<u>Twizzler Graph Activity</u>

This activity demonstrates properties of the radioactive half-life using simple readily available materials and graphs. Using actual twizzlers will also provide a snack for the participants.

Materials: One twizzler (red vine or length of string) for each participant

One pencil for each participant

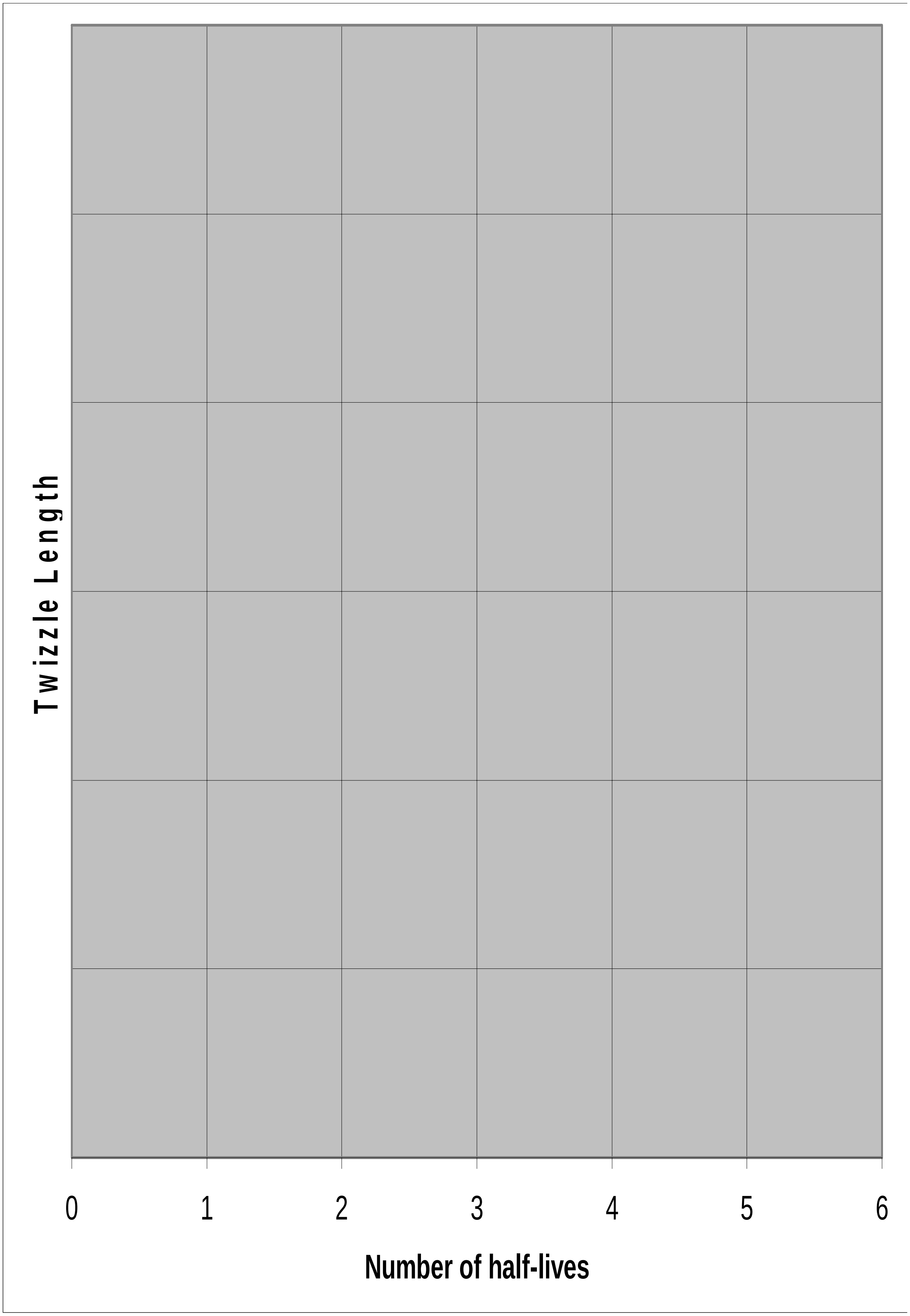
Scissors for cutting string (not necessary for twizzlers)

Ruler (12 inch long) with millimeter scale

Pocket calculator with Log (logarithm) function

We will start with a full-length twizzler, and begin dividing it to simulate radioactive decay. The length of the remaining twizzler will represent the number of remaining radioactive nuclei in a sample. Our first goal is to create a graph with **twizzler length** on the y axis and **time** on the x axis. This is called a graph of <u>twizzler length vs. time</u>. A graph template is available on the next page for this purpose. We will use the symbol "$t_{1/2}$" to denote half-life. The x axis (time axis) should be labelled with multiples of $t_{1/2}$ equally spaced along the axis: 0, $t_{1/2}$, $2t_{1/2}$, $3t_{1/2}$. $4t_{1/2}$, $5t_{1/2}$....

Place a twizzler vertically on the graph at time=0 and draw a mark to show the twizzler's original length, which we will call N_0 (You may need to trim the initial length to get it to fit on the page.). By the definition of a half-life, the twizzler should lose half its length every $t_{1/2}$ of time. Tear the twizzler in half for the passage of the first half-life (if you use string, cut the string in half with scissors) If you use twizzer, you can eat one half of the twizzler. If you use string, discard one half (do not eat the string). Then place the remaining piece vertically on the graph at time=$t_{1/2}$ (1 half-life)and draw a mark to graph the length at this time. Continue the process, dividing each piece in half, eating or discarding as appropriate, and graphing the length of the remaining piece at the next value of $n \cdot t_{1/2}$ (n half-lives) for n=2,3, etc.. Complete the entire graph if you can, or stop when the twizzler piece becomes too small to deal with accurately.


Twizzle Length
0
1
2
3
4
5
6
Number of half-lives

Now complete the following table, using your calculator when necessary (e.g., for the Log function and decimal fractions). For each mark on your graph, measure the length of the twizzle in millimeters. N_0 is the initial length so the first entry in the third column is $N_0/N_0=1$. You should use a calculator to compute the other fractions and the logarithms (Log function).

# Half Lives (n)	Length remaining (N)	Decimal fraction of original length (N/N_0)	Log (N)
0		1	
1			
2			
3			
4			
5			
6			

The length of the twizzler after n half-lives (n $t_{1/2}$'s) can be called $N(n*t_{1/2})$. Compare your results with the formula

$$N\left(n * t_{1/2}\right) = \frac{N_0}{2^n} = N_0 * \left(\frac{1}{2}\right)^n$$

On the following page, there is one more graph activity based on the above table.

Now graph the values of Log(N) from your table versus time (in multiples of $t_{1/2}$ as before). Your graph for Log(N) should look like a **straight line**. This is the magic of logarithms! Perhaps if you learned them in your math class you didn't realize what they were good for. They are actually very useful for helping to understand problems like radioactive decay. In particular, we can now predict the value of Log(N) when the time is *in between* integer numbers (like $1.5*t_{1/2}$) of half-lives by using the fact that Log(N) is a straight line!