Name: _____

Class: _____

Date: _____

Bonding, Structure & Properties part 2 AQA Triple Chemistry

Time: **68 minutes**

Marks: **66 marks**

Comments:

1. This question is about elements, compounds and mixtures.

(a) Substance **A** contains only one type of atom.

Substance **A** does **not** conduct electricity.

Which type of substance is **A**?

Tick (✓) **one** box.

- Compound ☐
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☐

(1)

(b) Substance **B** contains two types of atoms.

The atoms are chemically combined together in fixed proportions.

Which type of substance is **B**?

Tick (✓) **one** box.

- Compound ☐
- Metallic element ☐
- Mixture ☐
- Non-metallic element ☐

(1)

(c) What is the name of the elements in Group 0 of the periodic table?

Tick (✓) **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐
- Transition metals ☐

(1)

(d) Which statement about the elements in Group 0 is correct?

Tick (✓) **one** box.

- All elements in the group are very reactive. ☐
- All elements in the group form negative ions. ☐
- The boiling points increase down the group. ☐
- The relative atomic masses (A_r) decrease down the group. ☐

(1)

(e) Neon is in Group 0.

What type of particles are in a sample of neon?

Tick (✓) **one** box.

Atoms ☐

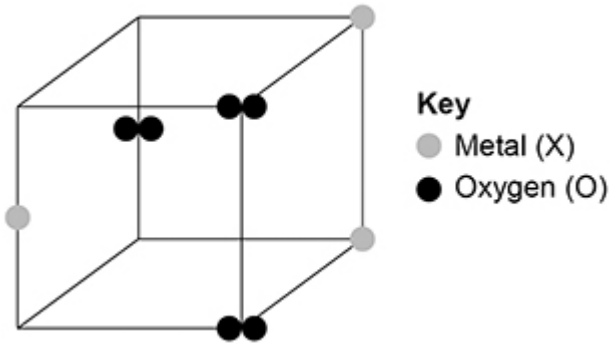
Ions ☐

Molecules ☐

(1)

(f) **Figure 1** represents part of the structure of an oxide of a metal.

Figure 1



Determine the empirical formula of this oxide.

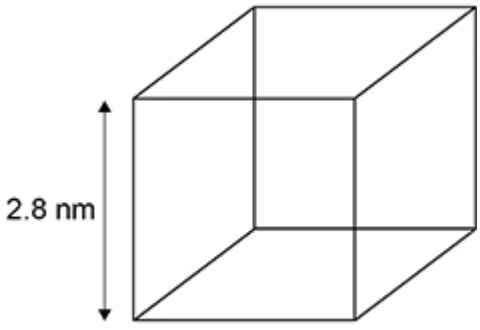
Empirical formula = XO___

(1)

A nanoparticle of a metallic element is a cube.

Figure 2 shows a diagram of the nanoparticle.

Figure 2



(g) The surface area of a cube is given by the equation:

$$\text{surface area} = (\text{length of side})^2 \times 6$$

Calculate the surface area of the cube in **Figure 2**.

Give your answer to 2 significant figures.

Surface area (2 significant figures) = _____ nm^2

(3)

(h) Fine and coarse particles of the metallic element are also cubes.

The length of a fine particle cube is 10 times smaller than the length of a coarse particle cube.

How does the surface area to volume ratio of the fine particle cube compare with that of the coarse particle cube?

Tick (✓) **one** box.

- Both surface area to volume ratios are the same. ☐
- The surface area to volume ratio of the fine particle is 10 times greater. ☐
- The surface area to volume ratio of the fine particle is 10 times smaller. ☐

(1)

(Total 10 marks)

2. This question is about carbon and its compounds.

Fullerenes are molecules of carbon atoms.

The first fullerene to be discovered was Buckminsterfullerene (C_{60}).

(a) What shape is a Buckminsterfullerene molecule?

_____

(1)

(b) Give **one** use of a fullerene.

_____

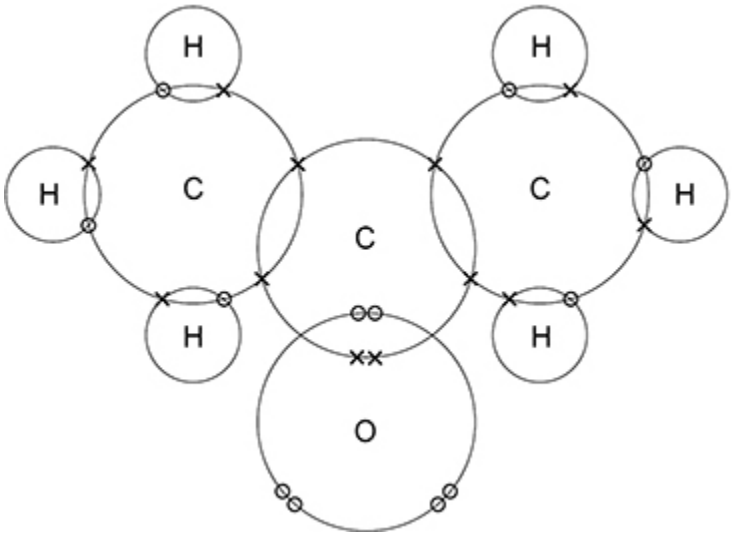
_____

(1)

