# Bonding & Structure 2

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

Marks: **65 marks**

Comments:

**1.** Lithium, carbon, nitrogen, fluorine and neon are elements in the same row of the periodic table.

(a) What is the chemical symbol of lithium?

Use the periodic table.

_____

**(1)**

(b) Lithium has metallic bonding.

Which electrons are involved in metallic bonding?

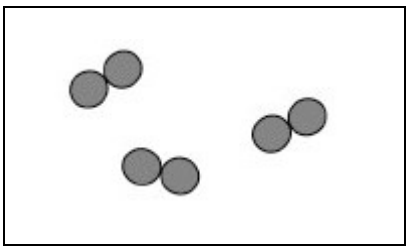
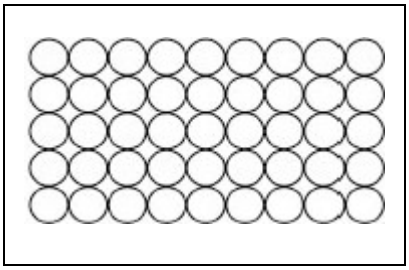
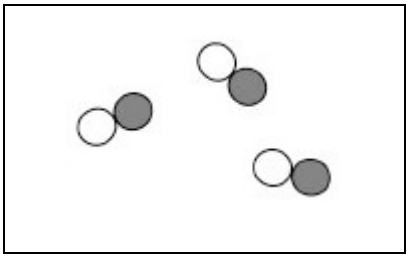
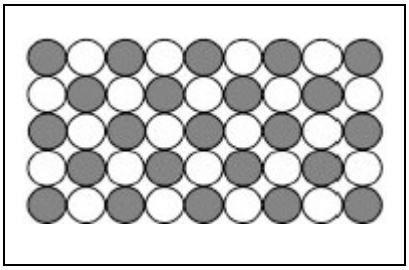
Tick (✓) **one** box.

| | |
|---|---|
| Delocalised electrons from the inner shell | ☐ |
| Delocalised electrons from the outer shell | ☐ |
| Fixed electrons in the inner shell | ☐ |
| Fixed electrons in the outer shell | ☐ |

**(1)**

(c) Lithium reacts with fluorine to produce lithium fluoride.

Draw **one** line from each substance to the particle diagram that represents the substance.

| **Substance** | **Particle diagram** |
| --- | --- |
| Lithium solid |  |
| Fluorine gas |  |
| Lithium fluoride solid |  |
| |  |

**(3)**

(d) The table below shows the electrical conductivity of three substances.

| Substance | Electrical conductivity when solid | Electrical conductivity when liquid |
|---|---|---|
| **C** | Poor | Poor |
| **D** | Poor | Good |
| **E** | Good | Good |

Lithium fluoride is an ionic compound.

Which substance is lithium fluoride?

Tick (✓) **one** box.

**C** ☐ **D** ☐ **E** ☐

**(1)**

(e) Carbon can exist in different forms.

**Figure 1** represents one form of carbon.

**Figure 1**

What is the name of the form of carbon in **Figure 1**?

Tick (✓) **one** box.

Buckminsterfullerene ☐

Diamond ☐

Graphite ☐

**(1)**

(f) Carbon and fluorine form a compound with the formula $CF_4$

Calculate the relative formula mass ($M_r$) of $CF_4$

Relative atomic masses ($A_r$): C = 12 F = 19

_____

_____

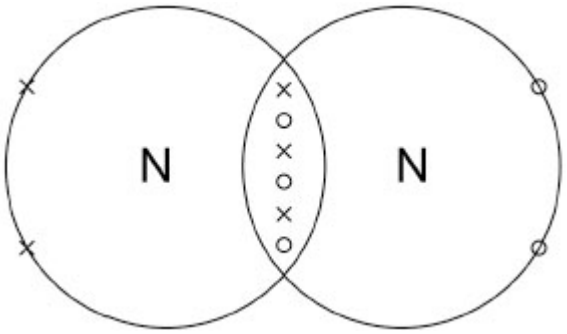
_____

Relative formula mass ($M_r$) = _____

**(2)**

(g) **Figure 2** represents a molecule of nitrogen.

**Figure 2**




What is the total number of shared electrons in the covalent bond shown in **Figure 2**?

_____

**(1)**

(h) Lithium and nitrogen form a compound with the formula $Li_3N$

Complete the sentence.

