

# INVISIBLE ENEMIES



*Slick Synergy*  
Slick and Smooth



# THE RISE OF RADON

# ABOUT THIS RESEARCH

This story is based on the FRESH study, a community-engaged project led by the University of Kentucky College of Nursing and funded by the National Institute of Environmental Health Sciences (R01ES021502). FRESH stands for **F**reedom from **R**adon **E**xposure and **S**moking in the **H**ome.

Radon and tobacco smoke exposure are the two leading causes of lung cancer. More than 220,000 new cases of lung cancer are diagnosed each year in the United States and Kentucky leads the nation with the largest proportion of new cases each year. People exposed to radon and tobacco smoke are 10 times more likely to be diagnosed with lung cancer than those who are not exposed to both. So, while radon is dangerous to everyone, it is even more dangerous to people who also inhale tobacco smoke.

Our story introduces readers to the combined risks of radon and tobacco smoke through the experiences of a small family with an asthmatic daughter. We also emphasize the importance of geology in understanding the origin and movement of radon, a completely natural radioactive gas, into buildings.

The good news is that many cases of lung cancer can be prevented by simply eliminating tobacco smoke and radon inside homes and other buildings. During the FRESH study, we found that offering free radon and tobacco smoke test kits in healthcare settings and providing personalized radon test results to each homeowner increases radon testing and mitigation. Our fictional family's behavior and actions as they seek to reduce radon levels within their home provides a general model that you can adapt and follow in your own home.

Because radon gas cannot be seen, smelled, or tasted, it is essential to test your home and know your level.

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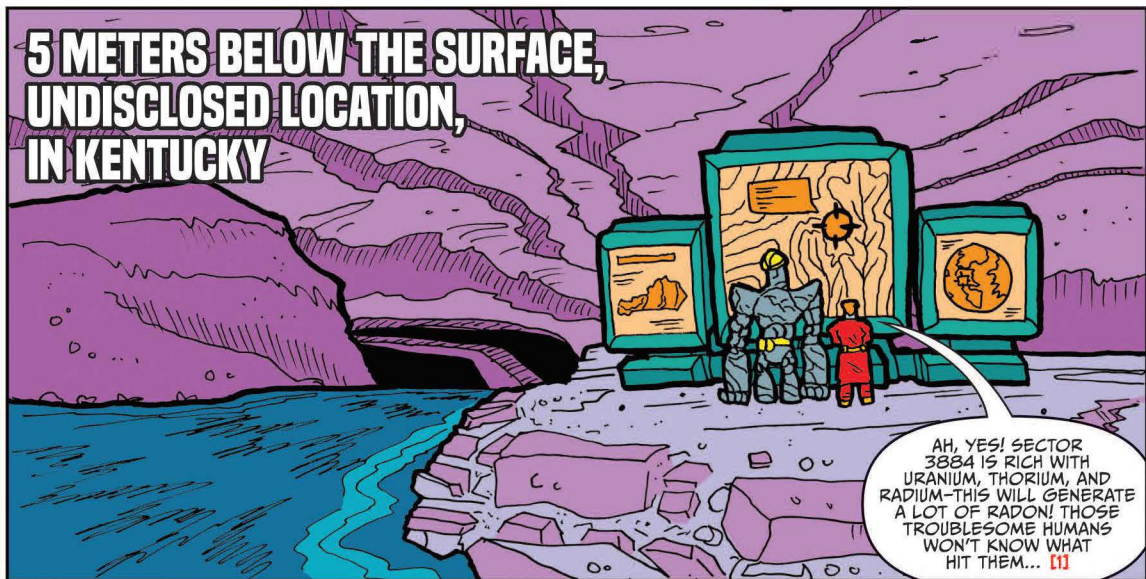
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**5 METERS BELOW THE SURFACE,  
UNDISCLOSED LOCATION,  
IN KENTUCKY**

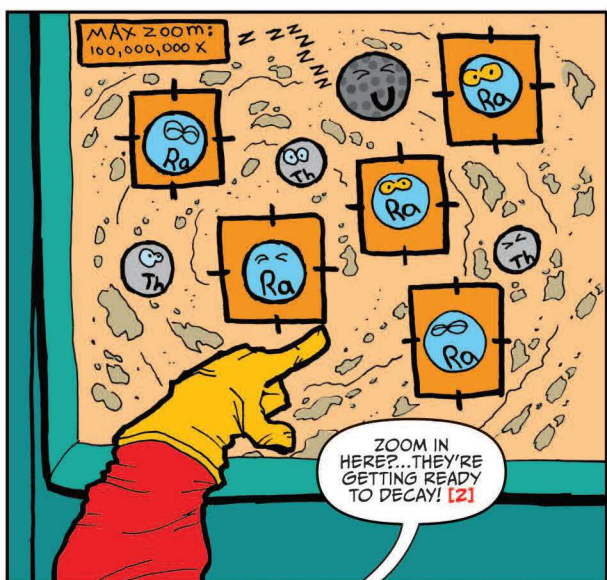


AH, YES! SECTOR 3884 IS RICH WITH URANIUM, THORIUM, AND RADIUM—THIS WILL GENERATE A LOT OF RADON! THOSE TROUBLESOME HUMANS WON'T KNOW WHAT HIT THEM... [1]

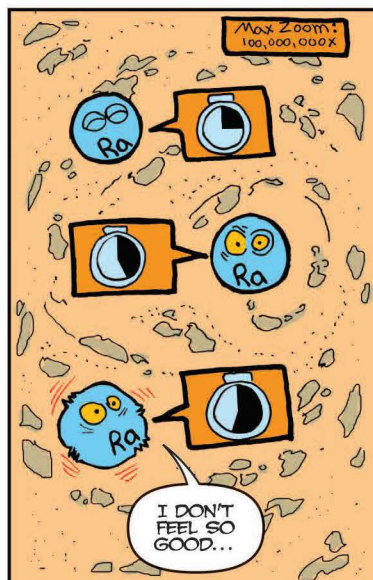


LEX, I'D LIKE TO TAKE A CLOSER LOOK AT SECTOR 3884.