Propanone is a compound of carbon, hydrogen and oxygen.

Figure 1 shows the dot and cross for a propanone molecule.

Figure 1

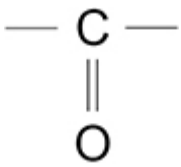


(c) Complete **Figure 2** to show a propanone molecule.

Use a line to represent each single bond.

Use **Figure 1**.

Figure 2



(1)

(d) Determine the molecular formula of propanone.

Use **Figure 1**.

Molecular formula = _____

(1)

(e) Propanone is a liquid with a low boiling point.

Why does propanone have a low boiling point?

Tick (✓) **one** box.

The covalent bonds are strong. ☐

The covalent bonds are weak. ☐

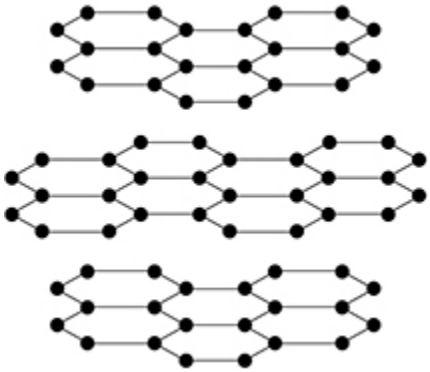
The intermolecular forces are strong. ☐

The intermolecular forces are weak. ☐

(1)

(f) **Figure 3** represents the structure of graphite.

Figure 3



Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

(6)

(Total 11 marks)

3. This question is about metals.

(a) The table below shows information about four substances.

Substance	Melting point in °C	Boiling point in °C	Does it conduct electricity in the solid state?	Does it conduct electricity in the liquid state?
A	–117	79	No	No
B	801	1413	No	Yes
C	1535	2750	Yes	Yes
D	1610	2230	No	No

Which substance could be a metal?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Explain why alloys are harder than pure metals.

_____

_____

_____

_____

_____

_____

(3)

(c) A student wants to compare the reactivity of an unknown metal, **Q**, with that of zinc.

Both metals are more reactive than silver.

The student is provided with:

- silver nitrate solution
- metal **Q** powder
- zinc powder
- a thermometer
- normal laboratory equipment.

No other chemicals are available.

Describe a method the student could use to compare the reactivity of metal **Q** with that of zinc.

Your method should give valid results.

(4)

(Total 8 marks)

4. This question is about structure and bonding.

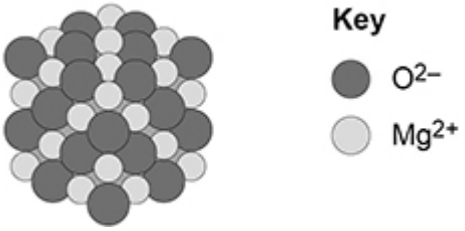
(a) Which **two** substances have intermolecular forces between particles?

Tick (✓) **two** boxes.

Diamond	☐
Magnesium	☐
Poly(ethene)	☐
Sodium chloride	☐
Water	☐

(2)

(b) The table below shows the structures of three compounds.

Compound	**Structure**
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

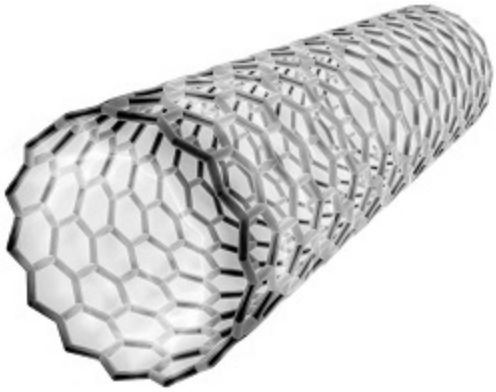
(6)

(Total 8 marks)

5. This question is about materials and their properties.

(a) **Figure 1** shows a carbon nanotube.

Figure 1



The structure and bonding in a carbon nanotube are similar to graphene.

