

Exercise walk-through

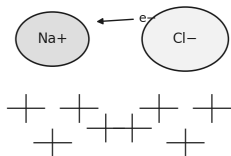
2.4

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

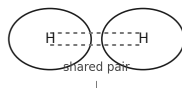
AQA · GCSE · Chemistry

Ionic bonding

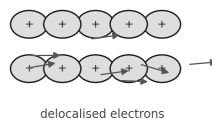
ionic — electrons transferred,
oppositely charged ions attract



covalent — shared
pairs of electrons



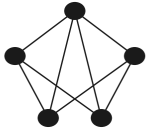
metallic — lattice of ions in a
sea of delocalised electrons



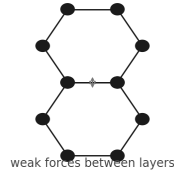
- Metal atoms lose electrons; non-metals gain them.
- Ion charges read straight off the group number.
- Opposite ions attract in a giant lattice.

Carbon's four forms

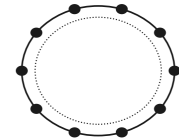
diamond — 4 bonds per atom,
very hard, no conduction



graphite — 3 bonds per atom, layers,
one delocalised electron



fullerene / nanotube



fullerene C60 — hollow sphere;
nanotubes are cylinders

- Diamond — four bonds per atom; hard, high-melting, non-conducting.
- Graphite — three bonds, layers, one delocalised electron.
- Graphene one layer; fullerenes hollow; nanotubes cylinders.

Nanoparticles

1 nm cube
SA:V = 6 : 1



side $\times 0.1 \rightarrow$ SA:V $\times 10$

0.1 nm side
SA:V = 60 : 1



side $\times 0.1 \rightarrow$ SA:V $\times 10$

0.01 nm side
SA:V = 600 : 1



side $\times 0.1 \rightarrow$ SA:V $\times 10$

- Chemistry only — 1 to 100 nm; fine particles to 2500 nm; coarse to 10 micrometres.
- Side shrinks ten times — surface-to-volume ratio grows ten times.
- Uses — catalysts, medicine, cosmetics; concerns — unknown long-term effects.

Exercises 2.1·2.3

2.1 Give the diameter range of nanoparticles in nanometres. [1]

2.2 Which is larger: a fine particle or a coarse particle? [1]

2.3 A cube's side drops from 5 nm to 0.5 nm. What happens to the SA:V ratio? [1]

Exercises 2.1·2.3

2.1 Give the diameter range of nanoparticles in nanometres. [1]

2.1 1–100 nm.

2.2 Which is larger: a fine particle or a coarse particle? [1]

2.2 A coarse particle.

2.3 A cube's side drops from 5 nm to 0.5 nm. What happens to the SA:V ratio? [1]

2.3 Increases $10\times$.

Exercises 3.1·3.3

3.1 (*HT*) Calculate the surface area : volume ratio of a cubic nanoparticle of side 10 nm. [2]

3.2 Explain why a nanoparticle catalyst can work in smaller quantities than the same material in bulk. [4]

3.3 Sun creams use nanoparticles. Give one benefit and one concern of this use. [2]

Exercises 3.1·3.3

3.1 (*HT*) Calculate the surface area : volume ratio of a cubic nanoparticle of side 10 nm. [2]

3.1 $SA = 6 \times 10^2 = 600 \text{ nm}^2$; $V = 10^3 = 1000 \text{ nm}^3$, so $SA:V = 600:1000 = 0.6:1$ (or 3:5).

3.2 Explain why a nanoparticle catalyst can work in smaller quantities than the same material in bulk. [4]

3.2 Nanoparticles have a much higher surface-area-to-volume ratio than bulk material; a greater proportion of their atoms is on the surface; so more of the catalyst's surface contacts the reactants per unit mass; the reaction rate per gram is higher, so less catalyst is needed.

3.3 Sun creams use nanoparticles. Give one benefit and one concern of this use. [2]

3.3 Benefit – the cream is transparent/not white while still blocking UV, and needs less material. Concern – the effects of nanoparticles absorbed through the skin on human health, and their environmental fate, are not fully known.