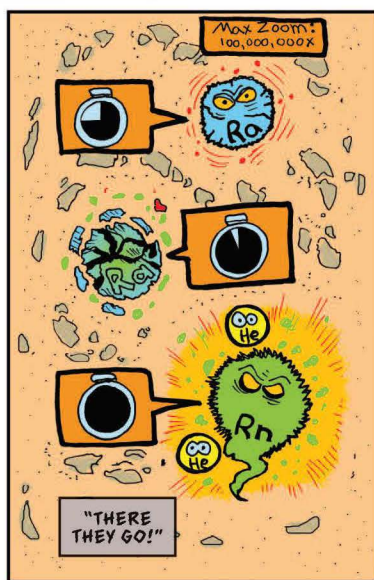
ABSOLUTELY, DR. RAY-DON. PLEASE STANDBY...



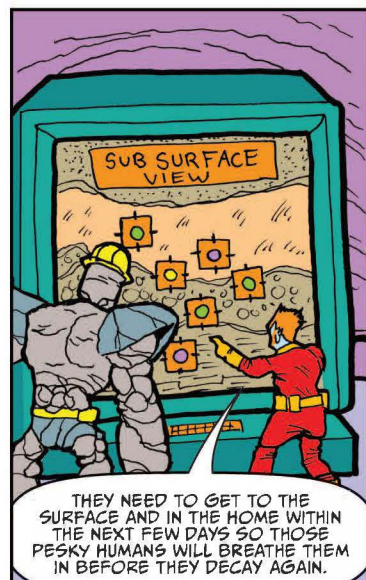
ZOOM IN HERE? ...THEY'RE GETTING READY TO DECAY! [2]



I DON'T FEEL SO GOOD...

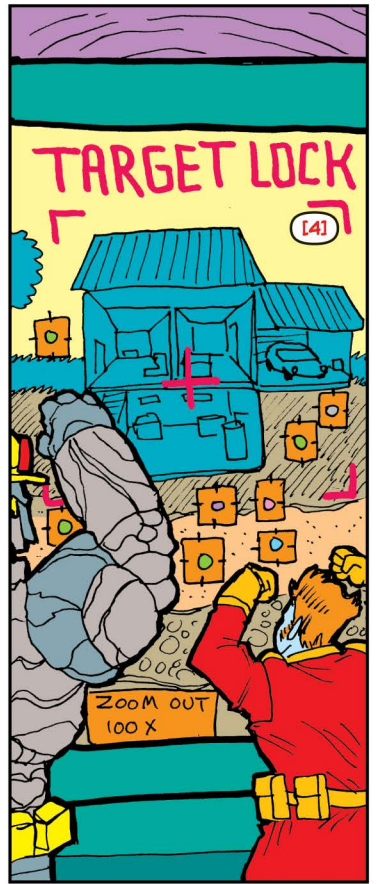
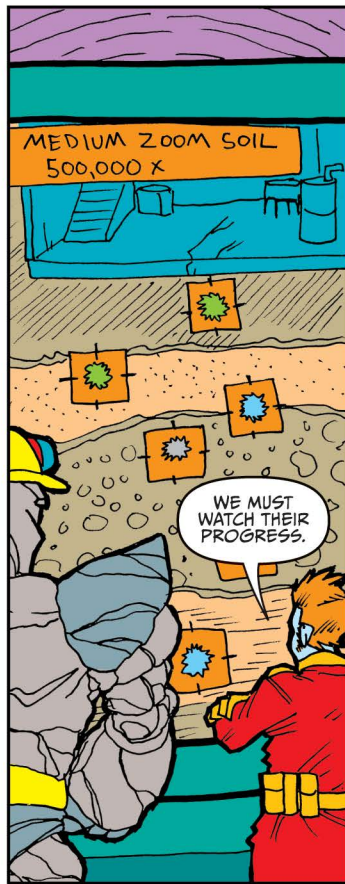
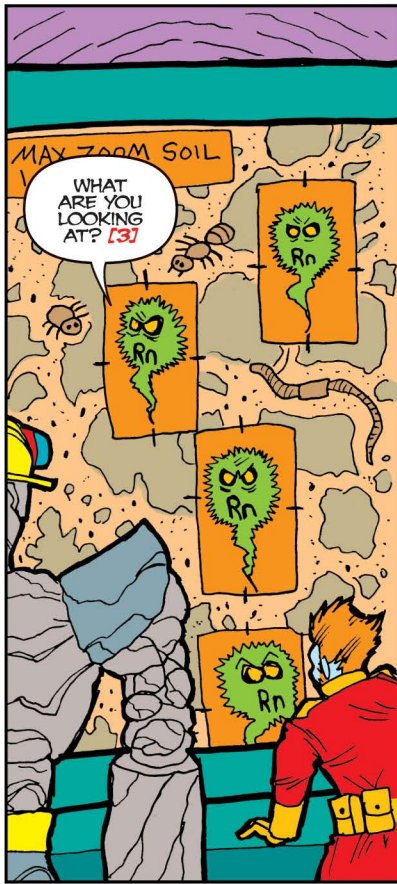


"THERE THEY GO!"



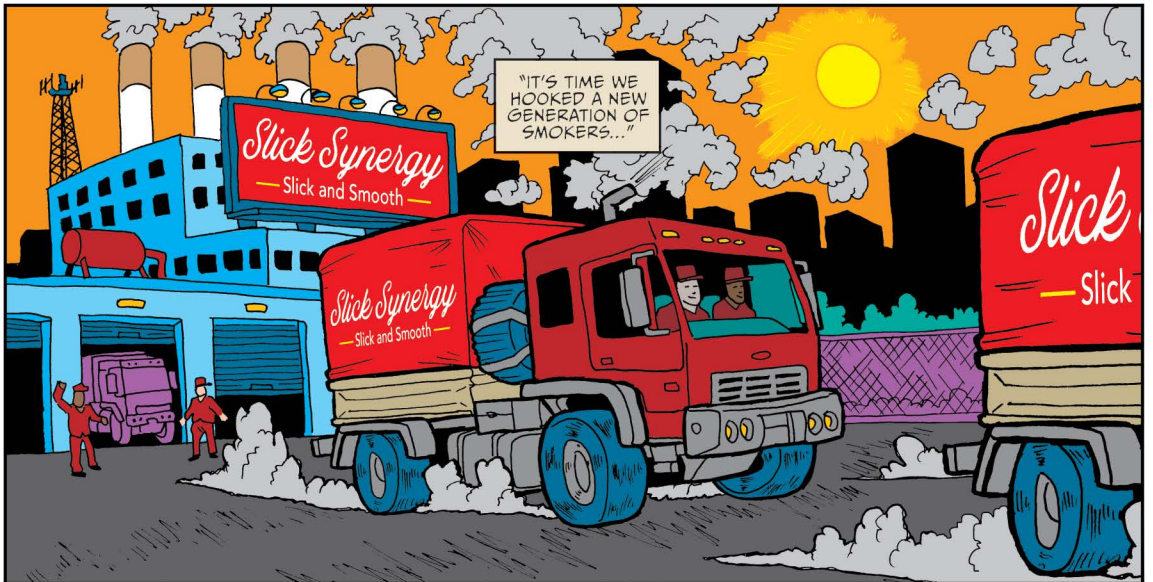
THEY NEED TO GET TO THE SURFACE AND IN THE HOME WITHIN THE NEXT FEW DAYS SO THOSE PESKY HUMANS WILL BREATHE THEM IN BEFORE THEY DECAY AGAIN.