Choose the answer from the box.

| | | |
|---|---|---|
| **nitrate** | **nitride** | **nitrogen** |

The name of the compound with the formula $Li_3N$ is lithium

_____.

**(1)**

(i) Neon does **not** react with other elements to form compounds.

Why is neon unreactive?

Tick (✓) **one** box.

Neon has a stable arrangement of electrons. ☐

Neon is a gas at room temperature. ☐

Neon is a non-metallic element. ☐

**(1)**

**(Total 12 marks)**

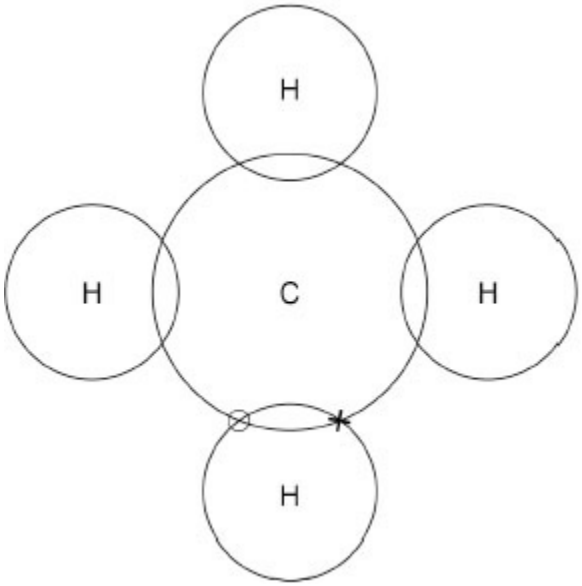
**2.** Carbon is in Group 4 of the periodic table.

(a) Methane contains carbon and hydrogen atoms.

A carbon atom has 4 electrons in the outer shell.

A hydrogen atom has 1 electron in the outer shell.

Complete the dot and cross diagram for a methane molecule.

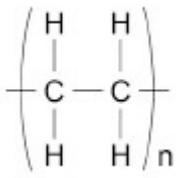



**(2)**

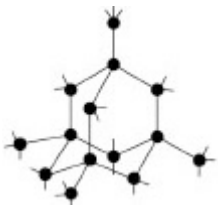
(b) Which diagram represents the structure of diamond?

Tick (✓) **one** box.

☐




☐

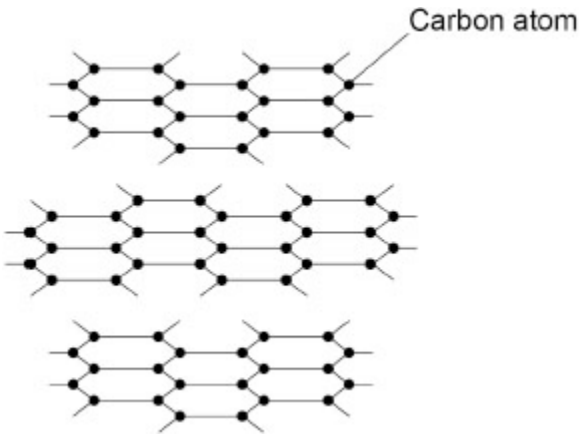


☐

**(1)**

**Figure 1** represents part of the structure of graphite.

**Figure 1**




(c) In graphite each carbon atom forms covalent bonds.

How many covalent bonds does each carbon atom form in graphite?

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

**(1)**

(d) Graphite conducts electricity.

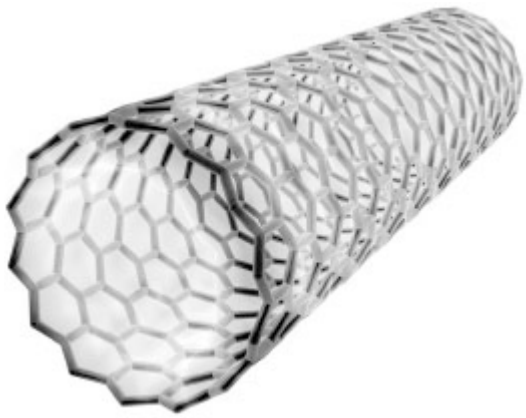
Which particles carry electrical charge through graphite?

_____

**(1)**

**Figure 2** represents the structure of a fullerene.

**Figure 2**



(e) Where are fullerenes used?

Tick (✓) **one** box.

In electronic components ☐

In self-heating cans ☐

In sports injury packs ☐

**(1)**

(f) Describe the structure of the fullerene shown in **Figure 2**.

