N9 – HALF LIFE

Target: I can perform calculations related to how quickly radioactive substances decay.

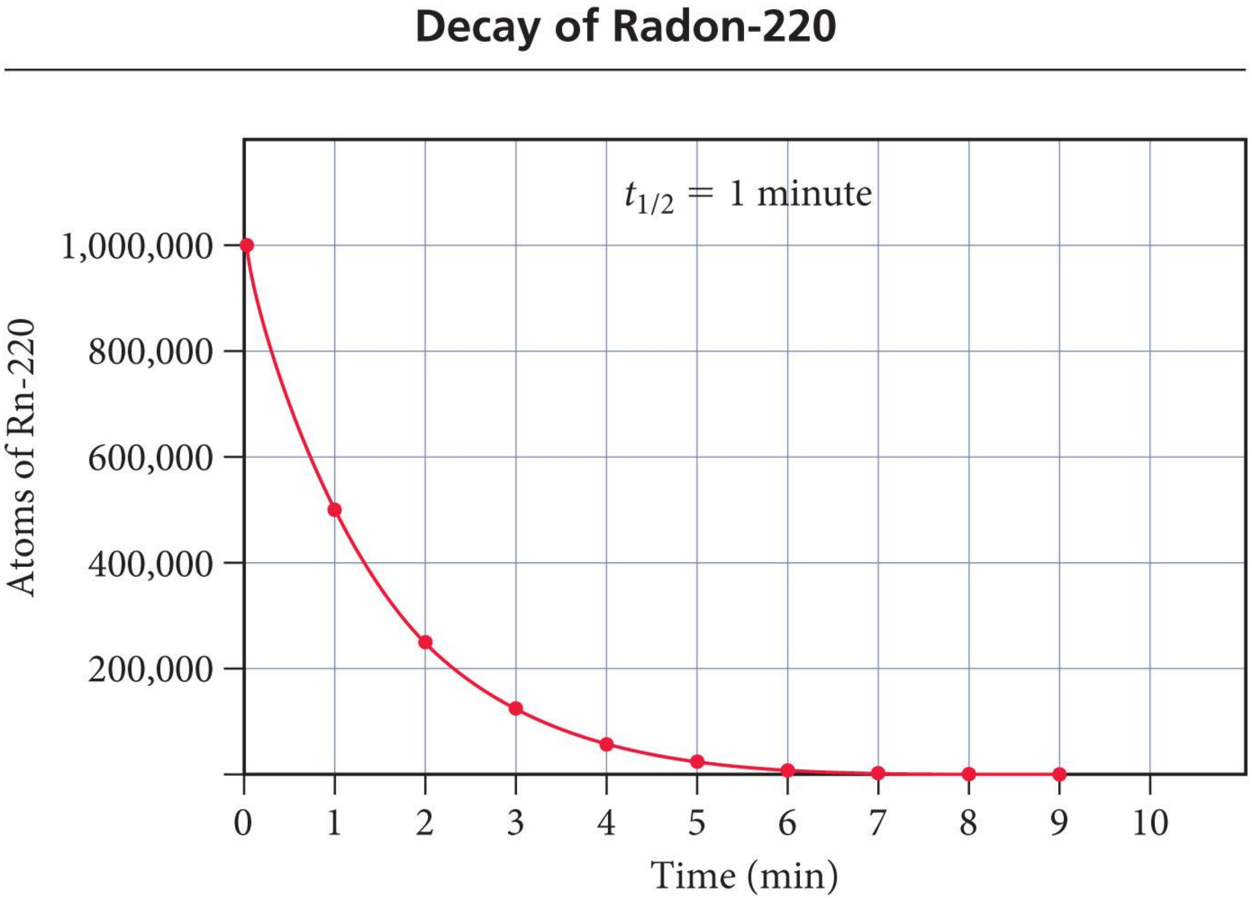
Half-Life

- Half Life is the time required for half of a radioisotope's nuclei to decay into its products.

# of ½ lives	% Remaining
0	100%
1	50%
2	25%
3	12.5%
4	6.25%
5	3.125%
6	1.5625%

Graphing Half-Life

Half of the radioactive atoms decay each half-life.



Using a Table

- Suppose you have 10.0 grams of strontium – 90, which has a half life of 29 years. How much will be remaining after x number of years?

# of ½ lives	Time (Years)	Amount Remaining (g)
0	0	10
1	29	5
2	58	2.5
3	87	1.25
4	116	0.625

Half-Life Equation

- Use a handy dandy equation!

$$A_E = A_S \times (0.5)^n$$

Amount Starting → A_S

# of half-lives → n

Amount Ending Still Radioactive → A_E

$$n = \frac{t}{h}$$

t = time passed
h = length of one half-life

Solving for % remaining

$$A_E = A_S \times (0.5)^n$$

$$\% \text{ remaining} = \frac{A_E}{A_S} \times 100$$

$$\frac{A_E}{A_S} = (0.5)^n$$

Then multiply your answer by 100 to put it in % format!

Example 1

- If gallium – 68 has a half-life of 68.3 minutes, how much of a 160.0 mg sample is left after 1 half life? __**80 mg**__. After 2 half lives? __**40 mg**__. After 3 half lives? __**20 mg**__

$$A_E = A_s \times (0.5)^n$$

$$80\ \text{mg} = 160.0\ \text{mg} \times (0.5)^1$$

$$40\ \text{mg} = 160.0\ \text{mg} \times (0.5)^2$$

Example 2

Cobalt – 60, with a half-life of 5 years, is used in cancer radiation treatments. If a hospital purchases a supply of 30.0 g, how much would be left after 15 years? ____**3.75 g**____

$$A_E = A_s \times (0.5)^n$$

$$A_E = 30.0g \times (0.5)^{(15/5)} = 3.75\ g$$

Example 3

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 2.000 mg sample will remain after 133.5 days? ________________

$$A_E = A_S \times (0.5)^{t/h}$$

$$A_E = 2.000\text{ mg} \times (0.5)^{(133.5/44.5)}$$

$$0.2500\text{ mg} = 2.000\text{ mg} \times 0.125$$

Solve for Time/Half-life

$$A_E = A_S \times (0.5)^{t/h}$$

Isolate $(0.5)^{t/h}$

$$\frac{A_E}{A_S} = (0.5)^{t/h}$$

Bring down exponent using logs

$$\text{Log}\left(\frac{A_E}{A_S}\right) = \frac{t}{h}\,\text{Log}\,(0.5)$$

Plug in your #'s then rearrange for t or h depending on what you want to solve for!

Example 4

The half-life of polonium-218 is 3.0 min. If you start with 20.0 g, how long before only 1.25 g remains?

$$\text{Log}\left(\frac{A_E}{A_S}\right) = \frac{t}{h}\ \text{Log}\ (0.5)$$

$$\text{Log}\left(\frac{1.25}{20.0}\right) = \frac{t}{3}\ \text{Log}\ (0.5)$$

t = 12min

Example 5

A sample initially contains 150.0 mg of radon-222. After 11.4 days, it contains 18.75 mg of radon-222. Calculate the half-life.

$$\text{Log}\left(\frac{A_E}{A_S}\right) = \frac{t}{h}\ \text{Log}\ (0.5)$$

$$\text{Log}\left(\frac{18.75}{150.0}\right) = \frac{11.4}{h}\ \text{Log}\ (0.5)$$

h = 3.8days

YouTube Link to Presentation

- https://youtu.be/7152ocNo7ko