displaced") or an impersonal first person, used consistently.
- **Opinion:** kept out of Results and confined to Discussion.

AN ESSAY

- **Reader:** someone who wants to be persuaded.
- **Purpose:** to defend a position against alternatives.
- **Dominant tense:** present tense for the argument itself.
- **Voice:** active and authorial, arguing in your own person.
- **Opinion:** present throughout by design — that is the point.

SOURCE Sollaci, L. B., & Pereira, M. G. (2004). The introduction, methods, results, and discussion (IMRAD) structure: A fifty-year survey. *Journal of the Medical Library Association*, 92(3), 364–371.

The order is the argument. A reader who cannot see what was done before being told what it means will not trust the result. If you find yourself explaining a number in the Results section, that explanation belongs in the Discussion.

2 The nine parts, and what does not belong in each

Part	What belongs in it	What does not
1. Title	What was measured, and by what method — specific enough to be found again.	"Physics practical 3". The marker already knows the course.
2. Aim	One or two sentences: the quantity to be determined, and to what precision.	A description of the apparatus, or background theory.
3. Introduction and theory	The relation you are testing, derived or stated, and the assumptions it rests on.	A history of the topic; material copied from the manual.
4. Apparatus and materials	Each instrument with its range and its smallest division.	"Standard laboratory equipment".
5. Method	Numbered steps, in the order performed, with the quantities varied and the readings taken.	A copy of the handout; a list of steps you did not actually follow.
6. Results	Tables and graphs of what was observed, to the precision the instruments justify.	Any explanation of why the numbers look as they do.
7. Sample calculation	One full worked substitution, with units carried through, from which the rest follow.	Arithmetic for every row of the table.
8. Discussion	What the result means, how it compares with the accepted value, and what limits it.	New measurements, or claims the data cannot support.
9. Conclusion	The value obtained, with its uncertainty, and whether the aim was met.	Speculation, or a restatement of the method.

TWO SECTIONS THAT FOLLOW, IF YOUR PROGRAMME ASKS FOR THEM

- **References** — only works you actually consulted, in the one style your school requires, applied consistently throughout.
- **Appendix** — the raw readings, the instrument's specification, or a full derivation. Nothing essential belongs here; if a reader needs it to follow the argument, it belongs in the body.



3 One experiment, written through completely

Everything below is a specimen of the nine parts in use, on a single experiment. The numbers are internally consistent, so the arithmetic can be followed from the table to the result.

1. TITLE

Determination of the acceleration due to gravity using a simple pendulum.

2. AIM

To determine the acceleration due to gravity, g , from the period of a simple pendulum, and to state the result together with an expanded uncertainty.

3. THEORY

For small angular displacements the period T of a simple pendulum of length l is $T = 2\pi\sqrt{l/g}$. Squaring gives $T^2 = (4\pi^2/g)l$, so a plot of T^2 against l is a straight line through the origin whose gradient is $4\pi^2/g$. The relation assumes a point mass on a massless, inextensible thread, and a swing amplitude small enough that the small-angle approximation holds.

4. APPARATUS

Retort stand and clamp; brass bob of mass 50 g; inextensible thread; metre rule, range 1 m, smallest division 1 mm; digital stopwatch, resolution 0.01 s; protractor, smallest division 1°.

5. METHOD

1. The thread was clamped and the bob attached. 2. The length l was measured from the clamp to the centre of the bob. 3. The bob was displaced through less than 10° and released without a push. 4. The time for 20 complete oscillations was measured with the stopwatch and repeated three times. 5. Steps 2 to 4 were repeated for $l = 0.200, 0.400, 0.600, 0.800$ and 1.000 m.

6. RESULTS

Length l / m	Time for 20 oscillations $t/20$ / s	Period T / s	T^2 / s ²
0.200	17.95	0.898	0.806
0.400	25.38	1.269	1.610
0.600	31.08	1.554	2.415
0.800	35.88	1.794	3.219
1.000	40.12	2.006	4.024

Units are carried in the column headers rather than repeated in every cell. The period column is the measured time divided by 20, which is why it carries more figures than the raw timing. Each timing above is the mean of three runs; the three individual readings are kept in the laboratory notebook and summarised here, because a table of fifteen raw timings would obscure the pattern rather than show it.

7. SAMPLE CALCULATION, FOR $l = 0.400$ M

$$T = t/20 = 25.38 \text{ s} / 20 = 1.269 \text{ s}; \quad T^2 = (1.269 \text{ s})^2 = 1.610 \text{ s}^2;$$

$$g = 4\pi^2 l / T^2 = 4\pi^2 (0.400 \text{ m}) / (1.610 \text{ s}^2) = 15.79 \text{ m} / 1.610 \text{ s}^2 = 9.81 \text{ m/s}^2.$$

The gradient of the graph of T^2 against l is $4.02 \text{ s}^2/\text{m}$, giving $g = 4\pi^2 / 4.02 \text{ s}^2 \text{ m}^{-1} = 9.81 \text{ m/s}^2$.

