

SI Geology - Full Discipline Demo

Absolute Dating

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Geology - Full Discipline Demo
Course	SI Geology - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term to its definition.

Alpha Decay	Process in which a neutron is converted into a proton and a high energy electron is ejected from an atom, thereby changing the identity of an atom	1
Atomic Mass	Two or more forms of an element with an equal number of protons but different numbers of neutrons	2
Beta Decay	Process in which atoms emit particles and energy to reach a more stable, lower energy atomic configuration	3
Gamma Decay	Sum of the protons and neutrons in an atom	4
Half Life	Process in which two protons and two neutrons are released from the nucleus of an atom, changing the identity of an atom	5
Isotope	Average time it takes for half of a parent atom to decay	6
Radioactive Decay	Process in which an atom relaxes from an excited state to a more stable one, releasing a high-energy electromagnetic wave	7

Correct answers:

- 1 Beta Decay 2 Isotope 3 Radioactive Decay 4 Atomic Mass
 5 Alpha Decay 6 Half Life 7 Gamma Decay

Classify each statement as true or false.

True	False
1	2

⚡ Daughter atoms are always isotopes of the parent atoms.

⚡

Half-life quantifies the known rate of decay for radioactive isotopes and can be used to measure a rock's age.

⚡ Isotope half lives can range from a few seconds to billions of years.

⚡

Radioactive dating measures the number of daughter atoms to determine the age of a rock.

⚡

Useful isotopes for radioactive dating are abundant in rock, have half-lives in billions of years, and are not dangerous.

Correct answers:

1

Half-life quantifies the known rate of decay for radioactive isotopes and can be used to measure a rock's age.

Isotope half lives can range from a few seconds to billions of years.

Useful isotopes for radioactive dating are abundant in rock, have half-lives in billions of years, and are not dangerous.

2 Daughter atoms are always isotopes of the parent atoms.

Radioactive dating measures the number of daughter atoms to determine the age of a rock.

Exploration

_____ decay occurs when there is an imbalance in the number of protons and neutrons in the nucleus of an atom, leading to the conversion of a neutron to a proton and the release of a high-energy electron.

- ☐ Alpha
- ☒ Beta ✓
- ☐ Gamma

Isotopes differ in their number of protons.

- ☐ True
- ☒ False ✓

The frequency of radioactive decay is determined by the half-life of an isotope.

- ☒ True ✓
- ☐ False

Which of the following is not a property of a useful radioactive isotope for geologic radioactive dating?

- ☒ Isotope should have a half-life less than one million years ✓
- ☐ Isotope should be significantly abundant in rocks
- ☐ Isotope should have a half-life in the billions of years
- ☐ Isotope should not be dangerous

Exercise 1

Identify and describe similarities and differences between this experiment and radioactive decay in nature.

Suppose your coins represented the isotope uranium-235 in a rock sample. How old was the sample after three half-lives?

Hint: Reference Table 2 for the half-life of uranium-235.

If 1/8 of a radioactive element remains after 600 years, what is that element's half-life?

What would your graph look like if only 5 coins were used in this exercise? What if 10,000 coins were used? What does this tell you about the relationship between half-life and sample size?

Data Table 1: Radioactive Decay Data Trial 1
(SAMPLE ANSWER BELOW)

Half-Life	Parent Atoms (heads up)	Daughter Atoms (tails up)	Daughter Atoms Cumulative Total
0	50	0	0
1	28	22	22
2	16	12	34
3	9	7	41
4	6	3	44
5	3	3	57
6	0	3	50
7			
8			
9			

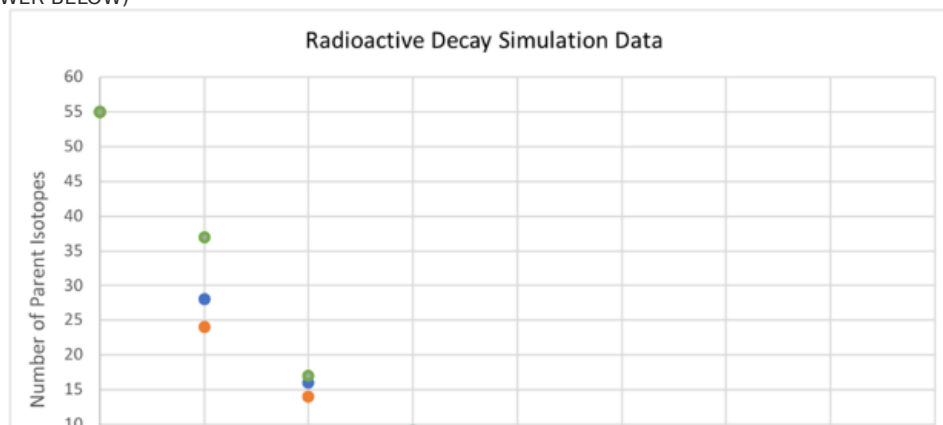
Data Table 2: Radioactive Decay Data Trial 2
(SAMPLE ANSWER BELOW)

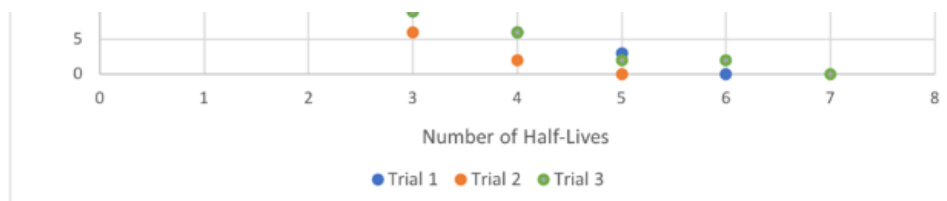
Half-Life	Parent Atoms (heads up)	Daughter Atoms (tails up)	Daughter Atoms Cumulative Total
0	Student data will vary. 55	0	0
1	24	31	31
2	14	10	41
3	6	8	49
4	2	4	53
5	0	2	55
6			
7			
8			
9			

