Bonding & Structure 1

Name: _____

Class: _____

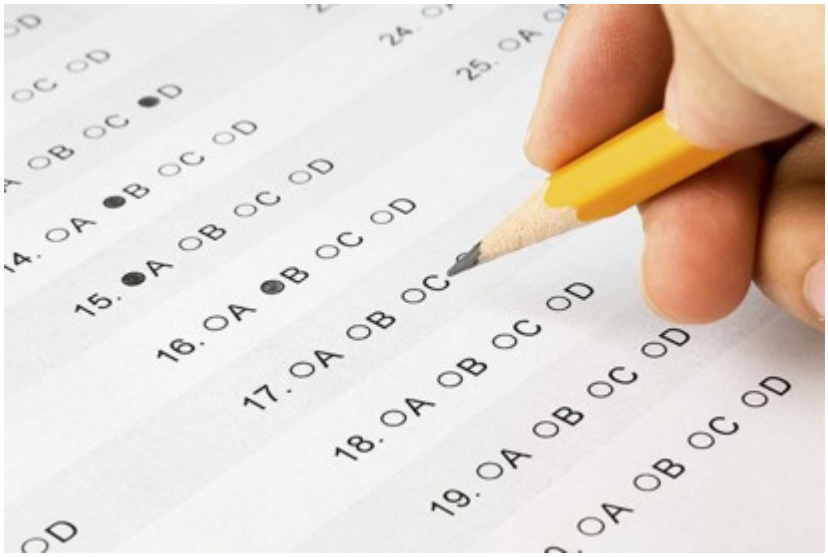
Date: _____

Time: **49 minutes**

Marks: **49 marks**

Comments:

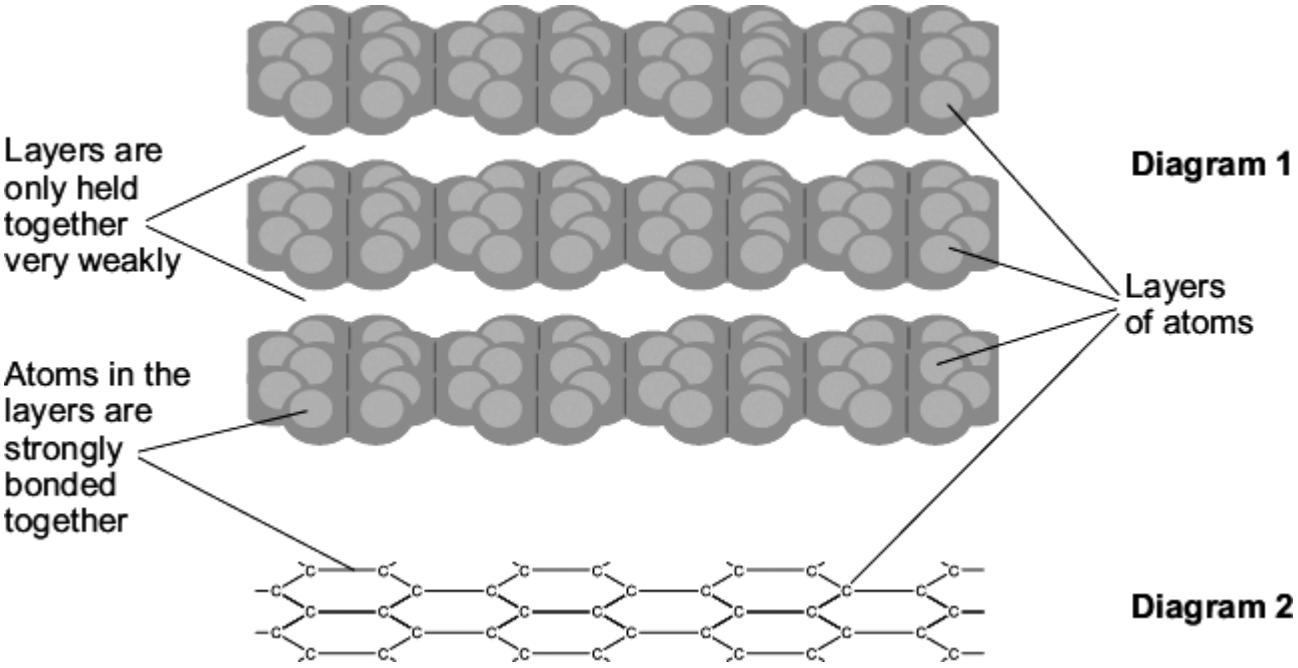
1. The picture shows a student using a pencil to complete a multiple choice answer sheet.



