Exploring Background Radiation
Collecting Radioactive Particles from the Air

Candace Davison
Zachary Van Horn
Pennsylvania State University
What is radiation?

Transmission of
Energy via

Particles
or
Waves
Natural radiation is everywhere.

- Cosmic Rays
- Our Bodies
- Plants
- Radioactive Soil and Rocks
- Radon
The average American receives a radiation dose of 620 millirem per year.
Electromagnetic Spectrum
Radiation detected

• Radiation detected on hands of Los Alamos National Lab workers who did not work with radioactive material.

• Investigation revealed workers played racquetball

• “Natural radioactivity collection by racquetballs” Investigation report HSE 84-4, May 1984 LANL, Los Alamos, NM
Any ideas?
Uranium decay

Radon gas is produced by the decay of naturally occurring uranium in soil and water.
What is radon?

• Radon is a colorless, odorless, tasteless and invisible “noble” gas
• Radioactive gas
• Gas moves through rock and soil into atmosphere
• Radon can “collect” in enclosed spaces
Radon decay products

\[ {}^{218}\text{Po} \quad 186\text{ s} \]

\[ {}^{214}\text{Bi} \quad 19.9\text{ m} \]

\[ {}^{210}\text{Po} \quad 5.01\text{ d} \]

\[ {}^{210}\text{Bi} \quad 22.3\text{ y} \]

\[ {}^{206}\text{Pb} \quad \]
Collecting radioactive particles from the air

1) Vacuum cleaner with coffee filter or medical gauze


3) Air filter from air purifier
Activity

Materials Needed:

1) Timer
2) Electricity
3) Vacuum cleaner
4) Filter paper, coffee filter, medical gauze, etc. Note: keep in sealed plastic bag or envelope until ready to use
5) Radiation detector – pancake probe or scalar preferred
Activity

Experiment

1) Use radiation detector to assess background radiation
2) Remove filter from envelope/bag and check for radioactivity
3) Place filter paper over vacuum inlet hose
4) Run vacuum for at least 5 minutes (note time)
5) Turn off vacuum and remove filter paper – observe particle dirt/dust on filter
6) Use radiation detector to assess radiation level
Activity

Data/Observations
1) Record initial radiation level
2) Take 1 minute readings every 5-10 minutes, record data
3) Describe observations
Experimental challenges

1) Radon levels vary over time and season
2) High humidity can reduce radon levels thus reducing decay product collection
3) The best collection areas for radon gas and decay products are sub-level or ground level. Upper floors tend to have lower radon concentrations.
Pennsylvania radon in homes

Question
The Radon problem in homes was discovered by “accident” when a nuclear power plant worker set off radiation detector alarms.

- True
- False
- ANSWER
- True
Over 40% of Pennsylvania homes have radon levels above the action limit (4 pCi/l)
The Map of Radon Zones was developed in 1993 to identify areas of the U.S. with the potential for elevated indoor radon levels. The map is intended to help governments and other organizations target risk reduction activities and resources. The Map of Radon Zones should not be used to determine if individual homes need to be tested. No matter where you live, test your home for radon—it’s easy and inexpensive. Fix your home if your radon level is 4 picocuries per liter (pCi/L) or higher. Consider fixing if your level is between 2 and 4 pCi/L.

The Map of Radon Zones was developed using data on indoor radon measurements, geology, aerial radioactivity, soil parameters, and foundation types. EPA recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential for a specific area.
Health risks

• The world Health organization and EPA have identified Radon Gas as the leading cause of lung cancer for non-smokers

• https://www.epa.gov/radon/health-risk-radon

• Watras house - 2,700 Pico-curies/liter

• EPA – recommends <4 Pico-curie/liter
Question

If Radon gas decayed directly into a non-radioactive element we would not be as concerned about radon in homes/buildings.

True  False

ANSWER

True
Health risks final question

The health effects of Radon gas are really due to the solid radioactive decay particles

True
False

Solid radioactive decay products that stay in the lungs are the health hazard

Inhaled radon products tend to stay in lungs

Alpha particles bombarding sensitive lung tissue can cause cancer.
When is National Radon Action Month?