8. UNCERTAINTY

The dominant contribution is reaction time when starting and stopping the stopwatch, taken as ± 0.2 s over 20 oscillations, which is ± 0.01 s in T — a relative uncertainty of 0.8% at $l = 0.400$ m. The length contributes 0.25%, and the gradient fit approximately 0.15%. Combining these in quadrature gives a standard uncertainty of about 0.01 m/s^2 . The expanded uncertainty, using a coverage factor $k = 2$ for approximately 95% confidence, is 0.02 m/s^2 . The result is therefore $g = 9.81 \pm 0.02 \text{ m/s}^2$ ($k = 2$).

9. DISCUSSION

The value agrees with the accepted 9.81 m/s^2 to within the stated uncertainty, so the small-angle approximation is adequate for the amplitudes used. The largest systematic risk is the definition of l : measuring to the centre of the bob assumes the bob behaves as a point mass, which slightly overstates the effective length. Thread stretch under load and air resistance act in the opposite direction, and both are small at these lengths.

10. CONCLUSION

The acceleration due to gravity was found to be $9.81 \pm 0.02 \text{ m/s}^2$ ($k = 2$), consistent with the accepted value. The aim was met, with the precision limited chiefly by the manual timing.

SOURCES BIPM (2019), *The International System of Units (SI)*, 9th ed. — units and symbols. JCGM (2008), *Evaluation of measurement data — Guide to the expression of uncertainty in measurement* — standard, combined and expanded uncertainty, coverage factor k .



4 Tables and figures

TABLES

- Number and caption above the table; the caption must be readable on its own.
- Units in the column header, never repeated in each cell.
- One measurement per column; the independent variable on the left.
- No vertical rules. Horizontal rules at the head and foot are enough.
- Values rounded to the precision the instrument justifies, and aligned on the decimal point.

FIGURES

- Number and caption below the figure; axes labelled with quantity, symbol and unit: T^2 / s^2 against l / m .
- Plot the quantity that gives a straight line, then fit it — do not join points dot to dot.
- State the gradient with its unit, and show the line of best fit.
- Error bars where the uncertainty is visible; say what they represent.
- Every table and figure must be referred to in the text, by number.

5 Significant figures and rounding

The authority for quantity and unit conventions is the IUPAC *Green Book* — there is no separate standalone standard on significant figures, so cite the Green Book. Two rules cover most of what a report needs: multiplying or dividing keeps the significant figures of the least precise input; adding or subtracting keeps its decimal places.

Value	To 3 significant figures	Why
4.5678	4.57	Fourth figure is 7, so round up.
0.0045678	0.00457	Leading zeros are not significant.
9.9965	10.0	Rounding carries into the next power of ten.
0.099955	0.100	Trailing zeros after a decimal point are significant.
0.000010234	1.02×10^{-5}	Standard form keeps the significant figures visible.

The commonest rounding error is not arithmetic. It is reporting a result to more figures than the instrument can support: the mean of three stopwatch readings does not gain precision by being averaged.

6 Pre-lab, safety, and the fifteen-point checklist

BEFORE YOU ENTER THE LABORATORY

- Read the protocol and write the method in your own words.
- Draw the results table in advance, with headers and units.
- Identify the hazards and the control for each one.
- Know the smallest division of every instrument you will use.

AS YOU WORK

- Record raw readings immediately, in ink, and never overwrite.
- Repeat the reading that disagrees, rather than deleting it.
- Note the conditions: temperature, time, anything unusual.
- Ask before improvising a change to the stated method.

FIFTEEN CHECKS BEFORE YOU SUBMIT

- Title names the quantity and the method.
- Aim states the quantity and the precision sought.
- The relation to be tested is stated, with its assumptions.
- Every instrument has its range and smallest division.
- The method is in numbered steps, in the order performed.
- Units appear in table headers, not in cells.
- Tables and figures are numbered, captioned and referred to in the text.
- One complete sample calculation is shown, with units.
- Significant figures match the instruments used.
- A graph is plotted where the relation permits one.
- The gradient is quoted with its unit.
- The uncertainty is stated, with the coverage factor.
- The result is compared with the accepted or expected value.
- Sources of error are distinguished from mistakes.
- The conclusion answers the aim in one sentence, with the uncertainty.

A source of error is not a mistake. A reaction time of ± 0.2 s is an inherent limit of the method and belongs in the report as a source of error. Writing 25.38 s where the clock showed 25.83 s is a mistake — correct it transparently, and never present it as an uncertainty.