Half-Life Problems

Problem #1: The half-life of Zn-71 is 2.4 minutes. If one had 100.0 g at the beginning, how many grams would be left after 7.2 minutes has elapsed?

$\frac{7.2}{2.4} = 3$ half lives $2^{-3} = \frac{1}{8}$ $100 \times \frac{1}{8} = 12.5g$

Problem #2: Pd-100 has a half-life of 3.6 days. If one had 6.02×10^{23} atoms at the start, how many atoms would be present after 20.0 days?

$N = 6.02 \times 10^{23} \times 2^{-\frac{20}{3.6}} = 1.28 \times 10^{22}$ atoms

Problem #3: Os-182 has a half-life of 21.5 hours. How many grams of a 10.0 gram sample would have decayed after exactly three half-lives?

Remaining: $\frac{10}{8} = 1.25g$ Decayed $10 - 1.25 = 8.75g$

Problem #4: After 24.0 days, 2.00 milligrams of an original 128.0 milligram sample remain. What is the half-life of the sample?

$\frac{2}{128} = \frac{1}{64}$ $64 = 2^6$ So 6 half-lives. $\frac{24}{6} = 4$ days

Problem #5: U-238 has a half-life of 4.46×10^9 years. How much U-238 should be present in a sample 2.5×10^9 years old, if 2.00 grams was present initially?

$m = 2.00 \times 2^{-\frac{2.5 \times 10^9}{4.46 \times 10^9}} = 1.36g$

Problem #6: How long will it take for a 40.0 gram sample of I-131 (half-life = 8.040 days) to decay to 1/100 its original mass?

$\frac{M}{M_0} = \frac{1}{100}$ $\frac{1}{100} = 2^{-\frac{t}{8.04}}$ $t = -8.04 \log_2 0.01 = -8.04 \frac{\log .001}{\log 2}$

$= 53.4$ days

Problem #7: Fermium-253 has a half-life of 0.334 seconds. A radioactive sample is considered to be completely decayed after 10 half-lives. How much time will elapse for this sample to be considered gone?

$0.334 \times 10 = 3.34s$

Problem #8: At time zero, there are 10.0 grams of W-187. If the half-life is 23.9 hours, how much will be present at the end of one day? Two days? Seven days?

1 day $M = 10 \times 2^{-\frac{24}{23.9}} = 4.98g$

2 days $M = 10 \times 2^{-\frac{48}{23.9}} = 2.48g$

7 days $M = 10 \times 2^{-\frac{168}{23.9}} = 0.0765g$

Problem #9: 100.0 grams of an isotope with a half-life of 36.0 hours is present at time zero. How much time will have elapsed when 5.00 grams remains?

$5 = 100 \times 2^{-\frac{t}{36}}$ $\frac{5}{100} = 2^{-\frac{t}{36}}$ $t = -36 \log_2 \frac{1}{20} = -36 \frac{\log \frac{1}{20}}{\log 2} = 155.6\ h$

Problem #10: How much time will be required for a sample of H-3 to lose 75% of its radioactivity? The half-life of tritium is 12.26 years.

25% remains. $\frac{m}{m_0} = \frac{1}{4}$ $\frac{1}{4} = 2^{-\frac{t}{12.26}}$ $2^{-2} = 2^{-\frac{t}{12.26}}$ $\frac{t}{12.26} = 2$ $t = 24.52$ days

Problem #11: The half life of iodine-131 is 8.040 days. What percentage of an iodine-131 sample will remain after 40.20 days?

$\frac{40.2}{8.04} = 5$ $\frac{M}{M_0} = 2^{-5} = \frac{1}{32} = 0.03125 = 3.125\ \%$

Problem #12: The half-life of thorium-227 is 18.72 days How many days are required for three-fourths of a given amount to decay?

Remains $\frac{1}{4}$, so 2 half-lives.
$18.72 \times 2 = 37.44$ days

Problem #13: If you start with 5.32×10^9 atoms of Cs-137, how much time will pass before the amount remaining is 5.20×10^6 atoms? The half-life of Cs-137 is 30.17 years.

