

Half-life Worksheet

1. If we start with 400 atoms of a radioactive substance, how many would remain after i > 1 half-life? ii > 2 half-lives? iii > 3 half-lives? iv > 5 half-lives? v > 10 half-lives?
2. The half-life of a radioactive isotope 'X' is 2 years. How long would it take for a 4 mg sample of isotope 'X' to decay until only 0.5 mg is left?
3. The half-life of chromium-51 is 28 days. If the sample contained 510 grams, how much chromium-51 would remain after 1 year?
4. If a sample of a radioactive isotope weighing 100 grams decays to 12.5 grams after 24.3 hours, what is the half-life of the radioactive isotope?
5. The half-life of Au-198 is 2.69 days. How long does it take a sample weighing 180 grams to decay to an $\frac{1}{8}$ th of its original mass?

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Answers

1. If we start with 400 atoms of a radioactive substance, how many would remain after i > 1 half-life? ii > 2 half-lives? iii > 3 half-lives? iv > 5 half-lives? v > 10 half-lives?

i > 200 ii > 100 iii > 50 iv > 12.5 v > 0.39

After 1 half-life, the amount of atoms left will be = $400 \times (\frac{1}{2})^1 = 200$

After 2 half-lives, the amount of atoms left will be = $400 \times (\frac{1}{2})^2 = 100$

After 3 half-lives, the amount of atoms left will be = $400 \times (\frac{1}{2})^3 = 50$

After 5 half-lives, the amount of atoms left will be = $400 \times (\frac{1}{2})^5 = 12.5$

After 10 half-lives, the amount of atoms left will be = $400 \times (\frac{1}{2})^{10} = 0.39$ or 0.40

2. The half-life of a radioactive isotope 'X' is 2 years. How long would it take for a 4 mg sample of isotope 'X' to decay until only 0.5 mg is left?

6 years

For 4 mg of 'X' to decay to 0.5 mg, it needs to pass through 3 half-lives [$4 \times (\frac{1}{2}) = 2 \times (\frac{1}{2}) = 1 \times (\frac{1}{2}) = 0.5$]. So, the years needed for this radioactive isotope to decay = 2×3 years = 6 years

3. The half-life of chromium-51 is 28 days. If the sample contained 510 grams, how much chromium-51 would remain after 1 year?

0.062 grams

After a year, the chromium-51 will have passed through = $365/28 = 13$ half-lives. So after a year, the amount of chromium-51 left would be = $(\frac{1}{2})^{13} \times 510 = 0.062$ grams.

4. If a sample of a radioactive isotope weighing 100 grams decays to 12.5 grams after 24.3 hours, what is the half-life of the radioactive isotope?

8.1 hours

For the sample to decay from 100 grams to 12.5 grams, the number of half-lives it has to pass through is 3 [$(\frac{1}{2}) \times 100 = 50 \rightarrow (\frac{1}{2}) \times 50 = 25 \rightarrow (\frac{1}{2}) \times 25 = 12.5$]. So, for 3 half-lives to pass, the time needed is $24.3/3$ hours = 8.1 hours

5. The half-life of Au-198 is 2.69 days. How long does it take a sample weighing 180 grams to decay to an $\frac{1}{8}$ th of its original mass?

8.07 days

For a sample to decay to an $\frac{1}{8}$ th of its mass, it must pass through 3 half-lives ($1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8}$). So, the time needed is = 2.69×3 days = 8.07 days.