**PHYS705/805 Experimental Physics**

**Homework #3**

**Name:**

**This is an individual assignment.**

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|  |  | (keV) |
| 354.588 | 0.039 | 569.70 |
| 646.387 | 0.035 | 1063.66 |
| 1055.096 | 0.403 | 1770.24 |
| 716.784 | 0.129 | 1173.24 |
| 810.951 | 0.096 | 1332.50 |
| 413.66 | 0.036 | 661.66 |
| 519.326 | 0.042 | 834.86 |
| 323.637 | 0.073 | 511.02 |
| 779.143 | 0.068 | 1274.54 |

1. [2pt] The table lists the channel numbers *x* and Δ*x*, obtained by fitting Gaussians to photopeaks of known energies *E* (the values are intentionally not fully rounded).  
     ***Hint*** 🡪 You do not need to do these calculations with pencil and paper. But it is informative to calculate the values of *A* and *B* ‘by hand’ using the method of least squares at least once rather than using a built-in fitting function.
   1. Fit a straight line to this data set (this should be a non-weighted fit, i.e. ignore the information in the second column). What are the best values of the parameters *A* and *B* and their errors? What are their units? (Hint: *A* should be -44.34 ± 8.64 keV (not properly rounded).
   2. Compare your values to those obtained from a linear fitting routine in MatLab, python, or another program.
   3. You observe an ‘unknown’ photopeak at . Use the results from part a. to determine its energy and the error (Result: 1130 ± 13 keV).
   4. The error in part c. is unreasonably large; you can reduce it by rewriting the function used for your calibration. Fit to your data set for fixed (as in part a), 100, 200, … 1100. What do you observe? Which value of will result in the most precise calibration? Choose that value to recalculate and its error (result: 1130 ± 4 keV).
2. [1pt] Show that errors should be added in quadrature by adding two Gaussians and examining the resulting distribution: add a Gaussian centered at *x* with width to a Gaussian centered at *y* with width and show that the resulting distribution has a width of .
3. [1pt] Let be a product of the parameters to some power, .
   1. Show that the relative uncertainty of *f* is related to the relative uncertainties of *a, b, c* as follows:
   2. Demonstrate that this relation enables a quick estimate if, for example, the powers *m, n, p* are equal, or at least not much different, and one of the parameters (say, *a*) has a much larger relative error than the others, i.e.: and . For this case, show that .