Name: _____

Class: _____

Date: _____

Bonding, Structure & Properties part 1 AQA Triple Chemistry

Time: **73 minutes**

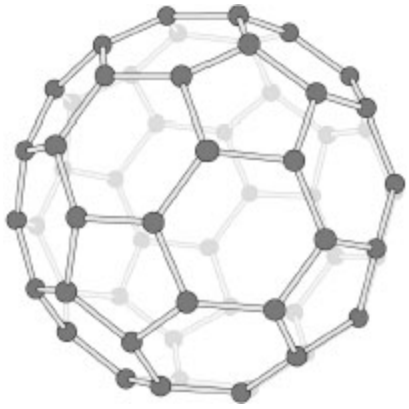
Marks: **69 marks**

Comments:

1. This question is about nanoparticles.

Figure 1 represents a type of nanoparticle made of carbon atoms.

Figure 1



(a) What is the name of the type of nanoparticle in **Figure 1**?

Tick (✓) **one** box.

Buckminsterfullerene ☐

Carbon nanotube ☐

Graphene ☐

(1)

(b) Nanoparticles of the type in **Figure 1** are slippery.

Which structural feature of these nanoparticles makes them slippery?

Tick (✓) **one** box.

The nanoparticles are hollow. ☐

The nanoparticles are made of carbon atoms. ☐

The nanoparticles are spherical. ☐

(1)

(c) A nanoparticle of a metal has a diameter of 15 nm.

A fine particle of the metal has a diameter of 1500 nm.

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

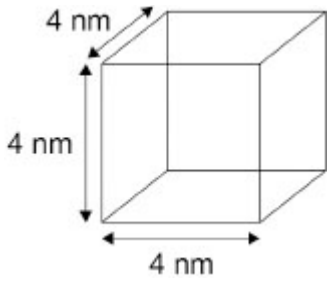
Tick (✓) **one** box.

10 ☐ 10^2 ☐ 10^3 ☐ 10^4 ☐

(1)

(d) **Figure 2** represents a cubic nanoparticle.

Figure 2



The surface area of the cubic nanoparticle is 96 nm^2.

Calculate:

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

The volume of a cube = (length of side)^3

_____

Volume of nanoparticle = _____ nm^3

Ratio of surface area : volume = _____ : _____

_____

_____

Simplest whole number ratio of surface area : volume = _____ : _____

(4)

(e) A substance can be used to provide a scratchproof coating on reading glasses.

The coating is a single layer of particles of the substance.

Nanoparticles are used instead of normal-sized particles.

Complete the sentences.

When using nanoparticles instead of normal-sized particles, the thickness of the layer that can be used is much _____.

This means the amount of light passing through the layer is _____.

(2)

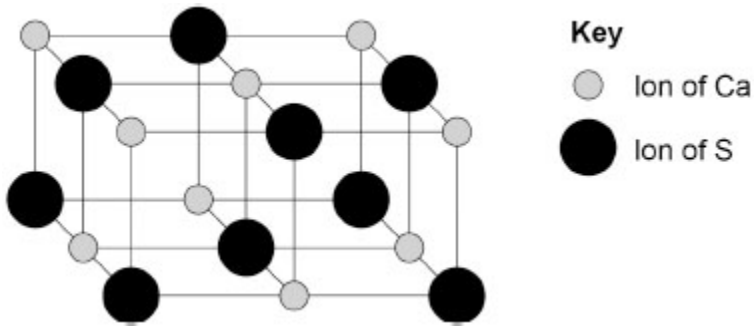
(Total 9 marks)

2. This question is about structure and bonding.

Calcium sulfide is an ionic compound.

Figure 1 represents the structure of calcium sulfide.

Figure 1



(a) Determine the empirical formula of calcium sulfide.

Empirical formula _____

(1)

(b) Calcium is in Group 2 of the periodic table.

Sulfur is in Group 6 of the periodic table.

