Exercise walk-through

2.4

Bulk and surface properties incl. nanoparticles – chemistry only (4.2.4)

AQA · GCSE · Chemistry

Carbon: one element, four structures

- **Diamond** is a **giant covalent structure** in which every carbon atom is bonded to four others. It is very hard, has a very high melting point and does not conduct electricity, because all its outer electrons are in bonds.
- **Graphite** is made of layers of hexagonal rings. Each carbon is bonded to three others, so one electron per atom is delocalised. There are no covalent bonds between the layers, only weak forces, so the layers slide: **graphite** is soft and slippery and is used in pencils and as a lubricant. The delocalised electrons let it conduct electricity.

Nanoparticles (chemistry only)

- Nanoscience studies structures from 1 to 100 nanometres (nm) across; 1 nm is 10^{-9} m.
- A **nanoparticle** contains only a few hundred atoms.
- A typical atom is about 0.2 nm across, so a 20 nm particle is about 100 atoms wide.
- Nanoparticles are smaller than fine particles (PM2.5, 100 to 2,500 nm), which are smaller than coarse particles, or dust (PM10, 2,500 to 10,000 nm, that is 2.5×10^{-6} to 1×10^{-5} m).

Sources for this lesson

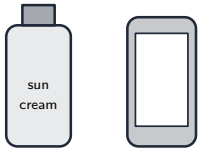
- AQA, *GCSE Chemistry (8462) specification*, section 4.2.
- K. S. Novoselov, A. K. Geim and others, "Electric field effect in atomically thin carbon films", *Science* (22 October 2004).
- The Nobel Prize in Physics 2010, press release (5 October 2010).
- H. W. Kroto and others, "C_{60}: Buckminsterfullerene", *Nature* (14 November 1985).

Exercises 2.1·2.2

2.1 Classify each particle as a nanoparticle, a fine particle or a coarse particle: 50 nm; 1 μm; 5 μm. [2]

50 nm | 1 μm | 5 μm

2.2 Give **two** uses of nanoparticles. [2]



Exercises 2.1·2.2

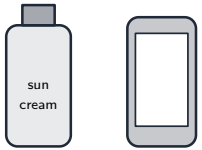
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50 nm | 1 μm | 5 μm

2.1

- 50 nm: nanoparticle; 1 μm: fine; 5 μm: coarse: all three; two correct

2.2 Give **two** uses of nanoparticles. [2]

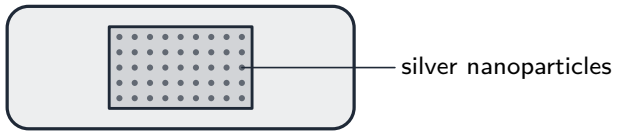


2.2

- any two: sun creams; cosmetics; deodorants; medicine (carrying drugs); electronics; catalysts; antibacterial coatings

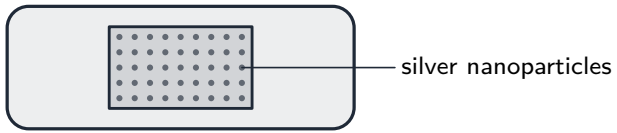
Exercise 3.1

3.1 Silver nanoparticles are used on wound dressings to kill bacteria. Explain why less silver is needed as nanoparticles than as larger pieces. [3]



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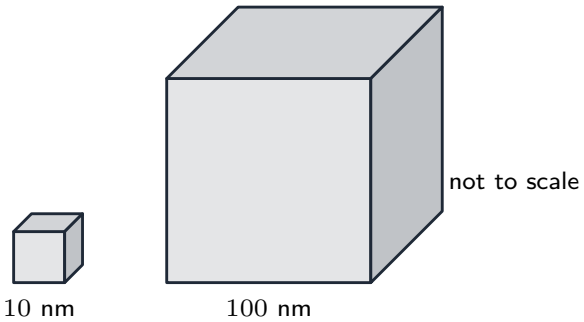
3.1

- nanoparticles have a much higher surface area to volume ratio
- so more of the silver atoms are on the surface, where they act on the bacteria
- so a smaller mass of silver has the same effect

Exercise 3.2 (a)

3.2 Titanium dioxide particles are used in sun creams. The diagram shows two cubes of different sizes.

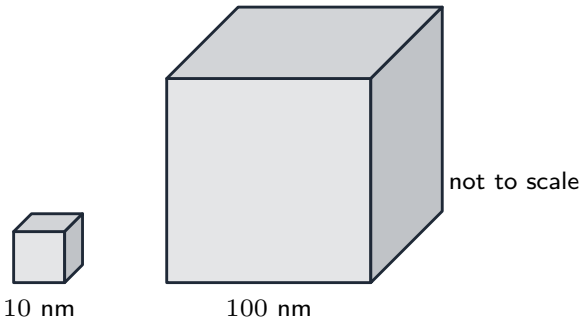
(a) Calculate the surface area to volume ratio of a cube with sides of 10 nm. [2]



Exercise 3.2 (a)

3.2 Titanium dioxide particles are used in sun creams. The diagram shows two cubes of different sizes.

(a) Calculate the surface area to volume ratio of a cube with sides of 10 nm. [2]



(a) area $= 6 \times 10^2 = 600$ nm^2; volume $= 10^3 = 1000$ nm^3; ratio $=$ **0.6** (per nm), or 3 : 5

Exercise 3.2 (b)

3.2 Titanium dioxide particles are used in sun creams. The diagram shows two cubes of different sizes.

(b) Calculate the ratio for a cube with sides of 100 nm. Describe how the ratio changes when the side gets 10 times smaller. [3]

Exercise 3.2 (b)

3.2 Titanium dioxide particles are used in sun creams. The diagram shows two cubes of different sizes.

(b) Calculate the ratio for a cube with sides of 100 nm. Describe how the ratio changes when the side gets 10 times smaller. [3]

(b) area = 60 000 nm^2; volume = 1 000 000 nm^3; ratio = **0.06**; when the side is 10 times smaller the ratio is 10 times bigger

Exercise 3.2 (c)

3.2 Titanium dioxide particles are used in sun creams. The diagram shows two cubes of different sizes.

(c) Evaluate the use of nanoparticles in sun creams. [6]

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(c) Evaluate the use of nanoparticles in sun creams. [6]

(c) points to include:

- benefit: nanoparticles block UV light well, which protects the skin from sunburn and skin cancer
- benefit: they do not leave white marks on the skin
- benefit: less material is needed because of the high surface area to volume ratio
- risk: they might pass through the skin into cells and harm the body
- risk: long-term effects are not known; they may wash into rivers and harm living things
- a conclusion, e.g. useful, but more research is needed

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.