Preview of Period 11: Ionizing Radiation and Health

11.1 How Is Ionizing Radiation Detected?

What do you see in the cloud chamber?

What other methods do we have for detecting ionizing radiation?

11.2 What Natural Sources of Radiation are Present?

Are these sources of radiation harmful?

Can we avoid exposure to them?

11.3 What is Radon?

Why is radon harmful?
The Cloud Chamber

- Alcohol vapor in the cloud chamber is cooled by dry ice (frozen carbon dioxide).

- The alcohol temperature is slightly below the temperature at which it would normally condense into droplets. (The vapor is supercooled.)

- Ions are produced along the paths of the particles that result from the decay of the radioactive sources.

- These ions seed the supercooled vapor and form tiny raindrops around the ions, leaving visible tracks.

- The tracks can also reveal the ionization density of the source, since some tracks appear thicker (more droplets) than others.
# Comparison of Ionizing Radiation types

<table>
<thead>
<tr>
<th>Particle</th>
<th>Type</th>
<th>Charge</th>
<th>Ionizing density</th>
<th>Penetrating ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>alpha $\alpha$</td>
<td>helium nuclei $^{4}_2$He</td>
<td>+2</td>
<td>highest</td>
<td>lowest</td>
</tr>
<tr>
<td>beta $\beta^-$</td>
<td>electron (e$^-$)</td>
<td>-1</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>beta $\beta^+$</td>
<td>antielectron (e$^+$)</td>
<td>+1</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>gamma $\gamma$</td>
<td>high energy photon</td>
<td>0</td>
<td>lowest</td>
<td>highest</td>
</tr>
</tbody>
</table>
Detecting Ionizing Radiation

Ionizing radiation can be detected by

Film because the energy deposited by ionizing radiation in photographic film causes chemical changes in the film, much as light does.

A Geiger counter because an electrical signal is produced each time an ionizing particle passes through the counter tube. The electrical signal is amplified and heard as clicks from a loudspeaker.

A cloud chamber produces a visible track along the path of ions left by the passage of an ionizing particle.
Exposure to Radioactivity

Our exposure to ionizing radiation depends on the

♦ number of ionizing particles
♦ time exposed to the particles
♦ energy of the particles

Exposure per person can vary greatly, but the average person's annual exposure is 200 millirems (mrem)

What natural sources of radioactivity are we exposed to? Can we avoid these sources?
Dangers of Radon

♦ Uranium-238 in the ground decays into radon gas, which can seep into buildings.

♦ Radon quickly decays into daughter elements. The half-life of radon gas is 3.85 days.

♦ The daughters of radon emit alpha and beta particles.

♦ When these particles are inhaled, they can ionize atoms in the body, causing lung damage.

♦ Buildings on shale bedrock are particularly susceptible to radon problems.

What Can Be Done About Radon?

♦ Radon levels can be tested with home test kits available at hardware stores.

♦ High levels of radon can be reduced by installing ventilation systems.
Period 11 Summary

11.1 Ionizing radiation strips electrons from atoms, turning the atoms into charged ions. Geiger counters, cloud chambers, and film badges can detect ionizing radiation.

11.2 Health damage from ionizing radiation

**Killing cells:** Exposure to large amounts of radiation can destroy enough body cells to cause death

**Genetic damage:** Ionizing radiation can damage DNA molecules in the body and result in genetic mutations and birth defects.

**Increased risk of cancer:** Damage to DNA molecules can result in cell mutations, which cause cancer.

11.3 Sources of ionizing radiation

Uranium-238 in the ground decays into **Radon gas**, which can seep into buildings.

**Cosmic rays:** High energy protons from outer space ionize molecules in the air

Rocks, soil, and building materials

Medical X-rays

Radioactive decay inside your body: **Potassium-40** from foods.
Period 11 Review Questions

R.1 Why is it so difficult to determine how many cases of cancer are caused by a small increase in a population's radiation exposure?

R.2 How does radon-222 increase the risk of lung cancer?

R.3 How can radon-222 be detected?

R.4 Can you decrease your natural radiation exposure significantly by avoiding foods containing potassium? Why or why not?

R.5 Should you avoid medical x-rays as a health hazard? Explain your answer.