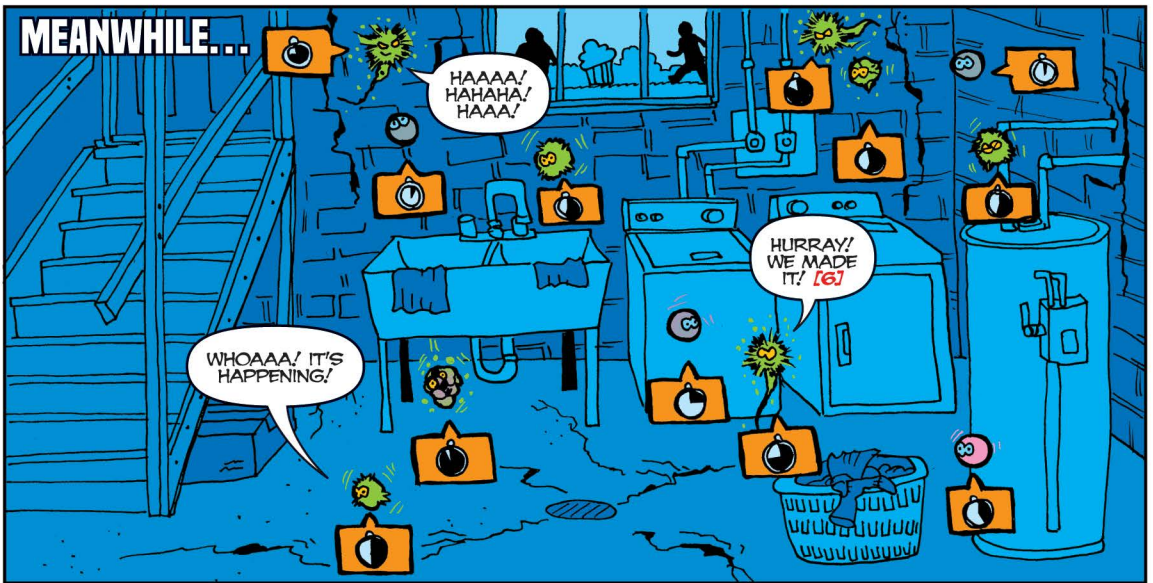
[1] Radon is a naturally occurring radioactive gas that is produced during the breakdown of uranium, thorium, and radium within soil, rocks, and water (NCEH, 2020).  
 [2] During radioactive decay, unstable atoms change from one type of element into another (TPT, 2020).



[3] Chemical elements make up everything around us. Most are stable (they do not change) and happy, while others are unstable and change over time. These unstable elements, like uranium, thorium, and radium, are radioactive. Tiny particles and energy ("radiation") fly out of radioactive elements, causing them to change into a different element with different radioactive properties (ATSDR, 2012).

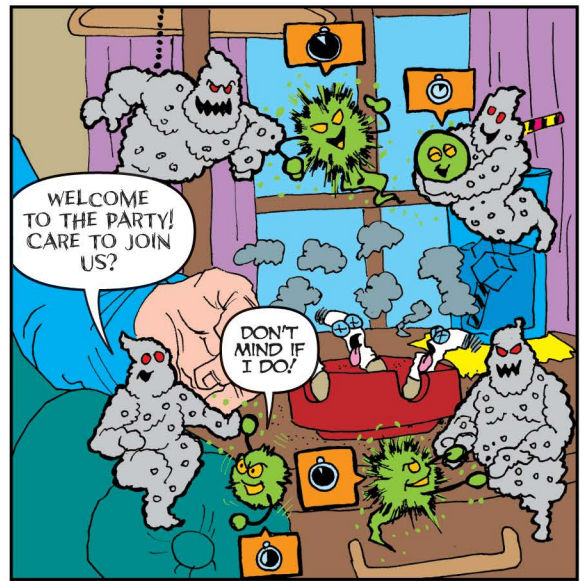
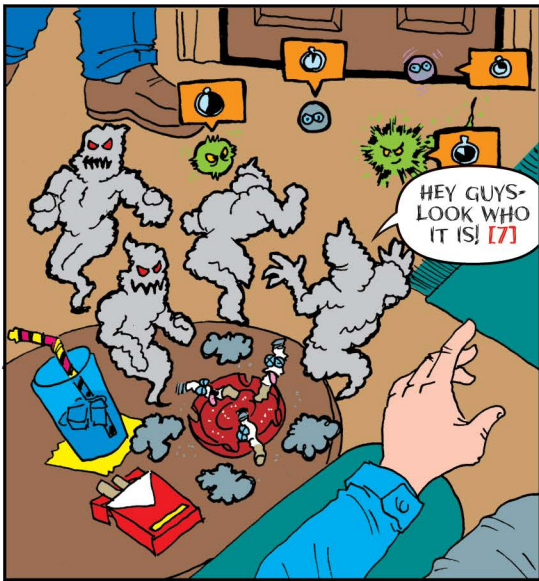
[4] Radon levels naturally vary depending on where you live (geographic area) and the local geology. In Kentucky, you can check the estimated radon values for your area at <https://www.uky.edu/KGS/radon/> (KGS, 2020).



