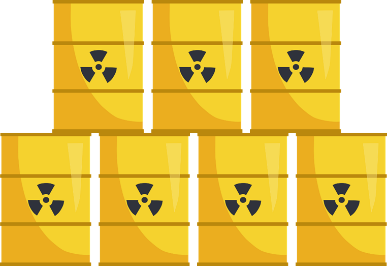
**Radioactive contamination**

Radioactive contamination can be dangerous.

Contaminated materials can cause harm.

They need to be dealt with safely.

**a.** Which of these are examples of **radioactive contamination**?

*Put a tick (✓) in the box next to the best answer.*

**W** Radon gas trapped in a room.

*Radon is radioactive gas found naturally in some types of rock.*

**X** Beta particles are absorbed by an aircraft’s wing.

*Beta radiation is shone through aircraft wings to spot tiny cracks.*

**Y** Nuclear bomb tests can release a lot of radioactive material into the air.

*Most is blown away by the wind.*

**Z** Gamma radiation is absorbed by cancer cells.

*Gamma radiation is shone through cancer cells to kill them.*

|  |  |  |
| --- | --- | --- |
| **A** | W and Y. |  |
|  |  |  |
| **B** | W, X and Y. |  |
|  |  |  |
| **C** | X and Z |  |
|  |  |  |
| **D** | Z. |  |
|  |  |  |
| **E** | W, X, Y and Z. |  |

**b.** What is the *best* reason to explain how something is contaminated?

*Put a tick (✓) in the box next to the best answer.*

|  |  |  |
| --- | --- | --- |
| **A** | Radioactive particles move into it. |  |
|  |  |  |
| **B** | Radiation moves into it. |  |
|  |  |  |
| **C** | Radioactive particles change it, so it becomes radioactive. |  |
|  |  |  |
| **D** | Radiation changes it, so it becomes radioactive. |  |

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.3: Ionising radiation*

|  |
| --- |
| **Diagnostic question** |
| **Radioactive contamination** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Some forms of radiation can ionise atoms or groups of atoms. Several properties of each form of ionising radiation are determined by its ionising power. |
| Observable learning outcome: | Explain radioactive contamination and how it differs from irradiation. |
| Question type: | Two-tier multiple choice |
| Key words: | Radioactive material, radioactive particle, radiation, contamination |

**What does the research say?**

Classroom discussions about ionisation often do not include opportunity for students to consider what happens to radiation particles after they have caused an ionisation (Eijkelhof, 1990). It is common for students to think that an object exposed to radiation becomes radioactive as a consequence\* (Prather, 2005), perhaps because they think that radiation is conserved (Morales Lopez and Tuzon Marco, 2021) and can transfer from one material to another. This often leads students to form misunderstandings about contamination and irradiation (Millar, 1994; Millar and Gill, 1996; Plotz, 2017). Students need to consider: whether objects have had radioactive material transferred to them (contamination); or whether they have been exposed to radiation, and possibly damaged, without becoming radioactive (irradiation).

\**It should be noted that high energy gamma radiation can in some instances can excite nuclei and cause a material to become radioactive.*

**Ways to use this question**

Students should complete the questions individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation. The follow on question will give you insights into how they are thinking and highlight specific misconceptions that some may hold.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

a. A b. A

**How to respond - what next?**

Radon is a radioactive gas that is most commonly produced by uranium-containing minerals in the ground. Its most common isotope, radon-222, undergoes alpha decay and has a half-life of about four days. There are many different radioactive isotopes that may be released during nuclear bomb testing. Both of these (statements W and Y) are examples of radioactive contamination of the air. In both cases, the air is contaminated because radioactive particles are added to it, particles that can later decay to release ionising radiation.

**a.** Option B links together the examples in which ‘particles’ are involved, but beta particles are not radioactive because they do not decay and emit ionising radiation.

Option C includes types of radiation, and it is quite common for students to think that radiation is conserved and passed from one material to another to transfer radioactivity.

Option D, like C includes gamma radiation, but not beta-particles. It is possible that a few students may think of gamma as radiation and beta as particles, which do not ‘contain’ radiation.

Option E is likely to be selected by students who have the misunderstanding that radiation and radioactive particles are the same thing. It is common for students to use these terms interchangeably.

**b.** The second part of this question should help to clarify which misunderstandings students are using for their answers to part a, and the options clearly indicate what these are.

It is likely that some students will have given an answer to part b that contradicts their answer to part b, probably because they are using the terms radiation, radioactive and radioactivity interchangeably, with no clear distinction between each one.

If students have misunderstandings about explaining radioactive contamination and how it differs from irradiation, it can help to lead a discussion about each of the four examples, given in this question, and to explore the processes involved in each situation. This should enable students to make connections between their earlier learning (irradiation, ionising radiation and radioactive particles) and each of the ‘new situations’.

The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Fukushima

**Acknowledgments**

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Image of a barrel by Mostafa Elturkey from Pixabay.

**References**

Eijkelhof, H. M. C. (1990). *Radiation and risk in physics education.* Rijksuniversiteit Utrecht.

Millar, R. (1994). School students' understanding of key ideas about radiation and ionizing radiation. *Public Understanding of Science,* 3**,** 53-70.

Millar, R. and Gill, J. S. (1996). School students' understanding of processes involving radioactive substances and ionizing radiation. *Physics Education,* 31**,** 27-33.

Morales Lopez, A. I. and Tuzon Marco, P. (2021). Misconceptions, Knowledge, and Attitudes Towards the Phenomenon of Radioactivity. *Science & Education*.

Plotz, T. (2017). Students' conceptions of radiation and what to do about them. *Physics Education,* 52(1)**,** 014004.

Prather, E. (2005). Students' beliefs about the role of atoms in radioactive decay and half-life. *Journal of Geoscience Education,* 53(4)**,** 345-354.