0 1

The 'enriched' uranium which is used in the fuel rods of nuclear reactors comes in the form of two isotopes. Information about each of these is given in the below table.

Isotope	Percentage of mass of fuel rod (%)	Half-life ($\times 10^9$ years)
Uranium-235	3	0.7
Uranium-238	97	4.5

0 1 . 1

The process of nuclear fission does not lead to the release of greenhouse gases, and so some countries rely heavily on nuclear energy in meeting their electricity demands.

Suggest then why many people are still opposed to the use of nuclear power.

Risk of reactor meltdown / fallout from nuclear accidents [1]
Problems with safe long-term disposal of hazardous radioactive waste [1]

0 1 . 2

A particular nuclear fuel rod contains 4.85 kg of uranium-238.
Calculate the mass of uranium-235 which it contains.

Mass = 4.85 ÷ 97 × 3 = **0.15 kg**

0 1 . 3

What fraction of this mass of uranium-235 would remain after 1.4 billion years?

1.4 billion years = 1.4×10^9 years = 2 half-lives (for uranium-235)
Fraction remaining = ½ × ½ = **1/4**

0 1 . 4

If some of the uranium from a fuel rod was accidentally released into the environment, which of the above isotopes would provide the larger contamination risk? Explain your answer.

EITHER uranium-238 because it has a longer half-life (and so it will take longer to decay) [1] and there is a greater mass present [1]

OR uranium-235 because its half-life is shorter and so it will decay more quickly [1] and so (a given number of U-235 nuclei will) release radiation into the environment at a greater rate (than the same number of U-238 nuclei) [1]

0 2

Radioactive substances may lead to the contamination or irradiation of places, objects, plants, animals or people.

0 2 . 1

Explain the difference between radioactive contamination and irradiation.

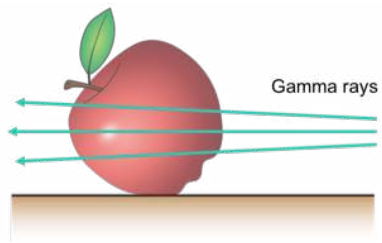
Contamination is when radioactive material (which will go on to decay and release ionising radiation) is present in an object [1].

Irradiation is when an object is exposed to ionising radiation [1].

(An object can be irradiated without being contaminated, but all contaminated objects will be irradiated by the radiation released when the radioactive nuclei they contain decay.)

0 2 . 2

Gamma rays are sometimes used for the sterilisation of foodstuffs.



Write down one reason why gamma rays are used in this way.

To kill bacteria / viruses / fungi / microbes / [1]; to prolong the shelf-life food [1].

0 2 . 3

A friend is concerned about eating apples and other foodstuffs which have been sterilised using gamma rays. How would you explain to them that there was no need to worry?

When gamma rays pass through an item of food, they just deposit energy in it [1]. (They do not have the effect of actually making the food radioactive / contaminating the food.)

0 2 . 4

They then go on to ask you about the radiation hazards which some people are exposed to in the workplace.

In a hospital, a radiographer might take dozens of X-rays per day. Write down **two** ways in which they protect themselves against the harmful effects of radiation.

Any TWO of: time, distance and shielding. They minimise their exposure time; they maximise their distance from the X-ray beam (and source); they use appropriate shielding to absorb and X-rays which might be travelling towards them (radiographers normally stand behind leaded glass, for example).