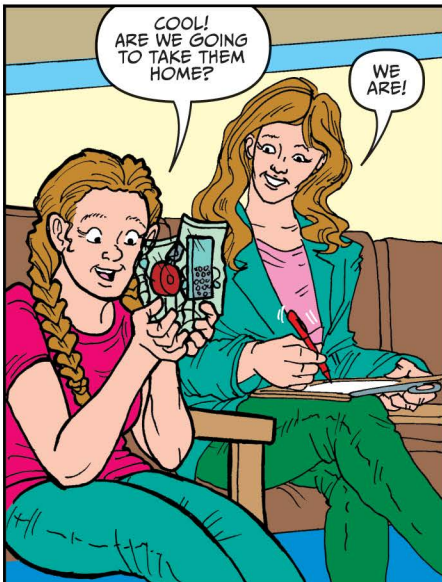
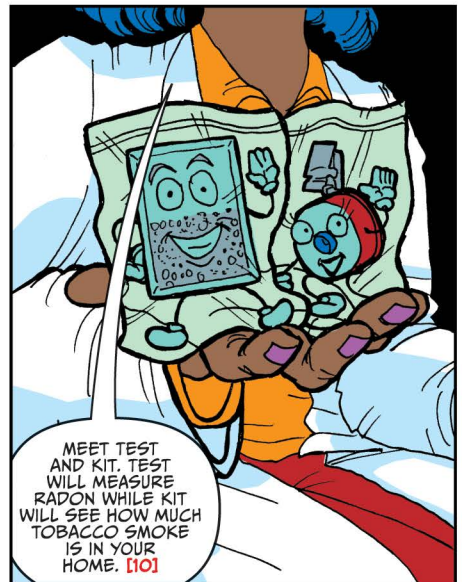
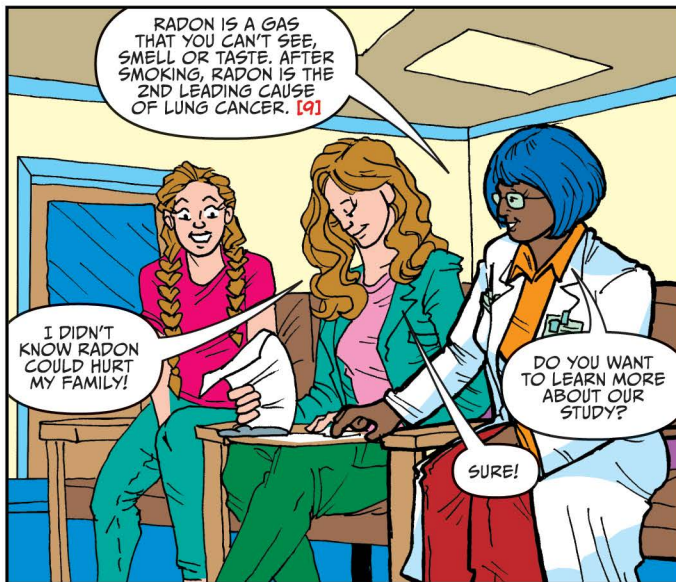


[5] Once radon is produced, the gas moves through the soil, into the air and/or dissolves into water (US EPA, 2016a).

[6] Radon enters all buildings, regardless of age or construction material, through openings and cracks in foundations, floors, walls, windows or around pipes (US EPA, 2016a).

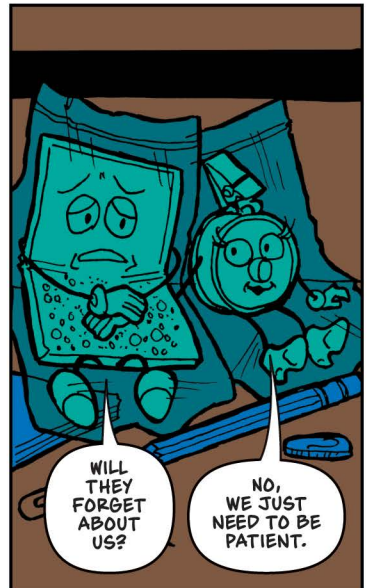
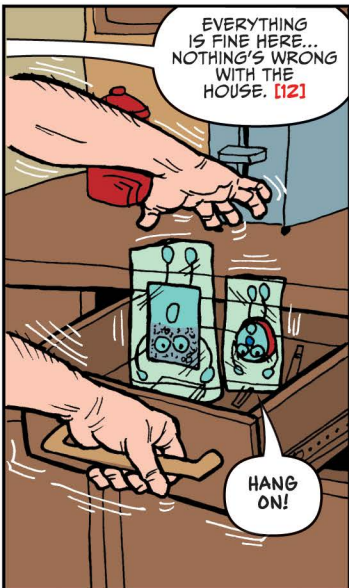
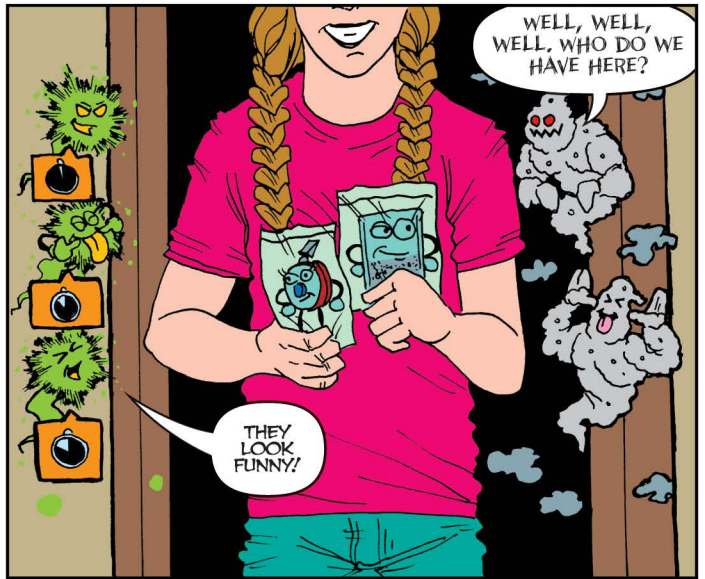


[7] Radon is a known cause of human lung cancer. There is no safe level of radon.

