Homework Template

Chapter x

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LaTeX **File name:** *HW_1_Error_Analysis_Owen_Fitzgerald.tex*
https://github.com/Fitzy1293/latex-school/blob/main/HW_1_Error_Analysis_Owen_Fitzgerald.tex

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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

$$student_{A_{time}} = 3 \text{ minutes} \quad student_{A\ Emitted\ 3\ minutes} = 28 \text{ particles} \tag{1.1}$$

$$student_{B_{time}} = 30 \text{ minutes} \quad student_{B\ Emitted\ 30\ minutes} = 310 \text{ particles} \tag{1.2}$$

(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.

$$student_{A\ Emitted\ 3\ minutes} = 28 \text{ particles} \tag{1.3}$$

$$student_{A\ uncertainty} = \sqrt{28} \approx 5.29150262212918 \tag{1.4}$$

$$student_{A\ uncertainty} = \pm 5 \text{ particles} \tag{1.5}$$

$$\boxed{student_{A_{Emitted_{3minutes}}} = 28 \pm 5 \text{ particles}} \tag{1.6}$$

(b) Student B's measurement

$$student_{B\ Emitted\ 30\ minutes} = 310 \text{ particles} \tag{1.7}$$

$$student_{B\ uncertainty} = \sqrt{310} \approx 17.6068168616590 \tag{1.8}$$

$$student_{B\ uncertainty} = \pm 18 \text{ particles} \tag{1.9}$$

$$\boxed{student_{B_{Emitted_{30minutes}}} = 310 \pm 18\, particles} \tag{1.10}$$

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

$$fractional\ uncertainty = \frac{\delta_\nu}{|\nu_{best}|} \tag{1.11}$$

$$student_{A\ fractional\ uncertainty} = \frac{5}{28} \approx 0.178571428571429 \tag{1.12}$$

$$student_{B\ fractional\ uncertainty} = \frac{18}{310} \approx 0.0580645161290323 \tag{1.13}$$

$$\boxed{\begin{aligned} student_{A\ fractional\ uncertainty} &= 18\% \quad (1.14a) \\ student_{B\ fractional\ uncertainty} &= 6\% \quad (1.14b) \end{aligned}}$$

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.
