# PHY3004W Laboratory
# Neutron activation of $^{27}Al$
(also known as Half-Life)

Dr Tanya Hutton

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May 2025

# Analysis and write-up

- Your write-up should contain a brief introduction to the context and experimental details (<< 0.5 page). The remaining space should be dedicated to:
  - presenting your measured data,
  - presenting your analysis of the gamma ray spectra and associated decay curve(s), and justifying any decisions made with respect to fitting, and
  - a critical discussion on your final results.

- Submission to Amathuba by 17:00 23 May 2025.
  - Late submissions not accepted.
  - Any content beyond 2 sides of A4 will not be marked.

# Assessment criteria

- Appropriate presentation of results
- Evidence led decision making, and communication thereof
- Correct treatment of uncertainties
- Correct use of scientific language
- Evidence based conclusions
- Proof reading
- Following the instructions
- Formatting, style etc.

# How to produce a concise scientific report

T. Hutton

June 2021

## Introduction

This document aims to provide additional guidance when you are writing your report on the measurement of the half-life of $^{28}$Al. Keep to single column, with a minimum font size of 11 px. This write-up is not intended to be a full lab report, but it should still include a concise overview of the context, underlying physics and techniques employed to produce, measure and analyse the half-life of $^{28}$Al. It is inefficient to reproduce content when you can refer the reader to a trusted resource (textbooks, journal articles, laboratory documentation [1], etc.). Youtube videos, and other internet sources are not considered trustworthy as there is no peer review in place. Consider what information is required to interpret the results presented in later sections. The introductory content should be restricted to a single paragraph, with the remaining space dedicated to the presentation of your results, analyses and discussions. Any content extending beyond two pages will not be marked. It is strongly suggested that you refer to the feedback given in previous laboratories [2] to develop your scientific communication skills.

## Results & analysis

Often these sections are presented separately, which can result in a "data-dump" of figures and tables without context. Not only is this bad practice, but is a highly inefficient use of space. Combining the presentation of the results with the analyses of those results can improve the flow of the document and ensure that all presented information is fully incorporated. The most economical way to present your data will be to use simple tables and figures. An excellent example of hardworking figures can be found in [3]. The figures are clear, but have a high information density, and the captions are descriptive.

When producing plots choose an aspect ratio that is appropriate to both the data and its position on the page, and ensure that the axis labels are legible without having to zoom in. Please do not "squish" figures to fit. If, for example, I wanted to present a gamma ray spectrum over a broad energy range, then an aspect ratio similar to that shown in Fig. 1 would be a good way to save space, but still present the information in a clear manner. Note how the image was introduced, the important information summarized, and is located in close proximity to its reference within the text. If the presented data required analysis or processing, then the details should be provided, including a justification of any decisions related to the acquisition, processing and subsequent analysis.


**Fig. 1: A series of rubber ducks adorned with various accessories [4] as indicated on the figure. Annotations have been used to improve the information density. Of particular note are the matching scarves on ducks 3 and 5, suggesting that they did not communicate prior to photograph day. How embarrassing.**

When presenting linked results, it may be sensible to combine multiple plots into a single figure. Not only is this a more efficient use of space, but is useful to guide the reader into considering these pieces of information together. Figure 2 provides a very general example of how you may choose to do this. Refer to the different parts of this figure as Fig. 2(a) and Fig. 2(b) respectively.

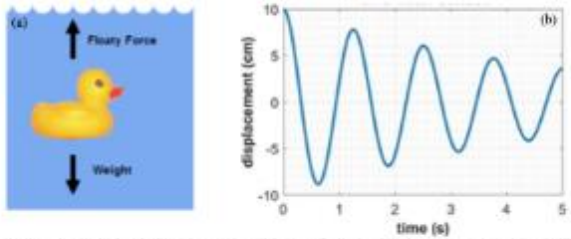


**Fig. 2: (a) A schematic of a rubber duck subject to the well-known "floaty force" in opposition to its weight. (b) The vertical displacement of a rubber duck as a function of time, relative to the water surface shown by the wavy line at the top of (a), with an average period of 1.25 ± 0.01 s.**

Maintain focus on the overall aim of the document, with all equations, figures and tables directly referenced in the text. Think about which pieces of information are critical to present and discuss to support your conclusions. If you have repeat measurements, do you need to present the full analysis process for all of them? Or just a subset of exemplar, or particularly interesting cases? Any numerical results should be quoted appropriately, with their uncertainties. When presenting the results of a fitting process, consider what evidence you need to provide to justify a "good" or "poor" fit. Can you provide both quantitative and qualitative evidence?