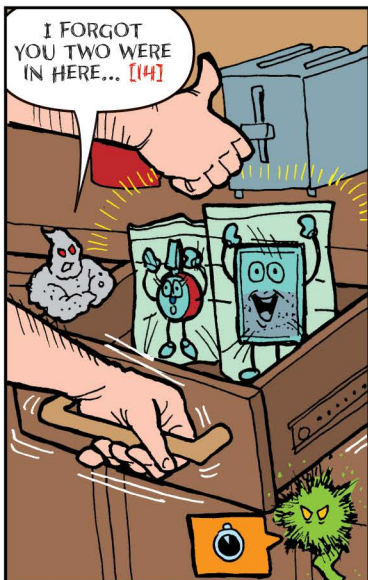
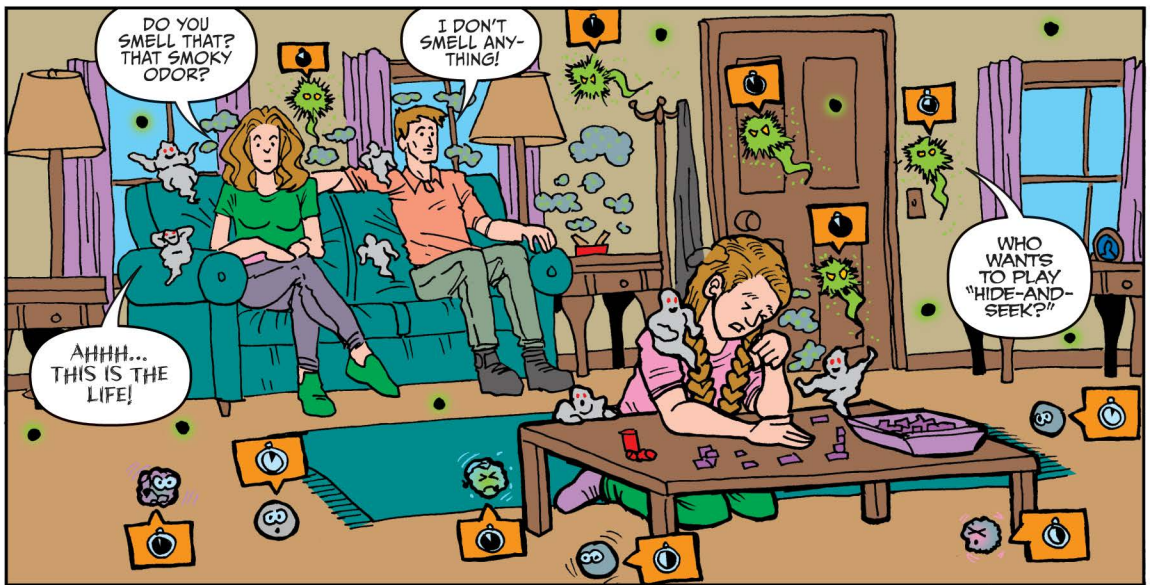


[8] Tobacco smoke and radon are the 2 leading causes of lung cancer, and exposure to both heightens the likelihood of getting the disease (Hahn et al., 2019).  
 [9] The only way to know if you are being exposed to radon is to test for the gas using commercially available test kits or handheld electronic monitors (US EPA, 2016a).  
 [10] Passive nicotine samplers are typically only available through research studies and are not commercially available.

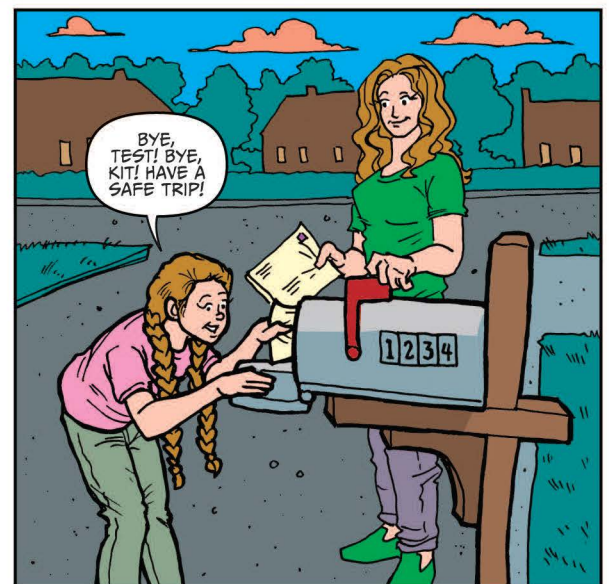
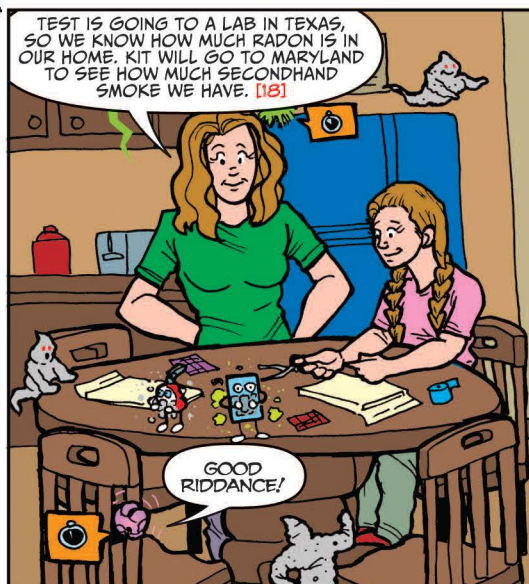
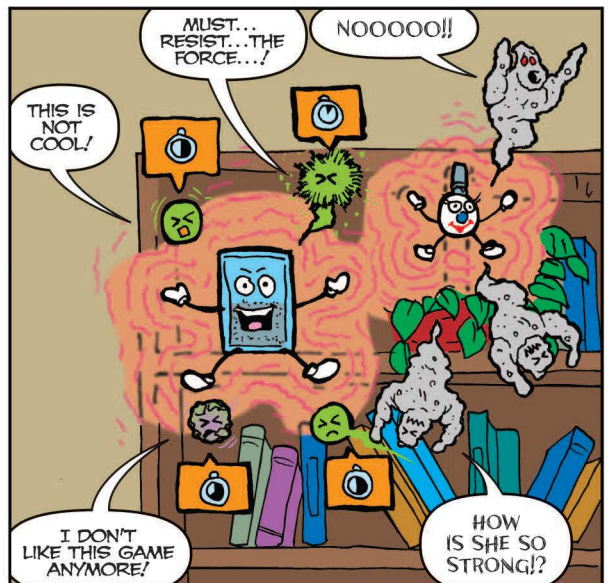




[11] Radon absorbs onto dust and other particles such as tobacco smoke in buildings. This increases our risk of exposure (ATSDR, 2012).  
[12] \*Anyone\* can be exposed to radon - there is no safe level of radon exposure.