By albertogp123 [CC BY 2.0] , via Flickr

The pencil contains graphite. Graphite rubs off the pencil onto the paper.

Diagrams 1 and **2** show how the atoms are arranged in graphite.



(a) Use **Diagram 2** and your Data Sheet to help you to name the element from which graphite is made.

_____

(1)

(b) Use **Diagram 1** to help you explain why graphite can rub off the pencil onto the paper.

_____

_____

_____

_____

(2)

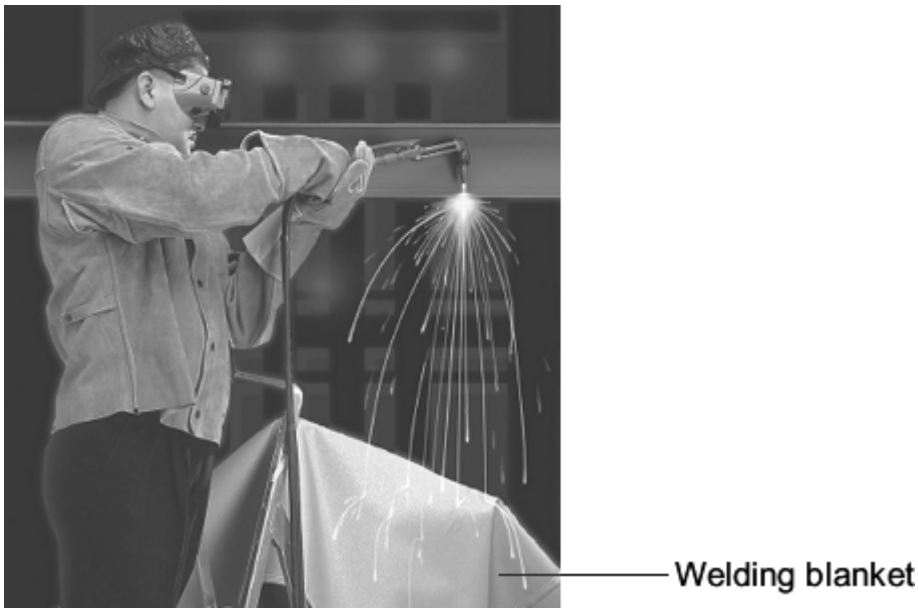
(c) Draw a ring around the type of bond which holds the atoms together in each layer.

covalent **ionic** **metallic**

(1)

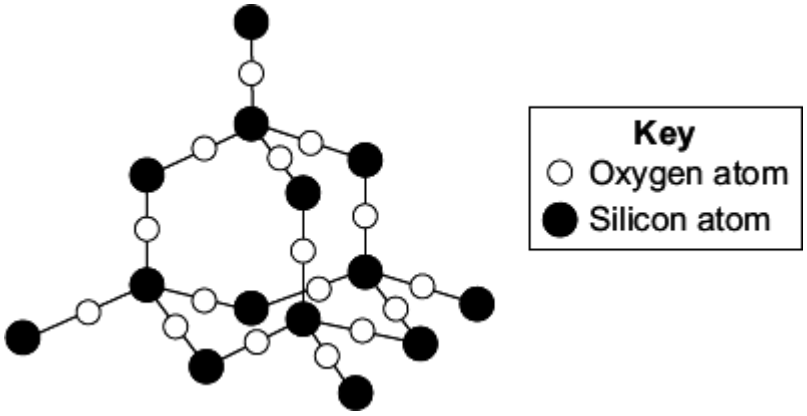
(Total 4 marks)

2. Welding blankets are placed under metals being welded. They protect the area under the welding.



Some welding blankets are made from silicon dioxide which does not melt when hit by sparks or molten metal.

