**A random question**

The outcome of a random event is not influenced by anything.

It is entirely down to chance.



Which one of these is ***not*** a random event?

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

|  |  |  |
| --- | --- | --- |
| **A** | A radioactive carbon-14 nucleus decaying. |  |
|  |  |  |
| **B** | Scoring a goal from a penalty kick in football. |  |
|  |  |  |
| **C** | A tossed coin landing on tails. |  |
|  |  |  |
| **D** | None, they are all random. |  |

*Physics > Big idea PMA: Matter > Topic PMA5: Nuclear physics > Key concept PMA5.4: Radioactive half-life*

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| --- |
| **Diagnostic question** |
| **A random question** |

**Overview**

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| Learning focus: | Radioactive half-life is the predicted time it takes for half of a large sample of radioactive nuclei to decay randomly. |
| Observable learning outcome: | Identify events that are random. |
| Question type: | Simple multiple choice |
| Key words: | Random, unpredictable, uninfluenced |

**What does the research say?**

Students often have difficulty in understanding what randomness is, and they find it even harder to understand how something predictable, like radioactive half-life, can emerge from a set of random events (Hull and Hopf, 2020). In a review, of the research about how students are able to understand and use probability-related ideas in science topics, Hull, Janksky and Hopf (2021) explore why these ideas are so challenging.

Students often think that random events are ones for which outcomes are unpredictable and that equations and other models are not useful for describing them. Conversely, when events lead to predictable outcomes, students typically expect to see a pattern in the outcomes that is determined by a set of rules and perhaps an equation. This thinking leads many students to believe that random events cannot be predictable and vice versa. (Hull et al., 2021)

Students’ belief that ‘only clearly determined events can lead to predictable outcomes’, is described by Hull et al. (2021) as a *deeply held* misunderstanding. It is a misunderstanding that can lead to students forming several other common misunderstandings about radioactive half-life. For this reason, Hull et al. (2021) strongly recommend that students are taught how random events can sometimes lead to predictable outcomes, and are given opportunity to consolidate that understanding, before learning about radioactive half-life.

**Ways to use this question**

Students should complete the question 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 answers to the question will show you whether students understood the concept sufficiently well to apply it correctly.

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**

B

**How to respond - what next?**

The success of scoring a goal from a penalty kick in football is dependent on many things, such as the skill and experience of the taker and also of the goalkeeper. The choice of which part of the goal to aim for will also have a big influence on the outcome, and so this event is not random.

A Some students may be aware that we can predict the rate at which a radioactive material will decay at, and because decay rate is predictable they may think that the decay of the nucleus is not random.

C Most students understand a coin toss is random and is not influenced by other factors. Those suggesting it is not random are likely to try to explain why it can be influenced by other things.

D This is the most likely wrong choice, as the outcomes of all choices is unpredictable and it is common for students to think that unpredictable outcomes are caused by random events.

If students have misunderstandings about identifying events that are random, it can help to lead a discussion on why some unpredictable outcomes are random and others are not.

Students could be given a range of different situations to discuss in pairs or in small groups and be challenged to justify whether or not each event is random. Some situations to consider might be:

* the number a dart hits on a dart board (not random because the player aims);
* the roll of a dice (random because each number is equally likely);
* winning first prize in a raffle (random because any ticket is equally likely to be chosen); and
* potting a ball on the first shot in a snooker game (not random because the aim and hardness of shot affect the outcome).

Students could also be challenged to describe other events that are random.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: nuclear decay by Peter Fairhurst (UYSEG); football by Micheal Zollner from Pixabay; and coin by litepix from Pixabay.

**References**

Hull, M. M. and Hopf, M. (2020). Student Understanding of Emergent Aspects of Radioactivity. *International Journal of Physics and Chemistry Education,* 12(2).

Hull, M. M., Janksky, A. and Hopf, M. (2021). Probability-related naive ideas across physics topics. *Studies in Science Education,* 57:1.