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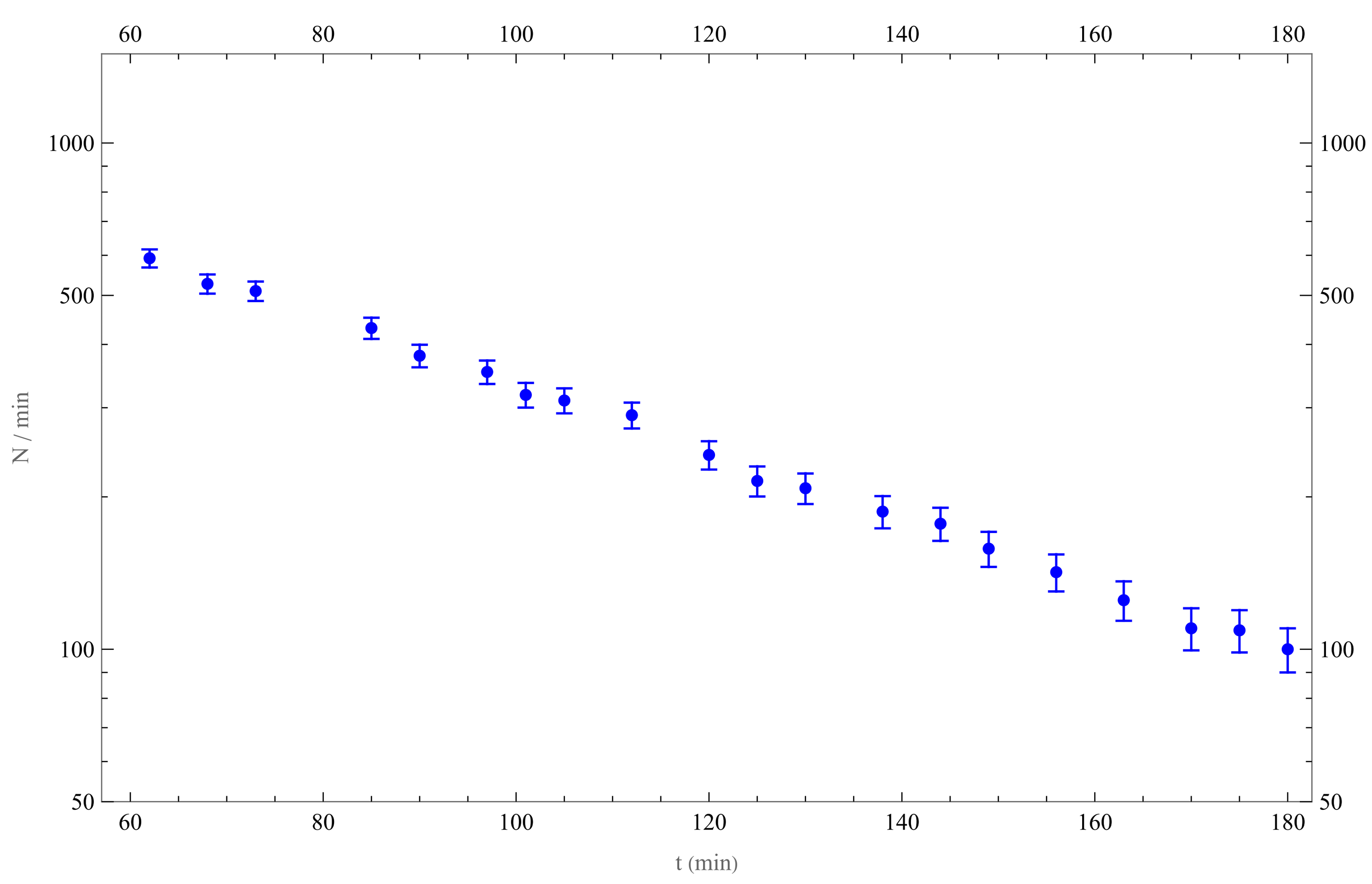
PHYS422 HW. 5

2/3/2023

Problem 1):

