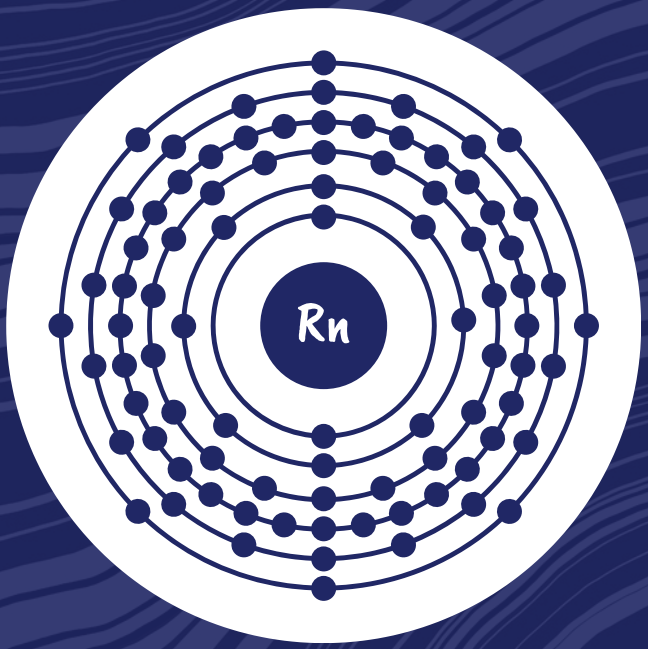
GEOSCIENCE FOR LEAVING CERTIFICATE TEACHERS

Continuing Professional Development Course 2024



UNDERSTANDING RADON AND ITS ENVIRONMENTAL EFFECTS ESCAPE ROOM

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Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

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Department of the Environment, Climate and Communications

Escape Room: The Silent Killer

Understanding Radon and Its Environmental Effects as a Geohazard

Participate in an escape room activity via the link provided, or create your own using OneNote, Google Slides, or paper with envelopes for each room. If you're unable to access the online platform, instructions for constructing your own rooms are available below. The **answers for each room can be found on the last page.**

In the project's final section, students will create a poster that illustrates the concept of radon, its effects, half-life, and methods for remediation. This task will allow students to demonstrate their knowledge and communicate their findings in a way that is accessible to the broader school and local community. A rubric along with helpful links will be provided to guide students on expectations and support their work.

Escape Room: The Silent Killer

Start here

- You will work together in a story adventure by solving puzzles and games; you will unlock pages to reveal more content.
- The ultimate goal is to see who can **BREAK OUT of the OneNote first** while solving all the puzzles correctly.
- Each section has a puzzle followed by a question that needs to be answered to reveal the password for each lock.
- Please remember to write each password in your notes.
- The answers to all locks are words except for lock 7 and 9 which are numerical numbers.
- All passwords are in lowercase letters.

Room 1: The Medical Mystery 🚑 🕵️

Mr. and Mrs. O'Connor and their children moved to Headford, Galway in the west of Ireland 20 years ago. They led a healthy and active lifestyle. Mr. O'Conner smoked for many years until the smoking ban was implemented in 2004.

Two years later, his wife was diagnosed with lung cancer and died in 2006. None of their kids smoked. Mr. O Connor developed a cough and despite taking medication it would not go away. He also lost 10 kg.

Mrs. Shanahan has lived in Galway for four years. She went to the doctor at the same time Mr. O'Connor did. Mrs. Shanahan never smoked and also suffered from a persistent cough.

Congratulations! You unlocked Lock 1 🎉

Room 2: Outdoor or Indoor Pollution 🎮 🚲

Over the next two years, their neighbourhood had over 20 cases of lung cancer. Is this a coincidence? 🤔🤔

They all lived in the countryside, were non-smokers, and did not have open fireplaces. What causes this type of lung cancer?

It would be helpful if you looked into the medical mystery.

For months, they had a persistent cough and weight loss.

Congratulations! You unlocked Lock 2 🎉

Room 3: Scientist

Hello there,

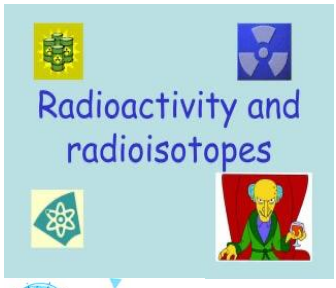
If you can guess my name, I will help you. I am a scientist who was the first woman to be awarded the Nobel Prize in both chemistry and physics for my work on radioactivity.

Radioactivity is caused by the spontaneous random decay of an unstable nucleus, which emits alpha, beta, and (or) gamma particles.

