

# ➤ Order of Radioactivity: Radiation Around Us

## Objectives

Students will:

- Understand that radiation is natural and found everywhere.

## Fast facts

**Subject:** Physics

**Age range:** 8+ years old

**Ambassador preparation time:** 30 minutes

**Demonstration time required:** 15 minutes

**Location:** Science Fair

## Overview

All of us are exposed to radiation every day, from natural sources such as minerals in the ground, and man-made sources such as medical X-rays.

When people hear the word radiation, they often think of atomic energy, nuclear power, and radioactivity, but radiation has many different forms and comes from many other sources.

Radioactive objects surround us every day, in and out of our home. This activity is designed to show that radiation is everywhere and is completely safe, up to a certain limit.

## Equipment

All the different items which can be used in this activity are listed at the end of the guide (Full Equipment List section). It is optional to obtain the some/ all of these items. An image pack is also included which can be used instead of or in conjunction with the below items (Radiation Around Us Image Pack).

**Procedure**

Show students the everyday items or the images of the items. Ask the students to put the items in order of least radioactive to most radioactive. Included in the image pack are two radioactive signs. The dose in sieverts (Sv) will be displayed on the reverse of the images.

**Answer**

The table below shows the correct order for the everyday items/activities and their associated radioactivity, from lowest to highest. One sievert (Sv) is the same as one joule/kg. The sievert represents the equivalent biological effect of the deposition of one joule of radiation energy in one kilogram of human tissue.

$$1 \text{ Sv} = 1,000 \text{ mSv} = 1,000,000 \text{ } \mu\text{Sv}$$

Item/activity	Dose / $\mu\text{Sv}$	Dose / mSv	
Smoke detector per hour at 30 cm distance	0.01	0.00001	less than
Living within 50 miles of a nuclear power plant	0.09	0.00009	
Eating 1 banana	0.1	0.0001	
Living within 50 miles of a coal power plant	0.3	0.0003	
Dental X-ray	5	0.005	
Brazil nuts, 100g	10	0.01	
Uranium glass at the surface per hour	54.2	0.0542	average
Living in a stone/ concrete/ brick building	70	0.07	
Trans-Atlantic flight	80	0.08	
Annual dose from natural potassium in the body	390	0.39	
Radon paint watch per hour	1920	1.92	
Head CT scan	2,000	2	
Normal UK yearly background dose	2700	2.7	
Living in Cornwall per year	6900	6.9	
Ceramic dinnerware	37500	37.5	average
Usually fatal dose	4000000	4000	

## Discussion

Talk about each item as you reveal the dose.

- **Smoke detector**

Smoke detectors use a radioactive element called Am-241 which emits charged alpha particles. The alpha radiation ionises the air particles inside the smoke detector. This allows a small electric current to flow. If there is a fire, smoke particles going into the detector are hit by alpha radiation. This reduces the ionisation of the air particles causing the current to drop. The drop in current is detected by the smoke detector, setting off the alarm.

- **Living within 50 miles of a nuclear power plant**

Most of an operating nuclear power plant's direct radiation is blocked by the plant's steel and concrete structures. An operating nuclear power plant produces very small amounts of radioactive gases and liquids, as well as small amounts of direct radiation. If you lived within 50 miles of a nuclear power plant, you would receive an average radiation dose of about 0.09 uSv per year.

- **Eating a banana**

The radioactive nature of bananas comes from the presence of Potassium, a naturally occurring mineral. The average banana contains 422 mg of potassium. About 0.012% of the atoms of potassium are radioactive, which means when they decay they emit radiation.

- **Living within 50 miles of a coal power plant**

Combustion of coal creates wastes that contain small amounts of naturally occurring radioactive material.

- **Dental X-rays**

Low levels of radiation are used in X-rays. High energy electromagnetic waves pass through the body to an x-ray detector on the other side of the patient. An image will be formed that represents the shadows formed by objects inside the body. The x-rays that are not absorbed are used to create the image. The amount the patient absorbs contributes to the patient's radiation dose. Radiation that passes through the body does not contribute to this dose.

- **Brazil nuts**

Brazil nuts are the most radioactive food that we eat. They absorb radium (a radioactive element) from the soil. In Brazil, where these nuts grow, there are elevated levels of radium in the soil.

- **Uranium glass/ vasiline glass**

Uranium glass is a glass which has had uranium added before melting for colourisation. The proportion varies from trace levels to about 2% U by weight. The added uranium was for a decorative effect, it causes the glass to be fluorescent.

## ➤ Radiation Around Us

- **Living in a stone/brick/concrete building for a year**

Radioactive materials in sandstone, concrete, brick, natural stone, gypsum, and granite contain naturally occurring radioactive elements like radium, uranium, and thorium. These naturally occurring elements can break down or decay into the radioactive gas radon.

- **Trans-Atlantic flight**

When you fly you go high into the atmosphere. Up at this high altitude the air gets thinner, the higher you go the thinner the air gets and the fewer molecules there are above you to deflect cosmic rays- this is radiation from outer space.

- **Natural potassium in the body**

Potassium is an essential mineral and electrolyte in the human body. Normal levels of potassium are between 3.6 and 5.2 mmol/L of blood. Potassium is found naturally in the soil and in the food we eat

- **Watch with radon paint**

Paint containing Radon is fluorescent. In the 1920s watches painted in this uranium paint were very popular, the dials were covered in the luminous paint. They shone all the time and didn't require charging in the sun.

- **Head CT scan**

CT scans rely on x-rays to generate images. In a CT scan these X-rays are administered in all directions (360 degrees). So your body will absorb more radiation giving you a higher radiation dose.

- **Normal UK yearly background dose**

There is background radiation everywhere. The UK government estimates that the average person receives an annual dose of 2.7 mSv. About 85% of this is natural sources of background radiation, these include; radon gas excreted from rocks and soil in the ground, background cosmic radiation and living things (plants absorb radioactive materials from the soil, these pass up the food chain). Artificial sources account for about 15 per cent of the average background radiation dose. Nearly all artificial background radiation comes from medical procedures, such as receiving X-rays for X-ray photographs. A small amount of background radiation is from nuclear missile tests and nuclear power.

- **Living in Cornwall**

There is background radiation everywhere, but on average Cornwall is the most radioactive part of the British isles. This is because it is largely made up of granite, this is an igneous rock which produces radon more rapidly than most other rock types.

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- **Ceramic dinnerware**

Often ceramics contain elevated levels of naturally occurring radionuclides. Before the 1970s, many companies used radioactive minerals to colour glazes. The most commonly used minerals were; uranium, thorium and potassium. These elements emit alpha, beta and/or gamma radiation. These glazes can be found on floor and wall tiles, pottery and other ceramics.

### Real-World Application

This activity shows how radiation is present in the world around us in everyday objects and places. Therefore, radiation can be shown to be completely safe, up to a certain limit, as sources of radiation occur naturally.

### Full Equipment List

- 2 Radioactive signs (big and small, representing most to least radioactive)
- Geiger counter
- Smoke detector, per hour measured at 30 cm
- Living within 50 miles of nuclear power plant (image of power plant)
- 1 banana
- Living within 50 miles of a coal power plant (image of power plant)
- Image of a dental X-ray
- Brazil nuts, 100g
- Uranium glass
- Image of a stone/concrete/brick building
- Trans-Atlantic flight ticket and/or small toy aeroplane
- Image of human body to represent annual dose from natural potassium in the body
- Radon-painted watch
- Image of a head CT scan
- Map of the UK to represent the normal UK yearly background dose
- Map of Cornwall to represent living in Cornwall for a year
- Ceramic dinnerware
- Image to represent usually fatal dose