The diagram shows a small part of the structure of silicon dioxide.



Describe the structure and bonding in silicon dioxide **and** explain why it is a suitable material for making welding blankets.

(3)

(Total 3 marks)

3. Lead compounds have been used for thousands of years as colours in paint.

Johannes Vermeer [Public domain], via Wikimedia Commons

(a) A sample of a red oxide used in paint was found to contain 6.21 g of lead and 0.64 g of oxygen.

Calculate the empirical (simplest) formula of this compound.

You **must** show all your working to gain full marks.

Relative atomic masses: O = 16; Pb = 207.

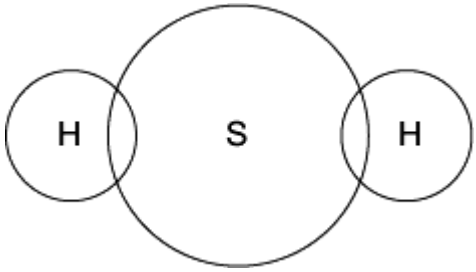
(4)

(b) A problem with lead compounds is that they slowly react with hydrogen sulfide in the air. This produces lead sulfide which is black.

(i) Hydrogen sulfide has the formula H_2S. The bonding in a molecule of hydrogen sulfide can be represented as:

H–S–H

Complete the diagram below to show the arrangement of the outer electrons of the hydrogen and sulfur atoms in hydrogen sulfide.
Use dots (●) and crosses (x) to represent the electrons.
You need only show the outer shell electrons.
(Atomic numbers: H = 1; S = 16.)



(1)

(ii) Hydrogen sulfide has a low boiling point.

Explain why.

_____

_____

_____

_____

(2)

(iii) Lead white is also used in paint. The white colour slowly darkens when lead sulfide is produced.

The painting can be restored with hydrogen peroxide. This converts the black lead sulfide into white lead sulfate.

Balance the equation for the reaction between lead sulfide and hydrogen peroxide (H_2O_2).

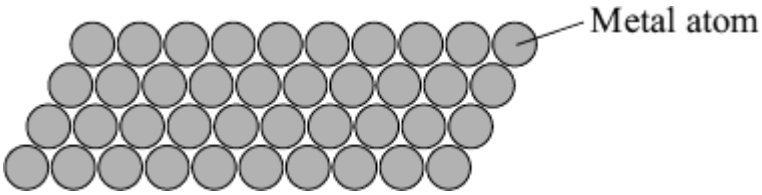
$$PbS(s) + \_\_\_\_\_H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

(1)

(Total 8 marks)

4. Metal is bent and shaped to make a car body.

The diagram below represents how atoms are arranged in a metal.



Which **two** statements in the table best explain why the metal can be bent and shaped?

Tick (✓) the **two** statements.

Statement	Tick (✓)
The atoms are in layers.	
The metal is shiny.	
The atoms can slide over each other.	
All the atoms are linked by strong covalent bonds.	

(2)

(Total 2 marks)

5. This question is about lead iodide and magnesium iodide.

(a) Lead iodide can be made by mixing a solution containing lead ions with a solution containing iodide ions.

Lead iodide is formed as a solid.

lead ions in solution	+	iodide ions in solution	→	lead iodide solid

(i) Draw a ring around the name given to this type of reaction.

electrolysis **neutralisation** **precipitation**

(1)

(ii) Tick (✓) the method used to separate solid lead iodide from the solution.

