

Chemical bonds, ionic, covalent and metallic – GCSE Chemistry

1. No.3

0 3

This question is about carbon.

0 3

1

Which type of substance is carbon?

[1 mark]

Tick (✓) **one** box.

Compound

☐

Element

☒

Mixture

☐

A compound is a substance formed when two elements are chemically bonded together.

An element is a pure substance that consists of only one type of atom.

Mixture is a combination of two or more substances that are not chemically bonded.

0 3

2

Carbon has isotopes with mass numbers 12, 13 and 14.

Complete the sentences.

Choose answers from the box.

[2 marks]

electrons	ions	molecules	neutrons	protons
-----------	------	-----------	----------	---------

The isotopes of carbon have the same number of Protons.

The isotopes of carbon have a different number of Neutrons.

Isotopes are atoms of the same element that have the same number of protons but different number of neutrons.

0 3 . 3 12 g of carbon contains 6.02×10^{23} atoms.

Which expression is used to calculate the mass of one atom of carbon?

[1 mark]

Tick (✓) **one** box.

$$\frac{12}{6.02 \times 10^{23}}$$

☒

$$\frac{6.02 \times 10^{23}}{12}$$

☐

$$12 \times 6.02 \times 10^{23}$$

☐

Mass of carbon = $\frac{\text{Total mass}}{\text{Number of atoms}}$

$\frac{12\text{g}}{6.02 \times 10^{23} \text{ atoms}}$

0 3 . 4 **Figure 2** shows diagrams that represent different forms of carbon.

Figure 2



A



B



C

Which diagram in **Figure 2** represents Buckminsterfullerene?

[1 mark]

Tick (✓) **one** box.

A ☐

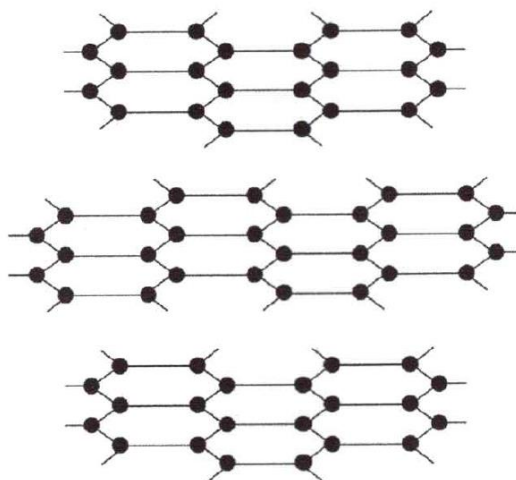
B ☒

C ☐

Buckminsterfullerene is a spherical molecule.

0 3 . 5 Figure 3 represents part of the structure of graphite.

Figure 3



Draw **one** line from each property of graphite to the structural feature that is the reason for that property.

[2 marks]

Property

Structural feature

Graphite conducts electricity.

Graphite has hexagonal rings of carbon atoms.

The bonds between carbon atoms in the layers are strong.

Graphite is soft.

There are no covalent bonds between layers of atoms.

There are delocalised electrons in graphite.

2. No.5

0 5

This question is about small particles.

0 5 . 1

Which type of particle is often referred to as dust?

[1 mark]

Tick (✓) **one** box.

Coarse particle

☒

Fine particle

☐

Nanoparticle

☐

coarse particles are larger than 10 micrometers and can be seen with naked eye.
 fine particles range from 2.5 to 10 micrometers.
 Nano particles smaller than 100 nanometers.

0 5 . 2

A spherical coarse particle has a diameter of 4000 nm.

A spherical fine particle has a diameter of 200 nm.

How many times larger is the diameter of the coarse particle than the diameter of the fine particle?

[1 mark]

Tick (✓) **one** box.

2 times

☐

5 times

☐

20 times

☒

50 times

☐

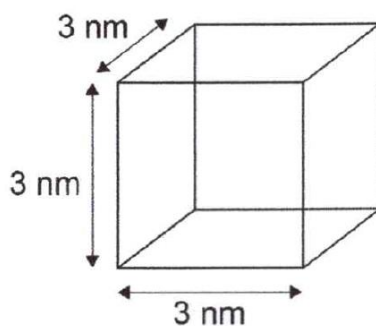
Diameter of coarse particle
 Diameter of fine particle

$$\frac{4000 \text{ nm}}{200 \text{ nm}} = 20$$

0 5 3

Figure 6 represents a cubic nanoparticle.