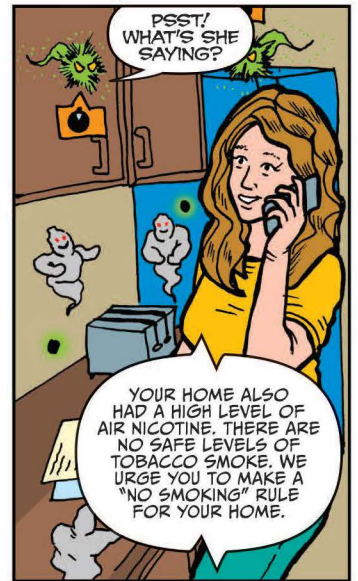
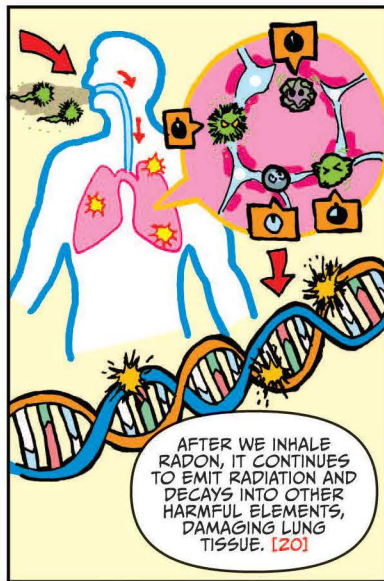
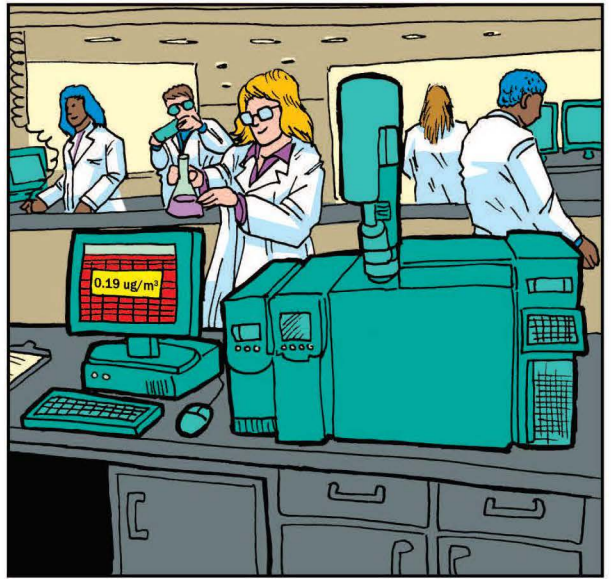
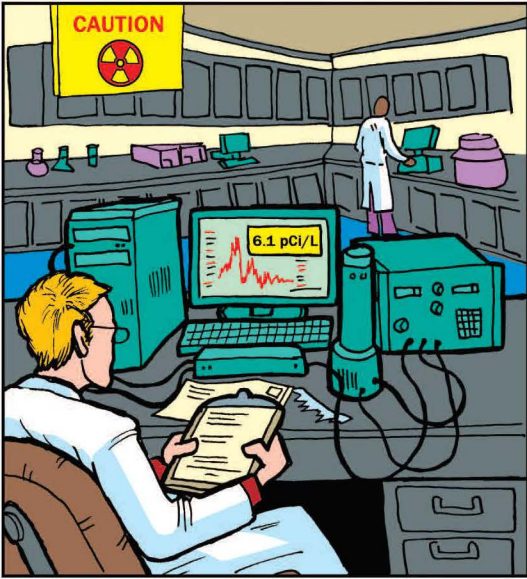
[13] Most radon exposure takes place at home (Miles, 2004).  
 [14] The short-term radon test kits will not expire as long as the plastic bag is not opened (First Alert, 2020).  
 [15] When deploying test kits within the home, pick a regularly used room. Place the kit on a surface at least 20 inches above the floor, where it will not be disturbed (US EPA, 2016a). Learn more at: <https://standards.aarst.org/MAH-2019/index.html>.



[16] When testing for radon in your home, do not place the kit in hallways or closets, rooms with high humidity (kitchens, bathrooms), or near a draft (US EPA, 2016a).

[17] To learn more about selecting the best location to monitor radon exposure within your home, check out: [https://www.epa.gov/sites/default/files/2016-12/documents/2016\\_a\\_citizens\\_guide\\_to\\_radon.pdf](https://www.epa.gov/sites/default/files/2016-12/documents/2016_a_citizens_guide_to_radon.pdf) (EPA, 2016).

