

Exercise walk-through

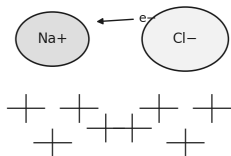
2.3

Structure and bonding of carbon (4.2.3.1–4.2.3.3)

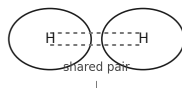
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Ionic bonding

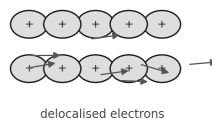
ionic — electrons transferred,
oppositely charged ions attract



covalent — shared
pairs of electrons



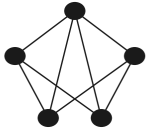
metallic — lattice of ions in a
sea of delocalised electrons



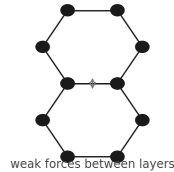
- Metal atoms lose electrons; non-metals gain them.
- Ion charges read straight off the group number.
- Opposite ions attract in a giant lattice.

Carbon's four forms

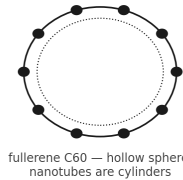
diamond — 4 bonds per atom,
very hard, no conduction



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



fullerene / nanotube



- 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 How many covalent bonds does each carbon atom form in diamond? [1]

2.2 Why can graphite be used as a lubricant? [2]

2.3 What is graphene? [1]

Exercises 2.1·2.3

2.1 How many covalent bonds does each carbon atom form in diamond? [1]

2.1 Four.

2.2 Why can graphite be used as a lubricant? [2]

2.2 The layers of hexagonal rings have no covalent bonds between them; so the layers slide easily over one another.

2.3 What is graphene? [1]

2.3 A single layer of graphite, one atom thick.

Exercises 3.1·3.3

3.1 Explain why diamond is hard and does not conduct electricity. [4]

3.2 Graphite conducts electricity but diamond does not. Explain the difference. [4]

3.3 Describe the structure of a carbon nanotube and give two uses of fullerenes. [4]

Exercises 3.1-3.3

3.1 Explain why diamond is hard and does not conduct electricity. [4]

3.1 In diamond every carbon atom is joined to four others by strong covalent bonds in a rigid giant covalent network; a lot of energy is needed to break the many strong bonds, making diamond very hard; there are no free/delocalised electrons to carry charge.

3.2 Graphite conducts electricity but diamond does not. Explain the difference. [4]

3.2 In graphite each carbon forms only three bonds, leaving one electron per atom delocalised; these free electrons move through the structure and carry charge. In diamond all four outer electrons form covalent bonds; none is free, so there is no charge carrier and no conduction.

3.3 Describe the structure of a carbon nanotube and give two uses of fullerenes. [4]

3.3 A carbon nanotube is a cylindrical fullerene, with a very high length-to-diameter ratio. Uses of fullerenes – any two: carriers for targeted drug delivery in medicine; catalysts; lubricants; strengthening composite materials; electronics/semiconductors.