_____

_____

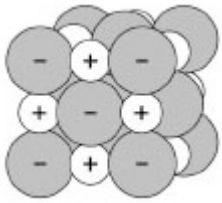
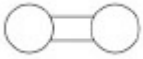
_____

_____

**(2)**

**(Total 8 marks)**

**3.** The table below shows diagrams which represent the structures of two substances.

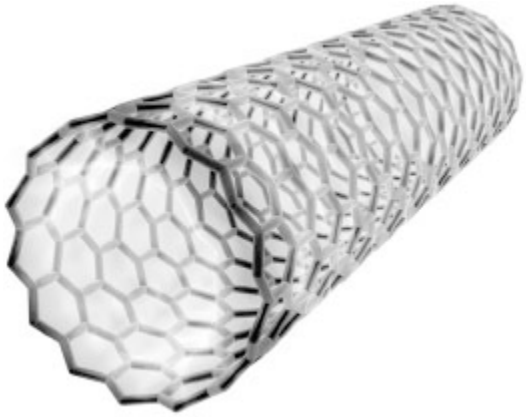
| Substance | Structure |
|---|---|
| Sodium chloride NaCl |  |
| Oxygen $O_2$ |  |

Compare the structure and bonding of sodium chloride and oxygen.

**(Total 6 marks)**

**4.** Carbon nanotubes are cylindrical fullerenes.

The figure below represents the structure of a carbon nanotube.



(a) Describe the arrangement of carbon atoms in the nanotube shown in above figure.

_____

**(1)**

(b) Nanotubes are used in electronics.

Give **one** other use of nanotubes.

_____

_____

**(1)**

(c) A nanotube contains 2380 carbon atoms.

Calculate the number of moles of carbon in this nanotube.

The Avogadro constant is $6.02 \times 10^{23}$ per mole.

_____

_____

_____

Number of moles of carbon = _____ mols

**(2)**

(d) Explain why carbon nanotubes can conduct electricity.

Refer to bonding between carbon atoms in your answer.

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 7 marks)**

**5.** This question is about structure and properties.

(a) Which pair of substances **both** contain atoms in hexagonal rings?

Tick (✓) **one** box.

Diamond and graphite ☐

Fullerenes and graphene ☐

Nanotubes and silica ☐

**(1)**

(b) Explain why the structure of copper allows the conduction of thermal energy.

**(3)**

(c) Explain why copper oxide (CuO) has a high melting point.

**(3)**

(d) Explain why water ($H_2O$) has a low melting point.

_____

_____

_____

_____

_____

_____

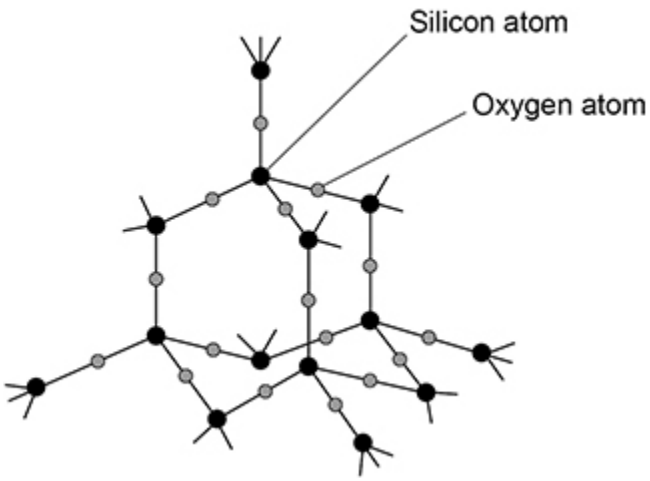
**(3)**

**(Total 10 marks)**

**6.** This question is about structure and bonding.

**Figure 1** represents part of the structure of silicon dioxide.

**Figure 1**




(a) What type of structure is silicon dioxide?

Tick (✓) **one** box.

Giant covalent ☐

Ionic lattice ☐

Simple molecular ☐

**(1)**

(b) Each oxygen atom forms two bonds.

What is the number of bonds formed by each silicon atom?

