

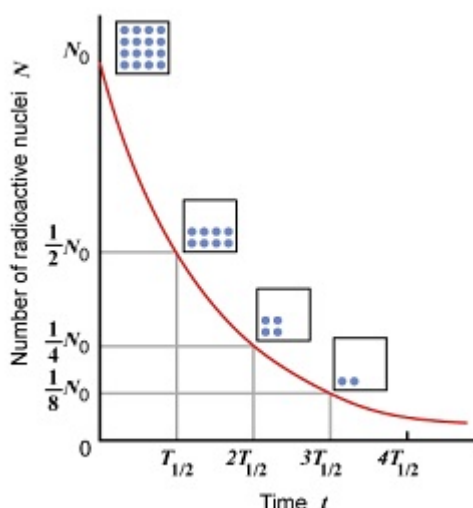
Physics 2204
Unit 3: Work, Power and Energy
Worksheet 13: Radioactive Half Life



Student Name: _____

Half Life refers to the time for half of the radioactive nuclei in a given sample to undergo decay. After one half life there is $\frac{1}{2}$ of original sample left. After two half-lives, there will be $\frac{1}{2}$ of the $\frac{1}{2} = \frac{1}{4}$ the original sample.

Graphical Representation of Half-Life – Exponential Decay:



- This is an example of an exponential graph
- The horizontal axis shows time – it is measured in number of half-lives.
- The vertical axis shows the amount or material, or number of radioactive nuclei remaining after decay. (represented by blue dots in the squares).

Some Common Radioactive Isotopes:

Isotope	Half Life	Decay
Carbon-14	5,730 years	β, γ
Radon-222	3.8 days	α
Uranium-235	7.0×10^8 years	α, γ
Uranium-238	4.46×10^9 years	α

Activity refers to measured by number of nuclei decaying per second.

Becquerels (Bq) is for decays per second or kilobecquerels (kBq) or megabecquerels (mBq). One becquerel is 1 count/sec or $1/s$ or s^{-1} .

Geiger counter is used to measure the activity of a radioactive material. It is a type of radiation detector invented to measure x-rays and other ionizing radiation, since they are invisible to the naked eye. It detects radiation such as alpha particles, beta Particles and gamma rays. It was invented by Hans Geiger.



Example 1:

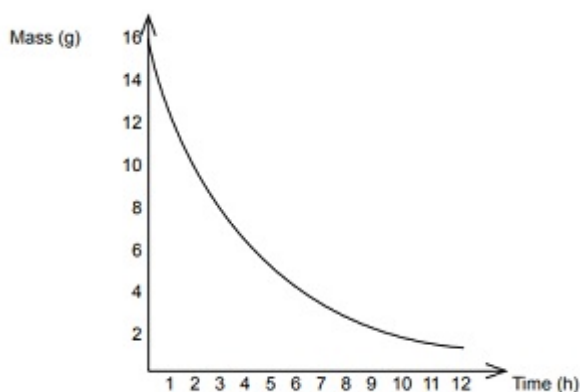
A radioactive chemical has an activity of 10,000Bq. What is the activity of this chemical after 2 half-lives have passed?

Example 2:

A 10.0 g sample of radioactive tracer iodine-123 is stored on a hospital shelf. Its half-life is 12 hours. How much radioactive material is left after 5.0 days?

Example 3:

Determine the half-life from the decay of the radioactive element represented in the graph below.



Example 4:

The number of radioactive nuclei in a particular sample decreases over 15 days to 1/16 of the original number. What is the half-life of these nuclei?

PART A: MULTIPLE CHOICE

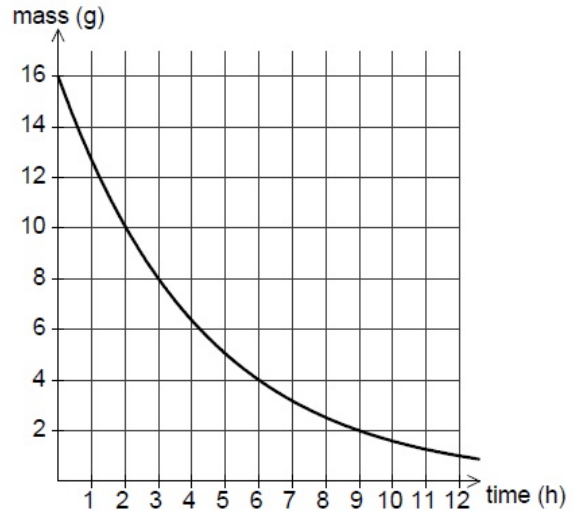
Instructions: Shade the letter of the correct answer on the computer scorable answer sheet provided

- Which of the following refers to the time for half of the radioactive nuclei in a given sample to undergo decay.
 - Decay
 - Double life
 - Half Life
 - Transmutation
- What device is used to measure radioactivity?
 - Accelerometer
 - Force meter
 - Geiger counter
 - Magnetometer

