

**Geology 12**  
**Radiometric Dating**

Name: \_\_\_\_\_

**Set Up:**

- Use as much of the graph paper as possible (make a big graph)
- Label the X-axis with number of half lives (0, 1, 2, ... 10)
- Label the Y-axis with number of parent atoms (1 to 1000)

**Drawing the Graph:**

- Begin with 1000 atoms of radioactive parent element and 0 atoms of stable daughter product.
- Plot points to draw the decay curve, showing the decrease in the number of parent atoms through ten half lives.
- Draw in the decay curve using a SMOOTH curve
- Plot points to draw the accumulation curve, showing the increase in the number of atoms of stable daughter product through ten half lives
- Draw in the accumulation curve using a SMOOTH curve
- Note: the half life of the radioactive element you graphed is given as 5730 years.

**Questions based on your graph:**

1. How many years are equal to 5 half lives?  $5 \times 5730 = 28650 \text{ yrs.}$
2. How many parent atoms will be left after 5 half lives?  
 $31 \text{ parents}$
3. How many daughter atoms will be accumulated after 5 half lives?  
 $1000 - 31 = 969 \text{ daughters}$
4. At what point in time (number of half lives) will the number of parent atoms be equal to the number of daughter atoms?  
 $1 \text{ h.l.}$
5. At what point in time (number of years for this sample) will the number of parent atoms be equal to the number of daughter atoms?  
 $5730 \text{ yrs.}$
6. At what point in time (number of half lives) will the number of daughter atoms be exactly three times the number of parent atoms?  
 $2 \text{ h.l.}$
7. How many half lives equals 22,920 years?  
 $4 \text{ h.l.}$
8. What element has a half life of 5730 years?  
 $\text{Carbon 14}$
9. What is the stable daughter product of this element?  
 $\text{Nitrogen 14}$
10. If you have 125 atoms of parent, how many daughter atoms will be present in this example?  
 $1000 - 125 = 875 \text{ daughters}$
11. If you have 125 atoms of parent, how old (number of years) is the sample?  
 $3 \times 5730 = 17,190 \text{ yrs.}$

# of h.l.	# of parent atoms
0	1000
1	500
2	250
3	125
4	63
5	31
6	16
7	8
8	4
9	2
10	1

100% P → 50% P → 25% P  
 50% d → 75% d

$$\text{Age} = \left( \frac{\# \text{ of}}{h.l.} \right) (\text{length of h.l.})$$

Key

### General Questions:

12. Define half life.

the length of time for half the parent atoms to decay into daughter

13. How many half lives have passed if a rock sample has:

- 50% daughter and 50% parent? ①

100% → 50%

- 150 stable and 50 radioactive atoms? ②

200P → 100P → 50P  
 100d → 150d

- 7/8 daughter and 1/8 parent? ③

$\frac{8}{8} \rightarrow \frac{4}{8} \rightarrow \frac{2}{8} \rightarrow \frac{1}{8} P$   
 $\frac{0}{8} \rightarrow \frac{4}{8} \rightarrow \frac{6}{8} \rightarrow \frac{7}{8} d$

14. What is the formula for calculating the age of a rock?

$$\text{Age} = \left( \frac{\# \text{ of}}{h.l.} \right) (\text{length of h.l.})$$

15. Calculate the ages for the above samples if the half life is 5 million years.

5million yrs, 10my, 15my

16. True or false: uranium 238 dating can be used to find the age of a dinosaur bone?

F - no uranium in living creatures

17. True or false: Carbon 14 can be used to find the age of a dinosaur bone?

F - too old, all C14 would be gone

18. A piece of wood found in an ancient tomb has a ratio of 1 parent to 15 daughters.

16 → 8 → 4 → 2 → 1  
 12 → 14 → 15

- How many half lives have passed?

4 h.l.

- How old is the wood?

