



## V. ASSESSMENT

Classroom teachers are encouraged to generate their own open-ended questions as a way of measuring students' understanding of the concepts presented. Open-ended questions have the following characteristics: (a) allow for experimental design or use of data, (b) encourage personal involvement or opinion, (c) encourage multi-level responses, (d) require the integration of past knowledge and skills, and (e) have basic science/societal implications. Provided below are some sample open-ended questions.

### Radioactivity

1. If you had to carry an alpha-emitting radioactive nuclide to school, would it be safer to carry it in your hand, in your shirt pocket, or in a peanut butter jar? Would it make any difference? Why or why not?



*Note to Teachers:*

The students should be able to answer that an alpha emitter is not dangerous *outside the body* because alpha particles do not penetrate the skin. Some students may also reason that there is danger in the possibility of accidentally inhaling or ingesting some of the radioactive material if it is not kept contained.

### Measurement

2. Why is it important to take careful note of the length of time that a radon detector(charcoal canister, electret, or alpha-track) is left open in the home?



*Note to Teachers:*

A detector measures the number of radioactive disintegrations that take place. Whether this number of disintegrations occurred during a period of 5 minutes, 5 days, or 5 months makes a great deal of difference. The data are totally useless unless you know how long the detector was deployed.

### Risk Communication

3. Based on data provided by the New Jersey Departments of Health and Environmental Protection and Energy and the U.S. Environmental Protection Agency, yearly deaths in New Jersey attributable to various causes could be presented approximately as follows. Some of these are estimates and some are reported real data.

Contaminants in drinking water - 10	Other accidents - 1300
Fires in homes and public buildings - 140	Homicide - 480
Home accidents - 460	Lung and other respiratory cancers - 4,400
Exposure to radon in indoor air - 500	Total cancer deaths - 17,000
Auto accidents - 1000	Heart disease - 27,000
Total deaths from all causes - 73,000	

Construct a bar chart to display these data. Assume that it is your responsibility to educate the public in New Jersey about health concerns and to eliminate as many as possible of the "preventable" deaths in New Jersey. You are given an annual budget of two million dollars. How are you going to spend it?

### Risk Assessment

4. You are looking at two houses trying to consider which is the best buy. After carefully examining each one you arrive at the following advantages and disadvantages for House A and House B:

House A		House B	
<u>Advantages</u>	<u>Disadvantages</u>	<u>Advantages</u>	<u>Disadvantages</u>
Less expensive than House B	Located underneath a high voltage line	Located in an upscale area	More expensive than House A
Initial radon testing shows radon level in bedroom at less than 2pCi/L	Homes in area have depreciated at a rate of 5% during the past two years	Homes in area have appreciated at a rate of 5% during the past 5 years	Has some cracks in the basement slab floor Home is 50 years old
Brand new house	Located near an old landfill	Well insulated	About 30 miles from school, work, and shopping area
Close to school, work, and shopping area		In walking distance to a beautiful lake	Initial radon testing shows radon level in bedroom at 8 pCi/L

Explain which home you would buy and why?

**Health**

5. If the energy given off by the nuclear disintegration of U-238 was about the same as the energy given off by polonium-218 (and thus the biological damage would be about the same), would you be better off inhaling the uranium or an equal amount of the polonium? Why?

**Radon Sources and Variability**

6. If equal amounts of radium-226, radon-222, and polonium-218 were found in the air spaces in the soil under your house, which of the three would pose a more *immediate* threat to people living in the house? Why?
7. A neighbor told you that he had tested his home for radon and the result came back with a radon level of 6 pCi/L. His neighbor (two doors down from you) also had a radon test done, and the result was 1 pCi/L. Being interested, you had your home tested and you also convinced your teacher to test your science classroom. The result from your home was 3 pCi/L and the classroom was 20 pCi/L. All the homes are within a block of each other and the school is across the street. How can you explain the different results? What does it mean in terms of your health and the health of your neighbors?

**Risk Evaluation**

8. The chart below shows a comparison of lung cancer risks with different concentrations of radon. The word “normal” refers to the national average of lung cancer among non-smokers.

Concentration pCi/L	Risk of Death from Lung Cancer
2000	more than 75 times normal
200	75 times normal
40	30 times normal
20	15 times normal
4	3 times normal

Explain what the chart means to you.

**Scoring Guide**

Open-ended questions can be scored in the following manner:

Grade   Criteria

- |   |   |
|---|---|
| A | Three or more concepts presented<br>Each concept is interrelated to one another<br>Evidence has been cited    |
| B | Three or more concepts presented<br>The interrelatedness of concepts is less clear<br>Evidence has been cited |
| C | Some concepts presented<br>No interrelatedness<br>Weak evidence   |
| D | Misconceptions, but inclusion of appropriate words and vocabulary<br>No interrelatedness<br>No evidence       |
| F | Total nonsense response<br>No interrelatedness<br>No evidence   |