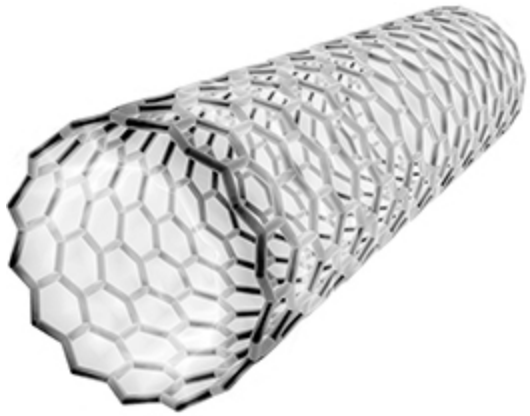
Use **Figure 1**.

_____

**(1)**

**Figure 2** represents part of a fullerene.

**Figure 2**



(c) Complete the sentence.

Choose the answer from the box.

| | | | |
|---|---|---|---|
| **hexagons** | **octagons** | **squares** | **triangles** |

The structure of fullerenes is based on _____.

**(1)**

(d) Complete the sentence.

Choose the answer from the box.

| | | |
|---|---|---|
| **carbon** | **hydrogen** | **oxygen** |

The fullerene molecule shown in **Figure 2** is made from

atoms of _____.

**(1)**

(e) What is the fullerene molecule shown in **Figure 2** used for?

Tick (✓) **one** box.

Electronics ☐

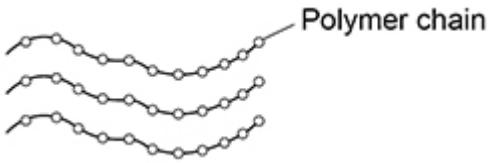
Hand warmers ☐

Sports injury packs ☐

**(1)**

**Figure 3** represents part of the structure of a polymer.

**Figure 3**




(f) What holds the atoms together in a polymer chain?

Tick (✓) **one** box.

Covalent bonds ☐

Ionic bonds ☐

Metallic bonds ☐

**(1)**

(g) Complete the sentence.

Choose the answer from the box.

| **atomic** | **intermolecular** | **macromolecular** |
|---|---|---|

In **Figure 3** the polymer chains are held together by

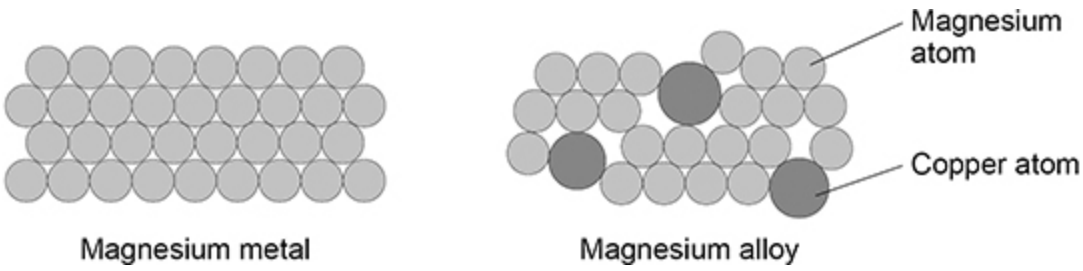
_____ forces.

**(1)**

**Figure 4** represents part of the structures of:

- magnesium metal
- a magnesium alloy.

**Figure 4**




(h) Calculate the percentage of copper atoms in the alloy.

Number of magnesium atoms in the alloy = _____

Number of copper atoms in the alloy = _____

Total number of atoms in the alloy = _____

_____

Percentage of copper atoms in the alloy = _____ %

**(3)**

(i) Explain why the magnesium alloy is harder than magnesium metal.

Use **Figure 4**.

_____

_____

_____

_____

_____

_____

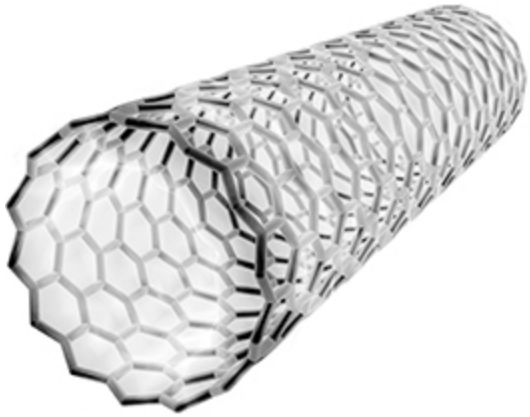
**(3)**

**(Total 13 marks)**

**7.** This question is about structure and bonding.

(a) **Figure 1** represents part of a carbon molecule.

**Figure 1**



Name the type of carbon molecule in **Figure 1**.

_____

**(1)**

(b) Suggest **one** property that makes the carbon molecule in **Figure 1** useful in nanotechnology.

