**General Physics eJournal 12**

**Radioactive Decay**

**Instructions:**

Follow the Writeup and fill out the eJournal as you complete the lab activities. Submit your eJournal report by uploading the completed WORD or PDF document to our class Learninghub site. If the Learninghub site is down, email the completed report file directly to a lab TA.

**Preliminaries:**

* Title:
* Name(s):
* Date:
* Time In & Out:

**Plan:**

**Hypothesis**

Form a hypothesis regarding the half-life of a coin-toss radioactive decay simulation.   
In particular, make graphical sketch predictions for N vs. t and ln(N) vs. t.

*Insert images of your graphs*

**Experiment Outline**

Briefly describe your plan for testing your hypothesis.

**Equipment List**

* List
* Equipment
* Here

**Action:**

Describe the techniques used to collect data by responding to the bullet point questions:

* How did you perform the coin-toss simulation?
* How did you use the computer simulation to measure C-14 nuclei vs. time?

*Insert screenshot of from your computer simulation*

**Results:**

Record the number of coins that are heads next to each trial number.   
Add/remove rows in the table as needed.

**Table I: Coin-Toss Simulation Data**

|  |  |
| --- | --- |
| **Trial #, t** | **# of Heads, Ncoins** |
| 0 | 100 |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |

Record the number of Carbon-14 nuclei next to the time in years.   
Add/remove rows in the table as needed.

**Table II: C-14 Simulation Data**

|  |  |
| --- | --- |
| **Time, t (yr)** | **# of C-14 Nuclei, NC-14** |
| 0 | 100 |
| 1500 |  |
| 3000 |  |
| 4500 |  |
| 6000 |  |
| 7500 |  |
| 9000 |  |
| 10500 |  |
| 12000 |  |
| 13500 |  |
| 15000 |  |
| 16500 |  |
| 18000 |  |
| 19500 |  |
| 21000 |  |

**Analysis:**

**Coin-Toss Simulation – Exponential Graph**

Generate a plot of # of heads, Ncoins (y-axis) vs. trial number, t (x-axis).   
Apply an exponential curve fit and record the fit parameters, “a” and “c”.

*Insert graph of Ncoins vs t*

Compare the fit parameter “a” to the initial number of coins, N0 theory = 100 coins.

**Table III: Coin-Toss Simulation N0 Comparison (Exponential Graph)**

|  |  |  |
| --- | --- | --- |
| **a = N0 meas (coins)** | **N0 theory (coins)** | **% Error** |
|  | 100 |  |

Calculate the measured half-life, t1/2 meas, and compare it to the theoretical half-life, t1/2 theory = 1 trial.

**Table IV: Coin-Toss Simulation Half-Life Comparison (Exponential Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **c = λmeas (1/trials)** | **t1/2 meas (trials)** | **t1/2 theory (trials)** | **% Error** |
|  |  | 1 |  |

**Coin-Toss Simulation – Linear Graph**

Generate a plot of ln(Ncoins) (y-axis) vs. trial number, t (x-axis).   
Apply a linear fit and record the y-intercept, b, and slope, m.

*Insert graph of ln(Ncoins) vs t*

Calculate the initial number of coins, N0 linear, and compare it to N0 theory = 100 coins.

**Table V: Coin-Toss Simulation N0 Comparison (Linear Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **y-int, b** | **N0 linear (coins)** | **N0 theory (coins)** | **% Error** |
|  |  | 100 |  |

Calculate the measured half-life, t1/2 linear, and compare it to the theoretical half-life,   
t1/2 theory = 1 trial.

**Table VI: Coin-Toss Simulation Half-Life Comparison (Linear Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **m = -λlinear (1/trials)** | **t1/2 linear (trials)** | **t1/2 theory (trials)** | **% Error** |
|  |  | 1 |  |

**Carbon-14 Simulation – Exponential Graph**

Generate a plot of # of C-14 nuclei, NC-14 (y-axis) vs. time, t (x-axis).   
Apply an exponential curve fit and record the fit parameters, “a” and “c”.

*Insert graph of NC-14 vs t*

Compare the fit parameter “a” to the initial number of C-14 nuclei, N0 theory = 100 nuclei.

**Table VII: Carbon-14 Simulation N0 Comparison (Exponential Graph)**

|  |  |  |
| --- | --- | --- |
| **a = N0 meas (nuclei)** | **N0 theory (nuclei)** | **% Error** |
|  | 100 |  |

Calculate the measured half-life, t1/2 meas, and compare it to the theoretical half-life,   
t1/2 theory = 5730 years.

**Table VIII: Carbon-14 Simulation Half-Life Comparison (Exponential Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **c = λmeas (1/years)** | **t1/2 meas (years)** | **t1/2 theory (years)** | **% Error** |
|  |  | 5730 |  |

**Carbon-14 Simulation – Linear Graph**

Generate a plot of ln(NC-14) (y-axis) vs. time, t (x-axis).   
Apply a linear fit and record the y-intercept, b, and slope, m.

*Insert graph of ln(NC-14) vs t*

Calculate the initial number of C-14 nuclei, N0 linear, and compare it to N0 theory = 100 nuclei.

**Table IX: Carbon-14 Simulation N0 Comparison (Linear Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **y-int, b** | **N0 linear (nuclei)** | **N0 theory (nuclei)** | **% Error** |
|  |  | 100 |  |

Calculate the measured half-life, t1/2 linear, and compare it to the theoretical half-life,   
t1/2 theory = 5730 years.

**Table X: Carbon-14 Simulation Half-Life Comparison (Linear Graph)**

|  |  |  |  |
| --- | --- | --- | --- |
| **m = -λlinear (1/years)** | **t1/2 linear (years)** | **t1/2 theory (years)** | **% Error** |
|  |  | 5730 |  |

**Conclusion:**

Interpret your results in light of your hypothetical predictions. How well do the results support your hypothesis? Which curve-fit (exponential or linear) seems to be the most accurate method of analysis? From your trials with the Dating Game Simulation, why is Carbon 14 dating appropriate for once-living objects in upper geologic layers, but uranium dating is appropriate for rocks? How might you improve this experiment or explore it further?