Method	**Tick (✓)**
distillation	
evaporation	
filtration	

(1)

(iii) The table below gives information about the solubility of some compounds.

Soluble compounds	Insoluble compounds
all sodium and potassium salts	
all nitrates	
most chlorides, bromides and iodides	silver and lead chlorides, bromides and iodides

Use the table to help you to:

draw a ring around a soluble compound which contains lead ions

lead bromide **lead chloride** **lead nitrate**

draw a ring around a soluble compound which contains iodide ions.

lead iodide **silver iodide** **sodium iodide**

(2)

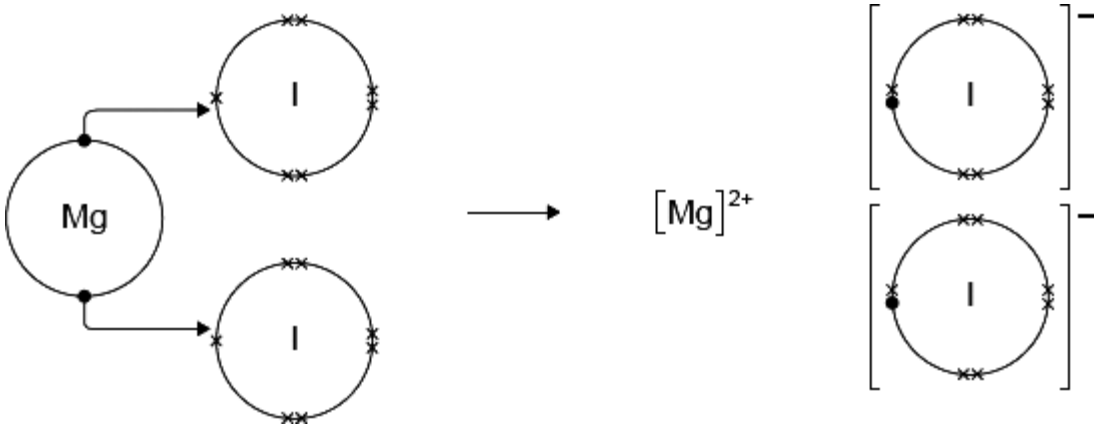
(b) Magnesium iodide can be made by reacting magnesium with iodine.

magnesium + iodine → magnesium iodide

The diagram shows how this takes place.

Only the outer electrons are shown.

The dots (●) and crosses(×) are used to represent electrons.



Use the diagram to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

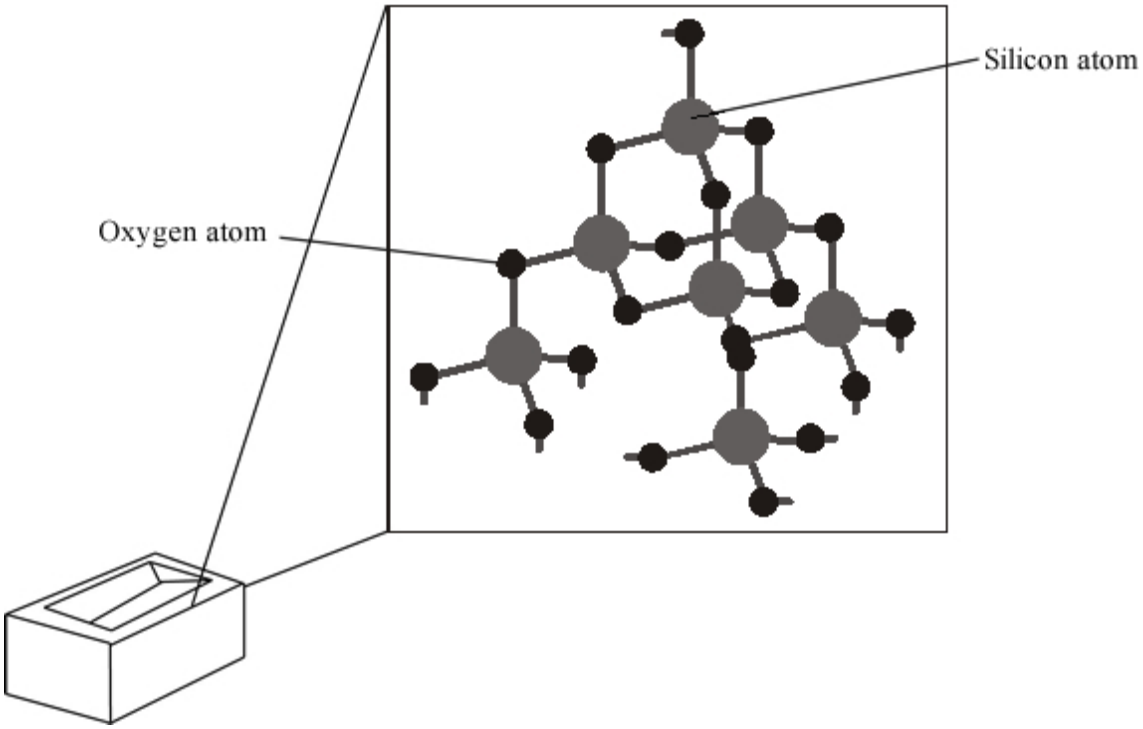
To gain full marks you should use the words atom, electron and ion in your answer.

