A model to determine half-life – transcript

Radioactive decay can be modelled surprisingly accurately using sweets to represent individual atoms of a radioactive substance.

Radioactive decay occurs when either energy or particles are emitted from the nucleus of a radioactive atom.

It occurs randomly, so at any point in time any atom has the same chance of decaying or not decaying.

The half-life of a radioactive substance is the average time taken for half the atoms in a sample to decay.

Sweets that are a regular shape and that have a letter or marking on one side are suitable for demonstrating radioactive decay. Each one has an equal chance of falling with its letter or marking facing up or down when dropped from a height.

Repeatedly dropping the sweets and removing the 'decayed' sweets means the half-life of a radioactive substance can be modelled.

If no suitable sweets are available same shaped coins could be used instead.

The experiment begins by counting out 100 sweets into a cup or beaker.

Next, the sweets are poured into the box. The sweets will land randomly across the bottom of the box.

Some of the sweets will land displaying their marking, while others will land with the blank side showing.

In this model, sweets blank side up represent atoms that have emitted some radiation and have 'decayed'.

Those sweets that have landed marking side up have not decayed, and so can still emit radiation.

The un-decayed sweets will be thrown again, so they are picked out and placed back in the plastic cup or beaker. It is important to count the number of sweets picked out.

The results of the first throw are recorded in a table by writing down how many sweets landed marked side up.

To prepare for the second throw of the un-decayed sweets, the ‘decayed’ sweets still in the box are removed and put aside.

Now the box is empty again the beaker of remaining sweets is poured into the box again

As before, the sweets that landed marking side up are removed. They are put back into beaker and counted.

The remaining sweets are put aside as before.

The results are recorded as previously.

The steps are repeated until all of the sweets have been used and put aside. The last throw that is recorded is when all the remaining sweets land blank side up.

Now that there is a complete set of results, they can be plotted onto a graph

Using a sharp pencil and a ruler, the x and y axes of the graph are drawn.

Axis labels are important. The x axis is labelled ‘throw number’ and the y axis ‘number of sweets’. The graph is given a title.

In this experiment the sweets were thrown seven times so x-axis on the graph needs to accommodate this.

On the graph paper the points showing the number of throws are equally spaced along the x axis.

The y axis should start at 0 as the experiment ended with all sweets having ‘decayed’.

The experiment began with 100 sweets, so the marks up the y-axis should be in equally spaced increments of 10 until 100 is reached.

A cross is placed on the graph for every result in the table. There were 100 sweets un-decayed before the first throw, so this is the first plot made on the graph.

The other plots are drawn on the graph, marking the number of sweets that remained at each throw.

Finally, the points on the graph are connected using a line of best fit.

This graph is showing exponential decay.

It can be used to deduce the half-life in the model

After one half-life, half of the atoms in the model will have decayed.

However, this does not mean that all of the atoms will have decayed after two half-lives.

Instead, at the start there are 100 undecayed atoms in the model and after one half-live a random selection of 50 atoms have decayed. After two half-lives a random selection of the remaining 50 atoms has decayed, leaving 25 undecayed atoms.

This process carries on until all the atoms have eventually decayed.

In the model sweets have been used as atoms. However, in real life the individual atoms in a radioactive substance cannot be counted, so radioactivity is measured in Counts using a Geiger counter.