Radioactive contamination

4.4.2.4 · Atomic structure · revision notes

The difference between radioactive contamination and irradiation, why the type of radiation affects the hazard inside and outside the body, the precautions that reduce the risk, and why studies of radiation's effects are published and peer reviewed. Expect 'compare', 'explain' and 'give precautions' questions.

Key facts

- Contamination = unwanted radioactive atoms on or in a material
- An irradiated object does NOT become radioactive
- Inside the body: α is most hazardous (strongly ionising, absorbed by nearby cells)
- Peer review: other scientists check published findings
- Irradiation = exposure to radiation from an outside source
- Outside the body: β and γ are more hazardous (can reach organs); α is absorbed by skin
- Precautions: tongs, gloves, lead-lined box, short time, keep your distance

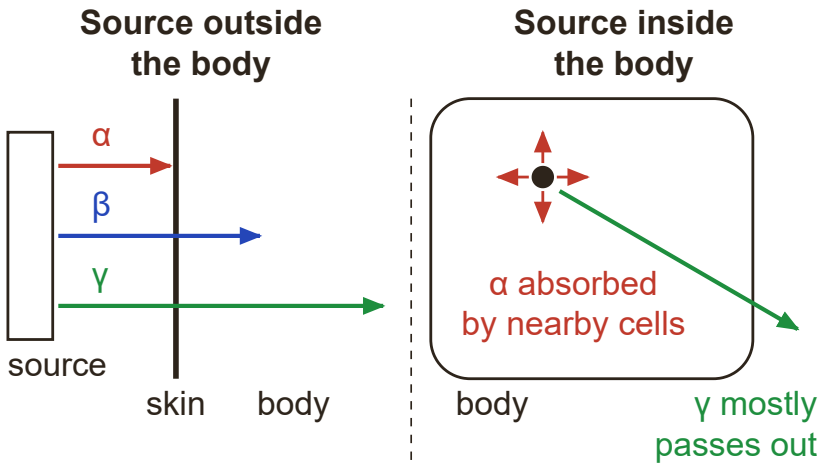
Notes

Contamination and irradiation

- **Radioactive contamination** is the unwanted presence of materials containing radioactive atoms on or in other materials, e.g. radioactive dust on skin, or radioactive gas breathed in.
- The hazard comes from the decay of the contaminating atoms. It continues until the material is removed or has decayed, and removing it can be difficult.
- **Irradiation** is exposing an object to nuclear radiation from a source outside it. The irradiated object does **not** become radioactive.
- Irradiation stops as soon as the source is taken away or shielded.

How the type of radiation affects the hazard

- Ionising radiation can damage or kill cells, and can change DNA, which may lead to cancer.
- **Outside the body**: alpha is the least hazardous, because the air or the outer layer of dead skin absorbs it. Beta and gamma are more hazardous, because they can penetrate the skin and reach organs.
- **Inside the body** (swallowed or breathed in): alpha is the most hazardous. It is strongly ionising, and all of its energy is absorbed by nearby cells, causing a lot of damage in one place.
- Inside the body, gamma is the least hazardous, because it is weakly ionising and most of it passes out of the body.



Outside the body alpha is the least hazardous; inside the body it is the most hazardous.

Precautions

- Handle sources with long tongs, to increase the distance between the source and your body.
- Wear gloves to stop radioactive material getting onto your skin.
- Keep sources in a lead-lined box, and take them out for as short a time as possible.
- Never point a source at anyone. Workers wear a dosimeter badge to monitor the dose they receive.

Sharing findings

- It is important that findings of studies into the effects of radiation on humans are **published** and shared with other scientists, so that they can be checked by **peer review**.

How to answer each type of question

Give precautions and explain them

2 to 4 marks | Grade 4

1. Give a specific precaution (tongs, gloves, lead-lined box, short time).
2. Say how it reduces the risk: more distance, less time, shielding, or stops contamination.

Example. A teacher uses a radioactive source in a lesson.
Give two precautions the teacher should take to reduce the risk to themselves. Explain how each precaution reduces the risk.

Model answer. Handles the source with long tongs (1), which keeps the source further from the body (1). Puts the source back in its lead-lined box as soon as possible (1), which reduces the time of exposure (and the lead absorbs the radiation) (1).

Compare contamination and irradiation

3 marks | Grade 6

1. Define each one in a sentence.
2. Say how long the exposure lasts in each case.
3. Say whether the object or person becomes radioactive.

Example. Compare the hazards of contamination and irradiation.

Model answer. Contamination is radioactive material getting onto or into a person or object, whereas irradiation is exposure to radiation from a source outside them (1). A contaminated person keeps receiving radiation until the material is removed or has decayed (1). An irradiated person stops receiving radiation as soon as the source is removed or shielded, and does not become radioactive (1).

Explain why findings are shared

2 marks | Grade 6

1. Say that other scientists can check (or repeat) the work: peer review.
2. Say why that matters: the conclusions can be trusted and used for safety.

Example. Scientists have studied the health of people exposed to radiation.
Explain why it is important that these findings are published.

Model answer. So that other scientists can check the findings (peer review) (1). This makes the conclusions more reliable, so they can be used to set safe limits for radiation doses (1).

Explain the hazard inside and outside the body

3 marks | Grade 7

1. Say what absorbs the radiation when the source is outside the body.
2. Say what absorbs it when the source is inside the body.
3. Link the ionising power to the damage done to cells or DNA.

Example. Radon is a radioactive gas that emits alpha particles.
Explain why radon is more hazardous when it is breathed in than when it is outside the body.

Model answer. Outside the body, the alpha particles are absorbed by the air or the outer layer of skin, so they do not reach living cells (1). Inside the lungs, the alpha particles are absorbed by nearby cells (1). Alpha is strongly ionising, so it damages these cells or their DNA, which may lead to cancer (1).

Don't lose marks

- Saying an irradiated object, such as sterilised equipment, becomes radioactive. It does not.
- Saying alpha is 'not dangerous'. It is very dangerous inside the body.
- Giving a precaution without saying how it reduces the risk, when the question asks you to explain.
- Saying peer review means other scientists 'agree' with the findings. It means they check them.

More tips

Memory tricks

- Contamination = the source is ON or IN you, so it goes where you go. Irradiation = the source is NEAR you; move away and it stops.
- Alpha: least hazardous outside, most hazardous inside. Beta and gamma are the danger from outside.
- Every precaution does one of four things: more distance, less time, shielding, or keeping the material off you.

Exam technique

- In comparison questions, make each point about both: 'contamination ... whereas irradiation ...'.
- Link the hazard to ionisation: 'strongly ionising', 'absorbed by cells', 'damages cells or DNA'.
- For peer review, the key words are 'other scientists' and 'check'.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Give precautions for handling radioactive sources**
Use tongs, wear gloves, keep the source in a lead-lined box and spend as little time near it as possible.

Grade 4 — **Define contamination and irradiation**
Contamination: unwanted radioactive material on or in something; irradiation: exposure to radiation from outside.

Grade 5 — **State that irradiation does not cause radioactivity**

An irradiated object does not become radioactive.

Grade 6 **Explain why findings are peer reviewed**

Published findings can be checked by other scientists, so the conclusions are more reliable.

Grade 6 **Compare the hazards of contamination and irradiation**

Contamination keeps exposing you until it is removed or decays; irradiation stops when the source is removed.

Grade 7 **Explain which radiation is most hazardous where**

Outside the body beta and gamma are more hazardous; inside the body alpha is most hazardous.

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