CHEMISTRY WORKSHEET: HALF-LIFE

1. Suppose you were given $1000 and told that you could spend one-half of it in the first year, one-half of the balance in the second year, and so on. One year corresponds to the half-life of the $1000.

   a) If you spent the maximum allowed each year, at the end of what year would you have $31.25 left?

   b) How much would be left after 10 half-lives?

2. A person is attempting to reach a telephone booth which is 512 meters away. Assume that the person covers half this distance (256 m) in the first minute, half the remaining distance (128 m) in the second minute, half the remainder (64 m) in the third minute, and so on. In other words, the "half-life" for this moving process is one minute.

   a) If the individual never covers more than half the remaining distance in each one-minute interval, theoretically how long will it take the person to reach the phone booth?

   b) Calculate the number of half-lives it will take to get within 25 cm (0.25 m) of the booth.

3. Living matter has a carbon-14 content that gives about 15 counts per minute per gram of carbon. What is the age of an artifact for which the carbon-14 emission is 3.3 counts per minute per gram?

4. How old is a bottle of wine if the tritium activity is 25% that of new wine? (Refer to your text for the half-life of tritium.)

5. Cobalt-60 is a radioisotope used as a source of ionizing radiation in cancer treatment; the radiation it emits is effective in killing rapidly dividing cancer cells. Cobalt-60 has a half-life of five years.

   If a hospital starts with a 1000-mg supply, how many milligrams of Co-60 would it need to purchase after 10 years to replenish the original supply? Does your answer

depend on whether or not the cobalt isotope is used to treat patients? Why or why not?

6. Strontium-90 is a radioactive by-product of nuclear explosions. If it gets into the food supply from fallout from above-ground nuclear testing, it is especially dangerous since it behaves chemically like calcium. Thus, instead of passing through the body, it is incorporated into our bone structure. Responding to this and other dangers of fallout, in 1963 the United States, the Soviet Union, and several other countries signed a nuclear test ban treaty, which ended most above-ground weapons testing. The strontium-90 released in previous explosions remains in the environment, however.

   a) Using your periodic table, explain why strontium behaves chemically like calcium.

   b) Given that the half-life of Sr-90 is 27.6 years, calculate the years that would represent one, two, three, etc., half-lives, using 1963 as year zero, when 100% of the Sr-90 released was present.

   c) Plot the percent of original radioactivity, from 0% to 100% on the y-axis and the years 1963 to 2100 on the x-axis. Connect the data points with a smooth curve.

   d) Using your graph, determine what percent of Sr-90 remains in our environment today.

   e) Using your graph, determine what percent of the Sr-90 will remain in the year 2100.

Appendix 12: Half Lives of Some Selected Isotopes

Isotope	Half Life
carbon 14	5720 y
cobalt 60	5.26 y
gallium 67	75 h
gold 198	2.69 d
hydrogen 3	12.5 y
iron 59	44.3 d
iodine 131	8.0 d
oxygen 15	1.97 m
phosphorus 32	14.3 d
plutonium 239	24,360 y
potassium 40	9.9×10^8 y
radium 226	1620 y
sodium 24	15.0 h
strontium 90	28.8 yr
technetium 99	2×10^5 y
thorium 232	1.4×10^{10} y
uranium 235	7.1×10^8 y
uranium 238	4.5×10^9 y
tungsten 187	24 h
platinum 197	18 h