(4)

(Total 8 marks)

6. Bricks made from silica (silicon dioxide) are used to line furnaces that operate at high temperatures.

Part of the structure of silica is shown in the diagram.



Suggest and explain why silica is used to make bricks for high-temperature furnaces. In your answer, you should refer to the structure of, and bonding in, silica.

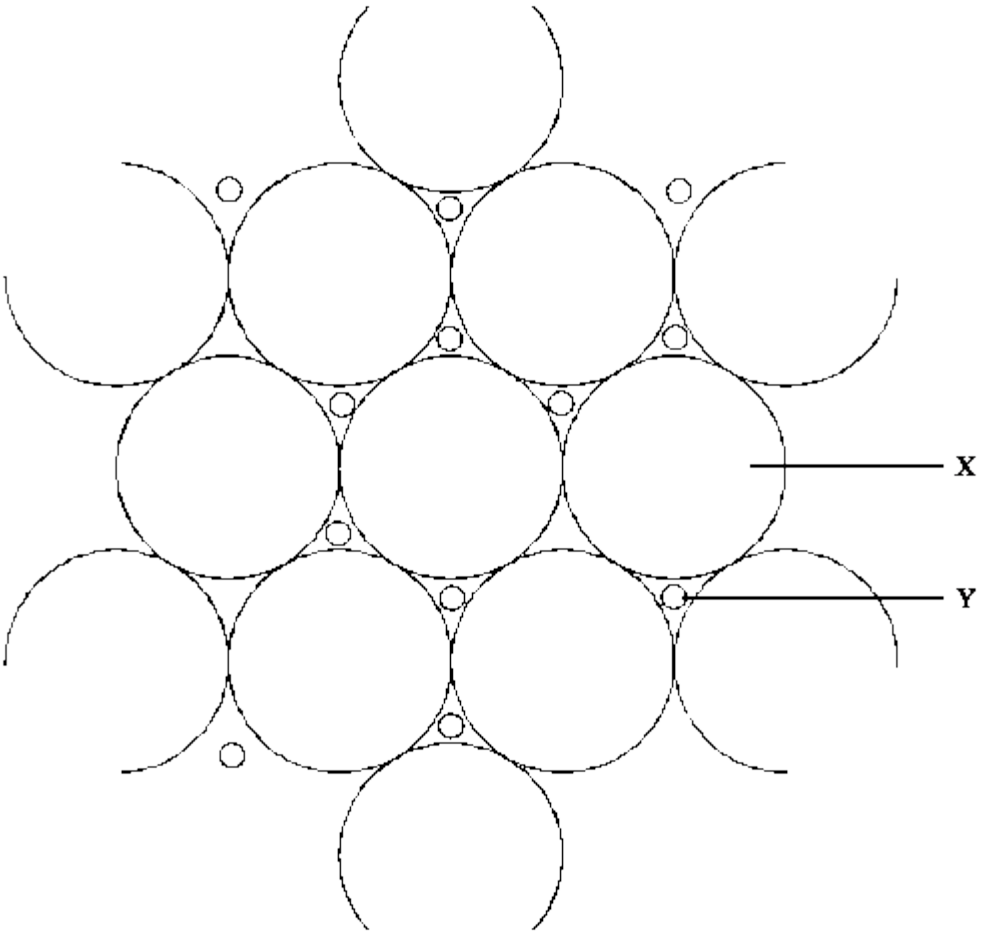
(Total 4 marks)