3. What is the SI derived unit of radioactivity?
- (A) Becquerel
 - (B) Decay
 - (C) Newton
 - (D) Tesla
4. What happens to the half-life of a radioactive substance as it decays?
- (A) It remains constant
 - (B) It increases
 - (C) It decreases
 - (D) It could do any of these
5. After the third half-life, how much of the sample is left?
- (A) 1/16
 - (B) 1/8
 - (C) 1/2
 - (D) 1/3
6. Barium-122 has a half-life of 2.0 minutes. A fresh sample weighing 80. g was obtained. If it takes 10. minutes to set up an experiment using barium-122, how much barium-122 will be left when the experiment begins?
- (A) 0.25g
 - (B) 2.5g
 - (C) 25g
 - (D) 80.g
7. Americium-242 has a half-life of 6.0 hours. If you started with 24 g and you now have 3.0 g, how much time has passed?
- (A) 6.0 hours
 - (B) 12 hours
 - (C) 18 hours
 - (D) 24 hours
8. A radioactive sample has a half-life of 5.0 min. What fraction of the sample is left after 20 min?
- (A) 1/2
 - (B) 1/4
 - (C) 1/8
 - (D) 1/16
9. 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?
- (A) 100.0g
 - (B) 50.0g
 - (C) 12.5g
 - (D) 8.5g
10. A radioactive material has an initial activity of 1320 Bq. What is its activity after 9.0 h if its half-life is 3.0 h?
- (A) 1.7×10^2 Bq
 - (B) 3.3×10^2 Bq
 - (C) 6.6×10^2 Bq
 - (D) 1.3×10^3 Bq

11. What is the half-life of the unknown substance shown?

- (A) 2 h
- (B) 3 h
- (C) 8 h
- (D) 10 h



12. A sample of radioactive material has an initial activity of 1.50×10^6 Bq. After how many half-lives will the activity decrease to 3.75×10^5 Bq?

- (A) $\frac{1}{4}$
- (B) $\frac{1}{2}$
- (C) 2
- (D) 4

13. How much of a 60.0 g radioactive isotope remains after four half-lives?

- (A) 3.75 g
- (B) 7.50 g
- (C) 9.60 g
- (D) 15.0 g

14. An isotope of krypton has a half-life of 3 minutes. If a sample of this isotope produces 1000 counts per minute in a Geiger counter, how many counts per minute are produced after 15 minutes?

- (A) 0
- (B) 15
- (C) 30
- (D) 60

15. A Geiger counter detects 240 decays per minute from a pure radioactive sample. If the rate reduces to 15 decays per minute after 12 days, what is the half life of the sample?

- (A) 3 days
- (B) 4 days
- (C) 8 days
- (D) 15 days

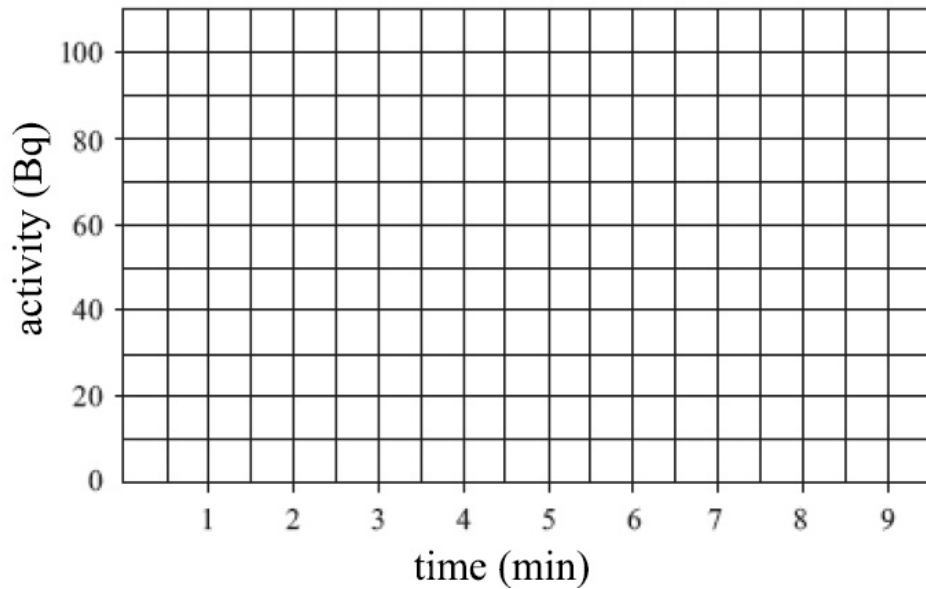
16. If element A has a half-life of 5 days, how many days will it take a 1.0×10^2 mg sample to decay to 12.5 mg?

- (A) 3
- (B) 8
- (C) 15
- (D) 20

PART B: WRITTEN RESPONSE

1. A radioactive sample has a half-life of 2.5 minutes, and the initial activity of the sample is 100 Bq.

(i) On the grid below, sketch a graph of activity versus time for this sample for the first 7.5 minutes.



ii) Using the graph, determine the activity of this sample at 6.0 minutes.

2. Strontium - 82 has a half-life of 25.0 days. If a sample originally contained 140 g of strontium - 82, in how many days will the sample contain 8.75 g of the isotope?

3. If element X has a half-life of 6 days, how many days will it take a 1.3×10^2 mg sample to decay to 4.1 mg?