Lesson plan 4

Classroom Activity:

Demonstration of half-life

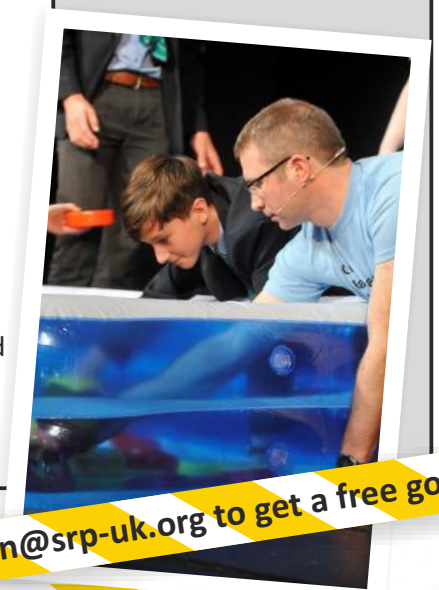
Teacher's Checklist

- **Target audience:** GCSE Science\ Physics students during 'hazards of radioactivity' modules
- **Activity format:** Interactive whole-class activity to form part of a lesson or revision session
- **Nominal duration:** 30 minutes
- **Learning Objectives:**
  - Understand that radioactive decay is a random event and cannot be predicted
  - Radioactive decay follows an exponential curve

- **Equipment & Space Required**
  - Cup for each group
  - Around 60 sweets per group (skittles or similar with a letter on one side)
  - Results table (see Appendix)
  - Graph paper

Time	Teacher Action	Learner Actions
0 min	Remind students why some isotopes are unstable. Ask students to reflect on what they think is emitted during radioactive decay. Focus students' attention on how many nuclei they think would be left after one half-life, after the second half-life, and so on. Explain that the cup full of sweets is going to represent a radioactive source and each sweet is an unstable nuclei. The learners are going to investigate how many unstable nuclei decay per each half life.	Split class into small groups (no more than 3)
5 mins	Explain that each group must first count the number of unstable nuclei are contained within their cup. 	Students should fill in the "activity" – the number of active nuclei they have – at time = 0 on the results table. Students should shake the cup and empty the contents onto the table

Time	Teacher Action	Learner Actions
10 mins	Explain to students that this represents one half-life. Explain that the sweets that land "S" up are still active, but those that land "S" down have now decayed (and are safe to eat!) Ask the students how many nuclei they expect to have decayed after one half-life. (50%)	Students should count the number of remaining active particles and record this number on the results table for 1
15 mins		Students should continue to tip out the remaining sweets, remove the decayed ones, count the active ones and record on the sheet then repeat, until there are no active particles left.
	Ask students how their number of remaining active particles relates to their original number. Is it exactly half? Remind students that radioactive decay is a probability so cannot be predicted – but we can make a best guess.	
25 mins		Students should then draw a graph of their results on the graph paper. Time on the x axis, activity on the y axis.
30 mins	Ask students what shape this graph is. Ask students what the curve suggests about radioactive decay. Explain that it is an exponential curve. These demonstrations could be followed up with: • Show graph of a real example of half life and use graph to calculate activity after a certain amount of time • Examples of half lives of different isotopes. (See appendix) and their uses, with respect to their half life to demonstrate suitability	



The Science:

- The rate of radioactive decay is described by the term half-life.
- Half-life refers to the time required for half of the nuclei in a sample of a radioactive isotope to decay.
- Because the rates of radioactive decay are measurable, unstable isotopes are useful tools in determining age. Through this technique, carbon-14 is used to date the remains of once living things. This process is called carbon dating.

Appendix A

Results Table

Half Life	Activity (number of active particles)
0	
1	
2	
3	
4	
5	

Extend table as far as required

Radionuclide	Half - life
Carbon-14	5730 years
Americium-241	432.6 years
Caesium-137	30 years
Tritium (H-3)	12.3 years
Krypton-85	10.7 years
Polonium-210	138 days
Phosphorous-32	14.3 days
Nitrogen-16	7.1 seconds

Discuss how half lives can range from thousands of years, to a matter of seconds and that this can often mean that they are then useful in different applications.
Ask if anyone knows what the some of the radionuclides are used for?

Carbon-14 - carbon dating because of its very long half life.

Americium-241 - in smoke detectors, few hundred years means it should last the lifetime of the your time in the house….changing the battery is annoying enough!

Phosphorus-32 - radioactive tracer, labels amino acids & phosphoproteins. Long enough half life to produce, use and get results in patient. Discuss precautions given after medical treatment. Talk about medical tracers setting off alarms at South African World Cup.