Activity: Case Study: The Lung Cancer Mystery

FOR THE TEACHER

Summary
In this activity, students will analyze a scenario about the sudden spike of lung cancer cases in a specific neighborhood. They will take on the role of an investigative reporter in order to examine important information related to the crisis. The activity will provide students the opportunity to learn about radon gas, radiation and radioactive isotopes. The activity will culminate with the creation of a poster in the form of a public service announcement, where students will focus on the decay of radon and bring awareness to the hazardous radiation that is emitted.

Grade Level
High School

NGSS Alignment
This activity will help prepare your students to meet the performance expectations in the following standards:

- **HS-PS1-8:** Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

- **Scientific and Engineering Practices:**
  - Asking Questions and Defining Problems
  - Engaging in Argument from Evidence
  - Obtaining, Evaluating, and Communicating Information

Objectives
By the end of this activity, students should be able to:

- Describe the three main types of nuclear radiation.
- Evaluate textual and graphic evidence to support that energy released in the process of nuclear decay may result in the incidence of cancer in human patients.
- Identify the composition of the nucleus before and after nuclear decay.
- Identify the emitted particles resulting from nuclear decay.

Chemistry Topics
This lesson supports students’ understanding of:

- Nuclear Chemistry
- Radiation
- Radioactive Isotopes

Time
**Teacher Preparation:** 10-20 minutes
**Lesson:** 120 minutes

Materials
- A copy of student handouts (printed or digital)
- Poster Paper
- Poster-making materials like paper, pencils, coloring markers

Safety
- No special safety considerations are needed.
Teacher Notes

- Students should work in groups of 3-4 to answer the case study. Within the group, students will pick jobs: reader, ambassador, investigator and writer. The duties of each are outlined in the supplemental PowerPoint presentation.
- The timing for each task is suggested on the PowerPoint presentation. This is editable, and you can change the suggested times for tasks as you see fit.
- Students should be provided with part 1 of the case study first. It contains four links for the students to research the causes of lung cancer, so you may want to consider providing an electronic copy as well.
- Case study is based on the original case study for medical students found in: Environmental Medicine: Integrating a Missing Element into Medical Education, 1995 – Case #50
- When students are done with the tasks and work from part 1, they are provided with part 2. I suggest that while each student should have their own copy (this could be in electronic form), each group can turn in one completed case study by the end of a 60-minute class period.
- The public service announcement poster activity is important for students to make a model of the nuclear decay of radon. I suggest this is done individually, but you student can work in pairs as you see fit.
- The poster portion of the activity can be omitted if time does not allow for it.
- While not ideal, the case study could be used as a substitute lesson plan with some modification and assigned as an individual activity.
Case Study: The Lung Cancer Mystery

Part 1
It was 1982 when Mr. and Mrs. Jones moved into their new home. They had 2 children and lived a relatively healthy and active life, except that Mr. Jones had been an avid smoker for many years. He quit smoking after 20 years. They resided in California and lived through an earthquake in 1994 of a magnitude of 6.7. In 1999 Mrs. Jones was diagnosed with lung cancer and died in 2000. Mr. Jones decided to quit smoking when his wife was diagnosed. Neither of the children ever smoked. Mr. Jones went to the doctor because he had a cough for 3 months that would not go away, even after taking cough medicine. He also lost 20 pounds.

Mrs. Perez moved to the same neighborhood 3 years before. Around the time Mr. Jones went to the doctor, Mrs. Perez who never smoked, found that she was also losing weight and had a cough that would not go away. Both Mr. Jones and Mrs. Perez were eventually diagnosed with lung cancer. Over the next 2 years their neighborhood had 20 total cases of lung cancer. Is this a coincidence?

Websites for research

Questions
1. What are some causes of lung cancer? Mention at least 3 different causes.

2. Imagine you are a reporter for the local newspaper. Write down 3 key details about this medical mystery that a reporter would need to investigate.

3. Imagine you are a reporter for the local newspaper. Mr. Jones, his children and Mrs. Perez have all agreed to be interviewed by the media. Which patient will you interview?

4. Write down 3 questions you would ask the patient.
Case Study: The Lung Cancer Mystery

Part 2
Mrs. Perez joined an online lung cancer support group. They had a lot of links that explain the many causes of lung cancer. She found an article about radon. With this new knowledge, she tested her house and found that the average amount of Radon in her home was above recommended levels. She started to urge neighbors and the community in general to be tested for Radon. The U.S. Environmental Protection Agency (EPA) recommends that homes need inspection and repair to lower the amount of radon if the measured level is 4 pCi/L or higher. pCi refers to picocuries. According to the EPA each year about 14,000 deaths in the United States are due to lung cancer caused by indoor radon exposure.

