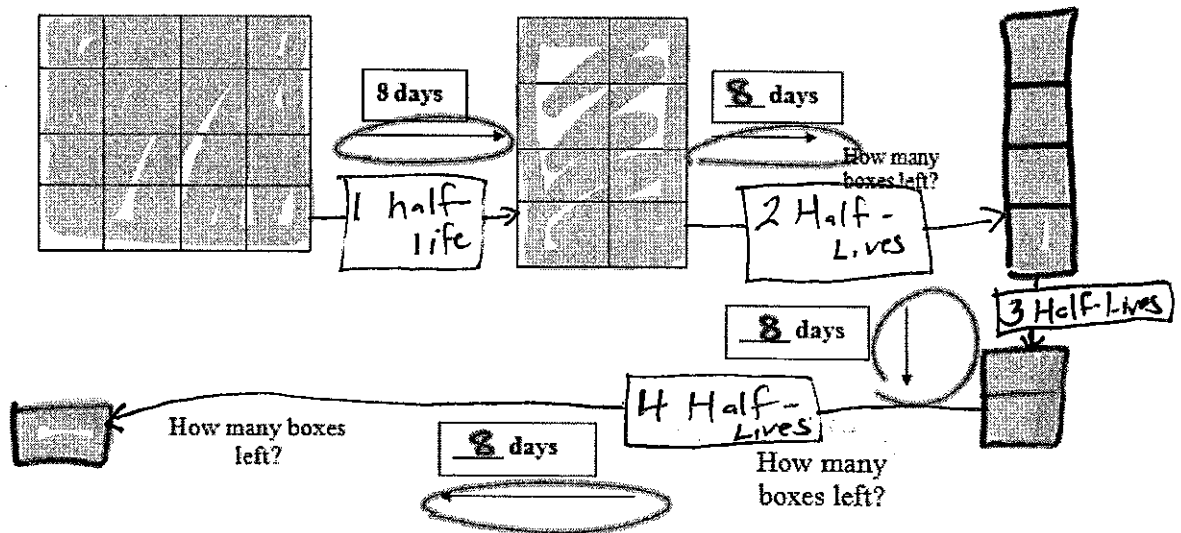# Half-life Problems

Reference Table N might be helpful!

10. What is half-life? (rate of decay)

The time interval required for half the sample of a radioactive isotope to disintegrate. Considered "constant" for an isotope!

11. Complete the following diagram by predicting the number of boxes left and the amount of time that has past during the decay.

of boxes = amount remaining radioactive AFTER decay!

8 days

1 half-life

8 days

How many boxes left?

2 Half-Lives

3 Half-Lives

8 days

4 Half-Lives

How many boxes left?

8 days

How many boxes left?

a. Looking at the diagram above how much total time did it take for the decay?

   8 × 4 = 32 days   "elapsed time"

b. According to the diagram how many decays occurred? Count the arrows!

   4 decays

12. We will learn **four** types of Radioactive Decay Problems: LET'S DO THEM
TOGETHER!

1

"Time Time"
forward decay

a. Indium-115 has a half-life equal to 4.5 hours. If the sample were
originally 12 mg how much would remain after 13.5 hours?

big time

$$\frac{13.5 \text{ hr}}{4.5 \text{ hr}} = 3 \text{ Decays}$$

little time

12 mg → 6 mg → 3 mg → 1.5 mg answer

2

"Time Time"
fraction remaining

Using info from 1

What is the fraction remaining?

1 "whole" → $\frac{1}{2}$ → $\frac{1}{4}$ → $\frac{1}{8}$ answer

3

"Mass Mass"
forward decay

b. A 50.0 g sample of ^{16}N decays to 12.5 g in 14.4 seconds. What is its
half life?

DO NOT DIVIDE !