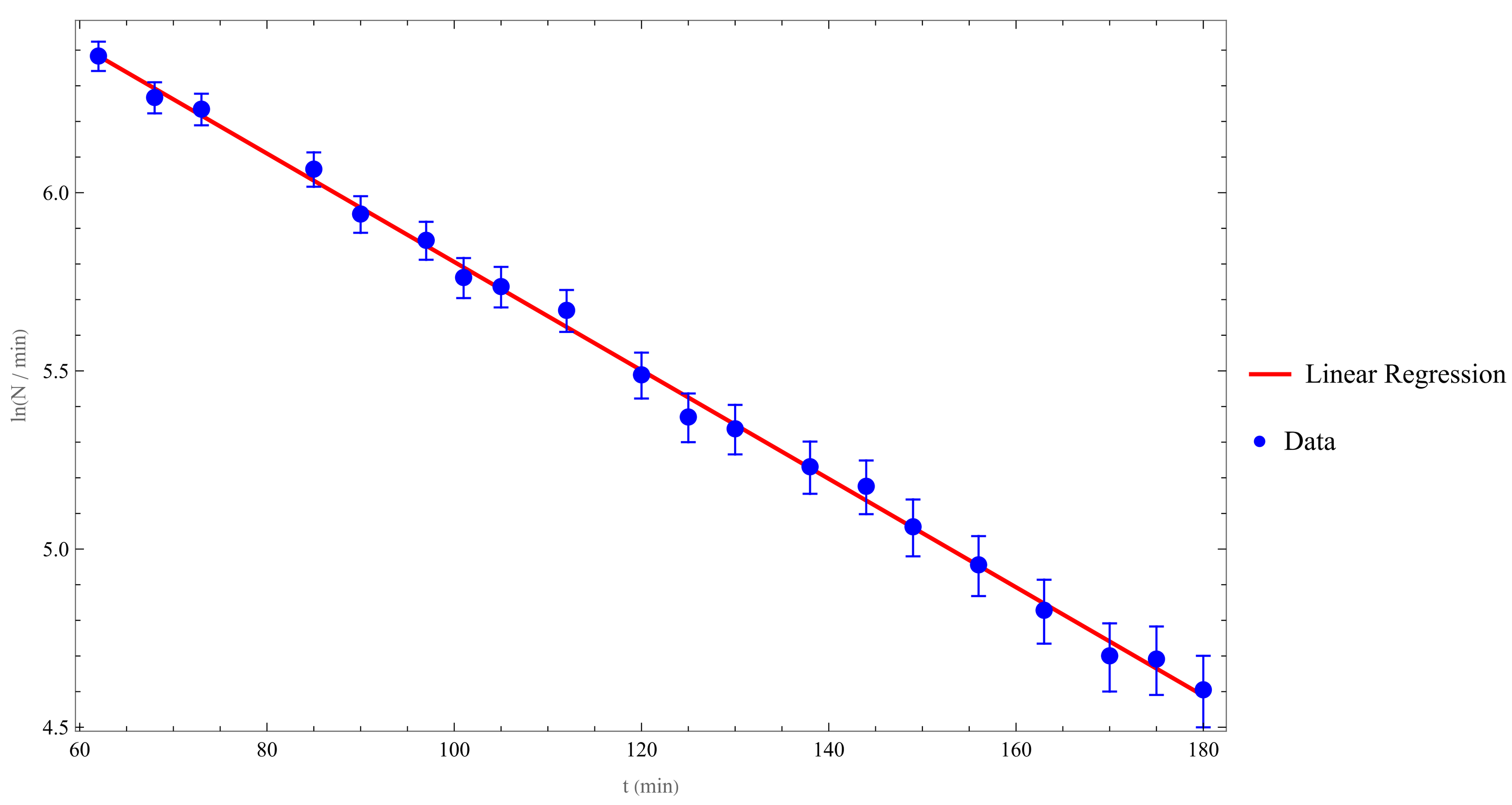
a)



b)

```
lm = LinearModelFit[data1, x, x];
lm["ParameterTable"]
```

	Estimate	Standard Error	t-Statistic	P-Value
1	7.327	0.0217341	337.12	1.16149×10^{-35}
x	−0.015213	0.000170749	−89.0958	2.88329×10^{-25}



I used Mathematica to perform the fit of $\ln N\ vs\ t$. We have :

$A(t) = A_0 e^{-\lambda t} \Longrightarrow \ln A(t) = -\lambda t + \ln A_0$

So, the original activity will be e to the power of the intercept, $e^{\ln A_0}$, and the slope represents -λ. Therefore:

$A_0 = e^{7.327\pm0.22} = 1521 \pm 1$ decay/min

$\lambda = 0.015 \pm 0.0002 \Longrightarrow t_{\frac{1}{2}} = \dfrac{\ln 2}{\lambda} = 46.21 \pm 0.61\text{min} = 2773 \pm 36.5\text{ s}$

Problem 19):

We can assume that the ratio of ^{14}C to ^{12}C in the atmosphere is the same is in organic materials, and it is 1.3 x 10^-12 . Moreover, ^{14}C has a half-life of 5700 years. So, to determine the activity, we use the following formula:

$$A = N\lambda = \frac{N_A}{12}\,\frac{1.3\times10^{-12}}{1}\,\frac{ln\,2}{t_{\frac{1}{2}} * 365 * 24 * 60} = 15\text{ Decay / min}$$

Problem 20):

From the ideal gas law, we know that $P\,V = N\,k\,T \Longrightarrow \dfrac{P\,V}{k\,T} = N$. After getting the number of C atoms, we can use the same ratio to get the numbers of ^{14}C. The decay constant is defined as probability of decay per nucleus per unit time. So, multiplying with the number if nuclei and the time will give us the probability of decay:

$$\frac{P\,V}{k\,T} \times 1.3\times10^{-12} = N_{C\,12} \times 1.3\times10^{-12} = \frac{1\times0.0003\times0.5}{k * 300} \times 1.3\times10^{-12} = 47\,079\ ^{14}\text{C Nuclei}$$

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}} * 365 * 24 * 60 * 60} \times 47\,079 \times 3.5 = 6.32\times10^{-7} = 6.32\times10^{-5}\ \%$$