$\frac{5.2 \times 10^6}{5.32 \times 10^9} = 2^{-\frac{t}{30.17}}$ $2^{-\frac{t}{30.17}} = 0.0009774436$

$t = -30.17 \log_2 0.0009774436 = -30.17 \frac{\log 0.0009774436}{\log 2} = 301.7$ years

Problem #14: The half-life of the radioactive isotope phosphorus-32 is 14.3 days. How long until a sample loses 99% of its radioactivity?

Remains $\frac{1}{100}$ $0.01 = 2^{-\frac{t}{14.3}}$ $t = -14.3 \frac{\log 0.01}{\log 2} = 95$ days

Problem #15: The half-life of Palladium-100 is 4 days. After 12 days a sample of Pd-100 has been reduced to a mass of 4.00 mg. (a) Determine the starting mass. (b) What is the mass 8 weeks after the start?

a) $4.00 = M \times 2^{-\frac{12}{4}}$ $M = 4 \times 8 = 32\ mg$

$4 = M \times 2^{-3}$ b) $M = 32 \times 2^{-\frac{56}{4}} = 0.00195\ mg$

Problem #16: Rn-222 has a half-life of 3.82 days. How long before only 1/16 of the original sample remains?

$\frac{1}{16} = 2^{-4}$ so 4 half-lives
$3.82 \times 4 = 15.3$ days

Problem #17: U-238 has a half-life of 4.46×10^9 years. Estimates of the age of the universe range from 9×10^9 years to 23×10^9 years (Cauldrons in the Cosmos: Nuclear Astrophysics, C.E. Rolfs and W.S. Rodney, Univ. of Chicago, 1988, p. 477). What fraction of this isotope present at the start of the universe remains today? Calculate for both minimum and maximum values, as well as a median value of 16×10^9 years.

$\frac{M}{M_0} = 2^{-\frac{9\times10^9}{4.46\times10^9}} = 0.247$ $\quad \frac{M}{M_0} = 2^{-\frac{23\times10^9}{4.46\times10^9}} = 0.028$ $\quad \frac{M}{M_0} = 2^{-\frac{16\times10^9}{4.46\times10^9}} = 0.0832$

Problem #18: A sample of Se-83 registers 10^{12} disintegrations per second when first tested. What rate would you predict for this sample 3.5 hours later, if the half-life is 22.3 minutes? 3.5 h = 210 min

$10^{12} \times 2^{-\frac{210}{22.3}} = 1.46 \times 10^9$

Problem #19: Iodine-131 has a half-life of 8.040 days. If we start with a 40.0 gram sample, how much will remain after 24.0 days?

$M = 40 \times 2^{-\frac{24}{8.04}} = 5.05\,g$

Problem #20: If you start with 2.97×10^{22} atoms of molybdenum-99 (half-life = 65.94 hours), how many atoms will remain after one week?

1 week = 168 hours

$N = 2.97 \times 10^{22} \times 2^{-\frac{168}{65.94}} = 5.08 \times 10^{21}$

Problem #21: The isotope H-3 has a half life of 12.26 years. Find the fraction remaining after 49 years.

$2^{-\frac{49}{12.26}} = 0.0626$

Problem #22: How long will it take for a 64.0 g sample of Rn-222 (half-life = 3.8235 days) to decay to 8.00 g?

$\frac{8}{64} = \frac{1}{8}$ so 3 half-lives $3.8235 \times 3 = 11.4705$ days

Problem #23: A scientist needs 10.0 micrograms of Ca-47 (half-life = 4.50 days) to do an experiment on an animal. If the delivery time is 50.0 hours, how many micrograms of $^{47}CaCO_3$ must the scientist order?

~~10.0 mg/0.723 = 13.8 mg~~ 4.5 days = 108 hours

$10 = M \times 2^{-\frac{50}{108}}$

$M = 10 \times 2^{\frac{50}{108}} = 13.8\,\mu g$

Problem #24: What percentage of the parent isotope remains after 0.5 half lives have passed?

$2^{-0.5} = 0.707 = 70.7\ \%$

Problem #25: Manganese-56 has a half-life of 2.6 h. What is the mass of manganese-56 in a 1.0 g sample of the isotope at the end of 10.4 h?

