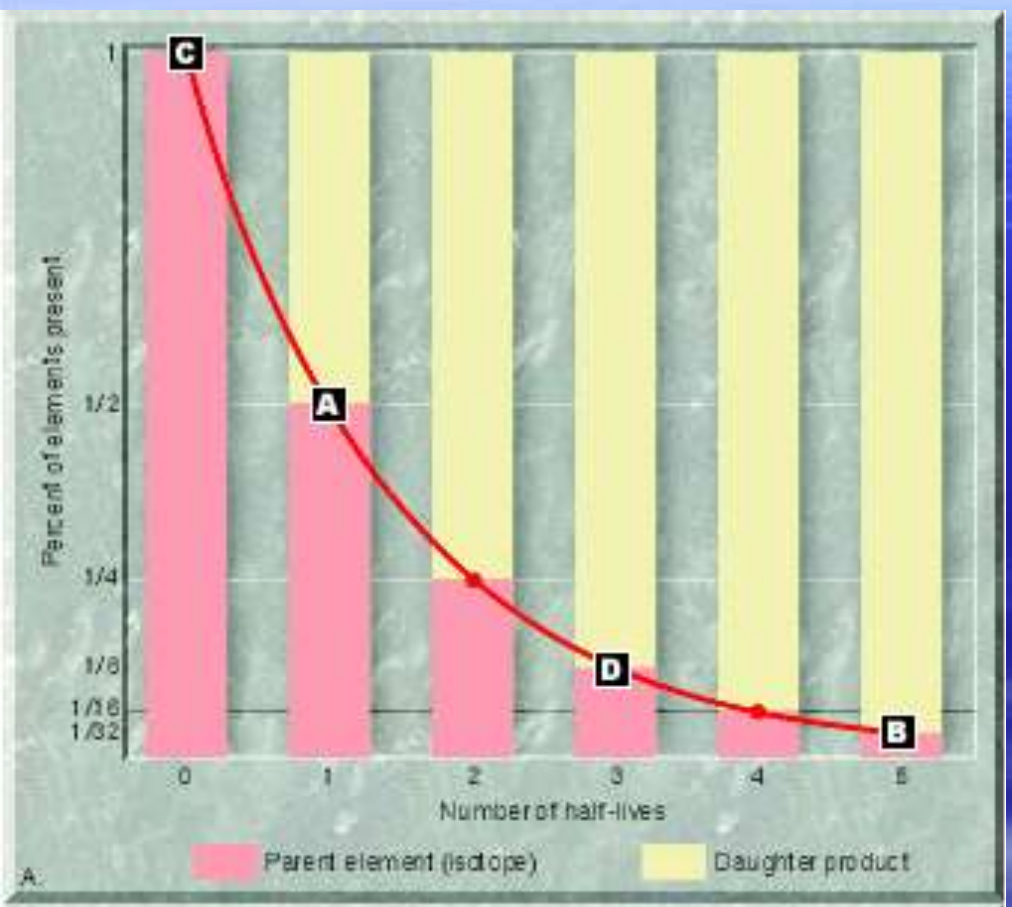
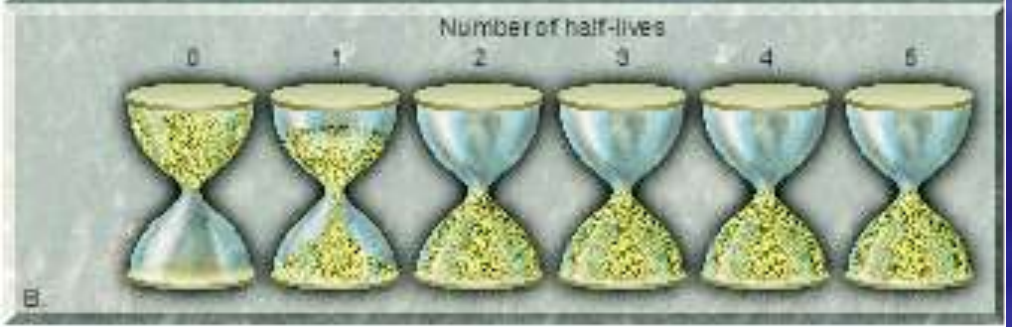
Half-Life

- Not all of the atoms in a sample of radioactive material break down or decay at the same time.
- This is a gradual process, but a rate can be determined.
- The process itself is measured in terms of the half-life, or the amount of time it takes for 1/2 of the total number of atoms present in a sample to decay.