Carbon nanotubes are used in electronics because they conduct electricity.

Explain why carbon nanotubes conduct electricity.

_____

_____

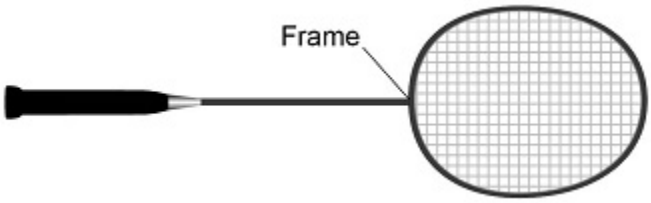
_____

_____

(2)

(b) **Figure 2** shows a badminton racket.

Figure 2



The following table shows some properties of materials.

The materials could be used to make badminton racket frames.

Material	**Density in g/cm^3**	**Relative strength**	**Relative stiffness**
Aluminium	2.7	0.3	69
Carbon nanotube	1.5	60	1000
Wood	0.71	0.1	10

Evaluate the use of the materials to make badminton racket frames.

Use the table above.

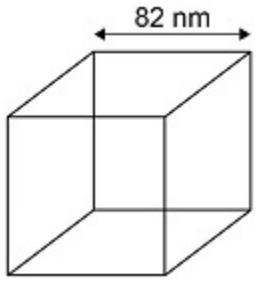
(4)

Zinc oxide can be produced as nanoparticles and as fine particles.

(c) A nanoparticle of zinc oxide is a cube of side 82 nm

Figure 3 represents a nanoparticle of zinc oxide.

Figure 3



Calculate the surface area of a nanoparticle of zinc oxide.

Give your answer in standard form.

_____

_____

_____

_____

Surface area = _____ nm^2

(1)

(d) Some suncreams contain zinc oxide as nanoparticles or as fine particles.

Suggest **one** reason why it costs less to use nanoparticles rather than fine particles in suncreams.

_____

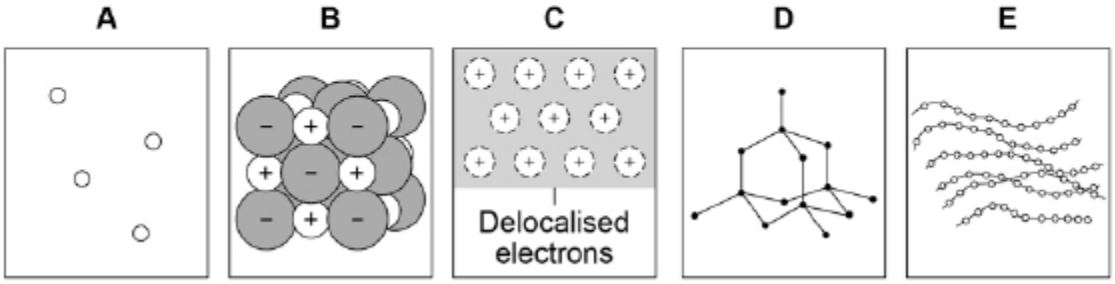
_____

(1)

(Total 10 marks)

6. **Figure 1** shows the structure of five substances.

Figure 1



(a) Which diagram shows a gas?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(b) Which diagram shows the structure of diamond?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(c) Which diagram shows a metallic structure?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(d) Which diagram shows a polymer?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐ **E** ☐

(1)

(e) A chlorine atom has 7 electrons in the outer shell.

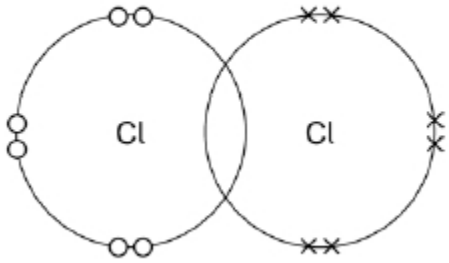
Two chlorine atoms covalently bond to form a chlorine molecule, Cl_2

Figure 2 is a dot and cross diagram showing the outer shells and some electrons in a chlorine molecule.

Complete the dot and cross diagram.

Show only the electrons in the outer shell.

Figure 2



(1)

(f) What is the reason for chlorine's low boiling point?

Tick (✓) **one** box.

Strong covalent bonds ☐

Strong forces between molecules ☐

Weak covalent bonds ☐

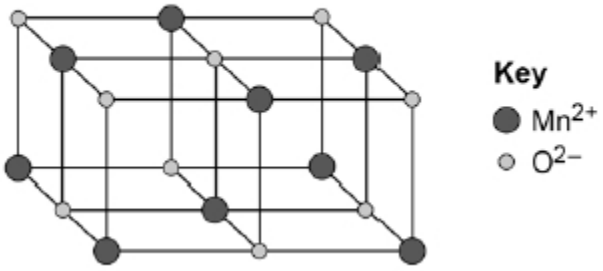
Weak forces between molecules ☐

(1)

Figure 3 represents the structure of manganese oxide.