Background Information

Summary:
Large quantities of isotope Radon-222 inside homes is the main cause of exposure to ionizing radiation in most of the world. This type of radiation is emitted by radioactive isotopes, like Rn-222, and has enough energy to remove electrons from atoms. The removal of electrons from atoms results in the production of ions. Ionizing radiation cannot be seen or smelled. However, it can be detected with specialized instruments like a Geiger counter or a film badge, usually worn by X-ray technicians. Exposure to radon gas does not cause immediate irritation and for this reason there are no obvious signs of discomfort in patients until symptoms appear. Symptoms include a cough that will not go away for months and weight loss. In addition, not everyone in a home is affected the same way by Radon-222 and some people may not develop symptoms, or may develop symptoms at different times. The only way to know if a home is contaminated with Rn-222 is to test and measure radon levels in homes.

What is Radon?
Radon is a gas with no detectable color or smell. The main source of radon in homes is soil, but sometimes the source can be building materials or underground water. Radon can concentrate inside a home in a few different ways. It can diffuse into a home through cracks, dirt floors or cinder block walls. While in the open air, radon gas will cause little risk. But inside a home, radon gas can become concentrated because of how airflow is regulated when homes have temperature controlled systems, exhaust fans, dryers, fire places, and other appliances that affect how air moves.

Radon gas is the result of the radioactive decay of radium, an element that is often found in rock and soil. Radon’s half-life is 3.8 days. While this is a relatively short time, it is enough time for the gas particles to move through the soil and building materials and concentrate inside homes. The gas is then inhaled by people living inside the home. Radon-222 can undergo radioactive decay inside the respiratory system, expose the patients to alpha radiation and result in the incidence of lung cancer. The decay of radon produces four isotopes with half-lives of less than 30 minutes.

Alpha Radiation:
Alpha radiation (α), is a type of radioactive emission characterized by a Helium nuclei. It contains two protons, two neutrons and a net positive charge of +2. When an alpha particle is released it can penetrate 0.05 mm into body tissue. With constant exposure this particle can eventually result in cellular damage. Here is an example of the emission of alpha radiation:
\[
\begin{align*}
226^{88}\text{Ra} & \rightarrow 222^{86}\text{Rn} + \alpha \\
222^{86}\text{Rn} & \rightarrow 216^{84}\text{Po} + \alpha
\end{align*}
\]

**Questions**

1. Are other members on the home of the patients at risk for lung cancer as a result of elevated radon levels?

2. What 4 main topics do you need to research to understand how Radon’s radioactive decay causes lung cancer?

**Instructions**

In your group, assign one topic (from question 2 above) to each group member. Set a timer for 10 minutes. Each member must research their own topic and find 2-3 important/noteworthy details. Record the information from each group member in the table below.

<table>
<thead>
<tr>
<th>Important Details Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team member’s name:</td>
</tr>
<tr>
<td>Question to research:</td>
</tr>
<tr>
<td>Write down 2-3 important details about this topic.</td>
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Radon Mystery Poster

Instructions
You will create a public health announcement that must include a model of the decay of Radon.

- Using an 8x10 sheet of paper create a poster to serve as a public health service announcement.
- The Poster must contain the following
  - Radon’s half-life and decay reaction
  - Explain all parts of the decay reaction
  - What type of radiation is emitted from radon decay
  - Ways we can identify radon contamination in our homes
  - The consequences of radon contamination in a home
  - Symptoms of lung cancer
  - References

Rubric

<table>
<thead>
<tr>
<th>Points</th>
<th>30</th>
<th>20</th>
<th>10</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>The poster is visually appealing, engaging, and has color. The poster is neat and shows effort was given. It is not a direct copy of a poster found online.</td>
<td>The poster has some visual appeal and color. Poster has some organization and shows effort was given. It is not a direct copy of a poster found online, but elements were “borrowed”.</td>
<td>The poster is a small amount of visual appeal or no color. Organization is confused and shows some effort.</td>
<td>The poster has limited visual appeal or no color. No organization and shows limited effort. May or may not be a copy of a poster found online.</td>
</tr>
<tr>
<td>Content and clarity</td>
<td>All text is clear and in complete sentences. Information makes sense. Citations are present.</td>
<td>Most text is clear and in complete sentences. Text generally makes sense. Citations are present.</td>
<td>Some text is clear and in complete sentences. Some citations or no citations are present.</td>
<td>Most text is unclear or not in complete sentences. Text does not make sense. Some citations or no citations are present.</td>
</tr>
<tr>
<td>Did you follow instructions?</td>
<td>These are present: Radon’s half-life and decay reaction, the type of radiation is emitted by Radon Decay, Symptoms of Lung Cancer, Explanation of home contamination by Radon gas</td>
<td>Most are included, one is missing.</td>
<td>Only some are included.</td>
<td>No important parts are included.</td>
</tr>
</tbody>
</table>

Total Points: Comments: