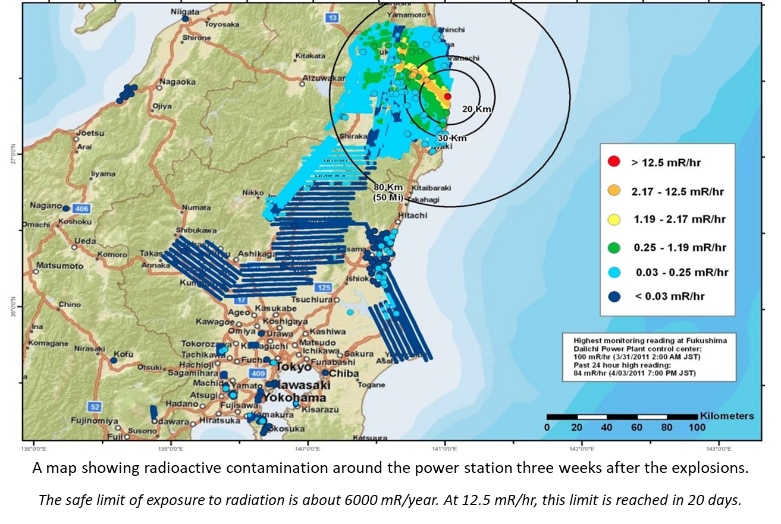
**Fukushima**

In 2011, there were several explosions at the Fukushima nuclear power station in Japan.

An earthquake in the Pacific Ocean caused a tsunami and, a short time later, a giant 14 m high wall of water swamped the power station.

This triggered a chain of events, leading to the explosions and the radioactive contamination of the surrounding area.



*The safe limit of exposure to radiation is about 6000 mR/year.*

*At 12.5 mR/hr, this limit is reached in 20 days.*

*A map showing radioactive contamination around the power station three weeks after the explosions.*

Some students are discussing radioactive contamination around Fukushima.

**Drew:** A huge amount of radioactive material was blasted into the air.

**Gracie:** Over time, the contamination will get less and less.

**Ffion:** Radioactive particles from the power station can be breathed in.

**Erin:** The radiation was blown across the area by the wind.

**Henry:** Radiation from the power station made the air radioactive.

**To answer**

**1.** Who is right about the radioactive contamination around Fukushima?

*Explain your answer*

**2.** Who is wrong about the radioactive contamination around Fukushima?

*What would you say to help them understand?*

|  |  |
| --- | --- |
| Cards for  **Fukushima** | **Drew:** A huge amount of radioactive material was blasted into the air. |
| **Erin:** The radiation was blown across the area by the wind. | **Ffion:** Radioactive particles from the power station can be breathed in. |
| **Gracie:** Over time, the contamination will get less and less. | **Henry:** Radiation from the power station made the air radioactive. |

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| Cards for  **Fukushima** | **Drew:** A huge amount of radioactive material was blasted into the air. |
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*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.3: Ionising radiation*

|  |
| --- |
| **Response activity** |
| **Fukushima** |

**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. |
| Activity type: | Talking heads |
| Key words: | Radioactive material, radioactive particle, radiation, contamination |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Radioactive 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 excite nuclei and cause a material to become radioactive.*

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Drew, Ffion and Gracie are right; and Erin and Henry are wrong.

In the explosions, a huge amount of radioactive material was blasted into the air and blown across the area by the wind. The radioactive particles in the air can be breathed in, or they may settle on the ground. Over time the contamination will decrease as radioactive particles decay, many forming particles that are not radioactive.

Erin is wrong because radiation is not blown across the area by the wind, but is emitted from radioactive particles as they decay. It is the *source* of the radiation that is blown.

Henry is wrong because radiation does not cause particles in the air to become radioactive. *Although, it could be argued that high energy gamma radiation can in some instances excite nuclei and cause a material to become radioactive, but here that would be the exception.*

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Image: work of a United States Department of Energy employee, made as part of that person's official duties.

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