

Homework Template

Chapter x

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L^AT_EX File name: *HW_1_Error_Analysis_Owen_Fitzgerald.tex*

<https://github.com/Fitzzy1293/latex-school/blob/main/HW1.tex>

1 Problem 1

To measure the activity of a radioactive sample, two students count the alpha particles it emits. Student A watches for 3 minutes and counts 28 particles; Student B watches for 30 minutes and counts 310 particles. (a) What should Student A report for the average number emitted in 3 minutes, with his uncertainty? (b) What should Student B report for the average number emitted in 30 minutes, with her uncertainty? (c) What are the fractional uncertainties in the two measurements? Comment.

Solution 3.1

Section 3.2: The Square-Root Rule for a Counting Experiment

$$student_{A\ Time} = 3\ \text{minutes} \quad student_{A\ Emitted\ 3\ minutes} = 28\ \text{particles} \quad (1.1)$$

$$student_{B\ Time} = 30\ \text{minutes} \quad student_{B\ Emitted\ 30\ minutes} = 310\ \text{particles} \quad (1.2)$$

(a) Student A's measurement

Using eq. 3.2 from the textbook: *Avg. events measurement* = $\nu \pm \sqrt{\nu}$ where ν - the greek letter *nu* - is the best average.

$$student_{A\ Emitted\ 3\ minutes} = 28\ \text{particles} \quad (1.3)$$

$$student_{A\ Uncertainty} = \sqrt{28} \approx 5.29150262212918 \quad (1.4)$$

$$student_{A\ Uncertainty} = \pm 5\ \text{particles} \quad (1.5)$$

$$\boxed{student_{A\ Emitted\ 3\ minutes} = 28 \pm 5\ \text{particles}} \quad (1.6)$$

(b) Student B's measurement

$$student_{B\ Emitted\ 30\ minutes} = 310\ \text{particles} \quad (1.7)$$

$$student_{B_{Uncertainty}} = \sqrt{310} \approx 17.6068168616590 \quad (1.8)$$

$$student_{B_{Uncertainty}} = \pm 18 \text{ particles} \quad (1.9)$$

$$\boxed{student_{B \text{ Emitted 30 minutes}} = 310 \pm 18 \text{ particles}} \quad (1.10)$$

(c) What are the fractional uncertainties? Comment, i.e interpret, the fractional uncertainties Using eq .2.21 from the textbook: $fractional \text{ Uncertainty} = \frac{\delta_x}{|x_{best}|}$, we can use eq. (1.11) with Students A and B.

$$fractional \text{ uncertainty} = \frac{\delta_\nu}{|\nu_{best}|} \quad (1.11)$$

$$student_A \text{ fractional Uncertainty} = \frac{5}{28} \approx 0.178571428571429 \quad (1.12)$$

$$student_B \text{ fractional Uncertainty} = \frac{18}{310} \approx 0.0580645161290323 \quad (1.13)$$

$$\boxed{student_A \text{ fractional Uncertainty} = 18\%} \quad (1.14a)$$

$$\boxed{student_B \text{ fractional Uncertainty} = 6\%} \quad (1.14b)$$

Student B's total uncertainty is higher than student A's, however B has a lower fractional uncertainty. Taking more data will always reduce your fractional uncertainty in scenarios where you count events. A lower fractional uncertainty implies a more accurate measurement, so B has a better measurement.