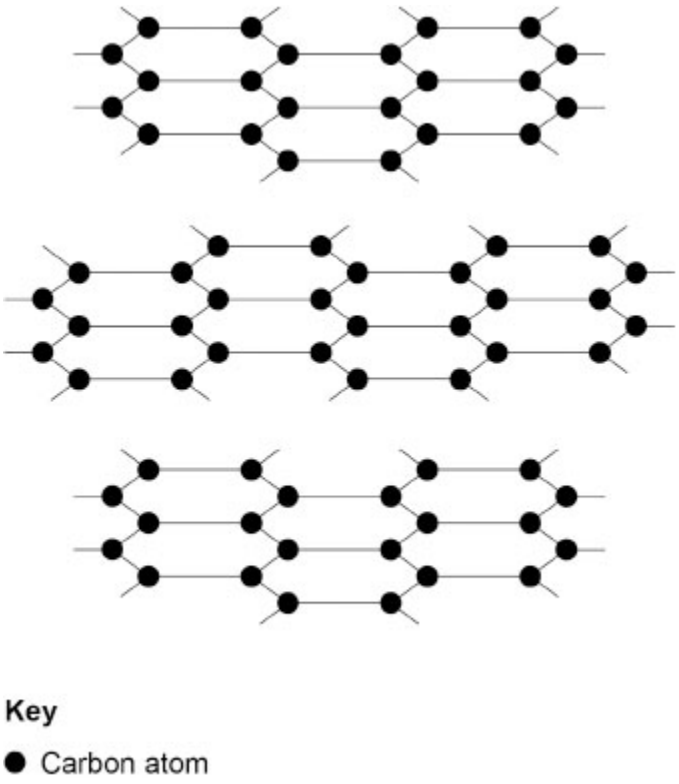
Describe what happens when a calcium atom reacts with a sulfur atom.

Answer in terms of electrons and ions.

(4)

Figure 2 shows the structure of graphite.

Figure 2



(c) Describe the structure and bonding of graphite.

(4)

(d) Substances that consist of small molecules do **not** conduct electricity.

Give **one** reason why.

(1)

(e) Methane consists of small molecules.

Poly(ethene) is a polymer.

Why does poly(ethene) have a higher melting point than methane?

Tick (✓) **one** box.

- Poly(ethene) has more covalent bonds to break than methane. ☐
- Poly(ethene) has no intermolecular forces to overcome. ☐
- Poly(ethene) has stronger covalent bonds to break than methane. ☐
- Poly(ethene) has stronger intermolecular forces to overcome than methane. ☐

(1)

(Total 11 marks)

3. This question is about carbon.

(a) Which type of substance is carbon?

Tick (✓) **one** box.

Compound ☐

Element ☐

Mixture ☐

(1)

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

Complete the sentences.

Choose answers from the box.

electrons	**ions**	**molecules**	**neutrons**	**protons**

The isotopes of carbon have the same number of _____.

The isotopes of carbon have a different number of _____.

(2)

(c) 12 g of carbon contains 6.02×10^{23} atoms.

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

Tick (✓) **one** box.

$\frac{12}{6.02 \times 10^{23}}$ ☐

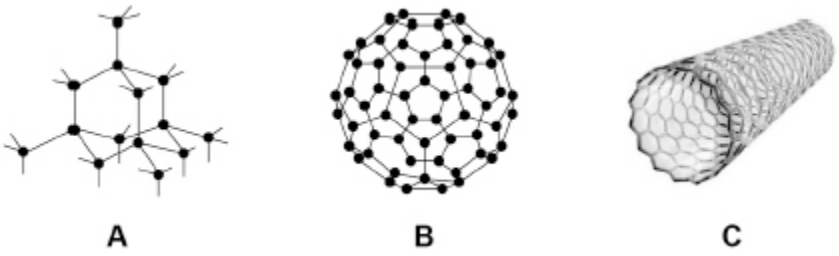
$\frac{6.02 \times 10^{23}}{12}$ ☐

$12 \times 6.02 \times 10^{23}$ ☐

(1)

(d) **Figure 1** shows diagrams that represent different forms of carbon.

Figure 1



Which diagram in **Figure 1** represents Buckminsterfullerene?

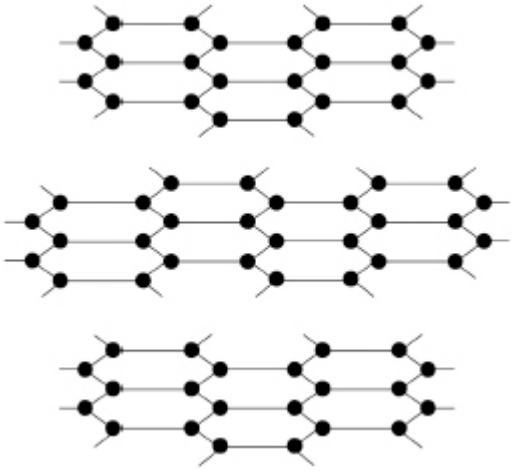
Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐

(1)

(e) **Figure 2** represents part of the structure of graphite.

Figure 2



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

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)

(Total 7 marks)

4. This question is about small particles.

(a) Which type of particle is often referred to as dust?