Radioactive dating





- Assume a radioactive isotope with a half-life of 1 million years.
- What percentage of 'parent material' is left after:
  - 1 million years?
  - 3 million?
  - 5 million?
  - 0?

Radioactivity Problems

Problem Type #1: Fraction of parent material remaining

Given the half-life of U-235 is 0.7 billion years, determine the age of a sample of U-235 if 1/16 of the starting material remains.

Given:	**Half-life = 0.7 billion years**
	Fraction of parent (U-235) remaining = 1/16

- **You must first find out how many half-lives have passed if 1/16 of the parent (U-235) remains.**

Number of half lives	Fraction remaining

Radioactivity Problems

Problem Type #1: Fraction of parent material remaining

Given the half-life of U-235 is 0.7 billion years, determine the age of a sample of U-235 if 1/16 of the starting material remains.

Given:	**Half-life = 0.7 billion years**
	Fraction of parent (U-235) remaining = 1/16

- **You must first find out how many half-lives have passed if 1/16 of the parent (U-235) remains.**

Number of half lives	Fraction remaining
0	1/1
1	1/2
2	1/4
3	1/8
4	1/16

Age = # of Half-lives x Time for 1 Half-life

Age = (4) (0.7 Billion years)

Age = 2.8 Billion years

Radioactivity Problems

Problem Type #2: Mass of parent material remaining

1200 g of a radioactive element has decayed to produce 150 g of the element. If the half-life of the mineral is 0.40 billion years, what is the age of the sample?

Given:

1200 grams decays to 150 grams & Half-life = 0.4 Billion years

You must first find out how many half-lives have passed when 1200 grams decays to form 150 grams

Radioactivity Problems

Problem Type #2: Mass of parent material remaining

1200 g of a radioactive element has decayed to produce 150 g of the element. If the half-life of the mineral is 0.40 billion years, what is the age of the sample?

Given:

1200 grams decays to 150 grams & Half-life = 0.4 Billion years

1200 g
↓
600 g
↓
300 g
↓
150 g

3 Half lives

Age = # of Half-lives x Time for 1 Half-life

Age = (3) (0.4 Billion years)

Age = 1.2 Billion years

Radioactivity Problems

Problem Type #3: Decay Graph

Element X has a half-life of 250,000 years. Suppose that 256 g of element X were initially present in a sample of rock.

(i) **Construct a half-life decay graph to illustrate the decay process for 5 half-life periods.**

(ii) **How many grams of element X will remain after one million years have expired?**

Information Given:

Half-life = 250,000 years

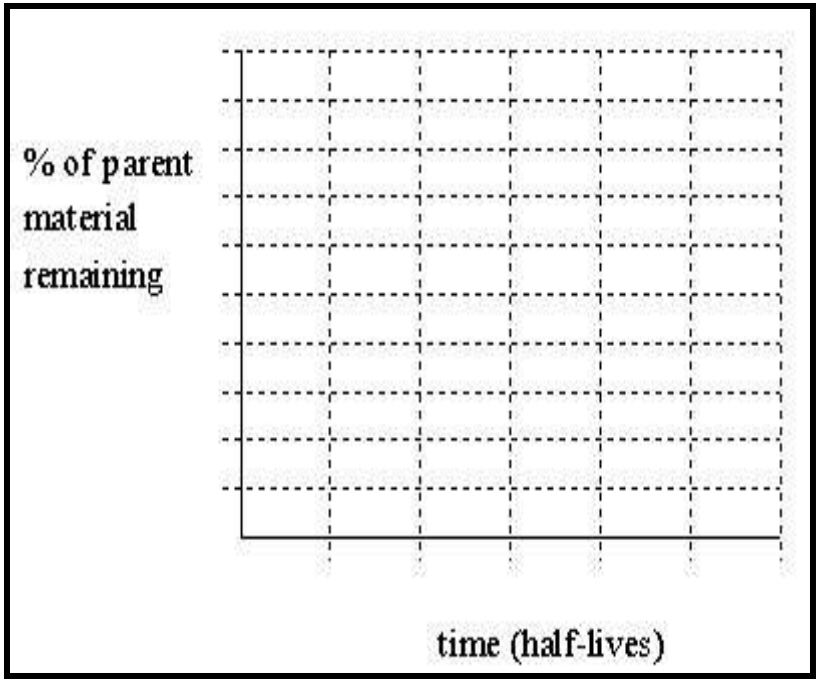
Mass of "X" = 256 grams (Initial amount of radioactive element)