Congratulations! You unlocked Lock 3

Room 4: α-alpha β-Beta ϒ-Gamma (α β ϒ)

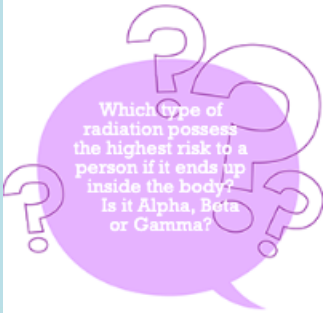
PPT: Alpha beta and gamma



The three types of radiation

Use this table to find information about and to compare α, β and γ radiation

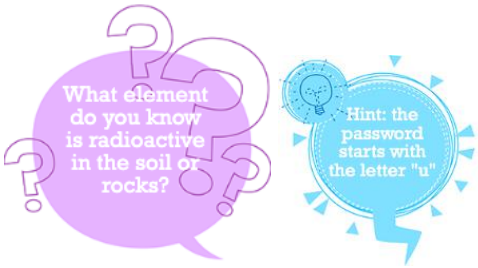
	Alpha (α)	Beta (β)	Gamma (γ)
Nature	It's a nucleus of helium ${}^{4}_{2}He$. Two protons and two neutrons	It's an electron e^-	It's an electromagnetic wave
Charge	+2	-1	0
Mass	Relatively large	Very small	No mass
Speed	Slow	Fast	Speed of light
Ionizing effect	Strong	Weak	Very weak
Most dangerous	When source is inside the body	When source is outside the body	When source is outside the body



Congratulations! You unlocked Lock 4

Room 5: What Lies Beneath

So, it must be alpha radiation. Since it's unable to penetrate the body, it must be inhaled. However, where does it come from inside the house? If they live in the countryside, it must be from the soil or rock.



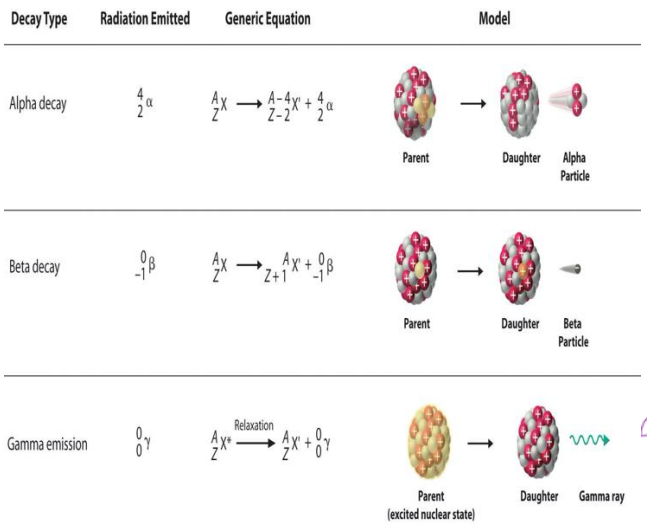
Congratulations! You unlocked Lock 5

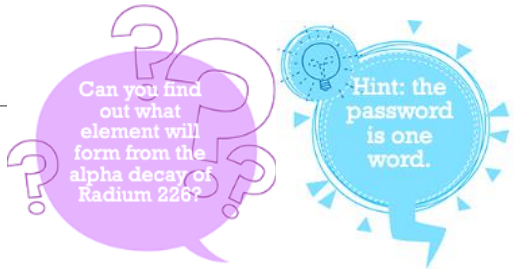
Room 6: Radioactive Decay α

The process by which an unstable atomic nucleus loses energy through radiation is known as radioactive decay. A radioactive material is one that contains unstable nuclei.

Alpha decay, beta decay, and gamma decay are three of the most common types of decay, all of which involve the emission of one or more particles.

Three most common modes of decay nuclear decay





So, traces of Uranium in the soil will undergo a radioactive decay series. This process will continue until a stable isotope forms. One of Uranium's radioactive decay daughters is Radium 226.

Congratulations! You unlocked Lock 6

Room 7: Half-life ½

An element's half-life is the time it takes for half of its nuclei to decay.

Do you believe radon, an odorless and colorless gas, is the cause of lung cancer?

However, each element's half-life is unique and can vary greatly. It could take billions of years or seconds. So how can we be sure that its radon that is affecting these people?

To be sure, we must calculate its half-life using the formula below. Radon 222 has a decay constant of 0.182.