$M = 1.0 \times 2^{-\frac{10.4}{2.6}} = 0.0625 g$

Problem #26: The half life in two different samples, A and B, of radio-active nuclei are related according to T(1/2,B) = T(1/2,A)/2. In a certain period the number of radio-active nuclei in sample A decreases to one-fourth the number present initially. In the same period the number of radio-active nuclei in sample B decreases to a fraction f of the number present initially. Find f.

A Decreases to 1/4 after 2 half Lives. B has twice smaller half-Life so for B it will be 4 half Lives.

After 4 half Lives : $\left(\frac{1}{2}\right)^4 = \frac{1}{16}$ remains

Problem #27: You have 20.0 grams of 32-P that decays 5% daily. How long will it take for half the original to decay?

$\frac{1}{2}$ decays in 1 half live. $20 \times 0.95 = 19g$

$19 = 20 \times 2^{-\frac{24}{T}}$ $\quad 2^{-\frac{24}{T}} = 0.95$ $\quad 2^{\frac{T}{24}} = \frac{20}{19}$ $\quad T = 24/\log_2\frac{20}{19} = 24 \div \frac{\log 20/19}{\log 2}$

$= 324.3\ h$

Problem #28: A sample of radioactive isotopes contains two different nuclides, labelled A and B. Initially, the sample composition is 1:1, i.e., the same number of nuclei A as nuclei B. The half-life of A is 3 hours and, that of B, 6 hours. What is the expected ratio A/B after 18 hours?

A: 18 hours is 6 half-Lives so $\left(\frac{1}{2}\right)^6 = \frac{1}{64}$ remains

B: 18 hours is 3 half Lives so $\left(\frac{1}{2}\right)^3 = \frac{1}{8}$ remains

$\frac{1}{64} \div \frac{1}{8} = \frac{1}{8}$

Problem #29: If the half-life of 238-U is 4.5 x 10^9 y and the half-life of 235-U is 7.1 x 10^8 y and the age of the Earth is 4.5 x 10^9 y and if the percentage of 238-U in the Earth is 99.3% and 235-U is 0.7% then what were their percentages when the Earth was formed?

U-238 1 half-life so $\frac{1}{2}$ remains

U-235 $2^{-\frac{4.5\times10^9}{7.1\times10^8}} = 0.0124$ remains

Let uranium now is 1kg, so 993g is U-238 and U-235 is 7g

Before: U-238 993×2 = 1986g U-235 $\frac{7}{0.0124} = 564.5g$ $\frac{1986}{1986+564.5} = 0.779$

77.9% U-238

Problem #30: A radioactive sample contains 3.25 x 10^{18} atoms of a nuclide that decays at a rate of 3.4 x 10^{13} disintegrations per 26 min.

(a) What percentage of the nuclide will have decayed after 159 days?
(b) What is the half-life of the nuclide?

b) 159 days = 159×24×60 = 228960 min After 26 min $\frac{3.4\times10^{13}}{3.25\times10^{18}} = 1.046\times10^{-5}$ decays. Remains 0.99998954

$0.99998954 = 2^{-\frac{26}{T}}$ $T = -\frac{26}{\log_2 0.99998954} = \frac{-26\log 2}{\log 0.99998954}$

= 1722919 min a) $2^{-\frac{228960}{1722919}}$ = 0.912 Left Decayed 1 − 0.912 = 0.088 = 8.8%

Problem #31: The radioisotope potassium-40 decays to argon-40 by positron emission with a half life of 1.27 x 10^9 yr. A sample of moon rock was found to contain 78 argon-40 atoms for every 22 potassium-40 atoms. The age of the rock is . . .

22% Left. $0.22 = 2^{-\frac{t}{1.27\times10^9}}$ $t = -1.27\times10^9 \log_2 0.22$

$= \frac{-1.27\times10^9 \log 0.22}{\log 2} = 2.77\times10^9$ years

Problem #32: What is the age of a rock in which the mass ratio of Ar-40 to K-40 is 3.8? K-40 decays to Ar-40 with a half-life of 1.27 x 10^9 yr.