7. Millions of years ago the Earth formed as a giant ball of molten rock. The outer surface cooled forming a thin, solid outer crust. Volcanic activity on the surface produced an atmosphere containing the compounds carbon dioxide, ammonia, methane and water vapour.

Describe the bonding in any **one** of these compounds. You must include electronic structures in your explanation.

(Total 4 marks)

8. The diagram shows a model of part of the giant lattice of a metal.



(a) Name particles **X** and **Y**.

X _____

Y _____

(2)

(b) Explain, in terms of the giant structure above, why is it possible to bend a piece of metal.

_____

_____

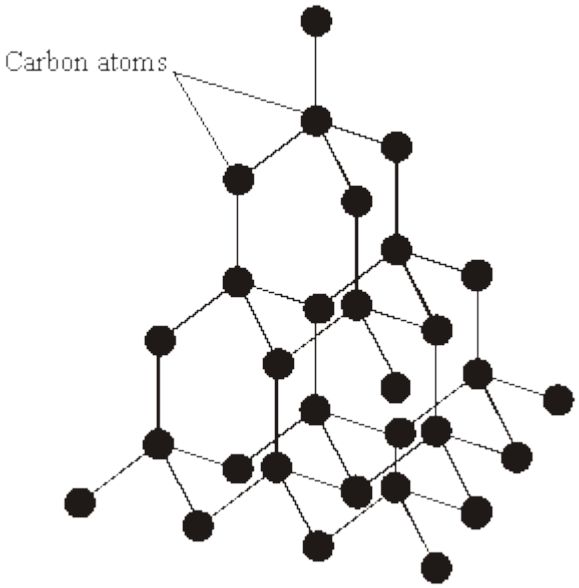
_____

_____

(2)

(Total 4 marks)

9. The diagram shows the structure of diamond.



(a) *To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words*.

Explain, as fully as you can, why diamond has a high melting point.