Data Table 3: Radioactive Decay Data Trial 3
(SAMPLE ANSWER BELOW)

Half-Life	Parent Atoms (heads up)	Daughter Atoms (tails up)	Daughter Atoms Cumulative Total
0	Student data will vary. 55	0	0
1	37	18	18
2	17	20	38
3	9	8	46
4	6	3	49
5	2	4	53
6	2	0	53
7	0	2	55
8			
9			

Photo 1: Radioactive Decay Simulation Graph
(SAMPLE ANSWER BELOW)





Exercise 2

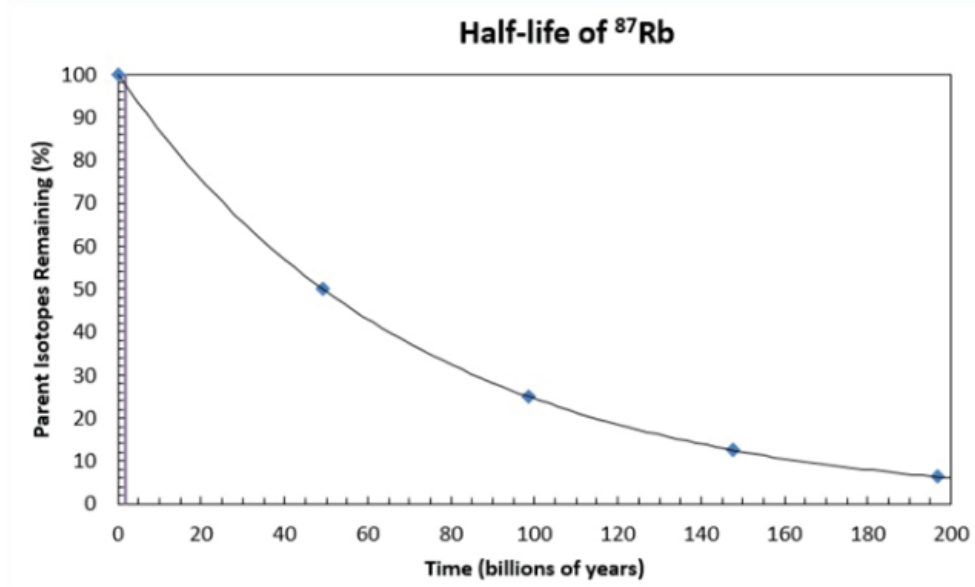
1. After 5 half-lives have passed, what would be the percent of parent isotopes, and the percent of daughter isotopes, in a sample containing ^{87}Rb ?

2. Use your graph submitted in Photo 2 to determine the percentage of parent isotopes that would remain in the sample after 10 billion years have passed.

Data Table 4: Parent Isotopes Predicted Over Time
(SAMPLE ANSWER BELOW)

Half-Life	Time (Billions of years)	Parent Isotopes Remaining (Percent)
0	0	100
1	49.23	50
2	98.46	25
3	147.69	12.5
4	196.92	6.25

Photo 2: Graph of ^{87}Rb Predicted Parent Isotopes Over Time
(SAMPLE ANSWER BELOW)



Competency Review

Two or more forms of an element containing an equal number of protons, but a different number of neutrons, are called ____.

- ☐ half-lives
- ☐ gamma rays
- ☒ isotopes ✓
- ☐ atoms

In Exercise 1, what do the two sides of the coin represent?

- ☐ Two isotopes of the same element
 - ☒ Parent and daughter atoms ✓
 - ☐ Parent atoms and number of half-lives
 - ☐ None of the above
-

____ decay occurs when two protons and two neutrons are released from the nucleus of an atom.

- ☒ Alpha ✓
- ☐ Beta
- ☐ Gamma

Consider a sample containing 432 uranium-238 atoms. After two half-lives, how much uranium-238 would remain in the sample?

- ☐ 216
- ☐ 60
- ☐ 119
- ☒ 108 ✓

Radioactive decay is one of the only truly random processes in nature.

- ☒ True ✓
- ☐ False

____ decay does not cause transmutation of the nucleus.

- ☐ Alpha
- ☐ Beta
- ☒ Gamma ✓

Consider a sample containing 624 rubidium -87 atoms. How many daughter strontium-87 atoms would be present after 3 half-lives?

- ☐ 234
- ☐ 312
- ☐ 468
- ☒ 546 ✓

Unstable isotopes undergo ____, in which atoms emit particles and energy to reach a more stable configuration.

- ☐ half-lives
- ☒ radioactive decay
- ☐ radioactive dating
- ☐ absolute dating



Extension Questions

Can radiometric dating accurately determine the age of a rock in all cases? Why or why not? (SAMPLE ANSWER BELOW)

Radiometric dating does not always accurately convey the age of a rock. When a sample is entirely composed of parent atoms, the isotopic clock starts ticking. When a rock's age is measured, it is measured from the formation of the rock and the present. However, if the rock undergoes melting - for example, via a volcanic eruption - the clock will be reset. As a result, the date of the original formation of the rock cannot be measured. Rather it will be measured from the formation of the new rock.