Remains $\frac{1}{4.8}$

$\frac{1}{4.8} = 2^{-\frac{t}{1.27\times10^9}}$

$t = -1.27\times10^9 \frac{\log(\frac{1}{4.8})}{\log 2} = 2.87\times10^9$

Problem #33: Arsenic-74 is a medical radioisotopes with a half-life of 18 days. If the initial amount of arsenic-74 injected is 2.30 mg, how much arsenic-74 is left in the body after 54 days?

$\frac{54}{18} = 3$ half-lifes $\quad \frac{1}{8}$ remains

$2.3 \times \frac{1}{8} = 0.288$ mg

Problem #34: Assume that today there is 10 grams of substance, while 1000 years ago there was 100 grams of it. If there is 15grams of substance today, how much will there be 600 years from now?

0.1 remains

$0.1 = 2^{-\frac{1000}{T}}$

$T = \frac{-1000}{\log_2 0.1} = \frac{-1000 \log 2}{\log 0.1} = 301.03$ years

$m = 15 \times 2^{-\frac{600}{301.03}} = 3.77g$

Problem #35: A radionuclide, cobalt-60, has a half-life of 5.27 years. How many hours would it take for the activity to diminish to one-thirty-secondth (3.125%) of its original value?

$0.03125 = 2^{-\frac{t}{5.27}}$

$t = -5.27 \frac{\log 0.03125}{\log 2} = 26.35$ years

$26.35 \times 365 \times 24 = 230826$ h

Half Life Worksheet – Extra Practice

1) Fluorine-21 has a half life of approximately 5 seconds. What fraction of the original nuclei would remain after 1 minute? $\frac{60}{5} = 12$ half Lives
$2^{-12} = \frac{1}{4096}$

2) Iodine-131 has a half life of 8 days. What fraction of the original sample would remain at the end of 32 days? $\frac{32}{8} = 4$ $2^{-4} = \frac{1}{16}$

3) The half-life of chromium-51 is 28 days. If the sample contained 510 grams, how much chromium would remain after 56 days? How much would remain after 1 year? How much was present 168 days ago?

4) If 20.0 g of a radioactive isotope are present at 1:00 PM and 5.0 g remain at 2:00 PM, what is the half life of the isotope? $5/20 = \frac{1}{4}$ 2 half lives
T = 30 min

5) The half life of Uranium-238 is 4.5 billion years and the age of earth is 4.5 X 10^9 years. What fraction of Uranium-238 that was present when Earth was formed still remains? 1 half-Life $\frac{1}{2}$ remains

6) Chromium-48 decays. After 6 half-lives, what fraction of the original nuclei would remain? $\left(\frac{1}{2}\right)^6 = \frac{1}{64}$

7) The half life of iodine-125 is 60 days. What fraction of iodine-125 nuclides would be left after 360 days? $\frac{360}{60} = 6$ half Lives $\left(\frac{1}{2}\right)^6 = \frac{1}{64}$

8) Titanium-51 decays with a half life of 6 minutes. What fraction of titanium would remain after one hour? $\frac{60}{6} = 10$ half lives $\left(\frac{1}{2}\right)^{10} = \frac{1}{1024}$

9) A medical institution requests 1 g of bismuth-214, which has a half life of 20 min. How many grams of bismuth-214 must be prepared if the shipping time is 2 h? $\frac{120}{20} = 6$ half lives $1 \times 2^6 = 64g$

10) The half life of radium 226 is 1602 years. If you have 500 grams of radium today how many grams would have been present 9612 years ago?
$\frac{9612}{1602} = 6$ half Lives
$500 \times 2^6 = 32000g = 32kg$

3) $\frac{56}{28} = 2$ half Lives
$510 \times 2^{-2} = 127.5g$

1 year ~~360~~ $510 \times 2^{-\frac{365}{28}} = 0.061g$

$\frac{168}{28} = 6$ half lives $510 \times 2^6 = 32640g$

HALF-LIFE PROBLEMS

Name____ Block ______

1. An isotope of cesium (cesium-137) has a half-life of 30 years. If 1.0 g of cesium-137 disintegrates over a period of 90 years, how many g of cesium-137 would remain?