_____

_____

_____

_____

_____

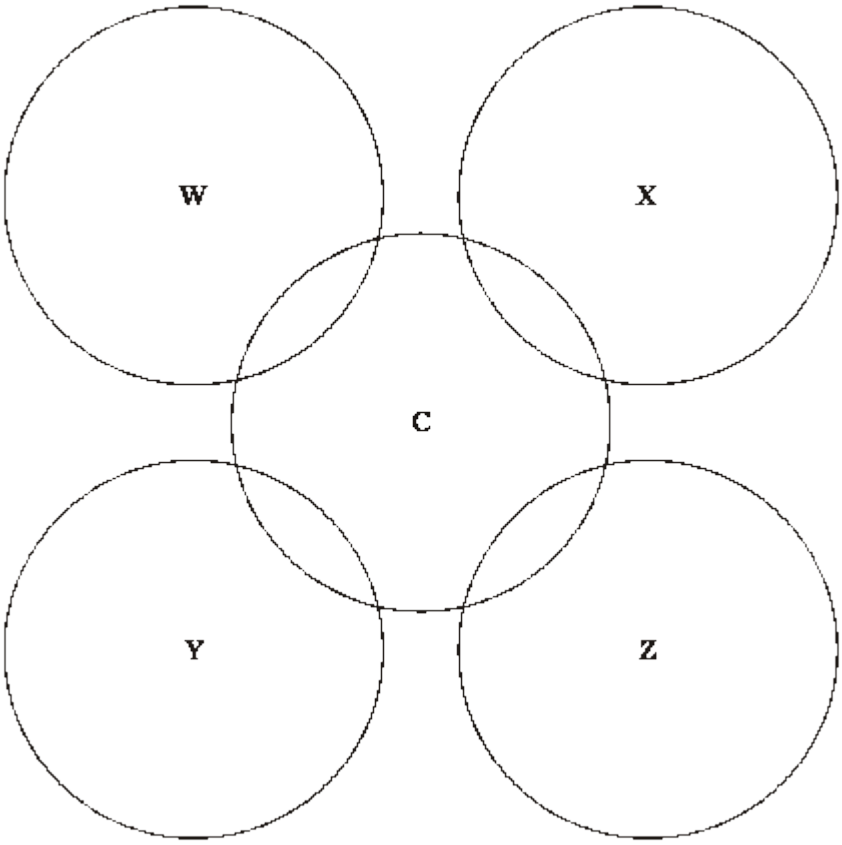
_____

(3)

(b) The diagram below shows the outer electron shells of five carbon atoms in the giant lattice of diamond.

Carbon atom **C** forms bonds with each of the carbon atoms **W**, **X**, **Y** and **Z**.

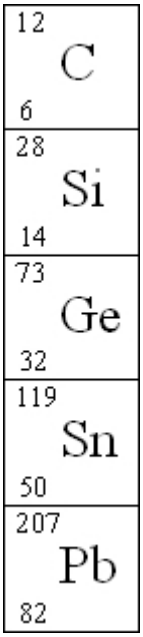
Draw the positions of all the electrons in the outer shells of each of carbon atoms **C**, **W**, **X**, **Y** and **Z**.



(3)

(Total 6 marks)

10. The diagram shows the elements in Group 4 of the periodic table.



Carbon is a non-metal and silicon is usually considered to be a non-metal.

Tin and lead have all the usual properties of metals.

Germanium has these properties:

- grey-white shiny solid
- melting point 937°C
- semi-conductor
- reacts with chlorine to form the chloride ($GeCl_4$) which is a liquid molecular compound
- germanium oxide reacts with acids to form a salt solution and water. It also reacts with alkalis.

(a) With reference to their structure, explain why tin and lead are good conductors of electricity.

_____

_____

_____

_____

_____

_____

(3)

(b) Would you classify germanium as a metal or as a non-metal? Give your reasons.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

1.

(a) carbon

1

(b) <u>layers</u>

1

have weak forces / attractions / bonds between them **or** are only held together weakly

second mark must be linked to layers

or

can slide over each other **or** separate (1)

1

(c) covalent

1

[4]

2.

three from:

*reference to ionic / metallic / intermolecular / (small) molecules = max **2***

structure: (max 2)

- giant structure / macromolecule / all the atoms are joined together

  allow (giant) lattice

  ignore large structure

  ignore diamond structure

- covalent (bonds)

- strong bonds / bonds difficult to break

- each silicon atom forms <u>4</u> bond sand / or each oxygen atom forms <u>2</u> bonds

explanation: (max 2)

- a lot of energy needed to break the bonds

- high melting point

  *if neither point given accept high temperature needed to break bonds for **1** mark*

- does not burn **or** react with oxygen

3

[3]

3. (a)

$\frac{6.21}{207}$ $\frac{0.64}{16}$

1 *mark for dividing mass by* A_r
max ***2*** *if* A_r *divided by mass*

1

= 0.03 = 0.04

1 *mark for correct proportions*

1

3 4

1 *mark for correct whole number ratio (allow multiples) can be awarded from correct formula*