$T_{1/2} = \ln 2/\lambda = 0.693/\lambda$

λ: decay constant

Congratulations! You unlocked Lock 7

Room 8: Testing ,,Testing

Three days is a reasonable time for the Radon gas to build up in an indoor environment, but how can we prove that radon gas is in their homes?

[How to test your home for Radon Gas]

Congratulations! You unlocked Lock 8

Room 9: (Bq)

Next step, we have asked them to install Radon detectors in their homes that will automatically read and provide an average radon concentration during the measurement period.

The SI unit of this activity is called becquerel (Bq).

Now

Use this formula to find the rate of decay of 1g of Radon 222. The rate of decay is the number of nuclei decaying per second (Bq) 1Bq= 1decay/s.

Rate of decay = λ N

λ = decay constant

N= Number of atoms

N= mole*Avogadro's Number= mass/molar mass* $6*10^{23}$

Congratulations! You unlocked Lock 9

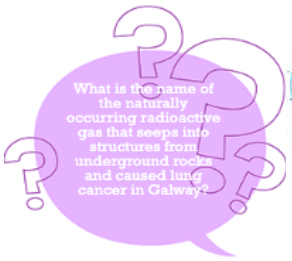
Room 10: Almost there 🎯

They must use the detector for three months; in the meantime, take a look at this map of Radon levels in Ireland, focusing on Galway. Is it high in their area?

Now consider the average radiation dose received by the Irish population. The current level of radiation recommended is 200Bq/m3.

The lab results arrived, and it was 400Bq/m3.

Therefore, it is higher than the average recommended rates in Ireland. **So from all the clues that you collected** .What is the name of the naturally occurring radioactive gas that seeps into structures from underground rocks and caused lung cancer in Galway?



Final Lock: Congratulations! You are Radioactive 🎉

[Imagine Dragons - Radioactive (Lyrics)]

What's next 😉

Radon Mystery Poster

Objective:
Create a public health service announcement poster to raise awareness about radon as a geo-hazard and its implications within the context of climate action, sustainability, and modern physics.

Instructions:
Your poster must address the following key elements:

Physics Integration:
- Include a model of radon decay.
- Describe the half-life of radon with the decay reaction equation.
- Explain the steps of radon's decay process.
- Identify the type of radiation produced by radon decay (alpha particles).

Environmental and Health Impact:
- Explain how radon is a geo-hazard and its role in lung cancer risks.
- Identify methods for detecting radon contamination in homes.

Socioeconomic Context:
- Discuss the effects of radon contamination on homes and families.
- Highlight ways to remediate radon in Irish homes (e.g., radon barriers, ventilation).
- Include symptoms of lung cancer for awareness.