$$4 \times 5730 = 22920 \text{ yrs.}$$

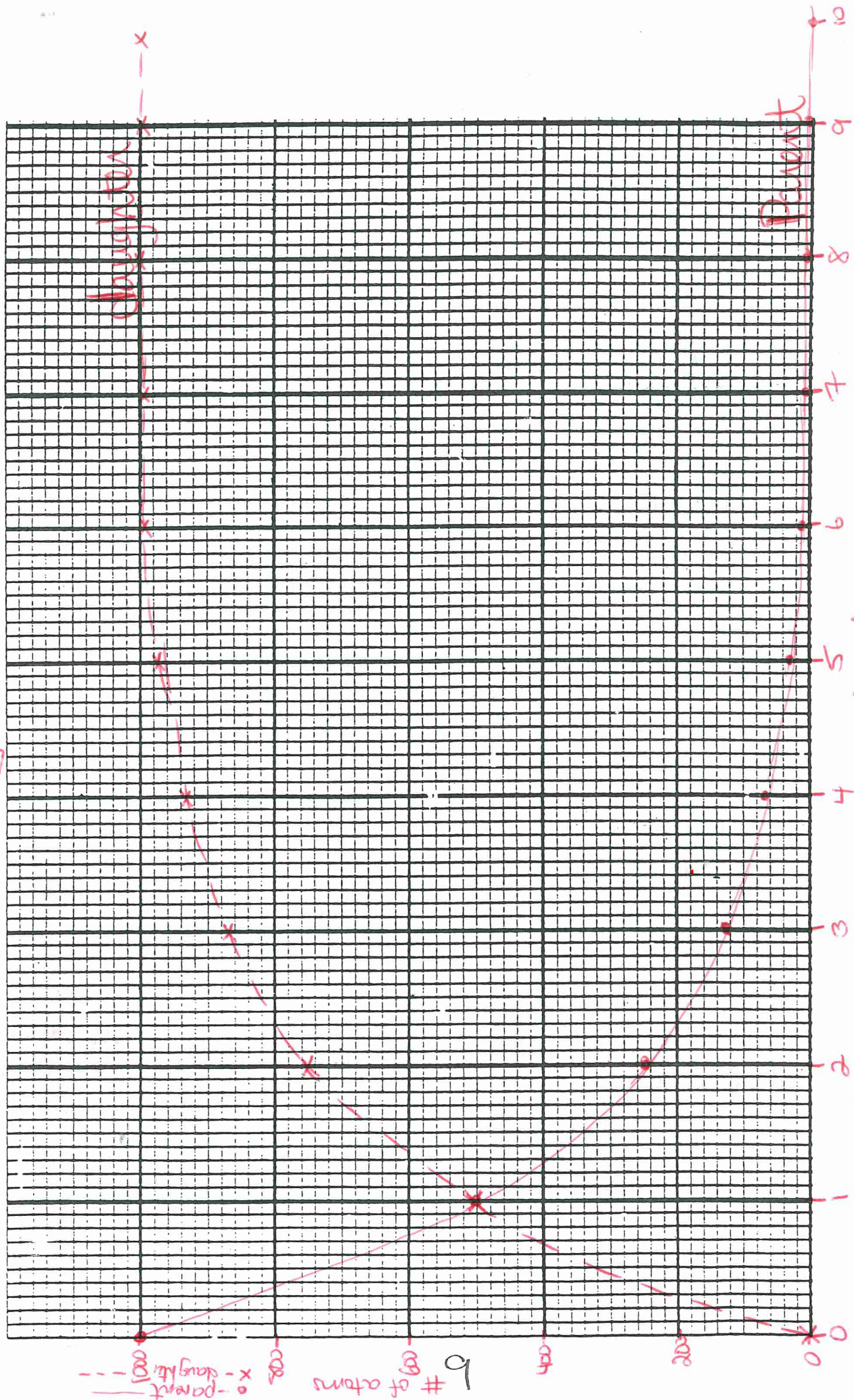
19. Explain in detail how to find the age of a rock using radiometric dating.

use the # of parent + daughters to find ~~length of~~ # of h.l. passed. Multiply by the length of the h.l.

20. Make up a radiometric dating question and have your partner find the age.



# Decay and Accumulation Curves



(each h.l. = 5730 yrs)



Name: Key

### Radiometric Dating

1. a. If a sample started with 100% parent and now has 75% daughter and 25% parent, how many half lives have passed?  $100 \rightarrow 50P \rightarrow 25P$   $50d \rightarrow 75d$   $2 \text{ h.l.}$

b. If one half life is 7 million years, how old is the sample?

$$2 \text{ h.l.} \times 7 \text{ my} = 14 \text{ my}$$

2. How long has a tree been dead if there is an equal amount of carbon-14 as nitrogen-14?

5730 yrs.

3. How much uranium-238 should be left on Earth compared to what was here when Earth formed 4.5 billion years ago?

half

4. a. An igneous rock from some distant galaxy (brought here by aliens) contains 8 parents and 56 daughter atoms. How many half lives have passed?

$$64 \rightarrow 32P \rightarrow 16P \rightarrow 8P$$

$$32d \rightarrow 48d \rightarrow 56d$$

$$3 \text{ h.l.}$$

b. If the parent is rubidium-87 and the daughter is strontium-87, how old is the sample? (Is this possible in our universe?!)  $h.l. = 48.8 \text{ by}$

$$A = 3 \times 48.8 = 146.4 \text{ by}$$

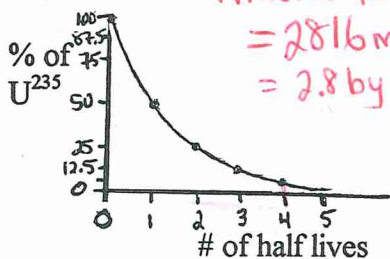
5. a. There was an earthquake that caused a rock containing argon-40 to fracture. Some of the argon escaped. How?

argon is a gas

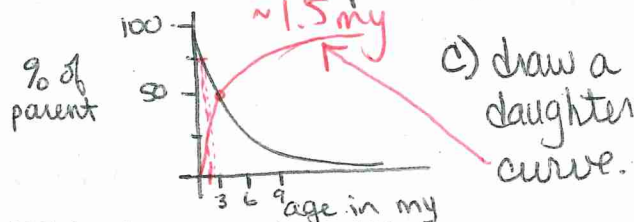
b. What effect will this have on the apparent age of the rock? Will it look younger or older than it should? Explain.

looks like less decay time has passed (no)

6. a) Given the following graph, how old is a sample that contains 6.25% parent and 93.75% daughter?



b) What is the age of a rock if 75% is still parent (radioactive)?  $\sim 1.5 \text{ my}$



7. If a piece of paper contains 5 parent atoms and 155 daughter atoms, how old is it? (Hint: what isotope must be being referred to in this case?)

$$160P \rightarrow 80P \rightarrow 40P \rightarrow 20P \rightarrow 10P \rightarrow 5P$$

$$80d \rightarrow 120d \rightarrow 140d \rightarrow 150d \rightarrow 155d$$

$$5 \text{ h.l.} \times 5730 \text{ yrs} = 28,650 \text{ yrs.}$$

8. If the daughter to parent ratio is 7, how many half lives have passed? How old would the sample be if the parent were thorium-232 and the daughter lead-208?

7:1

$$8 \rightarrow 4P \rightarrow 2P \rightarrow 1P$$

$$4d \rightarrow 6d \rightarrow 7d$$

$$3 \text{ h.l.} \times 14 \text{ by} = 42 \text{ by.}$$