INVESTIGATION 4

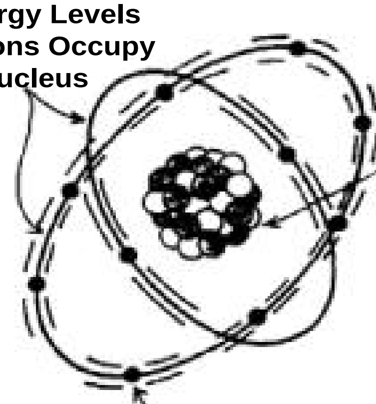
WHAT IS THE RELATIONSHIP BETWEEN RADIOACTIVITY AND RADON?

INTRODUCTION

Radon is a naturally-occurring radioactive gas. It is formed by the radioactive breakdow of radium, and is found in soils just about everywhere. You cannot see it, taste it, or smell it. is continuously formed in rocks and soils and escapes into the atmosphere. In some cases, makes its way into homes, builds up to high concentrations in indoor air, and can become a healt 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 disintegration reactions (decay series). The decay series begins when uranium-238 decays. Uranium is widely distributed in rocks and soils throughout the earth's crust. It has a half-life of 4.5 billion years, which means a very slow breakdown. The decay series is shown in Figure 1 and in Table 1. There are eight different elements and 15 different isotopes in the series, beginning with uranium-238 and ending with lead-206. New elements formed by radioactive disintegration are called decay products. Thus, radium-226 is one of the decay products uranium-238. Polonium-218 and lead-214 are decay products of radon-222. The final elemen lead-206, is stable (non-radioactive) and its formation ends the series. All of the elements in this series are solids, except radon.

> **Radioactivity** - the spontaneous emission of energy from the nucleus of certain (radioactive) atoms, resulting in a change from one element to another. The energy can be in the form of alpha or beta particles and gamma rays.



A model of an atom.

Because radon is a gas, it moves freely in the air spaces between rocks and in 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 be inhaled and cause lung cancer. The element in the series that is most damaging to biological tissues is polonium. **In this exercise you will examine the characteristics of the principal uranium decay products and their relationship to the radon-health issue.**

> **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.

> **Decay product** - an isotope formed as a result of the radioactive decay of a different isotope.