90 years – 3 half-lives.
After 1 halflife – 50% disintegrates 50% left
After 2 – 75% and 25% After 3 – 87.5% and 12.5%
1g – 87.5%
12.5% – $\frac{1}{7}$ g
answer: 1/7 g

2. Actinium-226 has a half-life of 29 hours. If 100 mg of actinium-226 disintegrates over a period of 58 hours, how many mg of actinium-226 will remain?

58 h – 2 half-lives.
After 2 half-lives 75% disintegrates, 25% remains
75% – 100 mg 25% – $\frac{100}{3}$ g – answer

3. Sodium-25 was to be used in an experiment, but it took 3.0 minutes to get the sodium from the reactor to the laboratory. If 5.0 mg of sodium-25 was removed from the reactor, how many mg of sodium-25 were placed in the reaction vessel 3.0 minutes later if the half-life of sodium-25 is 60 seconds?

3 half-lives $5 \div 2 = 2.5$ mg
$2.5 \div 2 = 1.25$ mg
$1.25 \div 2 = 0.625$ mg
or $M = 5 \times 2^{-\frac{3}{1}} = 0.625$ mg

4. The half-life of isotope X is 2.0 years. How many years would it take for a 4.0 mg sample of X to decay and have only 0.50 mg of it remain?

After 1 half-life 2 mg
2 1 mg
3 0.5 mg
3 half-lives 6 years

5. Selenium-83 has a half-life of 25.0 minutes. How many minutes would it take for a 10.0 mg sample to decay and have only 1.25 mg of it remain?

After 1 half-life 5 mg
2 2.5 mg
3 1.25 mg
3 half-lives 75 minutes

6. The half-life of Po-218 is three minutes. How much of a 2.0 gram sample remains after 15 minutes? Suppose you wanted to buy some of this isotope, and it required half an hour for it reach you. How much should you order if you need to use 0.10 gram of this material?

$M = 2 \times 2^{-\frac{15}{3}} = \frac{1}{16} g = 0.0625 g$

$0.1 = M_0 \times 2^{-\frac{30}{3}}$

$0.1 = \frac{M_0}{1024}$ $M_0 = 102.4 g$

HALF-LIFE WORKSHEET   Name ____________________

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

Equations:

½ lifes:
As-81 = 33 seconds
Au-198 = 2.69 days
C-14 = 5730 years

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

$\frac{100}{6.25} = 16 \quad 16 = 2^4$ So 4 half-lives $4 \times 33s = 132 s$

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

$8 = 2^3$

3 half-lives $3 \times 2.69 = 8.07$ days

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

$\frac{M}{M_0} = 2^{-\frac{43.2}{33}} = 0.369$

36.9 %

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

$\frac{500}{62.5} = 8 \quad 2^3 = 8$ 3 half-lives. $\frac{24.3}{3} = 8.1 h$

5. 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?

$\frac{80}{0.3125} = 256 \quad 2^8 = 256$

So 8 half-lives

$8 \times 5730 = 45840$ years

Name______________ Half-life Worksheet

Half-life Worksheet

1. What is radioactivity? The process by which nuclei emit particles and/or electromagnetic waves to decrease energy and become more stable.

2. What is nuclear radiation? Particles and electromagnetic waves emitted by nuclei.

3. What is half-life? The time required for half of the nuclei to decay.

4. If we start with 400 atoms of a radioactive substance, how many would remain after one half-life? 200 after two half-lives? 100 after three half-lives? 50 after four half-lives? 25

5. If we start with 48 atoms of a radioactive substance, how many would remain after one half-life? 24 After two half-lives? 12 after three half-lives? 6 after four half-lives? 3