Tick (✓) **one** box.

- Coarse particle ☐
- Fine particle ☐
- Nanoparticle ☐

(1)

(b) 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?

Tick (✓) **one** box.

2 times ☐

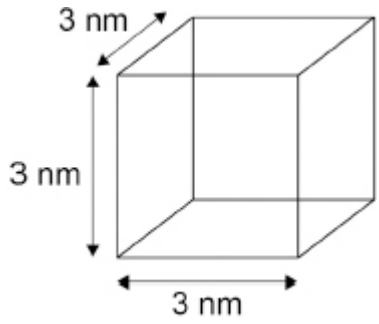
5 times ☐

20 times ☐

50 times ☐

(1)

(c) The figure below represents a cubic nanoparticle.



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:

surface area of cubic nanoparticle = 6 × surface area of one face

_____

_____

Surface area of cubic nanoparticle = _____ nm^2

_____

_____

Simplest whole number ratio of surface area : volume = _____ :1

(4)

Titanium oxide is used in some sun creams.

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

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. ☐

(1)

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

What is the formula of titanium oxide?

Tick (✓) **one** box.

TiO_2 ☐ TiO_4 ☐ Ti_2O ☐ Ti_4O_2 ☐

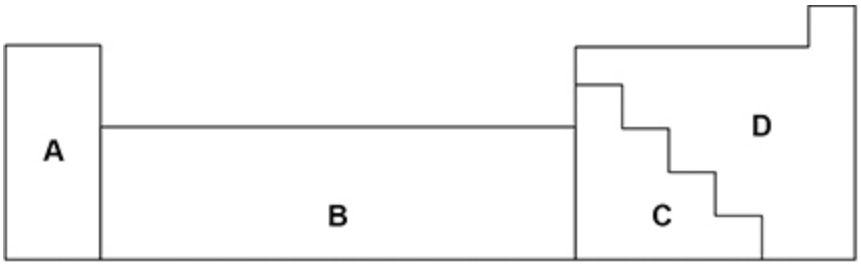
(1)

(Total 8 marks)

5. This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1



(a) Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 1** is most likely to contain element **Q**?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Element **R** forms ions of formula $\mathbf{R^{2+}}$ and $\mathbf{R^{3+}}$

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

1 _____

_____

2 _____

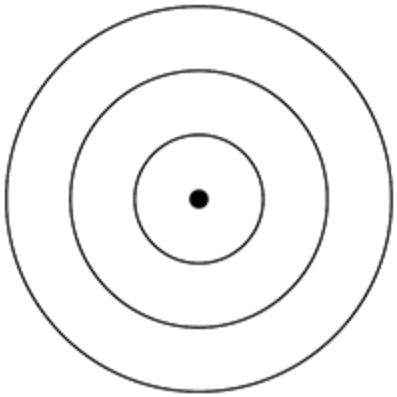
_____

(2)

(d) Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

Figure 2



(1)

(e) Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

_____

_____

_____

_____

_____

_____

(3)

(f) Name the type of bonding in compounds formed between metals and non-metals.

_____

(1)

(g) Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

(4)

(Total 13 marks)

6. This question is about small particles.

(a) Coarse particles, fine particles and nanoparticles are all small particles.

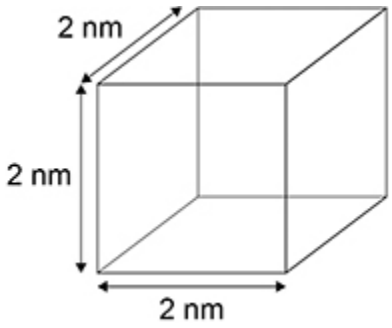
Which is the largest particle?

Tick (✓) **one** box.

- Coarse particle ☐
- Fine particle ☐
- Nanoparticle ☐

(1)

(b) The figure below shows a cubic nanoparticle.



The surface area of the cubic nanoparticle is 24 nm^2.

Calculate:

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

_____

_____

Volume = _____ nm^3

_____

_____

Simplest surface area : volume ratio = _____ : 1

(4)

(c) Catalysts made of nanoparticles are often more effective than catalysts made of normal sized particles.

Complete the sentences.

Compared with normal sized particles, the surface area to volume ratio of nanoparticles is _____.

This means that the mass of a nanoparticle catalyst needed to have the same effect

as the same catalyst made of normal sized particles is _____.

(2)

(d) Silver nanoparticles can be added to the material used to make socks.

Some facts about silver and bacteria are:

- silver nanoparticles are small enough to be breathed in
- silver is very expensive
- silver can kill bacteria
- bacteria can cause infections
- bacteria can break down sweat to produce unpleasant smells.

