Logbook on project on radiation 2016

Saturday 18th June
I decided I wanted to see if it was possible to measure radioactivity from objects around the home such as a banana, bricks, brazil nuts or even a person.

Mum has a geiger counter and data logger at her work, so we decided to use this. We started by measuring the number of counts in 30s for 2 hours with and without a cut banana in front (1cm) from the geiger counter and then compared this to nothing in front of the geiger counter (background)
It looks as though there is more radiation with the banana than without!

**Saturday 25th**

We tried measuring a small piece of banana and a big piece of banana as well as the background radiation for much longer to try to get clear results.

We measured the counts in 15s over 8 hours. We measured a small piece of banana first and then a big piece and saw an increase in the radiation, but then when we measured the background it was higher than the counts for the big piece of banana.

We think that it would be useful to try to reduce the background radiation levels so we can more easily measure any radiation due to the banana.
10th July
We went to Bunnings to get some lead – it was very expensive so we checked with them if it would be OK if we returned a roll of lead after we had used it as a shield – they were very helpful and said it would be OK – thankyou Bunnings!

We put the Geiger counter in one end of the lead – there was space at the other end of the roll for the banana, and we then covered each end of the roll with some more lead.
We tried taking background counts in 30s over 24h with the Geiger counter outside the Pb versus inside the Pb.

The dark red is outside the Pb and the light red is inside the lead, so the lead cuts the background radiation almost in half from 7 counts per 30s (14 per minute) to 4 counts per 30s (8 per minute).

We then tried taking 24h of counts per 30 with fresh banana and with dried banana and compared that to the background.
We thought we would try dried banana as potassium is emitting beta radiation which might be blocked by the water in the fresh banana, and the dried banana should have more potassium in the same volume.

It wasn't possible to see much difference in the data sets though.
22nd July
It looks like we will need to take a lot of data to see if we can measure any radiation from the banana, so we will take a week of measurements of counts per minute inside the lead for the banana chips and compare this to a week of measurements inside the lead without the banana chips. We are using banana chips in case the water in the banana is absorbing the beta radiation, because it has more potassium for a particular volume and also because the banana would go smelly over a week!(To smelly to eat at least)!!!
We used a small handful of chips – just enough that would fit inside the lead without touching the geiger counter. The handful weighed 38.8g.
30th July

We decided to do some research on how many decays we should expect to get every minute. Mum helped us a lot with this!

In 100g of fresh banana there is 358mg of Potassium and in 100g of dried banana chips there is 536mg (source: USDA) of Potassium.

A milligram is 1/1000th of a gram so this means that in our handful of banana chips there is \((38.8/100) \times 0.536g = 0.208g\) of Postassium.

From Wikipedia we found out that 120 in every million potassium atoms are radioactive Potassium 40.

Mum and Dad told me about Avagadro's number. It is \(6 \times 10^{23}\) (6.02 with 23 zeros). This is how many atoms there are in 12g of Carbon 12 and is called a "mole" of atoms, like 12 eggs is called a "dozen".

We looked up on a periodic table that the mass of a mole of Postassium is 39g. So this means that in 0.208g of potassium there is \((6.02 \times 10^{23}) / 39 \times 0.208 = 3.2 \times 10^{21}\) atoms.

Of these, 120 atoms in every million (0.012%) are radioactive. So there are \(3.8 \times 10^{17}\) radioactive potassium 40 atoms in our 39g of banana chips.

The half life of potassium 40 is 1.25 billion years. So in this amount of time half of the atoms would decay. So there would be \(1.9 \times 10^{17}\) left after a billion years so the decay rate would be this number divided by the number minutes in 1.25 billion years.

In an hour there are 60 minutes
In a day there are 24 hours
In a year there are 365.25 days

So, \(60 \times 24 \times 365.25 \times 1.25 \times 10^{9} = 6.6 \times 10^{14}\) minutes in 1.25 billion years

The number of decays we could expect in a minute would be \(1.9 \times 10^{17}\) atoms decaying divided by \(1.6 \times 10^{14}\) minutes = 290 decays every minute

We wouldn't see all of these as they go in different directions and some might be absorbed by the material between the atom that is decaying and the geiger counter. It looks like it might be possible that we would see something, but we would have to take a lot of data.
7th August
We have been taking data for the background radiation inside the lead for a little over a week (190 hours) so we stopped to compare the counts to those we took with the banana chips inside the lead. There appears to be some difference! The most frequent counts per minute for the banana was 10 cpm, but for the background radiation it appears to be 9 cpm. We might need to do some careful analysis of the data to see if this result is meaningful. Dad will help with that!

In the meantime, we thought we would try some sandstone, to see if we could see any radiation above background from it.

14th August
We didn't quite make 190h of data for the sandstone, but it doesn't look like the most frequent counts per minute is any different than background.

Radiation from sandstone (cpm over a week) compared to background (in Pb)
We decided to try measuring the radon levels in our house (wood walls) compared to Mum's work (brick/concrete walls)

20th August - Granite

After trying the banana, we decided to test something else that was not banana of any sort. We wanted to test other things that you could find around the home. We had heard that granite tables existed and were radioactive because they had traces of uranium and thorium in them. We looked at benchtops in the kitchen section at Bunning. We asked for a sample of a granite benchtop, but they didn't have any. They sent a message to a company that sells granite bench tops and they sent us a piece of granite by mail.

We measured it with mum's geiger counter for a week and it was similar to the banana. We thought that a lot of the radiation might be blocked, because there was a lot of other granite in front of it. We also read that thoium and uranium decay into radon gas. Maybe the radon was blocked by the granite. So Dad smashed up the granite with the drill and made granite dust.

........It was very, very loud! (Actually it was Dad smashing it that was loud)

Then we measured the dust with the Geiger counter.

Heres the histogram of the result – comparing background, banana chips and powdered granite.

23rd August - Statistics
We wanted to know if the data we had measured showed that the banana or granite made more radiation than the background. Had a long discussion with Dad about statistics. We learnt what the mean and standard deviation of a group of numbers is.

The mean is about the middle of the numbers. We tried calculating the mean for different sets of numbers like $(4,8)$ (mean = 6), $(1 \ 1 \ 4)$ (mean = 2) and $(1000000 \ 1 \ 8 \ 9 \ 60)$ (mean is about 200000). The standard deviation is how spread out the numbers are from the mean. If the mean of two groups of number is far apart compared with the standard deviations of the numbers, then the groups of numbers are probably from a different distribution.