

Chapter 3 Radioactivity and radiation

Module 3.4 Half-life and activity of radioisotopes

Evaluation and Analysis 3.4.2 Research topics

Total marks 20

Research topics

Controlling the fruit fly

The fruit fly is the most serious insect pest of fruit and vegetable crops in Australia. Crop damage is caused by the female laying her eggs in the fruit. The 10 to 15 million sterilised male flies that are released every week in the main southern fruit-growing areas ensure that few females lay fertile eggs and that larvae numbers are kept low.

- What role does radioactivity play in this sterilisation process?
- How does it work?
- What size doses are involved?
- Who conducts the sterilisations?
- Why is this program so incredibly effective in protecting our crops?
- Why is it critical to give the male flies just the right dose of radiation?
- Explain why this program is so much better for the environment than alternative control mechanisms.

Radioactivity and wine grapes

When growing plants such as wine-producing grapevines—which need just the right amount of water at just the right time—an accurate soil-monitoring device is required. The nuclear moisture probe is one of the most effective methods available.

- Find out how this device works.
- What role does radioactivity play in measuring moisture levels?
- Where, and by whom, was this device developed?
- Is there a health concern in having radioactive items so close to a food crop?
- What other applications does this device have in agriculture and industry?

Radiation sterilisation

Medical products, such as surgical dressings, sutures, catheters and syringes must be sterilised before they can be used in medical procedures. This is frequently done using radiation.

- How does this process work?
- What methods are used to produce the radiation?
- Once treated, are these sterilised instruments radioactive?
- What advantages does radiation sterilisation have compared with other techniques?
- Why are many of these products unable to be sterilised using steam or heat?
- What are the disadvantages of sterilisation via chemical processes?

Precision measuring in manufacturing

In the manufacturing industry it is essential that precise measurements can be made in production lines that often involve objects moving at high speeds. For example, the level of beer in bottles on a conveyor belt, or the thickness of steel plate as it is rolled off the presses is measured using radioactivity. The production of adhesive tape, detergents, floor coverings, jet engine fuel, many kinds of paper, petroleum, plastic, rubber, stainless steel, surgical adhesive, tyre fabric, vinyl wall coverings and wood chips can all use radioactivity-based measuring devices.

- Find out how radioactivity-based instrumentation is used in a production process.

Check-ups for aircraft and ships

In Australia, both civil and military aircraft are inspected by radiography during their regular maintenance schedules. Aircraft manufacturers require radiographic inspection of all wing structure components on commercial aircraft. Ships are checked for their seaworthiness.

- What sort of radiation is employed in these processes?
- How does the process work?
- For how long has this technology been employed in this field?
- Is it done on site?
- How detailed an image can be produced?
- How small is the smallest fault that can be detected?
- Does the process affect the strength of the materials tested?
- What areas in the aircraft are checked most frequently?
- What areas in an aeroplane most commonly fail?

Finding our fossil fuels

Radionuclides have been used in a variety of ways in oil exploration for many years.

- How is radioactivity used to locate oil deposits?
- What role does the measurement of radioactive material have in determining the best location for an oil well?
- Are these techniques the only way scientists have of locating and evaluating underground flow patterns?
- How does the use of radioactivity reduce the costs of oil exploration?

Keeping waterways healthy

Using isotopes to track the movement of sediments in the environment is one of the lesser-known applications of nuclear technology. Without the use of radioactive tracers we would know far less about water flow in our harbours and river systems.

- Explain the processes involved in using radioactive tracers to monitor waterways.
- What radioisotopes are most commonly used?
- What length half-lives do they have?
- What sort of information can scientists obtain from their use?
- Report on a case study of a river or harbour system that has been investigated using these techniques.

Replacement research reactor

The 50-year-old HIFAR reactor at Lucas Heights was decommissioned in 2007. A new research reactor, known as the OPAL, commenced operations in November 2006. It is a multipurpose facility for radioisotope production, irradiation services and neutron-beam research.

- What does OPAL stand for?
- Find out about the design of this reactor.
- What sort of fuel does it use?
- What does it produce?
- What safety systems have been included in the reactor?
- What sort of research is being carried out using the neutron beams?
- What major industry is likely to be an ongoing customer of the replacement reactor, making use of the neutron beams?
- What will the radioisotopes produced by the replacement reactor be used for?