Suggest **one** advantage and **one** disadvantage of wearing socks containing silver nanoparticles.

Advantage _____

_____

Disadvantage _____

_____

(2)

(e) An atom has a radius of 1×10^{-10} m.

A spherical nanoparticle has a radius of 1×10^{-8} m.

How many times larger is the radius of the nanoparticle than the radius of the atom?

Tick (✓) **one** box.

2 times ☐

10 times ☐

100 times ☐

200 times ☐

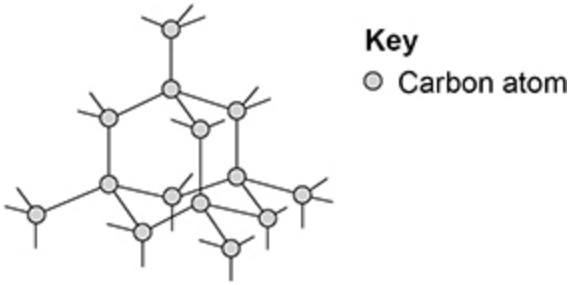
(1)

(Total 10 marks)

7. This question is about different forms of carbon.

Figure 1 represents the structure of diamond.

Figure 1



(a) Describe the structure and bonding of diamond.

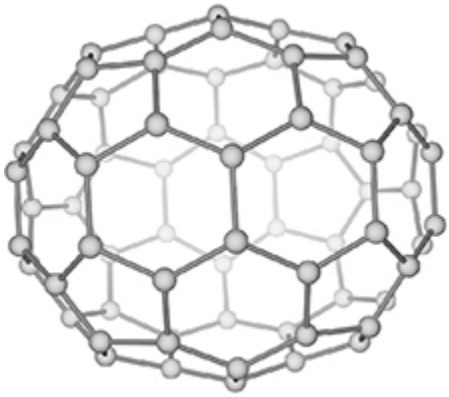
(3)

(b) Explain why diamond has a very high melting point.

(3)

Figure 2 represents the molecule C_{70}

Figure 2



(c) What is the name of this type of molecule?

Tick (✓) **one** box.

Fullerene ☐

Graphene ☐

Nanotube ☐

Polymer ☐

(1)

(d) Molecules such as C_{70} can be used in medicine to move drugs around the body.

Suggest **one** reason why the C_{70} molecule is suitable for this use.

_____

_____

(1)

(e) Calculate the number of C_{70} molecules that can be made from one mole of carbon atoms.

The Avogadro constant = 6.02×10^{23} per mole

Number of molecules = _____

(3)

(Total 11 marks)

1. (a) Buckminsterfullerene

1

(b) the nanoparticles are spherical

1

(c) 10^2

1

(d) volume = 4^3

1

= 64 (nm^3)

1

(surface area : volume ratio =)
96 : 64

allow correct use of an incorrectly determined volume

1

= 3 : 2

allow correct use of an incorrectly determined surface area : volume ratio

1

(e) thinner / smaller / less

1

greater / more

1

[9]

2. (a) CaS

1

(b) calcium (atom) loses electrons

1

sulfur (atom) gains electrons

1

reference to transfer of two electrons

1

calcium forms positive ions **and** sulfur forms negative ions

*allow Ca^{2+} (ions) **and** S^{2-} (ions) are formed*

*allow calcium ions **and** sulfide ions are formed*

1

(c) **Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.

3-4

Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.

1-2

No relevant content

0

Indicative content

- giant structure
- layers
- of hexagonal rings
- each (carbon) atom forms three bonds

- has no covalent bonds between layers
- with delocalised electrons
- one delocalised electron from each carbon atom

- the bonds are covalent
- with shared (pairs of) electrons
- the (covalent) bonds are strong

(d) the molecules do not have an (overall electric) charge

allow there are no ions

allow there are no delocalised electrons

1

(e) poly(ethene) has stronger intermolecular forces to overcome than methane

1

[11]

