

# FACTFILE: GCSE CHEMISTRY: UNIT 1.4



## Nanoparticles

### Learning outcomes

Students should be able to:

- 1.4.1 demonstrate knowledge and understanding that nanoparticles are structures that are 1-100 nm in size and contain a few hundred atoms;
- 1.4.2 demonstrate knowledge and understanding of surface area to volume relationships and that as the side of a cube decreases by a factor of 10 the surface area to volume increases by a factor of 10;
- 1.4.3 demonstrate knowledge and understanding that nanoparticles have properties different from those for the same material in bulk due to their high surface area to volume ratio;
- 1.4.4 evaluate the benefits of nanoparticles in sun creams including better skin coverage and more effective protection from the sun's ultraviolet rays, and the risks such as potential cell damage in the body and harmful effects on the environment.

### What is a nanoparticle?

**A nanoparticle is a structure that is 1-100 nm in size and contains a few hundred atoms.**

One nanometer is 0.000 000 001 m ( $1 \times 10^{-9}$  m)

**Bulk** materials include lumps and powdered materials and consist of huge numbers of atoms. Nanoparticles consist of only a few hundred atoms.

**Nanoparticles have very different properties and uses to the bulk material. This is due to their high surface area to volume ratio.**

A small particle has a larger surface area than a large particle. This can be explored by looking at two different sized cubes as shown in the table below.

Cube	Larger cube with dimensions 100 cm × 100 cm × 100 cm	Smaller cube with dimensions 10 cm × 10 cm × 10 cm
Surface area	Surface area of 1 side = 100 × 100 = 10000 cm <sup>2</sup> Surface area of 6 sides = 6 × 10000 = 60000 cm <sup>2</sup>	Surface area of 1 side = 10 × 10 = 100 cm <sup>2</sup> Surface area of 6 sides = 6 × 100 = 600 cm <sup>2</sup>
Volume	Volume = l × b × h = 100 × 100 × 100 = 1000 000 cm <sup>3</sup>	Volume = l × b × h = 10 × 10 × 10 = 1000 cm <sup>3</sup>
Surface area: volume ratio	60000 : 1000000 6 : 100 0.06 : 1	600 : 1000 6 : 10 0.6 : 1

By looking at the surface area to volume ratio, you can see that *when the sides of the cube decrease by a factor of 10 the surface area to volume ratio increases by a factor of ten.*

Nanoparticles show different properties from the same material due to their high surface area to volume ratio.

### Use of nanoparticles in sun creams

Sun creams protect against sunburn by absorbing some of the sun's ultraviolet. Many contain zinc oxide to absorb the uv radiation but it is difficult to rub in. Nanoparticles of zinc oxide are now often used in sun creams and have several benefits:

- they give better skin coverage to the sun cream;
- they give more effective protection from the sun's ultraviolet rays;
- they are clear and colourless which makes the sun cream invisible on the skin;
- they do not degrade on exposure to the sun.

Nanoparticles also have the following risks:

- potential cell damage in the body – the nanoparticles are so small they may be able to penetrate cell membranes, or be breathed in. In the body they may be more reactive or more toxic than the bulk material;
- harmful effects on the environment.

## Questions

1. What are nanoparticles?

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\_\_\_\_\_ [1]

2. State two benefits of using nanoparticles in sun creams.

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\_\_\_\_\_ [2]

3. State two risks of using nanoparticles in sun creams.

\_\_\_\_\_  
\_\_\_\_\_ [2]

4. How many atoms are approximately present in a nanoparticle of silver?

\_\_\_\_\_ [1]

5. Explain why nanoparticles of gold have different properties to a lump of gold.

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\_\_\_\_\_ [1]

6. State what happens to the surface area to volume ratio of a cubic shaped nanoparticle if the length of a side is decreased by a factor of ten.

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\_\_\_\_\_ [1]

