Half-life Calculations Worksheet

1. In the beginning, there are 10 grams of tungsten-187. If the half-life of tungsten-187 is 23.9 hours, how much will be present at the end of i> 1 day? ii> 2 days? iii> 7 days?

2. The half-life of tritium is 12.26 years. What time is required for a tritium sample to lose 75% of its radioactivity?

3. Polonium-214 has a half-life of 0.001 seconds. So how much of a 10 gram sample of Polonium-214 will be left after 5 seconds?

4. Iodine-131 has a half-life of 8 days. How much of the original sample remains after 32 days?

5. Selenium-83 has a half-life of 25 minutes. How much time would it take for a 10 mg sample to decay until only 1.25 mg of it remains?

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Answers

1. In the beginning, there are 10 grams of tungsten-187. If the half-life of tungsten-187 is 23.9 hours, how much will be present at the end of i> 1 day? ii> 2 days? iii> 7 days?

   i> 4.98 g
   ii> 2.48 g
   iii> 0.0765 g
   If tungsten-187 has a half-life of 23.9 hours, then each day = 24/23.9 = 1.0042 half-lives are completed. So, in 1 day = $(0.5)^{1.0042}$ = 0.498, meaning 10 x 0.498 = 4.98 grams is left, in 2 days = $(0.5)^{2.0084}$ = 0.248, meaning 10 x 0.248 = 2.48 grams is left, and in 7 days = $(0.5)^{7.0294}$ = 0.00765, meaning 10 x 0.00765 = 0.0765 grams is left.

2. The half-life of tritium is 12.26 years. What time is required for a tritium sample to lose 75% of its radioactivity?

   24.52 years
   After the sample loses 75% of its radioactivity, it still retains 25% of its radioactivity.
   So the number of half-lives it has passed is 2 [$(½)^n$ = 0.25 =¼ = $(½)^2$; n=2]
   So the time taken is 2 x 12.26 = 24.52 years

3. Polonium-214 has a half-life of 0.001 seconds. So how much of a 10 gram sample of Polonium-214 will be left after 5 seconds?

   0.002 grams
   Number of half-lives that passed in 5 seconds = 5 x 1/0.001 = 5000
   So after 5000 half-lives, the amount of Polonium-214 left will be = 10/5000 = 0.002 grams

4. Iodine-131 has a half-life of 8 days. How much of the original sample remains after 32 days?

   1/16th of the original sample will remain after 32 days.
   After 32 days, iodine-131 has passed through = 32/8 half-lives = 4 half-lives. So the amount of iodine-131 left = $(½)^4$ of the original sample = 1/16 th of the original.

5. Selenium-83 has a half-life of 25 minutes. How much time would it take for a 10 mg sample to decay until only 1.25 mg of it remains?

   75 minutes
   For a 10 mg sample of selenium-83 to decay to 1.25 mg it has to go through 3 half-lives (10/2 = 5 → 5/2 = 2.5 → 2.5/ 2 = 1.25). So the total time needed to reach that mass would be 3 x 25 minutes = 75 minutes.