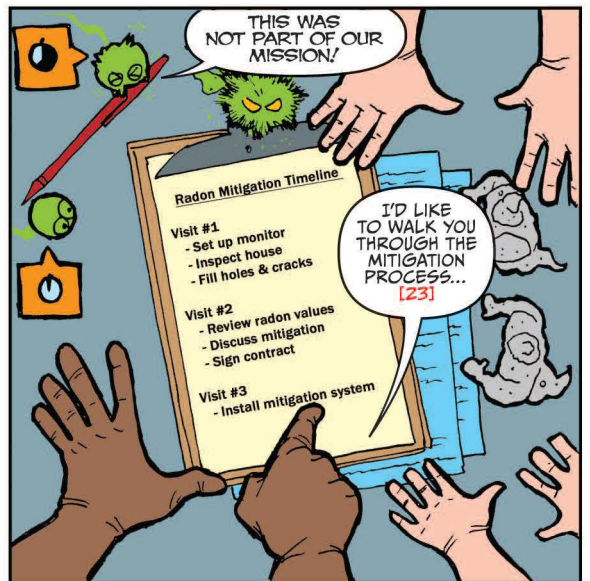
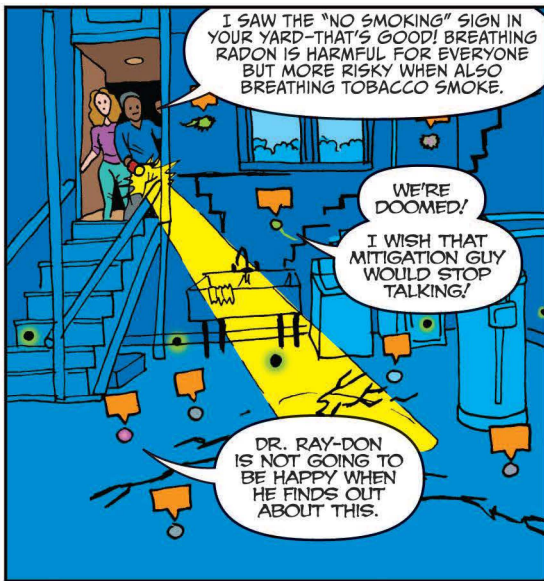
[18] Exposure to secondhand smoke can be determined by measuring concentrations of air nicotine and other particles that can penetrate deep into the lungs (JHU, 2020).



[19] The radioactivity of radon is measured in "picouries"(pCi). If the radon level in your home is 4.0 pCi/L or greater, contact your local health department or visit the KY Radon Program (KY DPH, 2017). Additional resources are also available at: <https://www.uky.edu/breathe/> (UK-CON, 2020).

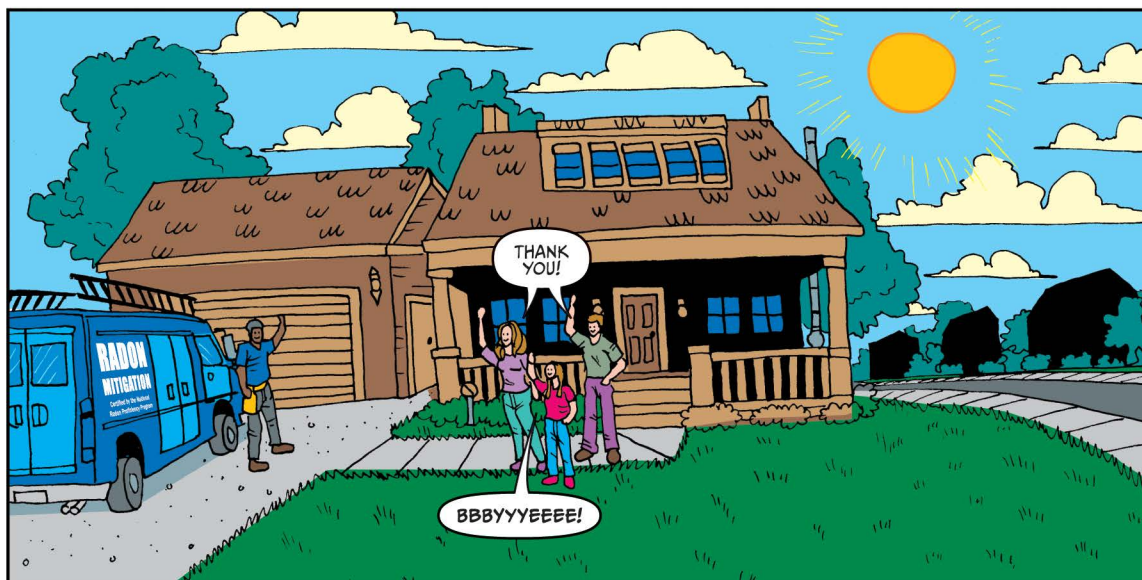
[20] The lower the radon level in your home, the lower your family's risk of developing lung cancer (US EPA, 2016b).

[21] If you, or someone you care about, wants to quit smoking, <https://smokefree.gov/> can help (NCI, 2020)!



[22] Always select a certified mitigation professional to help you reduce radon (<https://nrpp.info/pro-search/>) (NRPP, 2024).