3. (a) element

1

(b) protons

allow electrons

1

neutrons

1

must be in this order

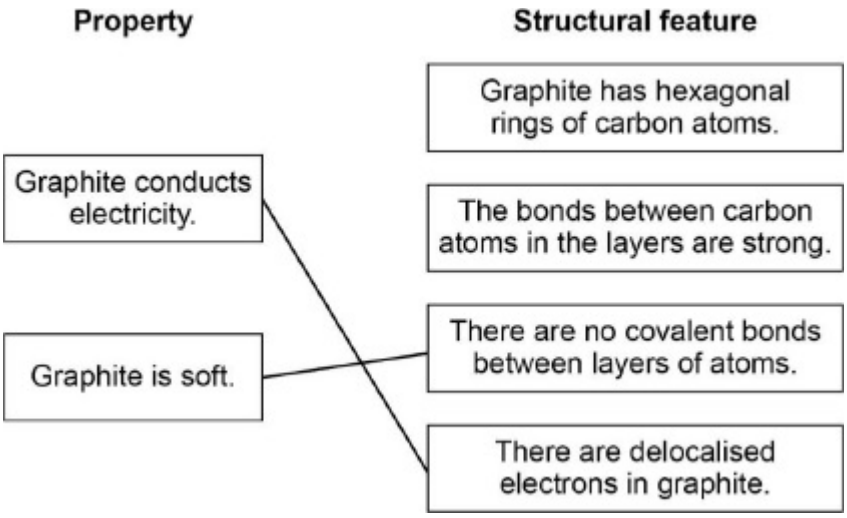
(c) $\frac{12}{6.02 \times 10^{23}}$

1

(d) B

1

(e)



*do **not** accept more than **one** line from a box on the left*

2

[7]

4. (a) coarse particle

1

(b) 20 times

1

(c) (surface area) = 6×3^2

1

= 54 (nm^2)

1

(surface area : volume) = 54 : 27

allow correct ratio from an incorrectly determined surface area

1

(simplest ratio) = 2 : 1

1

(d) a smaller mass of nanoparticles is needed to be effective

1

(e) TiO_2

1

[8]

5. (a) **D**

1

(b) **B**

1

(c) any **two** from:

(Group 1 elements)

- have lower melting / boiling points
- have lower densities
- are less strong
- are softer

allow (Group 1 elements are) more malleable / ductile

allow (Group 1 elements) are not useful as catalysts

ignore transition elements form coloured compounds

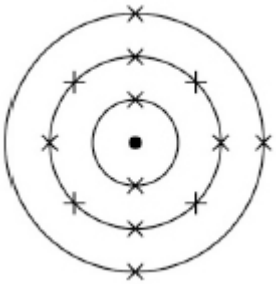
ignore transition elements form ions with different charges

ignore references to chemical properties

2

allow converse statements for transition elements

(d)



allow any combination of x, •, o, e$^{(-)}$ for electrons

1

(e) delocalised electrons

allow free electrons

1

(the electrons) carry (electrical) charge

ignore current / electricity for charge

1

(the electrons move) through the metal / aluminium / structure

ignore throughout for through

1

(f) ionic

1

(g) magnesium (atom) loses electrons

1

oxygen (atom) gains electrons

1

two electrons (are transferred)

1

magnesium ions **and** oxide ions are formed

*allow Mg^{2+} (ions) **and** O^{2-} (ions) are formed*

allow magnesium forms positive ions and oxygen forms negative ions

allow (both) form a complete outer shell

1

[13]

6. (a) coarse particle

1

(b) (volume =) 2^3

allow (volume =) 2×2×2

1

= 8 (nm^3)

1

(surface area : volume) = 24 : 8

allow correct use of an incorrectly calculated volume

1

(simplest ratio) = 3 : 1

1

(c) high(er) / large(r)

1

lower / less / smaller

1

(d) (advantage)
any **one** from:
- stops (unpleasant) smells
- can stop (foot) infections

allow specific (foot) infections

allow silver can kill bacteria

1

(disadvantage)
any **one** from:
- high cost of socks

allow silver is (very) expensive

- could be harmful if breathed in

1

(e) 100 times

1

[10]

7. (a) giant structure

allow macromolecular

allow (giant) lattice

1

covalent (bonds)

1

four bonds per carbon / atom

1

(b) (covalent) bonds are strong

1

(and many covalent) bonds must be broken

1

(so) a lot of energy is required

1

(c) fullerene

1

(d) any **one** from:
- (C_{70} is) hollow

allow (C_{70}) acts as a cage

allow (C_{70}) traps the drug

- (C_{70} is) unreactive
- (C_{70} is) not toxic
- (C_{70} has) a large surface area to volume ratio

ignore references to ease of movement around the body

1

(e) $\left(\text{moles of } C_{70} \text{ molecules} = \frac{1}{70} = \right) 0.0\dot{1}42857\dot{1}$

1

(molecules =) $0.0\dot{1}42857\dot{1} \times 6.02 \times 10^{23}$

allow correct use of an incorrect attempt at the calculation of the number of moles of C_{70} molecules

1

$= 8.6 \times 10^{21}$

1

[11]