Background radiation

4.4.3.1 · Atomic structure · revision notes

What background radiation is, where it comes from, why the dose people receive depends on their job and where they live, and the unit of radiation dose. Expect recall and data questions, often with a table or pie chart of sources. GCSE Physics only, not in Combined Science.

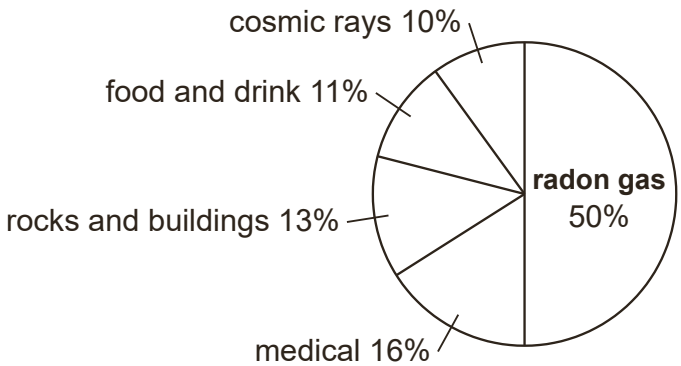
Key facts

- Background radiation: radiation around us all the time
- Man-made sources: fallout from nuclear weapons testing and nuclear accidents
- 1 Sv = 1000 mSv
- Corrected count rate = measured count rate − background count rate
- Natural sources: rocks (radon gas), cosmic rays, food and drink
- Radiation dose (risk of harm) is measured in sieverts (Sv)
- Dose depends on occupation and location

Notes

What background radiation is

- **Background radiation** is around us all the time. A detector always records a low count rate, even with no source nearby.
- Natural sources: **rocks** (some release **radon**, a radioactive gas), **cosmic rays** from space, and radioactive isotopes in food, drink and our own bodies.
- Man-made sources: **fallout** from nuclear weapons testing and from **nuclear accidents**. Medical procedures such as X-rays also add to the dose people receive.
- Most of the background radiation we receive comes from natural sources.



Approximate shares of the average yearly dose in the UK (figures vary between sources). Most of it is natural; radon gas is the biggest part.

Radiation dose

- **Radiation dose** is a measure of the risk of harm to the body from exposure to radiation.
- It is measured in **sieverts (Sv)**. 1000 millisieverts (mSv) = 1 sievert. You do not need to recall the unit, but you must be able to use it.
- The level of background radiation, and your radiation dose, can depend on your **occupation** and your **location**.
- Occupation: aircrew spend many hours at high altitude, where cosmic rays are stronger. Nuclear industry workers, radiographers and miners may also receive higher doses.
- Location: areas with granite rocks, which release radon, have more background radiation. So do high places, which receive more cosmic rays.

Correcting for background

- A detector measuring a source also picks up background radiation.
- Measure the background count rate with no source present, then subtract it from every reading.
- Corrected count rate = measured count rate − background count rate.

How to answer each type of question

Name sources of background radiation 1 to 2 marks **Grade 4**

1. Check whether the question wants natural or man-made sources.
2. Give a specific source, e.g. 'radon gas from rocks' rather than just 'the ground'.

Example. Give one natural source and one man-made source of background radiation.

Model answer.

Natural: cosmic rays / rocks / radon gas (1)
Man-made: fallout from nuclear weapons testing / nuclear accidents (1)

Correct a count rate for background 2 marks **Grade 5**

1. Find the background count rate (the reading with no source).
2. Subtract it from the reading with the source, keeping the same units.

Example. With no source present, a detector records 45 counts in one minute. With a source present, it records 510 counts per minute.
Calculate the count rate due to the source alone.

Model answer.

510 − 45 (1)
= 465 counts per minute (1)

Suggest why a person's dose is higher

2 marks | Grade 6

1. Name the source of the extra radiation (e.g. cosmic rays, radon).
2. Link it to the person's job or where they live.

Example. An airline pilot receives a higher yearly radiation dose than a person who works in an office at ground level.
Suggest why.

Model answer. The pilot spends many hours at high altitude (1), where there is more cosmic radiation because there is less atmosphere above to absorb it (1).

Use data on radiation dose

3 marks | Grade 5

1. Convert all doses to the same unit (Sv or mSv).
2. Divide or subtract as the question asks.
3. Give the unit, and round sensibly.

Example. A person receives an average dose of 2.4 mSv each year from background radiation. A medical scan gives a dose of 0.0080 Sv.
(a) Convert 0.0080 Sv to mSv. (1 mark)
(b) Calculate how many years of background radiation give the same dose as the scan. (2 marks)

Model answer.

(a) 0.0080 × 1000 = 8.0 mSv (1)
(b) 8.0 ÷ 2.4 (1) = 3.3 years (1)

Don’t lose marks

- Forgetting to subtract the background count rate when finding the count rate from a source.
- Naming mobile phones, microwaves or Wi-Fi as sources of background radiation. They do not give out nuclear radiation.
- Converting the wrong way: 0.008 Sv is 8 mSv, not 8000 mSv.
- Saying most background radiation is man-made. Most is natural.

More tips

Memory tricks

- Sources from the ground up: rocks and radon below you, food and drink inside you, cosmic rays above you.
- milli means one thousandth: to change Sv into mSv, multiply by 1000.
- If a question gives a reading 'with no source present', that is the background count: subtract it.

Exam technique

- For 'suggest why' questions on dose, name the source (cosmic rays, radon) and link it to the job or place.
- Read pie charts and tables carefully: natural sources may be split into several parts that you need to add.
- Write the unit with every dose, and check whether the answer should be in Sv or mSv.

What each grade needs

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

Grade 3 — **Define background radiation**
Radiation that is around us all the time, from natural and man-made sources.

Grade 4 — **Name natural sources of background radiation**
Rocks (including radon gas released from rocks) and cosmic rays from space.

Grade 4 — **Name man-made sources of background radiation**
Fallout from nuclear weapons testing and from nuclear accidents.

Grade 5 — **Correct a count rate for background**
Subtract the background count rate from the measured count rate.

Grade 5 — **Convert and compare doses in sieverts**
Use 1 Sv = 1000 mSv to compare doses given as data.

Grade 6 — **Explain how job and location affect dose**
E.g. aircrew receive more cosmic rays; people in granite areas receive more radon.

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