50 g → 25 g → 12.5 g

(count arrows)
2 decays

then ... DIVIDE

$$\frac{14.4 \text{ s}}{2} = 7.2 \text{ s}$$ answer

4

"Time Time"
reverse decay

c. There are 5.0 grams of I-131 left after 40.35 days. How many grams
were in the original sample if its half life is 8.07 days?

$$\frac{40.35}{8.07} = 5 \text{ decays}$$

160 g ← 80 ← 40 ← 20 ← 10 ← 5.0 g
  answer

HALF-LIFE WORKSHEET

1. What is radioactivity?

2. What is half-life?

3. If we start with 400 atoms of a radioactive substance, how many would remain after one halflife?_____ after two half-lives? _____
    after three half-lives? _____ after four halflives?_____

4. If we start with 48 atoms of a radioactive substance, how many would remain after one halflife?_____ after two half-lives? _____
    after three half-lives? _____ after four halflives?_____

5. If we start with 16 grams of a radioactive substance, how much will remain after three halflives?_____

6. If we start with 120 atoms of a radioactive substance, how many will remain after three halflives?_____

Use the following graph to answer questions 7-10.
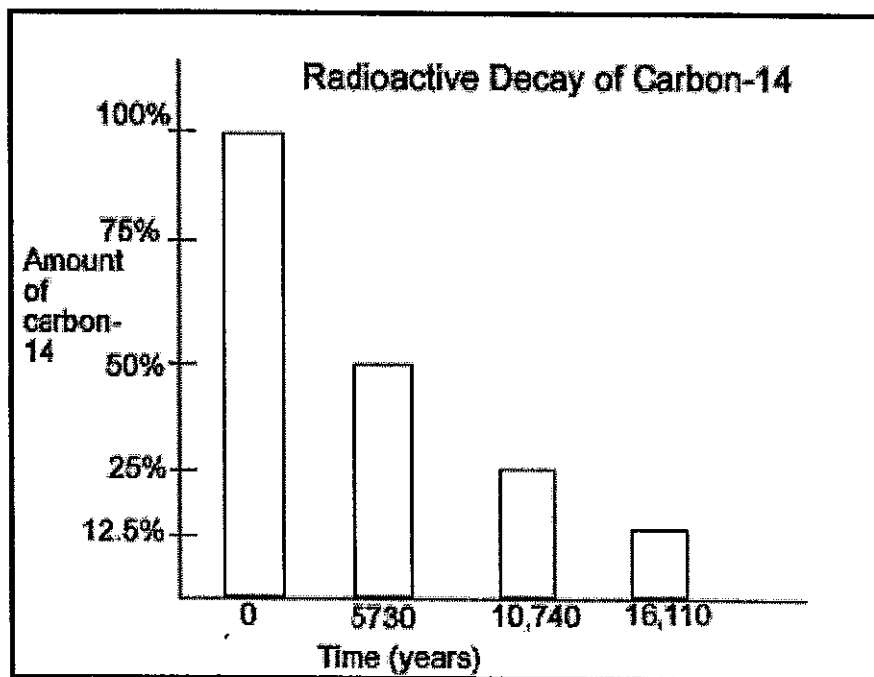
7. How long is a half-life for carbon-14?_____

8. If only 25% of the carbon-14 remains, how old is the material containing the carbon-14?_____

9. If a sample originally had 120 atoms of carbon-14, how many atoms will remain after 16,110 years? _____

10. If a sample known to be about 10,740 years old has 400 carbon-14 atoms, how many atoms were in the sample when the organism died? _____

Use the following chart to answer questions 11-14.

Radioactive Substance	Approximate half-life
Radon-222	4 days
Iodine-131	8 days
Radium-226	1600 years
Carbon-14	5,730 years
Plutonium-239	24,120 years
Uranium-238	4,470,000,000

ex.

11. If we start with 8000 atoms of radium-226, how much would remain after 3,200 years?

2000 atoms   Half life of Radium-226 is 1600 yrs. 3,200/1600 = 2 half-lives. So

1st Halflife
8000 → 4000

2nd Halflife
4000 → 2000

12. If we start with 20 atoms of plutonium-239, how many would remain after 48,240 years?

_____

13. If we start with 60 atoms of uranium-238, how many remain after 4,470,000,000 years?

_____

14. If we start with 24 atoms of iodine-131, how many remain after 32 days? _____

Use the Reference Table on the side to assist you in answering the remaining questions.

15. How long does it take a 100.00g sample of As-81 to decay to 6.25g?

16. How long does it take a 180g sample of Au-198 to decay to 1/8 its original mass?

| Half-lives: |
| As-81 = 33 seconds |
| Au-198 = 2.69 days |
| C-14 = 5730 years |

17. What percent of a sample of As-81 remains un-decayed after 43.2 seconds?

18. What is the half-life of a radioactive isotope if a 500.0g sample decays to 62.5g in 24.3 hours?

19. How old is a bone if it presently contains 0.3125g of C-14, but it was estimated to have originally contained 80.000g of C-14?