When is Radon Action Week?

• January is National Radon Action Month. The aim of National Radon Action Month is to increase the public's awareness of radon, promote radon testing and mitigation, and advance the use of radon-resistant new construction practices.

• Radon Action Week is the third week in October. Some communities might observe Radon Action Week with other indoor air quality topics during the remaining weeks in October.

• You can use any of the materials on our Radon Media Resources Webpage to spread awareness about the health risks of radon through your social network and educate others.
Questions?
Question

What is the main way that radon gas gets into the home?

• Through cracks, gaps and openings in the ground floor and walls of the home
• Through open windows
• By emissions from Granite countertops and consumer products
Radon entry points

- Soil and well water
- Chimney effect
- Negative pressure
- Ventilation/Exhaust fans
Radon testing and variation

Question
Which type of test would provide a better estimate of radon concentration in the home?

Short-term test
Long-term test

- Day/night variation
- Seasonal variation
- Weather
Mitigation strategies

- Watras House – test case
- Prevent gas from entering home
- Seal exterior and penetrations, cracks, etc. – retested and determined – not successful
- Sub-slab suction system collects gas before it enters the home – vented at the ground
- Gas – re-entrained (re-entered)
- Recommend Vent gas above roof
Mitigation strategies

- Seal walls, penetrations, cracks, etc.
- Sub-slab suction system collects gas before it enters the home
- Vent gas above roof
- Discuss down-draft
“Deadly” radon gas

Radon and Smoking – significantly increases risk

Protect family by Testing?

Testing is the first step, but if levels are above 4 pCi/l then you need to take action
Radon test kits

Charcoal Short-term Radon Test Kit
$17.50
RadonZone.com

Alpha Track Long-term Radon Test Kit
$39.50
RadonZone.com

First Alert Radon Gas Test Kit, RD1
$14.98
Amazon.com
<table>
<thead>
<tr>
<th>Radon Level</th>
<th>If 1,000 people who never smoked were exposed to this level over a lifetime*…</th>
<th>The risk of cancer from radon exposure compares to**…</th>
<th>WHAT TO DO:</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 pCi/L</td>
<td>About 36 people could get lung cancer</td>
<td>35 times the risk of drowning</td>
<td>Fix your home</td>
</tr>
<tr>
<td>10 pCi/L</td>
<td>About 18 people could get lung cancer</td>
<td>20 times the risk of dying in a home fire</td>
<td>Fix your home</td>
</tr>
<tr>
<td>8 pCi/L</td>
<td>About 15 people could get lung cancer</td>
<td>4 times the risk of dying in a fall</td>
<td>Fix your home</td>
</tr>
<tr>
<td>4 pCi/L</td>
<td>About 7 people could get lung cancer</td>
<td>The risk of dying in a car crash</td>
<td>Fix your home</td>
</tr>
<tr>
<td>2 pCi/L</td>
<td>About 4 people could get lung cancer</td>
<td>The risk of dying from poison</td>
<td>Consider fixing between 2 and 4 pCi/L</td>
</tr>
<tr>
<td>1.3 pCi/L</td>
<td>About 2 people could get lung cancer</td>
<td>(Average indoor radon level)</td>
<td>(Reducing radon levels below 2 pCi/L is difficult)</td>
</tr>
<tr>
<td>0.4 pCi/L</td>
<td>(Average outdoor radon level)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THE ELECTROMAGNETIC SPECTRUM

Wavelength (in meters)

Size of a wavelength

Common name of waves

Sources

Frequency (waves per second)

Energy of one photon (electron volts)
Uranium-238 Decay Chain
Radon decay products
Have you had your home tested for radon?

Should Every Home Inspection Include Radon?

by Inspection News | Oct 2, 2017 | News |

Old houses are risky, but there's no way that a new-construction house could have a radon problem, right? Nope. Although it's a common misconception, the age of a home has nothing to do with whether or not radon is seeping up into the living spaces. In fact, some older homes might be safer because construction isn't as tight as a new house.