_____

_____

**(1)**

(c) An alloy of aluminium contains small amounts of other metals.

Explain why other metals are added to aluminium.

_____

_____

_____

_____

_____

_____

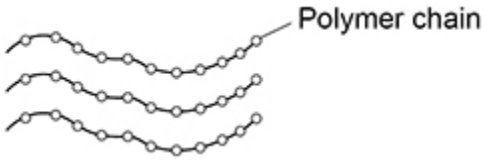
_____

_____

**(4)**

(d) **Figure 2** represents part of the structure of a polymer.

**Figure 2**




Compare the bonding within the chains with the forces between the chains in this polymer.

_____

_____

_____

_____

_____

_____

**(3)**

**(Total 9 marks)**

**1.**

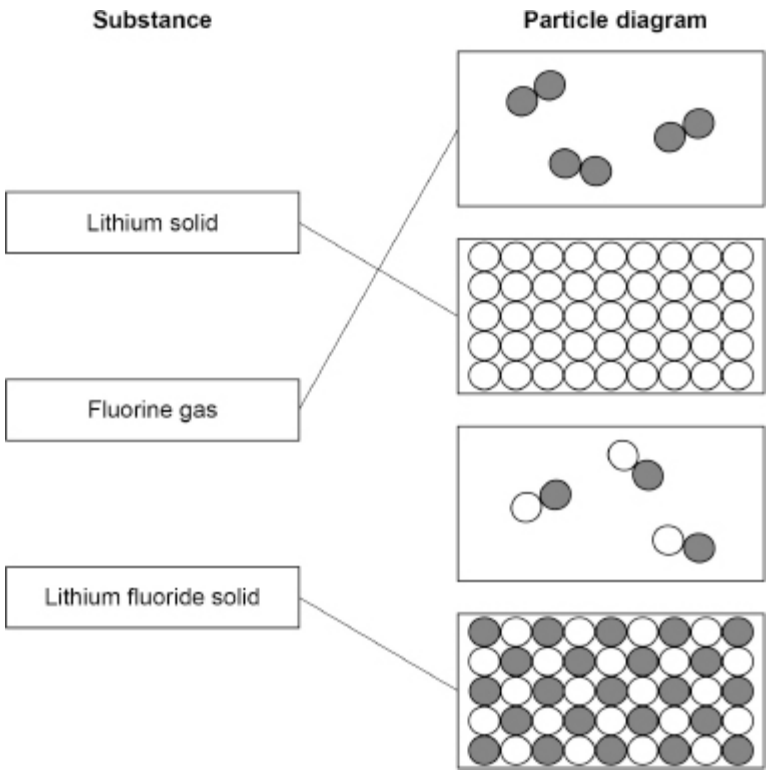
(a) Li

**1**

(b) delocalised electrons from the outer shell

**1**

(c)




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

**3**

(d) **D**

**1**

(e) diamond

**1**

(f) (relative formula mass =)
12 + (19 × 4)

**1**

= 88

**1**

(g) 6

*allow 3 pairs*

**1**

(h) nitride

**1**

(i) neon has a stable arrangement of electrons

1

**[12]**

**2.** (a) one pair of electrons drawn in each of the three overlaps

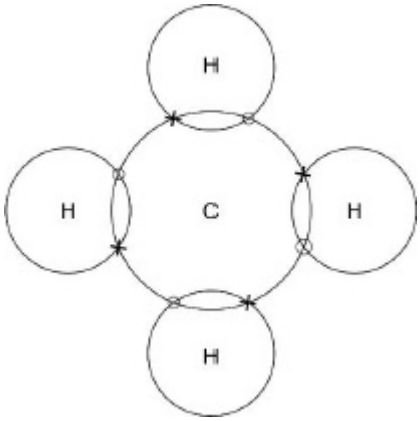
*allow any combination of circles, dots, crosses, $e^{(-)}$ for electrons*

*ignore inner shell electrons on the carbon atom*

*do **not** accept extra electron(s) on outer shell of carbon / hydrogen*

*allow **1** mark for one shared pair in one overlap without non-bonding electron(s) on that hydrogen*

*an answer of*




*scores **2** marks*

2

(b)

1

(c) 3

1

(d) (delocalised) electrons

*allow (free) electrons*

1

(e) in electronic components

1

(f) any **two** from:

- hollow (shape)