Figure 6



The volume of the cubic nanoparticle is 27 nm^3 .

Calculate:

- the surface area of the cubic nanoparticle
- the simplest whole number ratio of surface area : volume for the cubic nanoparticle.

Use the equation:

$$\text{surface area of cubic nanoparticle} = 6 \times \text{surface area of one face}$$

[4 marks]

$$\text{Area of one face} = 3 \times 3 = 9 \text{ nm}^2$$

$$\text{Surface area of cube} = 6 \times 9 = 54 \text{ nm}^2$$

$$\text{Surface area of cubic nanoparticle} = \underline{54} \text{ nm}^2$$

$$\text{Simplest whole number ratio: (surface area : volume)}$$

$$54 : 27 = 2 : 1$$

$$\text{Simplest whole number ratio of surface area : volume} = \underline{2} : 1$$

Titanium oxide is used in some sun creams.

0 5 . 4

Which is an advantage of using nanoparticles of titanium oxide rather than normal-sized particles of titanium oxide in sun creams?

[1 mark]

Tick (✓) **one** box.

A smaller mass of nanoparticles is needed to be effective.

☒

Nanoparticles cost more than the same mass of normal-sized particles.

☐

Nanoparticles have a lower surface area to volume ratio than normal-sized particles.

☐

Nanoparticles have a larger surface area to volume ratio, which increases their effectiveness in blocking UV rays with a smaller mass.

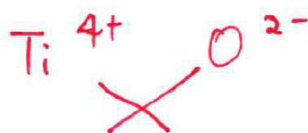
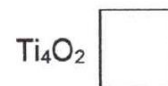
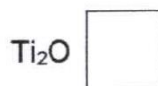
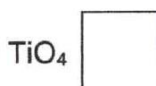
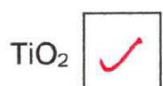
0 5 . 5

Titanium oxide contains Ti^{4+} ions and O^{2-} ions.

What is the formula of titanium oxide?

[1 mark]

Tick (✓) **one** box.



Ti_2O_4 - simplify. (balance charges we need two oxide ions for every titanium ion)
 TiO_2

3. No.10

1 0

This question is about titanium dioxide (TiO_2).

1 0

. 1

Self-cleaning windows are coated with a layer of nanoparticles of titanium dioxide.

Titanium dioxide:

- helps sunlight break down dirt particles
- attracts water, so dirt is washed away by rain.

Nanoparticles of titanium dioxide are used instead of fine particles of titanium dioxide for coating self-cleaning windows.

Suggest **two** reasons why.

[2 marks]

- 1 Have large surface area to volume ratio for better photocatalytic activity.
- 2 Form a thinner and more uniform coating, improving transparency and durability.

1 0 2

Titanium is extracted from titanium dioxide in a two-stage process.

The equation for the first stage in the process is:



Calculate the volume of chlorine gas needed to react completely with 100 kg of titanium dioxide.

Relative atomic masses (A_r): O = 16 Ti = 48

The volume of one mole of gas = 24 dm³

[6 marks]

Molar mass of $\text{TiO}_2 = 80 \text{ g/mol}$
 100 kg = 100000 g
 Number of moles of $\text{TiO}_2 = \frac{100000}{80 \text{ g/mol}} = 1250 \text{ mol}$
 Mole ratio $\text{Cl}_2 : \text{TiO}_2 = 2 : 1$
 2 moles of Cl_2 react with 1 mole of TiO_2
 Number of moles of $\text{Cl}_2 = 1250 \text{ mol TiO}_2 \times \left(\frac{2 \text{ mol Cl}_2}{1 \text{ mol TiO}_2} \right) = 2500 \text{ mol Cl}_2$
 Volume of 1 mol of gas = 24 dm³
 Volume of 2500 mol of $\text{Cl}_2 = 2500 \text{ mol} \times 24 \text{ dm}^3/\text{mol} = 60000 \text{ dm}^3$

Volume = 60000 dm³