# Uses of nanoparticles

4.2.4.2 · Bonding, structure and the properties of matter · revision notes

Where nanoparticles are used (medicine, electronics, cosmetics and sun creams, deodorants and catalysts), and the benefits and possible risks of using them. You do not need to learn specific examples: questions give you information and ask you to evaluate a use, usually for 1 to 2 marks. GCSE Chemistry only, not in Combined Science.

## Key facts

- Uses: medicine, electronics, cosmetics and sun creams, deodorants, catalysts
- Sun creams: better UV protection and better skin coverage
- Long-term effects are not yet fully understood
- Advantage: high surface area to volume ratio → more effective → smaller quantities needed
- Risks: may get into the body and cells, possible cell damage, possible harm to the environment
- Evaluate = benefits + risks + a justified judgement

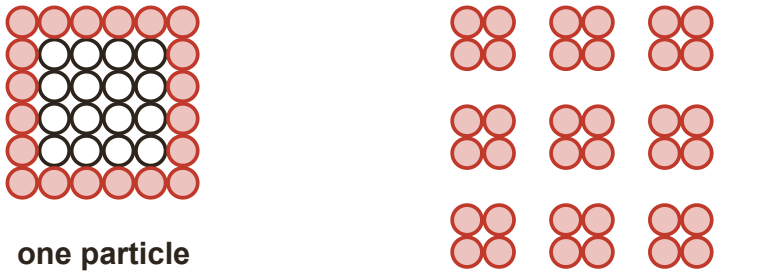
## Notes

### Where nanoparticles are used

- **Medicine**: for example, carrying drugs to particular places in the body, or killing bacteria.
- **Electronics**: very small components and conducting materials.
- **Cosmetics and sun creams**: nanoparticles in sun creams give better protection from harmful ultraviolet (UV) light and better skin coverage, and they do not leave white marks on the skin.
- **Deodorants**: for example, nanoparticles that kill the bacteria that cause body odour.
- **Catalysts**: the high surface area to volume ratio means more of the catalyst's atoms are at the surface, so less catalyst is needed.
- New uses of nanoparticles are an important area of research.

## Advantages

- Their very high surface area to volume ratio makes them very effective, so **smaller quantities** are needed.




Surface atoms are red. Smaller particles expose more atoms, so less catalyst is needed.

- A coating made of nanoparticles can be **thinner** than one of fine particles, so less material is used and, on a lens or window, more light gets through.
- They can have useful **properties that the bulk material does not have**.
- They are small enough to reach places that larger particles cannot, e.g. inside cells.

## Possible risks

- Nanoparticles are so small that they may be **breathed in** or **absorbed through the skin**, and could get into cells or the bloodstream.
- Their different properties mean they might **damage cells** or be toxic, even if the bulk material is harmless.
- They may be washed into the **environment** (e.g. from sun cream) and harm living things there.
- Because nanoparticles are quite new, their **long-term effects** on health and the environment are **not yet fully understood**.

## How to evaluate a use

- Give the benefits, using the information in the question.
- Give the risks or disadvantages.
- Make a **judgement** with a reason, e.g. 'the benefits outweigh the risks because…, but more research into safety is needed'.

## How to answer each type of question

### Give uses of nanoparticles

1 to 2 marks | Grade 4

1. Choose from the five areas: medicine, electronics, cosmetics and sun creams, deodorants, catalysts.
2. Give exactly the number asked for.

**Example.** Give two uses of nanoparticles.

**Model answer.** Any two from: medicine / drug delivery (1); electronics (1); cosmetics or sun creams (1); deodorants (1); catalysts (1). [max 2]

### Explain a possible risk of using nanoparticles

2 marks | Grade 5

1. Say how the nanoparticles might get into the body or the environment (they are tiny).
2. Say what harm they might do, e.g. damage cells.
3. You can add that the long-term effects are not yet known.

**Example.** Some sun creams contain nanoparticles of titanium dioxide.
Suggest one possible risk of using these sun creams.

**Model answer.** The nanoparticles may be absorbed through the skin into the body (1) and may damage cells / have effects that are not yet known (1).

### Explain why nanoparticles are used for a purpose

2 marks | Grade 5

1. Link the use to the high surface area to volume ratio.
2. Say what that means for this use: more atoms at the surface, more effective, less material needed.

**Example.** The catalyst in a car's catalytic converter contains nanoparticles of platinum.
Explain why using nanoparticles reduces the mass of platinum needed.

**Model answer.** Nanoparticles have a very high surface area to volume ratio (1). So a larger proportion of the platinum atoms are at the surface, where the reactions happen, and less platinum is needed for the same effect (1).

**Evaluate the use of nanoparticles**

4 to 6 marks | **Grade 8**

1. Pick out the benefits from the information given, quoting any data.
2. Give the risks or disadvantages.
3. Make a judgement and give a reason for it.

**Example.** A company makes two sun creams. Both contain zinc oxide particles.

| | Cream A | Cream B |
|---|---|---|
| Size of zinc oxide particles | 200 nm | 30 nm (nanoparticles) |
| UV light blocked | 90% | 98% |
| Appearance on the skin | leaves a white layer | cannot be seen |

The long-term effects of zinc oxide nanoparticles on the body are not fully known.
Evaluate the use of cream B instead of cream A. [4 marks]

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**Model answer.**

Cream B blocks more UV light (98% compared with 90%), so it gives better protection against sunburn and skin damage (1).

Cream B cannot be seen on the skin, so people may be more willing to use it (1).

But the nanoparticles may be absorbed through the skin and could damage cells, and their long-term effects are not known (1).

A judgement with a reason, e.g. cream B is the better choice because its extra UV protection is a clear benefit, but more research into its safety is needed (1).

## Don’t lose marks

- Giving only advantages, or only risks, in an 'evaluate' question.
- Writing a conclusion with no reason. Say why the benefits do or do not outweigh the risks.
- Saying nanoparticles are definitely dangerous or poisonous. The risks are possible and not yet fully understood.
- Ignoring the data in the question. Quote the figures you are given.

## More tips

### Memory tricks

- Five uses, 'My Electric Sun Deodorant Catalyses': Medicine, Electronics, Sun creams (and cosmetics), Deodorants, Catalysts.
- Evaluate = for, against, verdict. No verdict, no top marks.
- Every advantage comes back to the high surface area to volume ratio; every risk comes back to 'small enough to get into the body, and long-term effects unknown'.

### Exam technique

- In 'evaluate' questions, use the information in the question: it is there to be used.
- Explain each point: 'blocks more UV, so less risk of sunburn' scores more than 'it is better'.
- Finish with a judgement that follows from the points you have made.

## What each grade needs

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

**Grade 4**

**List the main uses of nanoparticles**

Medicine, electronics, cosmetics and sun creams, deodorants, and catalysts.

**Grade 5**

**Give advantages of using nanoparticles**

Their high surface area to volume ratio makes them effective, so smaller quantities are needed.

**Grade 5**

**Explain possible risks of nanoparticles**

They may get into the body or into cells and cause harm, and their long-term effects are not yet known.

**Grade 5**

**Use data to compare nanoparticles with normal particles**

For example, compare the protection, the coverage or the amount of material needed.

**Grade 8**

**Evaluate a use of nanoparticles with a judgement**

Weigh benefits against risks using the information given, and reach a justified conclusion.

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