## Discussion & conclusions

This section should neatly tie everything together. Remind the reader of the aims of this work, quote final results with their uncertainties, discuss their quality and make comparisons to literature values. Any conclusions you draw have to be evidenced with the data presented in this document. Use specific language, i.e. do not include sentences like "it is clear that…" or "it can be seen…", rather "Figure N demonstrated…*some feature/behaviour*… which suggests… *some conclusion*…" etc. Be critical of your experiment and analysis, and discuss any improvements or further work that would be of interest. Leave sufficient time to proof read your document thoroughly. Try reading the document aloud, or changing the font type, to help you spot errors.

## References

[1] T. Hutton, *PHY3004W Laboratory: Half-life experiment*, UCT Physics, 2021.
[2] T.W. Leadbeater *General comments on Phy3004W – Gamma spectroscopy reports*, UCT Physics, 2021.
[3] S.S. McGaugh, et al., Phys. Rev. Lett. 117, 201101 (2016).
[4] Niradj, https://stock.adobe.com/contributor/3153272/niradj, accessed June 2021

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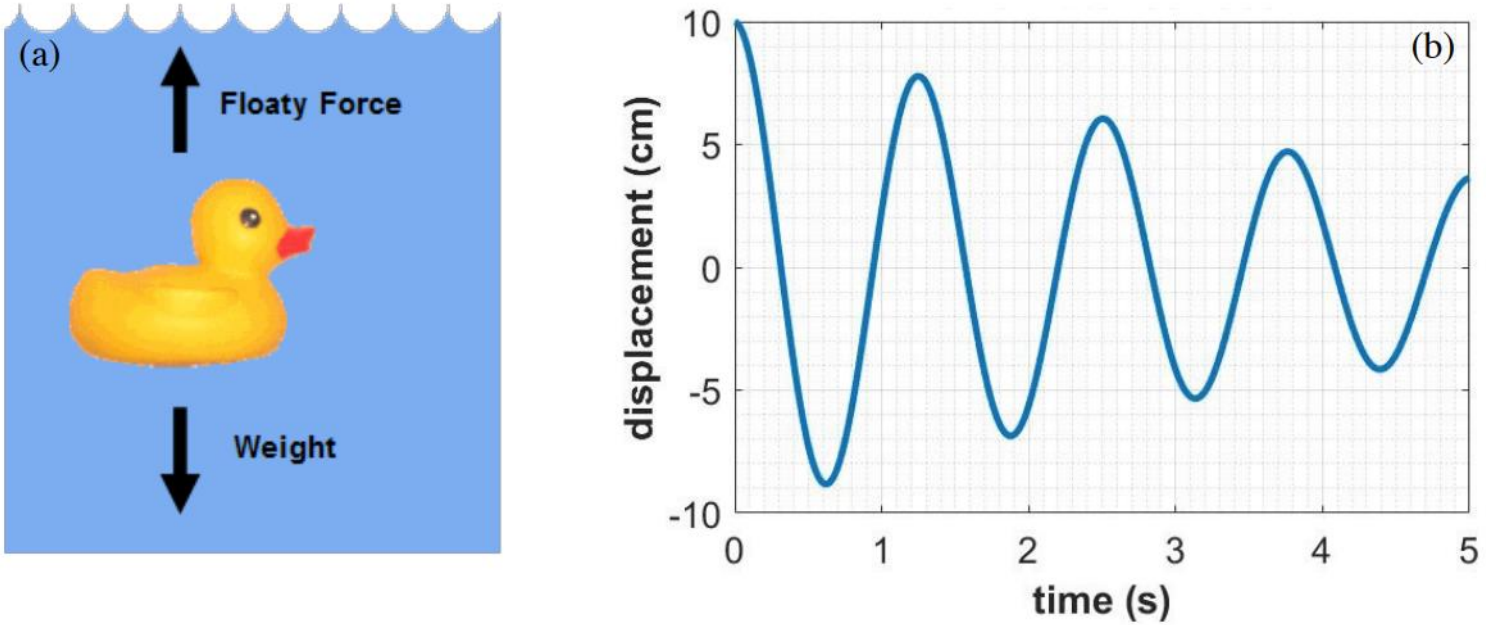