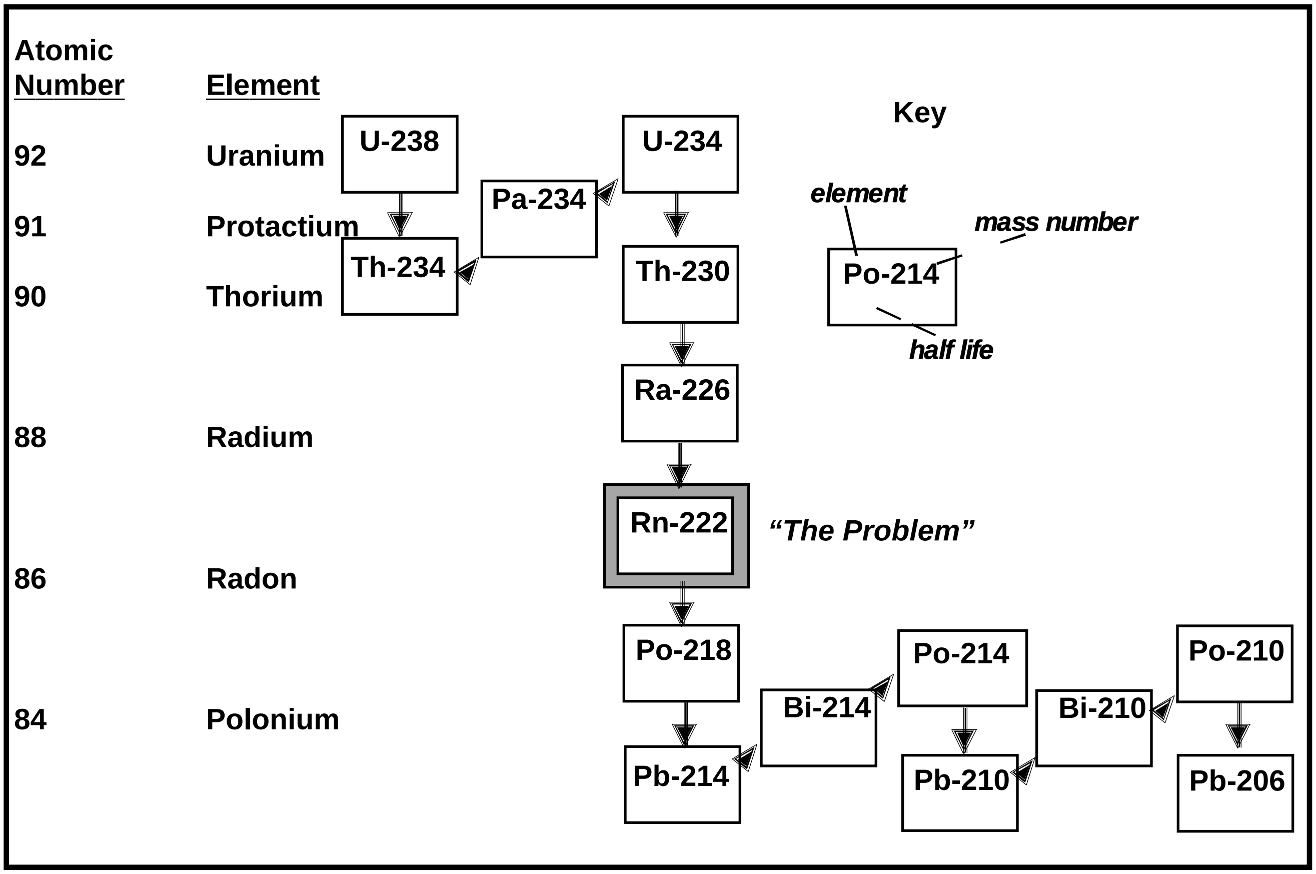


Figure 1. Radioactive decay series that proceeds from uranium-238 to lead-206. Radon-222 is the only gas formed during this series, thus allowing it to move out of the rocks and soils where uranium is found and into a home.

Kinds of Radiation

Radioactive elements can give off three kinds of radiation: alpha, beta, and gamma. Each kind of radiation can damage your health under certain conditions. But the kinds of radiation are very different; they differ in how far they travel, how much energy they possess, and how much damage they are likely to do.

Type of Radiation	Relative Size	Amount of Energy	Relative Penetrating Ability
Alpha particle	large particle	lot	poor - will not penetrate human skin
Beta particle	small particle	little	medium - can penetrate human skin
Gamma Ray	very small energy ray	little	good - can pass right through your body

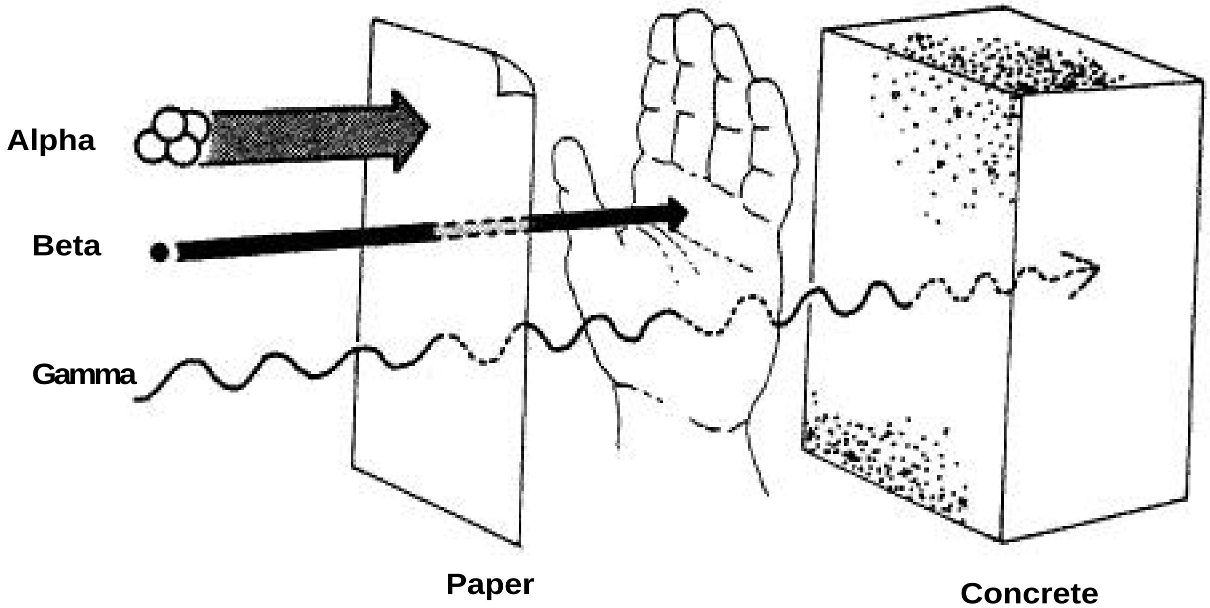


Figure 2. Penetrating power of radiation. Alpha particles are relatively large, but are easily stopped by a piece of paper or a layer of skin. Beta particles are much smaller, travel at high speed, and can penetrate skin. Gamma radiation has no mass, travels at the speed of light, and can go right through the body.

OBJECTIVE

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

PROCEDURE

1. Examine the data presented in the Table below, showing some characteristics of selected isotopes of elements in the uranium-238 decay series, and the various kinds of radiation described below.

2. Complete the analyses and answer the questions that follow.

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

* Microsecond = millionth (1/1,000,000 or 10^{-6}) of a second.

ANALYSIS

3. The half-life of a radioactive isotope is a reflection of how long the material lasts, on average, before it emits its radiation and turns into something else. Would radon constitute 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, especially polonium-218, are more dangerous than radon itself. They emit relatively high energy alpha particles that can damage lung tissue if they disintegrate while inside the lung. Would radon be more, or less, health threat if polonium-218 had a half-life of 20 days, instead of 3 minutes? Why?

CONCLUSIONS

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

7. Describe how radon gets from underground, where it is formed, into your lungs, where it can cause damage.

8. What have you learned about radioactivity that you did not know before class?

NOTES