SPH3U Task – Hwk – 7.3 Name: Sol'n

7.3 Questions

1. Chlorine-38, which undergoes beta-negative decay, has a half-life of 37.24 min. K/U T/I C
   (a) Construct a table that compares the mass of Cl-38 remaining after *t* minutes for several values of *t*.
   (b) Draw a graph that illustrates this relationship.
   (c) What isotope does Cl-38 decay into?
2. Gold-198, with a half-life of 2.6 days, is used to diagnose and treat liver disease. T/I C
   (a) Write a half-life decay equation that relates the mass of Au-198 remaining to time in days.
   (b) What percentage of a sample of Au-198 would remain after
      (i) 1 day?
      (ii) 1 week?
3. Cobalt-60, with a half-life of 5.3 years, has a number of applications, including medical therapy and the sterilization of medical tools. Determine the mass of a 50 g sample that would remain after
   (a) 6 months
   (b) 5 years T/I C
4. What type of radioactive decay is involved in carbon dating? Explain the process of carbon dating. K/U C
5. A fossil contains 70 % of the carbon-14 it once had as a living creature. Use the half-life decay equation to determine when the creature died. T/I C

Aluminum-26, which decays into magnesium-26, has a half-life of approximately 720 000 years. Use this information to answer Questions 6 and 7.

6. (a) What type of decay does Al-26 undergo?
   (b) Does Al-26 decay in the same way as C-14? Explain. K/U C
7. A moon rock has 3 % of its original Al-26 mass. K/U T/I C
   (a) Determine the age of the moon rock.
   (b) Discuss any assumptions that must be made when using this method of dating.
8. Take a regular sheet of paper. Measure its length and width and determine the area. Fold the paper neatly in half. Determine the new area. Repeat until you cannot fold the paper any longer. Explain how this model can be used to describe half-life. K/U C

#2 (a) $A_f = A_i\left(\frac{1}{2}\right)^{t/2.6}$

final mass ↑ ↑ initial mass

(b) $\frac{A_f}{A_i} = \left(\frac{1}{2}\right)^{t/2.6}$

↑ this ratio can be expressed as a percentage

(i) 1 day

$\frac{A_f}{A_i} = \left(\frac{1}{2}\right)^{1/2.6}$

$\frac{A_f}{A_i} = 0.766$

$A_f = 0.766\,A_i$

$\therefore$ 76.6% remains

(ii) 1 week = 7 days

$\frac{A_f}{A_i} = \left(\frac{1}{2}\right)^{7/2.6}$

$\frac{A_f}{A_i} = 0.155$

$A_f = 0.155\,A_i$

$\therefore$ 15.5% remains

#3 $A_f = A_i\left(\frac{1}{2}\right)^{t/5.3}$

(a) 6 months → 0.5 yrs $A_i = 50\,g$

$A_f = 50\left(\frac{1}{2}\right)^{0.5/5.3}$

$A_f = 46.8\,g$

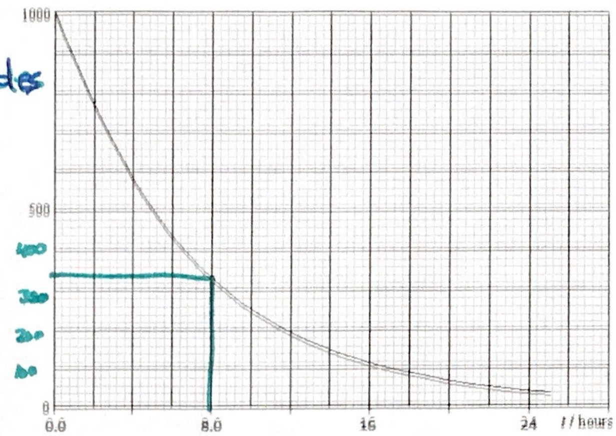
(b) $A_f = 50\left(\frac{1}{2}\right)^{5/5.3}$

$= 26\,g$

Rate

SPH4U1 Task – Half-Life Name: Sol'n

The decay curve of a radioactive nuclide sample is shown. Its initial activity is measured to be X Bq.



14. What is the population at $t = 8.0$ hours? 320 nuclides

15. After how many half lives will the population be 125 nuclides?

1000 → 500 → 250 → 125 3 half lives

16. What will be the level of activity (in terms of X) after two half lives have elapsed?

Rate is proportional to population. $X \rightarrow \frac{1}{2}X \rightarrow \frac{1}{4}X$ 2 half lives

17. What would the activity of the above sample be if we tripled its size?

If the initial population was tripled, the Activity level would triple as well. Activity = 3X Bq

18. If the initial activity of 0.365 grams of the above sample is *Y* Bq, what would the activity be if we increased the initial sample to 0.950 grams?

$\frac{0.950}{0.365} = 2.6$

∴ activity level would be 2.6x greater; 2.6 Y Bq

A radioactive nuclide X having a mass of 65.0 grams is sealed in a container having a mass of 5.00 grams. The nuclide X decays into the nuclide Y. The nuclide X has a half life of 6.00 hours.

$A_f = 65\left(\frac{1}{2}\right)^{24/6}$ $A_f = 4.1g$ nuclide X

19. What will the mass of nuclide *X* be after 24 hours have elapsed?

20. What will the mass of nuclide *Y* be after 24 hours have elapsed?

$A_f = 65 - 4.1$

$A_f = 60.9g$ Nuclide Y

21. What will the mass of the sealed container be after 24 hours have elapsed? Mass = 70g

22. 256 grams of a radioactive sample decays to 4 grams in 120 minutes. What is the half life of the sample?

256 → 128 → 64 → 32 → 16 → 8 → 4 $\frac{120\text{min}}{6}$ = 20min half life

six half lives

23. Suppose the activity of a radioactive sample decreases from X Bq to X/16 Bq in 80 minutes. What is the half-life of the substance?

$X \rightarrow \frac{X}{2} \rightarrow \frac{X}{4} \rightarrow \frac{X}{8} \rightarrow \frac{X}{16}$ $\frac{80\text{min}}{4}$ = 20min half life

Four half lives