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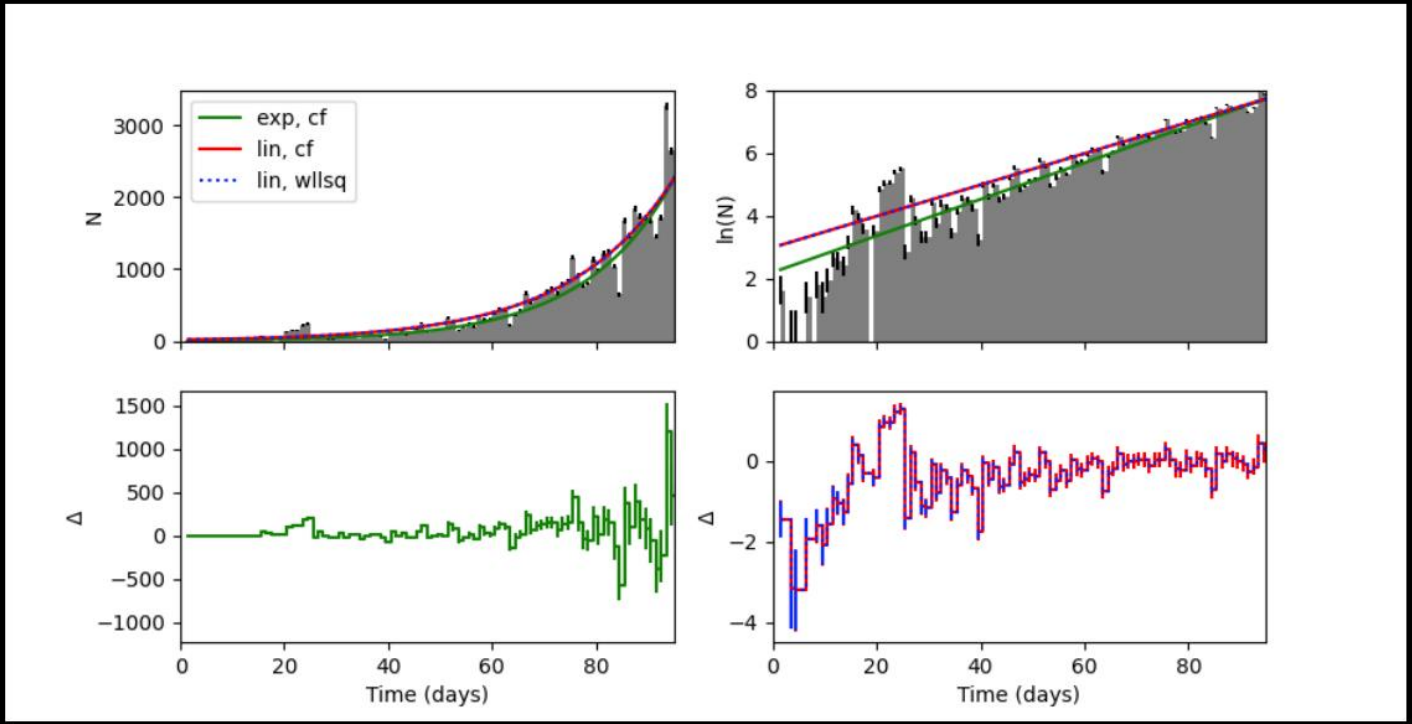


Exponential, curve_fit
$\lambda$ = 0.0582 ± 0.0017 day$^{-1}$
$X^2_{DOF}$ = 40.4

Linearised, curve_fit
$\lambda$ = 0.0499 ± 0.0016 day$^{-1}$
$X^2_{DOF}$ = 41.5

Linearised, wllsq
$\lambda$ = 0.04990 ± 0.00025 day$^{-1}$
$X^2_{DOF}$ = 41.5

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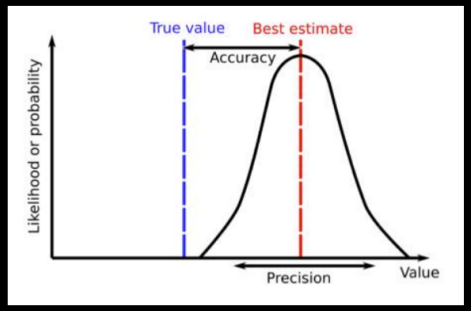
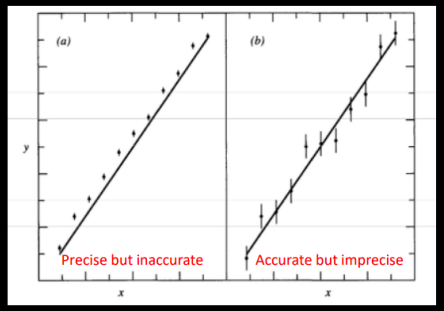
## Accuracy vs precision

Measure to find an estimate of the true value of a quantity




**Accuracy**: a measure of how close the result is to the true value

**Precision**: how well the result has been determined, without reference to the true value

## References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