INVESTIGATION 4

WHAT IS RADON?

INTRODUCTION

Did you know that there is a radioactive gas in the air inside your home? It is called radon. Radon is a naturally-occurring radioactive gas. It is formed by the radioactive breakdown of radium, and is found in soils just about everywhere. You cannot see it, taste it, or smell it. It is formed in rocks and soils and escapes into the atmosphere. In some cases, it makes its way into homes, builds up to high concentrations in indoor air, and can become a health hazard.

Although there are several different isotopes of radon, the one that is of greatest concern as a potential human health threat is called radon-222. Radon-222 is formed naturally during a chain of radioactive decay. The decay series begins with uranium-238, and among the substances formed is radium-226, which decays directly to radon-222. The uranium is widely distributed in rocks and soils throughout the earth's crust. It has a half-life of 4.5 billion years, so it breaks down slowly. The decay series is pictured in Figure 1.

Isotopes - two or more forms of the same element which have the same number of protons, but a different number of neutrons in their nuclei.

There are eight different elements and 15 different isotopes in the radioactive decay series that begins with uranium-238 and ends with lead-206. New elements formed by radioactive decay are called decay products. Thus, radium-226 is a decay product of uranium-238. Polonium-218 and polonium-214 are decay products of radon-222. All of the elements in this series are solids, except radon, which is a gas. Because radon is a gas, it moves freely in the air spaces within rocks and soils. It becomes a human health concern when it leaks from the underlying soil into homes and other buildings. If it builds up to high concentrations in indoor air, radon and its decay products can cause lung cancer.

Decay product - a radioactive substance formed as a result of the breakdown or decay of another radioactive element.

In this exercise you will examine the characteristics of the principal uranium "decay products" and their relationship to the radon-health issue.

OBJECTIVE

To identify what radon is, how it is formed, and why it is a human health concern.

PROCEDURE

1. Review the data presented in Table 1, showing some characteristics of selected isotopes in the uranium-238 decay series.