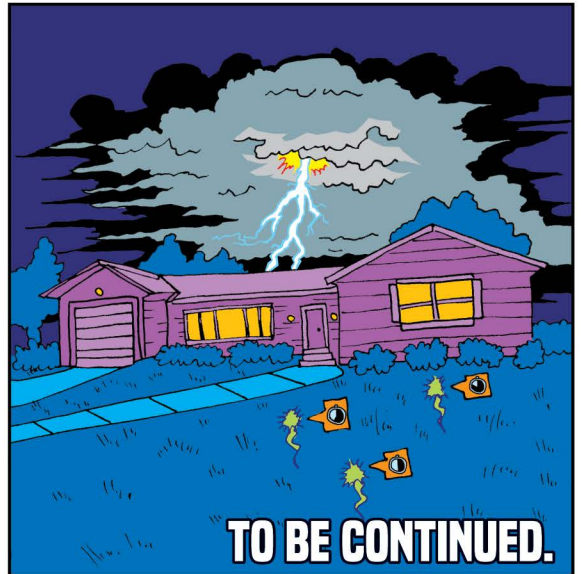
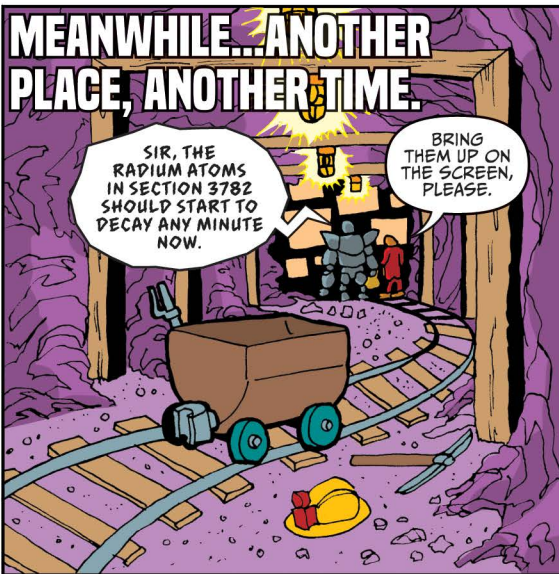
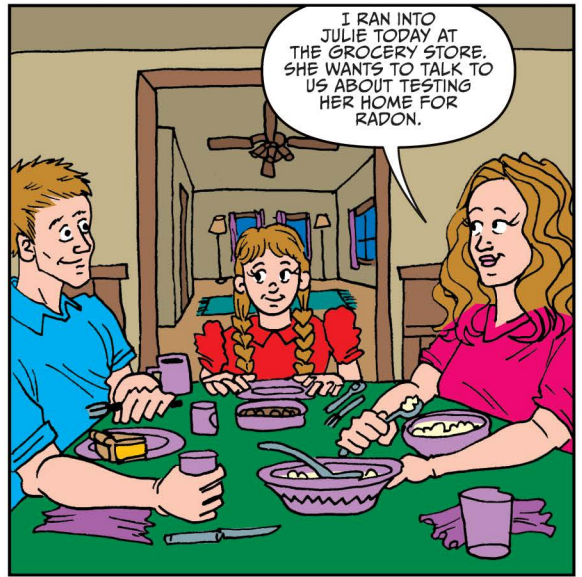
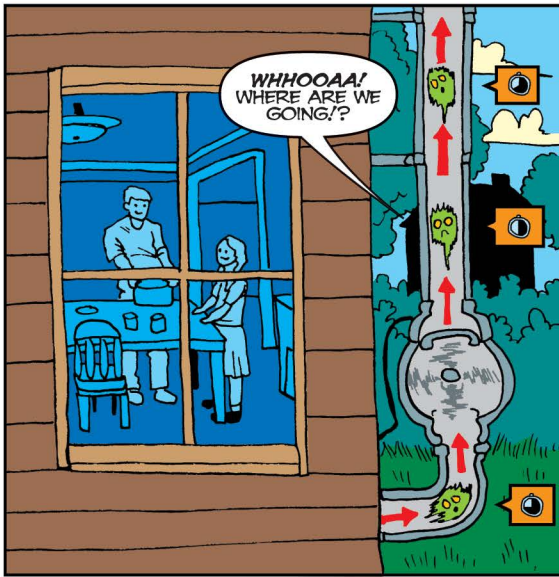
[23] The US EPA provides a "Consumer's Guide to Radon Reduction" to help guide you through the process of fixing your home (US EPA, 2016b).



[24] A "sub slab" radon mitigation system is the most common and usually the most reliable radon reduction method (US EPA, 2016b).

[25] NEVER turn the fan off - it must run continuously for the mitigation system to work correctly (US EPA, 2016b).

[26] All mitigation systems need occasional maintenance; discuss your system's requirements with a professional (US EPA, 2016b).



# CAST OF CHARACTERS



**Mom**

*Loving, level-headed, and decisive: her family's well-being is her top priority, and she leads by example*



**Tina**

*Bright, confident, and curious; loves science and playing with Legos. She is empathetic and has a gentle personality*



**Dad**

*Laid-back, protective and, sometimes, a bit stubborn. He is devoted to his family*



**Dr. Ray-Don**

*Brilliant scientist, tactical wizard, commander of radon minions, and arch enemy of the lungs*



**Radon Minions**

*Odorless, tasteless, and colorless, radon minions cause widespread destruction by inflicting damage to DNA, cells, and/or tissue in individuals. Minions are loyal to Dr. Ray-Don and committed to causing lung cancer*



**Smokey**

*Owner of the tobacco company "Slick Synergy". An extravagant mastermind, he is desperate to revitalize the tobacco industry and increase cigarette sales*



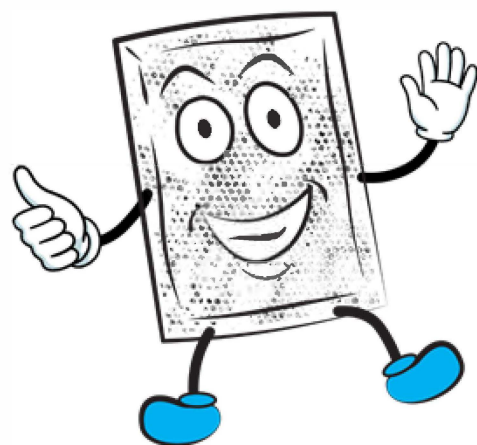
**Grey Bands**

*Loyal to Smokey, these wisecracking jokesters love to socialize and hang out, but can also display a mean streak*



**Susan Smart**

*Public health researcher and advocate, passionate about reducing environmental risks for lung cancer, community leader*



**Test**

*Don't be fooled by his easy-going nature: steadfast and committed, he poses a serious threat to the radon minions and is determined to help defend humans against radon*



**Kit**

*A Grey Band's worst nightmare. Patient, spunky and incredibly strong, she hangs from high places, looking for Grey Bands*







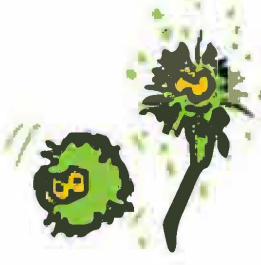




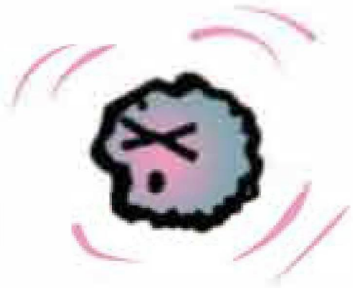
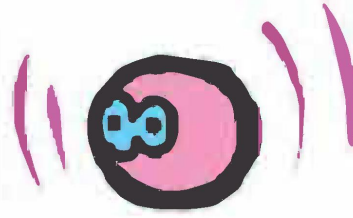
**Radon Mitigation Expert**

*Expert in reducing radon exposure in homes, friendly and approachable, loves problem-solving*



# CAST OF CHARACTERS

## CHEMICAL CHARACTERS

Uranium (U)		Thorium (Th)		Radium (Ra)		Radium (Ra) → Radon (Rn)	
Radon (Rn)		Radium (Ra) → Polonium (Po)		Polonium (Po)		Polonium (Po) → Lead (Pb)	
Lead (Pb)		Lead (Pb) → Bismuth (Bi)		Bismuth (Bi)		<b>Legend</b> → "Decaying into"	

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