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Lab 0 Part B

don't care about sig figs*

1.8 **ii** $N = N_0 \exp(-x/\lambda)$ $N_0 = 1000 \pm 5\cdot10^6$

$x = 1.00 \pm .01m$

$\lambda = 0.25 \pm .06m$

$N_{best} = 1000 \cdot \exp\left(\frac{-1}{.25}\right)\cdot 10^6$

$= 1000 \exp(-4) \cdot 10^6$

$= 18.3156... \cdot 10^6$ particles

$\sigma_N^2 = \sum_i \left(\frac{\partial N}{\partial P_i}\right)^2 \sigma_{P_i}^2$ $P_1 = N_0$ $P_2 = x$ $P_3 = \lambda$

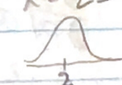
$\frac{\partial N}{\partial N_0} = \exp\left(-\frac{x}{\lambda}\right)$

$\frac{\partial N}{\partial x} = \frac{-N_0}{\lambda} \exp\left(-\frac{x}{\lambda}\right)$

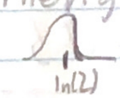
$\frac{\partial N}{\partial \lambda} = N_0 \exp\left(\frac{-x}{\lambda}\right)(-x)\left(-\frac{1}{\lambda^2}\right)$

$= \frac{N_0 x}{\lambda^2} \exp\left(\frac{-x}{\lambda}\right)$

Could the way these numbers play into the equation change our best result? For example, $y = \ln(x)$ if $x = 2 \pm .5$



since the log will essentially squish the gaussian from the right...



We might want define a new best result due to the fatter tail on the left.

$\sigma_N^2 = \left(\exp\left(\frac{-1}{.25}\right)5\cdot10^6\right)^2 + \left(\frac{-10^9}{.25}\exp\left(\frac{-1}{.25}\right)(.01)\right)^2 + \left(10^9\frac{1}{.25^2}\exp\left(\frac{-1}{.25}\right)(.06)\right)^2$

$= 3.097... \cdot 10^{14}$

$\sigma_N = \sqrt{3.097... \cdot 10^{14}} = 1.7... \cdot 10^7 \approx 2\cdot10^7$

$\boxed{N = 1.8 \pm 0.2 \cdot 10^7 \text{ particles}}$

$\boxed{1.8}\boxed{iii}$ $y = a + bx$

$a = 3.5 \pm .3\,cm$

$b = 5.0 \pm .1 \cdot 10^{-2}$

$\boxed{a}$ $x = 4m = 400cm$

$y_{best} = 3.5 + 5 \cdot 10^{-2} \cdot 400$

$y_{best} = 23.5cm$

$\sigma_y^2 = \left(\frac{\partial y}{\partial P_i}\right)^2 \sigma_{P_i}^2$ $\quad P_1 = a$ $\quad P_2 = b$ $\quad \frac{\partial y}{\partial a} = 1$

$= (.3)^2 + (.1 \cdot 10^{-2}(400))^2$ $\quad \frac{\partial y}{\partial b} = x$

$= .25$

$\sigma_y = \sqrt{.25} = 0.5cm$

$\boxed{Y = 23.5 \pm 0.5cm}$

$\boxed{b}$ $x = 4 \pm .1m = 400 \pm 10cm$ → *bad notation I know*

$y_{best} = 23.5cm$

*make units match

$\sigma_y^2 = \left(\frac{\partial y}{\partial P_i}\right)^2 \sigma_{P_i}^2$ $\quad P_1 = a$ $\quad P_3 = x$ $\quad P_2 = b$ $\quad \frac{\partial y}{\partial x} = b$

$= (1 \cdot 0.3)^2 + (.1 \cdot 10^{-2}(400))^2 + ((10(5))^2$

$= 2500.25$

$\sigma_y = \sqrt{2500.25} \approx 50cm$

1 significant figure

$\boxed{Y = 2 \pm 5 \cdot 10^1 cm}$

$[c] = \frac{mJ}{mol \cdot K}$

$\boxed{iv}$ $c = aT + bT^3$ $\quad a = 1.35 \pm 0.05 \frac{mJ}{mol \cdot K^2}$

$c_{best} = 1.35(5) + .021(5)^3$ $\quad b = 0.021 \pm 0.001 \frac{mJ}{mol \cdot K^4}$

$T = 5.0 \pm .5 K$

$c_{best} = 9.375 \frac{mJ}{mol \cdot K}$

$\sigma_c^2 = \left(\frac{\partial c}{\partial P_i}\right)^2 \sigma_{P_i}^2$ $\quad P_1 = a,\ P_2 = b,\ P_3 = T$

$\frac{\partial c}{\partial a} = T,\ \frac{\partial c}{\partial b} = T^3,\ \frac{\partial c}{\partial T} = a + 3bT^2$

$\sigma_c^2 = (5(0.05))^2 + (5^3(0.001))^2 + ((1.35 + 3(.021)(5)^2)(.5))^2$

$= 2.217...$

$\sigma_c = \sqrt{2.217...} = 1.48... \approx 1 \frac{mJ}{mol \cdot K}$

1 significant figure

$\boxed{c = 9 \pm 1 \frac{mJ}{mol \cdot K}}$