References

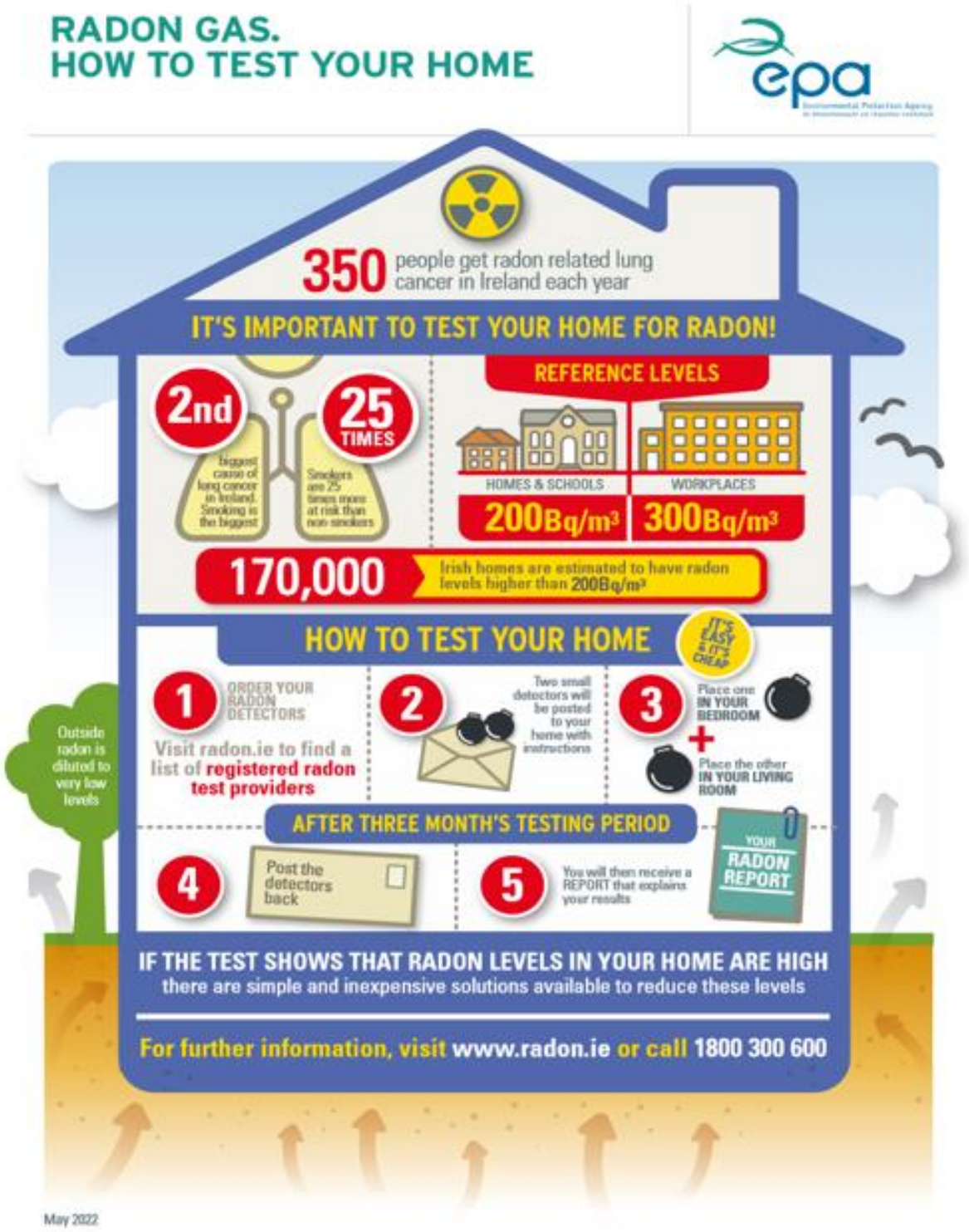
Rubric

Points	30	20	10	5
Creativity	Poster is highly engaging, colorful, and visually appealing. Original work with clear effort.	Poster is engaging and has color. Shows some originality and effort, but borrows elements online.	Poster has minimal appeal or limited color. Organization is somewhat unclear but shows effort.	Limited visual appeal, disorganized, or a direct copy. No effort evident.
Content and clarity	Text is clear, concise, and makes sense. Full sentences used. All information cited properly.	Most text is clear and logical. Full sentences used. Citations are present.	Text is partially clear, with incomplete sentences. Some or no citations present.	Text is unclear, nonsensical, or incomplete. Few or no citations
Did you follow instructions?	All required components are included (physics, health impacts, detection, and socioeconomic aspects).	Most components are included; one key element is missing.	Some components are missing, or parts of instructions were not followed.	Few or none of the instructions were followed.
Total Points: **Comments:**				

Resources	Helpful design links
• Radon –EPA Ireland • Radon Map • Radon testing • Health risk • Radon Remediations	• https://www.adobe.com/express/ • https://piktochart.com/ • https://www.easel.ly/ • https://www.canva.com/en_gb/

Answers:

Room1: lungcancer	Room2: indoor	Room3: curie	Room4: alpha	Room5: uranium
Room6: radon	Room7: 4	Room8: detector	Room9: 5*10^20	Room10: radon


RADON GAS.
HOW TO TEST YOUR HOME
epa
Environmental Protection Agency
350 people get radon related lung cancer in Ireland each year
IT'S IMPORTANT TO TEST YOUR HOME FOR RADON!
2nd
biggest cause of lung cancer in Ireland. Smoking is the biggest
25 TIMES
Smokers are 25 times more at risk than non-smokers
REFERENCE LEVELS
HOMES & SCHOOLS
WORKPLACES
200Bq/m³
300Bq/m³
170,000
Irish homes are estimated to have radon levels higher than 200Bq/m³
HOW TO TEST YOUR HOME
IT'S EASY & IT'S CHEAP
1
ORDER YOUR RADON DETECTORS
Visit radon.ie to find a list of registered radon test providers
2
Two small detectors will be posted to your home with instructions
3
Place one IN YOUR BEDROOM
+
Place the other IN YOUR LIVING ROOM
Outside radon is diluted to very low levels
AFTER THREE MONTH'S TESTING PERIOD
4
Post the detectors back
5
You will then receive a REPORT that explains your results
YOUR RADON REPORT
IF THE TEST SHOWS THAT RADON LEVELS IN YOUR HOME ARE HIGH
there are simple and inexpensive solutions available to reduce these levels
For further information, visit www.radon.ie or call 1800 300 600
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