Regents Earth Science

Absolute Dating with Isotopes and Skittles!

Name_____ Period ___

INTRODUCTION:

For some time now, we have known about certain UNSTABLE atoms (atoms with excess energy) that undergo spontaneous (look it up) breakdown into more STABLE (lower energy) forms. These unstable atoms are called RADIO ISOTOPES, and they break down by the process of RADIOACTIVE DECAY. The RADIO in these words comes from the fact that the energy they lose as they become stable is given off as RADIATION, and the atoms are said to be RADIOACTIVE. The STABLE DECAY PRODUCT (the new, lower energy atoms that result from the decay) are called DAUGHTER ELEMENTS.

If a certain radioactive element, say Potassium 40 (written K^{40}), is incorporated into a crystal of K-Feldspar, it will decay, over time, to the stable element Argon 40 (written Ar^{40}). When we find the crystal and measure the amount of the radio isotope K^{40} and the daughter element Ar^{40} , we know that if there's a lot of K^{40} and not much Ar^{40} that the sample has not been around long enough for much K^{40} to have decayed - the sample is young!

On the other hand, if there isn't much K^{40} and a lot of Ar^{40} we know the crystal is old - there must have been a lot of time for all that K^{40} to decay!

Isotopes of various elements decay at different rates, but they all follow a similar pattern of decay. The rate of decay is measured in HALF LIVES - the time it takes for half the atoms in a sample to decay (we have no way of knowing exactly which atoms will decay, but we know half of them will). For example, if there are 100 atoms of K^{40} in a sample, after one half life there will be only 50 K^{40}'s left. After the second half life, half of the remaining 50 K^{40} atoms will decay, leaving 25 K^{40}'s. This continues on and on until the sample is nearly gone.

The half lives of several radio isotopes are given in your Reference Tables. Look them up and fill in the table below:

RADIO ISOTOPE	HALF LIFE	DAUGHTER ELEMENT
CARBON 14		
URANIUM 238		
POTASSIUM 40		
RUBIDIUM 87		

In this lab, we're going to shake and spill Skittles. the ones that land S - up we'll consider to be RADIOACTIVE, and the S - down Skittles are a safe stable decay product. YOU DO NOT WANT TO EAT RADIOACTIVE SKITTLES - SO NEVER EAT AN S- UP SKITTLE! Don't eat any others until you know what you're doing with them either.

PROCEDURE:

1. Get a cup of 60 (or so) skittles and a plate to spill them out on. Assume that at one point all the Skittles were S-up on the plate. This represents a sample of 100% radioactive isotope and I've entered that data on the data table below.
2. Gently shake the cup of Skittles (make sure we have no flying Skittles) and gently spill them on to the plate. Carefully count and remove all the S- down Skittles, and record your results in the 2nd and 3rd columns on the table below in the 1ST Half Life row. The S - down Skittles you've counted are safe to eat now.
3. Return the S - up Skittles to the cup, and repeat step 2 above, only this time entering your data in the 2nd Half Life row. The counted, recorded and removed S - down Skittles are OK to eat!
4. Do it again, recording your data in the 3rd half life row. Then do it again, and again, until all the S - up Skittles are gone.

HALF LIFE	ISOTOPE ATOMS (S - UP) REMAINING	DAUGHER ELEMENT ATOMS REMOVED	CUMULATIVE # DAUGHTER ELEMENT ATOMS	PERCENT OF ORIGINAL ISOTOPE REMAINING	RATIO OF ISOTOPE TO DAUGHTER ELEMENT
0	60	0	0	100	
1ST					
2ND					
3RD					
4TH					
5TH					
6TH					
7TH					

ONLY A FOOL WOULDN'T USE A SPREADSHEET TO DO THE FOLLOWING:

5. Calculate and enter the Cumulative (or *total*) # of Daughter Elements by adding the together the daughter elements removed in what ever half life you're on to the sum of all the daughter elements produced in earlier half lives.

6. Calculate and enter the Percentage of Original Isotope Remaining by simply dividing the # of Isotope Atoms Remaining by the total number of original isotopes (here it is 60) and multiplying by 100%
7. Calculate and enter the Ratio of Isotope to Daughter Element by dividing the Isotopes remaining by the Cumulative # of Daughter Elements

8. Prepare 3 neatly labeled graphs, each with the number of half lives on the X-axis:
   A) On the 1st graph plot BOTH the Isotope Atoms Remaining and the Cumulative Daughter elements as a function of half life
   B) On the second graph, plot the Percent of Isotope remaining as a function of half life.
   C) On the third graph, plot the ratio of isotope to daughter element as a function of half life.

ANSWER THE FOLLOWING QUESTIONS:

Define the following terms:

STABLE _____

UNSTABLE _____

RADIOACTIVE DECAY_____

_____

RADIO ISOTOPE _____

_____

DAUGHTER ELEMENT_____

_____

HALF LIFE_____

_____

1. If the Skittles are C^{14} atoms, how many years do 3 half lives represent ? _____

2. About how much of the original U^{238} that was formed with the earth remains in the planet today? (this is a reference table problem, if you hadn't guessed)

_____

Explain:_____

_____

3. If a sample contains about 40% of its original isotope content, how many half lives old is it? _____

Explain:_____

_____

4. If, in a sample of granite, the ratio of U^{238} to Pb^{206} is 1:3, how many half lives old is the sample?

_____

How many YEARS old is the sample?_____