6. If we start with 16 grams of a radioactive substance, how much will remain after three half-lives? 2

7. If we start with 120 atoms of a radioactive substance, how many will remain after three half-lives? 15

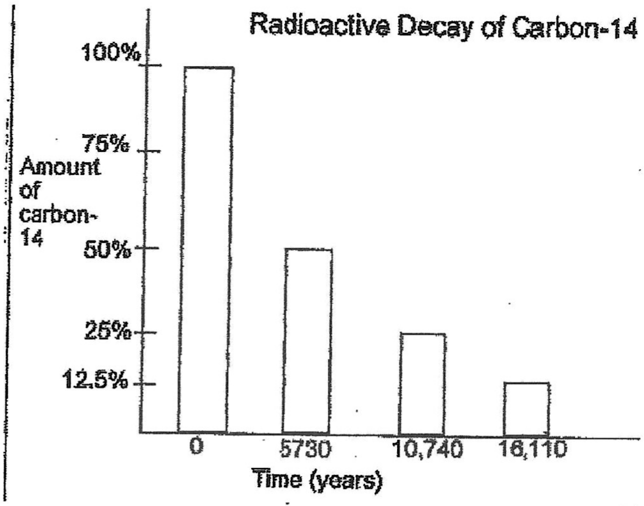
8. Which type of radiation (beta particles, gamma rays, or alpha particles) can be blocked by...

a) a piece of paper Alfa

c) a piece of lead Alfa and beta

d) a large block of lead All

Use the following graph to answer questions9-12...



9. How long is a half-life forcarbon-14? 5730

10. If only 25% of the carbon-14remains, how old is the material containing the carbon-14? $5730 \times 2 = 11460$

11. If a sample originally had120 atoms of carbon-14, how many atoms will remain after 16,110 years? $120 \times 2^{-\frac{16110}{5730}} = 17$

12. 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? $400 = N_0 \times 2^{-\frac{10740}{5730}}$ $N_0 = 1467$

Use the following chart to answer questions 13-16.

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

13. If we start with 8000 atoms of radium-226, how much would remain after 3,200 years? 2000

14. If we start with 20 atoms of plutonium-239, how many would remain after 48,240 years? 5

15. If we start with 60 atoms of uranium-238, how many remain after 4,470,000,000 years? 30

16. If we start with 24 atoms of iodine-131, how many remain after 32 days? 1 or 2

HALF-LIFE CALCULATIONS

Name ____________

Half-life is the time required for one-half of a radioactive nuclide to decay (change to another element). It is possible to calculate the amount of a radioactive element that will be left if we know its half-life.

Example: The half-life of Po-214 is 0.001 second. How much of a 10 g sample will be left after 0.003 seconds?

Answer: Calculate the number of half-lives:

$$0.003 \text{ seconds} \times \frac{1 \text{ half-life}}{0.001 \text{ second}} = 3 \text{ half-lives}$$

After 0 half-lives, 10 g are left.
After 1 half-life, 5 g are left.
After 2 half-lives, 2.5 g are left.
After 3 half-lives, 1.25 g are left.

Solve the following problems.

1. The half-life of radon-222 is 3.8 days. How much of a 100 g sample is left after 15.2 days?

   $100 \times 2^{-\frac{15.2}{3.8}} = 6.25 g$ ____________

2. Carbon-14 has a half-life of 5,730 years. If a sample contains 70 mg originally, how much is left after 17,190 years?

   $70 \times 2^{-\frac{17190}{5730}} = 8.75 mg$ ____________

3. How much of a 500 g sample of potassium-42 is left after 62 hours? The half-life of K-42 is 12.4 hours?

   $500 \times 2^{-\frac{62}{12.4}} = 15.625 g$ ____________

4. The half-life of cobalt-60 is 5.26 years. If 50 g are left after 15.8 years, how many grams were in the original sample?

   $50 = M_0 \times 2^{-\frac{15.8}{5.26}}$ $M_0 = 50 \times 2^{\frac{15.8}{5.26}} = 400 g$ ____________