Radioactivity Problems

Problem Type #3: Decay Graph

(i) **Construct a half-life decay graph to illustrate the decay process for 5 half-life periods.**

Number of half lives	grams remaining	percent remaining
0		
1		
2		
3		
4		
5		

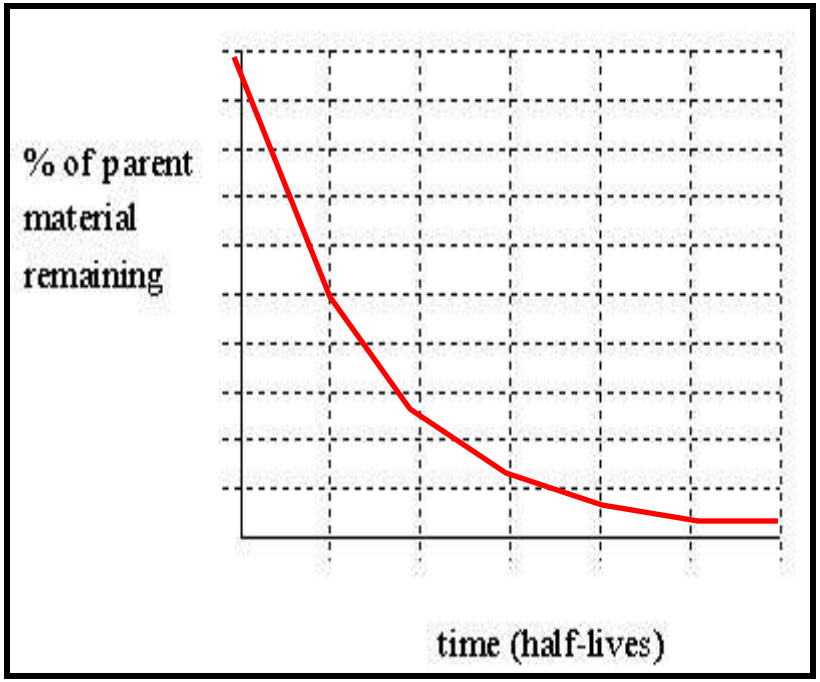


Radioactivity Problems

Problem Type #3: Decay Graph

(i) **Construct a half-life decay graph to illustrate the decay process for 5 half-life periods.**

Number of half lives	grams remaining	percent remaining
0		
1		
2		
3		
4		
5		



Radioactivity Problems

Problem Type #3: Decay Graph

(ii) How many grams of element X will remain after one million years have expired?

You must first find out how many half-lives can pass in 1 million years.

Number of half lives	grams remaining (grams)	percent remaining (%)
0	256	100
1	128	50
2	64	25
3	32	12.5
4	16	6.25
5	8	3.125

 # Half-Lives = $\frac{\text{Total time}}{\text{Time 1 Half-Life}}$

 # Half-Lives = $\frac{1{,}000{,}000 \text{ yrs}}{250{,}000 \text{ yrs}}$

 # Half-Lives = 4

Answer:

16 grams will remain after 1 million years.