  *allow cylindrical (shape)*
  *allow (nano)tube*

- hexagonal rings

  *allow (made of) hexagons*

- (of) carbon atoms

- each (carbon) atom forms 3 (covalent) bonds

**2**

**[8]**

**3.**

**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

**4–6**

**Level 1**: Relevant features are identified and differences noted.

**1–3**

**No relevant content**

**0**

**Indicative content:**

Similarities
- both have strong bonds
- particles have full outer shells

Differences
- sodium chloride is a compound
- sodium chloride is made from two elements
- oxygen is an element

- sodium chloride is a giant structure of ions
- oxygen is a small molecule

- sodium chloride has ionic bonds
- sodium chloride consists of oppositely charged ions
- electrons are transferred from sodium atoms to chlorine atoms
- oxygen is covalent
- oxygen (molecules) are made up of oxygen atoms
- joined by double covalent bond
- electrons are shared between oxygen atoms
- with weak forces between oxygen molecules

For **Level 2**, there must be a comparison of either the structure **or** bonding of both sodium chloride **and** oxygen, and a description of magnitude.

**[6]**

**4.**

(a) hexagonal (rings of carbon atoms)

**1**

(b) any **one** from:

- nanotechnology
- materials

*ignore references to electronic use*

*allow suitable use such as:*
- *sporting equipment*
- *body armour*

*allow drug delivery*

**1**

(c)

$$\text{(number of moles =)} \frac{2380}{6.02 \times 10^{23}}$$

**1**

$= 3.95 \times 10^{-21}$ (mols)

*allow $3.953488 \times 10^{-21}$ (mols) correctly rounded to at least 2 significant figures*

**1**

(d) each (carbon) atom forms three covalent bonds

**1**

(so) one electron from each (carbon) atom is delocalised

**1**

(so these) delocalised electrons carry (electrical) charge through the structure / nanotube

*ignore throughout for through*

*ignore current / electricity*

**1**

**[7]**

**5.** (a) fullerenes and graphene

**1**

(b) delocalised electrons

**1**

(which) move through the structure

**1**

(and) transfer energy

**1**

(c) strong (electrostatic) forces of attraction

1

(between the) oppositely charged ions

1

(so) large amounts of energy needed to break the many / strong bonds / forces

*allow (so) large amounts of energy needed to break the bonds / forces in all directions*

*allow (so) large amounts of energy needed to break the bonds in the lattice*

1

(d) small molecules

*allow simple molecules*

1

(with) weak forces between the molecules
**or**
(with) weak intermolecular forces

*allow (with) weak intermolecular bonds*

*do **not** accept incorrect references to covalent bonds*

1

(so) little energy required to overcome / break the forces between molecules
**or**
(so) little energy required to overcome / break the intermolecular forces

*allow (so) little energy required to separate the molecules*

*allow (so) little energy required to overcome / break the intermolecular bonds*

*ignore less energy*

1

**[10]**

**6.** (a) giant covalent

1

(b) 4 / four

1

(c) hexagons

1

(d) carbon

1

(e) electronics

1

(f) covalent bonds

1

(g) intermolecular

**1**

(h) (magnesium) 22 **and** (copper) 3

**1**

(percentage =)

$\frac{3}{25}$ (× 100)

*allow correct use of incorrectly determined value(s) for number of magnesium atoms and / or copper atoms*

**1**

= 12 (%)

**1**

(i) (alloy is harder because) copper atoms are larger

**or**

(copper) atoms are a different size

**1**

(so the) layers of (magnesium) atoms are distorted

**1**

(and therefore the) layers cannot easily slide

*allow (so) the atoms cannot slide over each other*

**1**

**[13]**

**7.** (a) fullerene

*allow (carbon) nanotube*

*do **not** accept Buckminsterfullerene*

**1**

(b) any **one** from:

- conducts heat
- conducts electricity
- very high length to diameter ratio

*allow large surface area to volume ratio*

*allow high tensile strength*

*allow can trap other molecules / atoms / ions*

**1**

(c) other metal atoms have different sizes to aluminium atoms

**1**

(so) the layers of aluminium atoms are distorted

**1**

(so) the layers cannot slide

*allow (so) the atoms cannot slide over each other*

**1**

(which) makes the alloy harder

*allow (which) makes the alloy stronger*

**1**

(d) covalent bonds (between atoms) in the chain

**1**

intermolecular forces between the chains

**1**

covalent bonds are strong
**and**
intermolecular forces are weak

**1**

**[9]**