Manganese oxide is an ionic compound.

Figure 3



(g) Determine the empirical formula of manganese oxide.

Use **Figure 3**.

_____

_____

Empirical formula = _____

(1)

(h) Why does manganese oxide conduct electricity as a liquid?

Tick (✓) **one** box.

Atoms move around in the liquid ☐

Electrons move around in the liquid ☐

Ions move around in the liquid ☐

Molecules move around in the liquid ☐

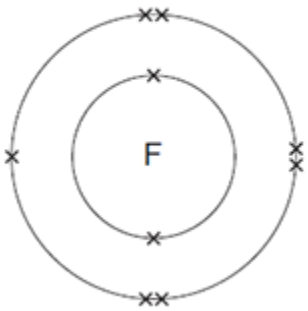
(1)

(Total 8 marks)

7. This question is about fluorine.

(a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

Figure 1



(i) In which group of the periodic table is fluorine?

Group _____

(1)

(ii) Complete the table below to show the particles in an atom and their relative masses.

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

(2)

(iii) Use the correct answer from the box to complete the sentence.

alkalis	**alloys**	**isotopes**

Atoms of fluorine with different numbers of neutrons are

called _____ .

(1)

(b) Sodium reacts with fluorine to produce sodium fluoride.

(i) Complete the word equation for this reaction.

sodium + _____ → _____

(1)

(ii) Complete the sentence.

Substances in which atoms of two or more different elements are chemically combined are called _____ .

(1)

(iii) The relative formula mass (M_r) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

ion	**mole**	**molecule**

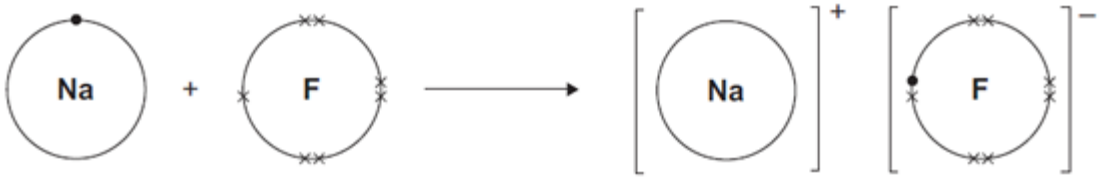
The relative formula mass (M_r), in grams, of sodium fluoride is one _____ of the substance.

(1)

(iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

Tick (✓) **two** boxes.

Dissolve in water ☐

Gas at room temperature ☐

High melting point ☐

Low boiling point ☐

(2)

(Total 13 marks)

1. (a) non-metallic element

1

(b) compound

1

(c) noble gases

1

(d) the boiling points increase down the group

1

(e) atoms

1

(f) XO_2

1

(g) $(2.8)^2 \times 6$

1

= 47.04

1

= 47 (nm^2)

allow an answer correct to 2 significant figures resulting from an incorrect attempt at the calculation

1

(h) the surface area to volume ratio of the fine particle is 10 times greater

1

[10]

2. (a) spherical

allow ball-shaped

ignore round / circular

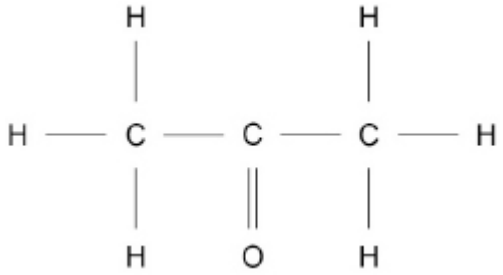
1

(b) any **one** from:

- drug delivery (round the body)
- hydrogen storage
- anti-oxidants
- reduction of bacterial growth
- catalysts
- (cylindrical fullerenes for) strengthening materials
- (spherical fullerenes for) lubricants

1

(c)



1

(d) C_3H_6O

allow CH_3COCH_3

allow elements in any order

1

(e) the intermolecular forces are weak

1

(f) **Level 3**: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- bonds are covalent
- giant / macromolecular structure

- three (covalent) bonds per carbon atom
  or
  only three electrons per carbon atom used in (covalent) bonds
- so one electron per carbon atom (is delocalised)
- these delocalised electrons
- can move through the structure
- carrying (electrical) charge
- so graphite conducts electricity

