

Half-Life Calculations

Name: _____

1. If 100.0g of carbon-14 decays until only 25.0g of carbon-14 is left after 11,460 years, what is the half-life of carbon-14?

Starting amount 100g
 ending amount 25g
 Total Time 11460 yrs
 Half life ?

100	50	25
	1	2

$$2 \sqrt{11460} = \textcircled{5730 \text{ yrs}}$$

2. What is the half-life of a 100.0g sample of nitrogen-16 that decays to 12.5g of nitrogen-16 in 21.6 seconds?

Starting amount 100g
 ending amount 12.5g
 Total Time 21.6s
 Half life ?

100	50	25	12.5
	1	2	3

$$3 \sqrt{21.6} = \textcircled{7.2 \text{ s}}$$

3. A 208g sample of sodium-24 decays to 13.0g of sodium-24 within 60.0hrs. What is the half-life of this radioactive isotope?

Starting amount - 208g
 ending amount - 13g
 Total time 60hr
 Half life ?

208	104	52	26	13
	1	2	3	4

$$4 \sqrt{60} = \textcircled{15 \text{ hrs}}$$

4. Thallium-208 has a half-life of 3.053 minutes. How long will it take for 120.0g to decay to 7.5g?

Starting amount 120g
 ending amount 7.5g
 Total time ?
 Half life 3.053 min

120	60	30	15	7.5
	1	2	3	4

$$\begin{array}{r} 3.053 \\ \times 4 \\ \hline \end{array} = \textcircled{12.212 \text{ min}}$$

5. The half-life of hafnium-156 is 0.025 seconds. How long will it take a 560g sample to decay to 140g?

Starting amount 560g
 ending amount 140g
 Total time ?
 Half life 0.025s

560 280 140
 1 2
 0.025
 x 2 → 0.050s

6. Chromium-48 has a half-life of 21.6 hours. How long will it take 360.0g of chromium-48 to decay to 11.25g?

Starting amount 360g
 ending amount 11.25g
 Total time ?
 Half life 21.6 hrs

360 180 90 45 22.5 11.25
 1 2 3 4 5
 21.6
 x 5
 108.0 hrs

7. Gold-198 has a half-life of 2.7 days. How much of a 96g sample of gold-198 will be left after 8.1 days?

Starting amount 96g
 ending amount ?
 Total time 8.1 days
 Half life 2.7 days

$2.7 \overline{) 8.1} = 3$
 96 48 24 12g
 1 2 3

8. Potassium-42 has a half-life of 12.4 hours. How much of an 848g sample of potassium-42 will be left after 62.0 hours?

Starting amount 848g
 ending amount ?
 Total Time 62 hrs
 Half life 12.4 hrs

$12.4 \overline{) 62} = 5$
 848 424 212 106 53
 1 2 4 5
 26.5g

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

Starting amount 100g
 ending amount ?
 Total Time 58hrs
 Half life 29hrs

$29 \sqrt{58} = 2$

100	50	25g
	1	2

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

Starting amount 10mg
 ending amount 1.25g
 Total Time ?
 Half life 25min

10	5	2.5	1.25
	1	2	3

$\frac{25}{\times 3}$ → 75 min

11. How old is a bone if it presently contains 0.3125g of carbon-14, but it was estimated to have originally contained 80.000g of carbon-14. The half-life of carbon-14 is 5730 years.

Starting amount 80g
 ending amount 0.3125
 Total time - ?
 Half l. fe 5730yrs

80	40	20	10	5	2.5	1.25
	1	2	3	4	5	6

$\frac{5730}{\times 8}$

45840 yrs

0.625
 7
 0.3125
 8

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

Starting amount ?
 ending amount 50
 Total Time 15.8yrs
 Half life 5.26 yrs

$5.26 \sqrt{15.8} = 3$

50	100	200	400g
	1	2	3

13. The half-life of polonium-218 is three minutes. How much of the isotope should you buy if you need a 0.10g sample of this material and you know the polonium-218 will take 30 minutes to

Starting amount ^{reach you?} 7 $3\sqrt{30} = 10$
 ending amount 0.10g
 Total Time 30min
 half life 3min

0.10	0.20	0.40	0.80	1.6	3.2
	1	2	3	4	5
6.4	12.8	25.6	51.2	102.4g	
6	7	8	9	10	

14. The half-life of tritium is 12.3 years. If 48.0mg of tritium is released from a nuclear power plant during the course of a mishap, what mass of the tritium will remain after 49.2 years?

Starting amount 48mg $12.3\sqrt{49.2} = 4$
 ending amount ?
 Total time 49.2 yrs
 Half life 12.3 yrs

48	24	12	6	3mg
	1	2	3	4

15. Iron-59 is used in medicine to diagnose blood circulation disorders. The half-life of iron-59 is 44.5 days. How much of a 2000mg sample will remain after 133.5 days?

Starting amount 2000mg $44.5\sqrt{133.5} = 3$
 ending amount ?
 Total time 133.5 days
 Half life 44.5 days

2000	1000	500	250g
	1	2	3

16. A doctor suspects that his patient may have Grave's Disease, a thyroid disorder. To be sure he asks the technician to perform radionuclide scanning. This procedure requires the use of iodine-131 which, when given in small doses, is used as a medical tracer to detect thyroid disorders. A patient swallows 10 grams of the iodine-131. Sixteen days later, the detectors observe 2.5 grams of iodine in the patient's thyroid. What is the half-life of iodine-131?

Starting amount 10g
 ending amount 2.5g
 Total Time 16 days
 Half life - ?

$$10 \begin{array}{c} 5 \\ | \\ 2 \end{array} 2.5$$

$$2\sqrt{16} = 8 \text{ days}$$

17. To prevent food spoilage, food can be irradiated with gamma rays from cobalt-60. If the half-life of cobalt-60 is 5.3 years, how much of a 75g sample will remain after 1.3 years?

Starting amount 75g
 ending amount ?
 Total Time 1.3 yrs
 Half life 5.3 yrs

$$75 \begin{array}{c} 37.5 \\ | \\ 9.375 \end{array}$$

$$75 - 9.375 = 65.625$$

18. Scientists use carbon-14 dating to determine the age of archeological artifacts up to 50,000 years old. Carbon-14 has a half-life of 5730 years. A 10,000 year old fossil currently contains 1.8g of carbon-14. How many grams of carbon-14 did the fossil originally contain?

Starting amount ?
 ending amount 1.8g
 Total time 10000
 Half life 5730

$$1.8 \begin{array}{c} 3.6 \\ | \\ 5.4 \end{array}$$

$$2 \cdot 0.75 = 1.5 \quad 3.6 \cdot 1.5$$

19. Manganese-56 decays by beta emission and has a half-life of 2.6 hours. How many mg of a 20.0mg sample will remain after 13 hours?

Starting amount 20 mg $2.6 \overline{)13} = 5$
 ending amount 20 10 5 2.5 1.25 **0.625**
 Total time 13 hrs 2 3 4 5
 Half life 2.6 hrs

20. Uranium-238 has a half-life of 4.46 billion years. How long will it take for a 12g sample to decay to 0.1875g?

Starting amount 12g 12 6 3 1.5 0.75
 ending amount 0.1875g 1 2 3 4
 Total Time? 0.375 0.1875
 Half life 4.46 billion yrs 5 6

4.46
 6

 26.76 billion years