

# Nuclear Chemistry & Half-life Worksheet

1. Lawrencium-257 has a half-life of 8 seconds. How long will 75% of a lawrencium-257 sample take to decay?
2. Sodium-24 has a half-life of 15 hours. If, after 45 hours, we are left with a 2-gram sample of sodium-24, how much did we have in the beginning?
3. After 18 days, a sample of fermium-253 decays to 6.25% of its activity. What is the half-life of fermium-253?
4. Carbon-14 has a half-life of about 5000 years and is used in carbon dating. This process involves using carbon-14 to determine the age of organic matter, including fossils. Scientists have discovered a sample about 3% as radioactive as it should be compared to carbon-14 from a living organism. What is the age of the fossil?
5. A 64-gram sample of technetium-95 is reduced to 4 grams in 80 hours. Use this information to determine the half-life of technetium-95.

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## Answers

1. Lawrencium-257 has a half-life of 8 seconds. How long will 75% of a lawrencium-257 sample take to decay?

16 seconds

After the sample has passed through one half-life, it has undergone 50% decay. To undergo 75% decay, it must pass through another half-life, so the time taken for the sample =  $2 \times 8 = 16$  seconds.

2. Sodium-24 has a half-life of 15 hours. If, after 45 hours, we are left with a 2-gram sample of sodium-24, how much did we have in the beginning?

16 grams

After 45 hours, sodium-24 has passed through 3 half-lives ( $45/15 = 3$ ). So, the amount of sodium-24 in the sample at the start was =  $2^3 \times 2 = 16$  grams.

3. After 18 days, a sample of fermium-253 decays to 6.25% of its activity. What is the half-life of fermium-253?

4.5 days

If a sample has decayed to 6.25%, it has passed through 4 half-lives ( $100\% \rightarrow 50\% \rightarrow 5\% \rightarrow 12.5\% \rightarrow 6.25\%$ ). So, the half-life of the sample is =  $18/4 = 4.5$  days.

4. Carbon-14 has a half-life of about 5000 years and is used in carbon dating. This process involves using carbon-14 to determine the age of organic matter, including fossils. Scientists have discovered a sample about 3% as radioactive as it should be compared to carbon-14 from a living organism. What is the age of the fossil?

25,000 years

For the sample of carbon-14 to decay to about 3%, it must pass through 5 half-lives ( $100\% \rightarrow 50\% \rightarrow 25\% \rightarrow 12.5\% \rightarrow 6.25\% \rightarrow 3.125\%$ ). So the fossil is =  $5 \times 5000 = 25000$  years old.

5. A 64-gram sample of technetium-95 is reduced to 4 grams in 80 hours. Use this information to determine the half-life of technetium-95.

20 hours

For a 64-gram sample to decay to 4 grams, it must pass through 4 half-lives [ $64 \rightarrow 32 \rightarrow 16 \rightarrow 8 \rightarrow 4$ ]. From this information, it is possible to determine that the half-life of technetium-95 is =  $80/4$  hours = 20 hours.