- layered structure
- of (interlocking) hexagonal rings
- with weak (intermolecular) forces between layers
  or
  no (covalent) bonds between layers
- so the layers can slide over each other
- so graphite is soft and slippery

[11]

3. (a) C

1

(b) (in an alloy) the atoms are of different sizes

1

(so) the layers (of atoms in an alloy) are distorted

1

(so in an alloy) the layers slide over each other less easily (than in a pure metal)

1

(c) measure temperature change

*allow measure the temperature before **and** after the reaction*

1

when each metal is added to silver nitrate solution

1

same concentration / volume of solution
or
same mass / moles of metal

allow same initial temperature (of silver nitrate solution)

1

the greater the temperature change the more reactive

1

[8]

4. (a) poly(ethene)

1

water

1

(b) **Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.

4–6

Level 1: Relevant features are identified and differences noted. 1–3

1–3

No relevant content

0

Indicative content

- (both) carbon dioxide and silicon dioxide are made up of atoms
- (but) magnesium oxide is made up of ions

- (both) silicon dioxide and magnesium oxide are giant structures
- (but) carbon dioxide is small molecules
- with weak intermolecular forces

- all three compounds have strong bonds
- (both) carbon dioxide and silicon dioxide are formed from two non-metals
- (so) bonds formed are covalent
- (so) electron (pairs) are shared (between atoms)
- (but) magnesium oxide is formed from a metal and a non-metal
- (so) bonds in magnesium oxide are ionic
- (so) electrons are transferred
- from magnesium to oxygen
- two electrons are transferred

- bonds in silicon dioxide are single bonds
- (where) each silicon forms four bonds
- (and) each oxygen forms two bonds
- (but) in carbon dioxide the bonds are double bonds
- (where) carbon forms two double bonds
- (and) oxygen forms one double bond

ignore properties e.g. melting point, electrical conductivity

[8]

5. (a) contain delocalised electrons

allow contain free electrons

1

(so) electrons can move through the structure / nanotube

allow (so) electrons can carry charge through the structure / nanotube
ignore throughout for through
ignore current / electricity for charge

1

(b) **Level 2:** Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

- wood is the least dense so lightest to use
- aluminium is the most dense so will make the racket too heavy

- carbon nanotube is the strongest so least likely to break
- wood / aluminium are too weak so the racket will break more easily

- carbon nanotube is the stiffest so least likely to bend out of shape
- wood / aluminium are not very stiff so could bend out of shape

- justified conclusion

(c)

*an answer of 4.0 x 10^4 (nm^2) scores **3** marks*
*an answer of 40344 (nm^2) scores **2** marks*

(822 =) 6724 (nm^2)

1

(6 x 6724 =) 40344 (nm^2)

allow 40344 (nm^2) correctly rounded to any number of significant figures
allow correct calculation using incorrectly calculated value of area of one face from step1

1

= 4.0 x 10^4 (nm^2)

allow 4.0344 x 10^4 (nm^2) correctly rounded to 1 or more significant figures
allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area

1

(d)

allow converse statements about fine particles

any **one** from:

- less can be used (for the same effect)
  ignore nanoparticles are smaller
- greater surface area (to volume ratio)

1

[10]

6. (a) **A**

1

(b) **D**

1

(c) **C**

1

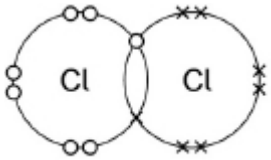
(d) **E**

1

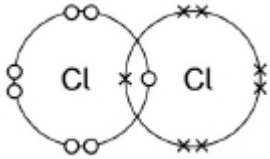
(e) bonding pair of electrons drawn

electrons can be dots, crosses or $e^{(-)}$ in any combination

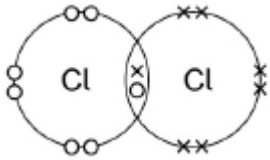
eg



or



or



*do **not** accept if electrons added to outer shells outside overlap*

1

(f) weak forces between molecules

1

(g) MnO

1

(h) ions move around in the liquid

1

[8]

7. (a) (i) 7 / seven

1

(ii) 1

*do **not** accept –1*

1

Electron

1

(iii) isotopes

1

(b) (i) (sodium +) fluorine → sodium fluoride

1

(ii) compounds

1

(iii) mole

1

(iv) sodium (atom) loses

1

fluorine (atom) gains

1

one electron

1

ions formed

1

allow sodium forms positive (ion) ***or*** *fluorine forms negative (ion)*
allow form ionic bond
allow to gain a full outer shell of electrons
allow forms noble gas structure
max 3 *if reference to incorrect particle / bonding*

(v) Dissolve in water

1

High melting point

1

[13]