5. The half-life of I-131 is 8.07 days. If 25 g are left after 40.35 days, how many grams were in the original sample?

   $M_0 = 25 \times 2^{\frac{40.35}{8.07}} = 800 g$ ____________

6. If 100 g of Au-198 decays to 6.25 g in 10.8 days, what is the half-life of Au-198?

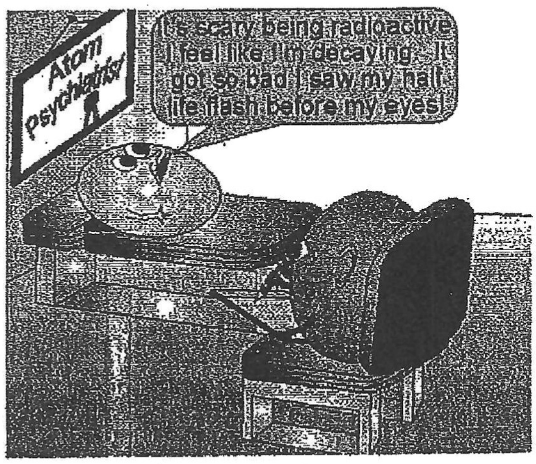
   $\frac{100}{6.25} = 16$ $16 = 2^4$ 4 half-lives $\frac{10.8}{4} = 2.7$ days ____________

Chemistry: Form WS12.6.1A Name ____________________

NUCLEAR CHEMISTRY Date ______________ Period _____

Working With Half-Life

When radioactive materials decay they release high speed particles that bang into other unstable radioactive atoms, hastening their decay. As the process proceeds, the amount of radioactive material decreases. This causes the number of high speed emissions to decrease. The fewer emissions there are, the slower the decay process becomes. As a result, large samples of radioactive material decay at a faster rate than small samples. In fact, as the sample size decreases, the rate of decay slows in such a way that the amount of time it takes for half the sample to decay is constant regardless of the sample size. In other words, it takes 500 g of uranium the same amount of time to decay into 250 g of uranium as it does for 2 g of uranium to decay into 1 g of uranium. The amount of time it takes for a radioactive sample to decay to half its original mass is called the half-life.



The easiest way to solve half life problems is to set up a table.

Sample Problem

How much ^{42}K will be left in a 320 g sample after 62 h?

Step 1: Look up the half life in *Table N*, the table of Selected Radioisotopes 12.4 h

Step 2: Set up a table showing the mass, time elapsed, the fraction remaining, and number of half lives starting with the initial conditions and ending when the full time has elapsed. For each half life elapsed, cut the mass in half, increase the time by an amount equal to the half life, cut the fraction in half, and add one to the number of half lives.

Mass	Time	Fraction	Half lives
320	0	1	0
160	12.4	½	1
80	24.8	$^1/_4$	2
40	37.2	$^1/_8$	3
20	49.6	$^1/_{16}$	4
10	62	$^1/_{32}$	5

Following this procedure it is possible to determine the final mass, the time elapsed, the fraction of the original sample, or the number of half lives elapsed.

Answer the questions below using data from *Table N*, the table of *Selected Radioisotopes.*

1. How long will it take for 30 g of ^{222}Rn to decay to 7.5 g?

$\frac{30}{7.5} = 4$ $4 = 2^2$ 2 half-lives

$3.82 \times 2 = 7.64$ days

2. How many grams of ^{16}N will be left from a 16 g sample after 21.6 s?

$16 \times 2^{-\frac{21.6}{7.2}} = 2g$

Continue ☞

3. How many half lives will it take for 50 g of ^{99}Tc to decay to 6.25 g?

$\frac{50}{6.25} = 8 \quad 8 = 2^3$ 3 half-lives

4. What fraction of a sample of ^{32}P will be left after 42.9 d?

$\frac{42.9}{14.3} = 3 \quad \frac{1}{2^3} = \frac{1}{8}$

5. How long will it take for a 28 g sample of ^{226}Ra to decay to 3.5 g?

$\frac{28}{3.5} = 8$ 3 half-lives $3 \times 1600 = 4800$ years

6. How long will it take for 50% of a sample of ^{131}I to decay?

8.07 days (1 half-life)

7. After 9.8×10^{10} y, how many grams will be left from a 256 g sample of ^{232}Th?

$256 \times 2^{-\frac{9.8 \times 10^{10}}{1.4 \times 10^{10}}} = 2$ g

8. How long will it take for 500 g of ^{90}Sr to decay to 125 g?

$\frac{500}{125} = 4 \quad 2^2 = 4$ 2 half-life 56.2 years

9. What fraction of a sample of ^{3}H will be left after 36.78 y?

$\frac{36.78}{12.26} = 3$ half-lives $\frac{1}{8}$