Pre/Post Test

1. What do we most commonly use to determine the absolute age of a rock or mineral?
   a) stratigraphic relations
   b) fossils
   c) radioactive decay

2. What controls how much decay occurs in any given radioactive system?
   a) the decay constant of the parent isotope
   b) the amount of parent
   c) the amount of time that has passed
   d) a & c
   e) a, b & c

3. True or False: The basic form of the decay equation is the same for different isotopic systems (i.e. U-Pb or K-Ar).
   a) true
   b) false

4. Consider the following diagrams, and imagine that each block represents a bucket containing some amount of a parent or daughter isotope. Both systems A & B are the same isotopes (U-Pb, for example) Considering a typical situation with no complexities, which has been decaying longer, parent A or B? Circle one.

5. Give two conditions for which the answer you gave in 4 might be different.

6. On a scale of 1 to 10, 1 being least confident and 10 being completely confident, how confident are you in your understanding of radioactive decay and its use in dating?

Laboratory Activity: Radioactive Decay and Radiometric Dating

USEFUL TERMS & CONCEPTS

radioactive decay
decay constant
decay rate
half-life
parent isotope
daughter isotope

Instructions:

For the following activities, consider the shampoo in the upper beaker to be the parent isotope, and the shampoo in the lower beaker to be the daughter isotope. The size of the hole is proportional to the decay constant for the system.

Run 1:

- Place the beaker with the smaller diameter hole into the beaker stand, directly over the beaker with no hole.
- Insert the stopper into the hole.
- Pour 5 cm of shampoo into the upper beaker.
- Remove the stopper, allowing the shampoo to run into the lower beaker. One person be in charge of timing, and announce to the group each 30 second interval. Record the depth of shampoo in the upper beaker at each 30 second interval in the table below. Allow the experiment to run for 5 minutes, or until a majority of the shampoo has passed through.

Run 2:

- Clean out the lower beaker with the spatula (return all shampoo to the original beaker).
- Repeat the experiment with the upper beaker with the larger diameter hole and 5 cm of shampoo.

Run 3:

- Clean out the lower beaker with the spatula (return all shampoo to the original beaker).
- Repeat the experiment with the upper beaker with the smaller diameter hole and 10 cm of shampoo.

RUN 1:

Time (min)	Parent/Upper depth (cm)
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	

RUN 2:

Time (min)	Parent/Upper depth (cm)
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	

RUN 3:

Time (min)	Parent/Upper depth (cm)
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	

While one or two group members enter the data into excel (Data Synthesis step below), other members of the group can perform this task.

Set up to begin a run like RUN 1 again with 5 cm of parent and the smaller hole. Start the timer and remove the stopper. After several minutes at a time of your choosing (before the run has gone to completion), insert the stopper into the hole. Record the time that passed on an index card and turn it face down beside your setup. Leave the setup in this condition for now, while you complete the data synthesis.

Data Synthesis (in Excel):

For each run:

- Enter the data into excel in a form like the above tables.
- Create a line graph with time on the x axis and depth on the y axis.
- Add a trendline to the line representing the parent isotope, and show the equation… this is the decay equation for your system!! Use this to answer the questions below.

Questions:

1. Considering how the 3 runs varied and which were faster/slower, what 3 things determine how much decay occurs in an isotopic system?

2. For Run 1:
   a. What is the decay equation? _____
   b. What is the initial parent (N_0)? _____
   c. What is the decay constant (λ)? _____

3. For Run 2:
   a. What is the decay equation? _____
   b. What is the initial parent (N_0)? _____
   c. What is the decay constant (λ)? _____

4. For Run 3:
   a. What is the decay equation? _____
   b. What is the initial parent (N_0)? _____
   c. What is the decay constant (λ)? _____

5. Using the form of your 3 equations above, write a general decay equation, using "N" for "number of atoms", "N_0" for "initial number of atoms," using "λ" for the decay constant, and using "t" for 'time."

Radiometric Dating Activity:

Now, move one table clockwise. You are going to "date" the experiment of another group. Measure the amount of parent/daughter in these beakers. Using your equations from RUN 1 and what you just measured, calculate an age for this system. Turn over the index card and check your answer. You will have to rearrange your decay equation to solve for time (t).

Solve decay equation for time:

Calculated time: _____

Measured time (from card): _____

Synthesis Questions:

You know that the amount of shampoo moving through the hole increased with a larger hole and with more shampoo in the upper beaker. This means that the AMOUNT of radioactive decay increases with larger decay constant and with more initial parent. But you know that the RATE of decay is constant for any given isotope, as evidenced by the fact that any given isotope has a set half-life. Explain.

During these experiments, you always knew what the initial parent was. For the next 3 questions, consider how the system works if you don't know the amount of initial parent.

If you didn't know the amount of initial parent, how could you determine the age?

How would it affect the age determination if some of the daughter product was somehow lost from the rock or mineral? Think about how it would affect your date if some of the shampoo had leaked out of the lower beaker when you went to date someone else's experiment (not knowing the initial parent).

How would it affect the age determination if some daughter product already existed in the rock or mineral when it was formed? Think about how it would affect your date if there had initially been a centimeter or two of shampoo in the lower beaker when you went to date someone else's experiment (not knowing the initial parent).