2. Complete the analysis and answer the questions below.

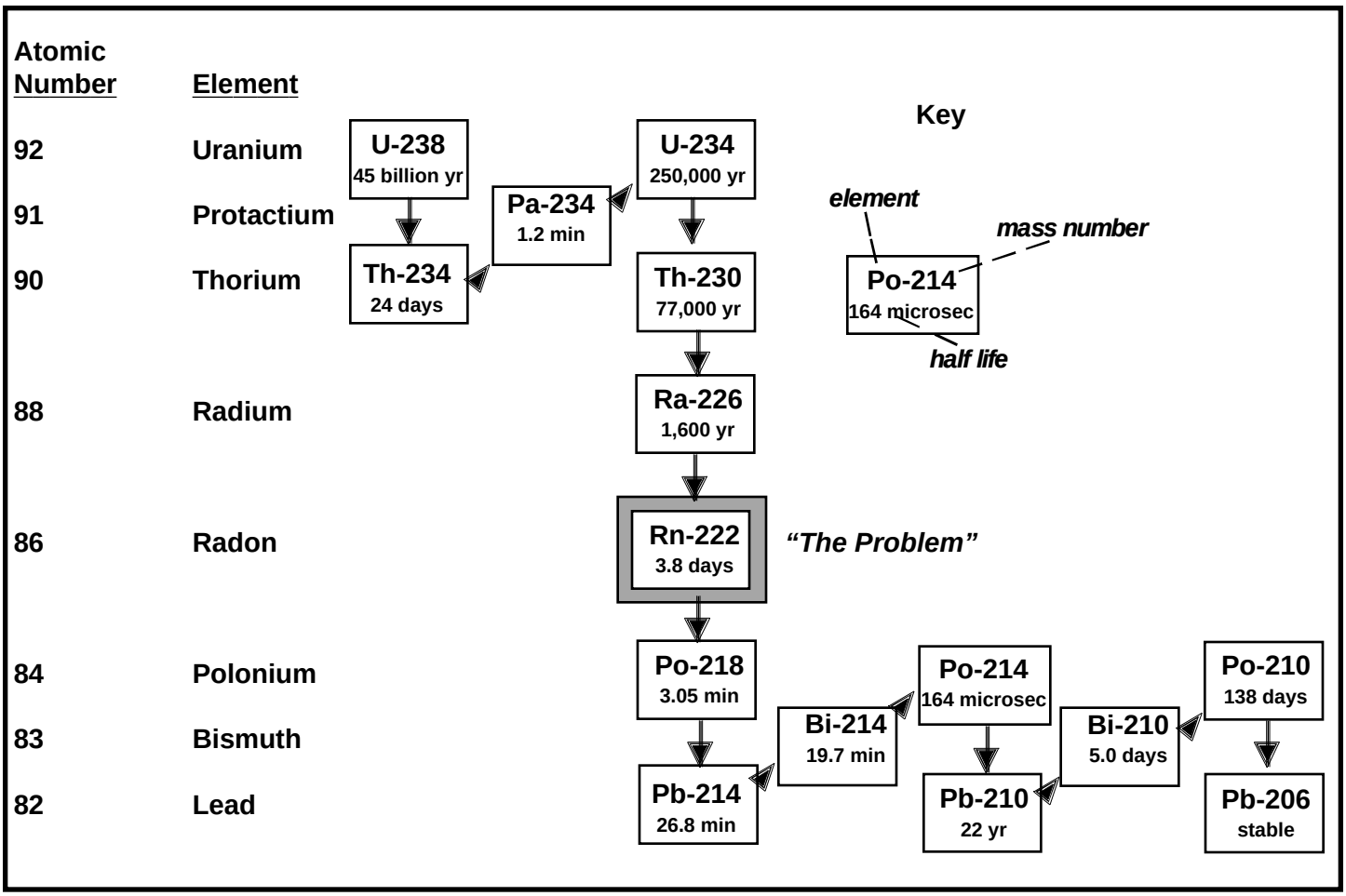

Figure 1.Radioactive decay series that proceeds from uranium-238 to lead-206. Radon-222 is the only gas formed during this series, thus allowing it to move out of the rocks and soils where uranium is typically found and into a home. The downward arrows indicate radioactive decay that emits an alpha particle. The diagonal arrows represent radioactive decay that emits a beta particle. Additional gamma rays are also emitted at some steps in the series.

DATA

The following table provides information on some of the isotopes of elements that occur in the uranium-238 decay series.

Table 1.

Isotope	Physical State	Principal Radioactive Emission	Half-life	Decays to Form
uranium-238	solid	alpha	4.5 billion years	thorium-234
radium-226	solid	alpha	1600 years	radon-222
radon-222	gas	alpha	3.8 days	polonium-218
polonium-218	solid	alpha	3 minutes	lead-214
lead-214	solid	beta, gamma	27 minutes	bismuth-214
bismuth-214	solid	beta, gamma	19.7 minutes	polonium-214
polonium-214	solid	alpha	164 microseconds	lead-210

ANALYSIS

3. Would radon become a greater, or lesser, health threat if its half-life was 1 second instead of 3.8 days? Why? What if its half-life was 50 years?

4. Does the fact that radon is the only gas in the uranium-238 decay series increase or decrease its importance as a potential health threat? Why and how?

5. The radon decay products, such as polonium-218, are more dangerous than radon itself. They emit alpha particles with a large amount of energy that can damage lung tissue if the particles are emitted while inside the lung. Would radon be more, or less, a health threat if polonium-218 had a half-life of 20 days, instead of 3 minutes? Why?

6. Although alpha particles can do a great deal of damage to human tissue, they cannot penetrate very far in tissue, or even in air. They are stopped by colliding with other molecules. What does the penetrating ability of alpha particles have to do with lung damage from some of the radon decay products?

CONCLUSIONS

7. List four properties, or characteristics, of radon that cause it to be an important health concern. Explain why each property is important in influencing radon human health effects.

8. Radon has been known to reach the ground surface from several hundred feet below the ground. Outline how this might occur, based on the physical characteristics and half-life of radon?