1

Pb_3O_4

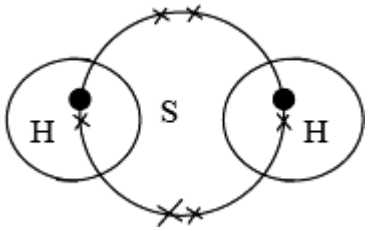
1 *mark for correct formula*

ecf *allowed from* ***step 2 to step 3*** *and* ***step 3 to step 4*** *if sensible attempt at* ***step 1***

correct formula with no working gains ***2*** *marks*

1

(b) (i)



allow all dots ***or*** *all crosses* ***or*** *e* ***or*** e^-

ignore inner shells and any inner electrons

allow 4 non-bonded electrons anywhere on shell as long as not in overlap – need not be paired

1

(ii) forces of attraction / bonds between molecules are weak (owtte)

*do **not** accept intramolecular forces / covalent bonds are weak*

*do **not** accept reference to ions*

or

intermolecular forces / bonds are weak (owtte)

or

it is made of small molecules with weak forces of attraction

*if **2** marks not awarded*

*made of small molecules / simple molecular gains **1** mark*

*forces of attraction are weak (without specifying between molecules / intermolecular) gains **1** mark*

(accept easily broken / not much energy needed to break instead of weak)

bonds are weak without specifying intermolecular would not gain a mark and would be ignored

2

(iii) 4

1

[8]

4. the atoms are in layers

1

the atoms can slide over each other

1

[2]

5. (a) (i) precipitation

1

(ii) filtration

1

(iii) lead nitrate

1

sodium iodide

1

(b) *sharing / covalent / metallic = max **3***

any **four** from:

- magnesium (atom) reacts with **two** iodine (atoms)
- magnesium (atom) loses
- **2** electrons
- iodine (atom) gains
- **1** electron **or** an electron
- iodide ion formed

  allow iodine ion

  allow iodine

  ignore I^{2-}
- iodide has negative charge / is a negative ion / particle
- magnesium ion formed
- magnesium has positive charge
- oppositely charged ions attract
- a giant structure / lattice is formed

  *if reference to ions being formed is made unqualified, allow **1** mark*

4

[8]

6. any **four** points from:

- high melting point owtte
  ignore boiling point
- many **or** all atoms joined together
- each silicon (atom) joined to four oxygen (atoms) **or** each oxygen joined to two silicon
- covalent (bonds)
- many bonds would need to be broken
- strong bonds
  allow hard to break bonds
- lot of energy / heat needed to break bonds
  allow high temperature needed to break bonds
- giant / macromolecular / lattice / diamond structure
- unreactive
  *allow doesn't react with materials within furnace = **1** mark*
- rigid / hard structure
- no free electrons
- poor conductor of heat
  *giant covalent structure = **2** marks*
  *max **3** if ionic / metallic bonding mentioned*
  ignore electrostatic
  ignore molecules / intermolecular forces

[4]

7. answers apply to:
accept diagrams and/or descriptions

carbon dioxide CO_2

ammonia NH_3

methane CH_4

water H_2O

*outer electronic structure of one atom correct **or** needs correct number of electrons to complete outer shell

1

*outer electronic structure of other atom correct **or** needs correct number of electrons to complete outer shell

1

*one shared **pair** of electrons (as one covalent bond)

use of ions or reference to ionic bonding negates this mark

1

*outer electronic structure of compound correct **or** each atom now has a full outer shell/noble gas electron structure

1

[4]

8.

(a) **X** – (metal) atom / ion

1

Y – electron

1

(b) free electrons or electrons move

1

(allow metal) atoms / ions to slide over each other

OR

bonding non - directional for 2 marks

1

[4]

9.

(a) Quality of written communication: All scientific words used correctly (covalent, bonds, atoms)

1

any **two** from

- large numbers of covalent bonds

  allow giant lattice / structure

- between <u>atoms</u>

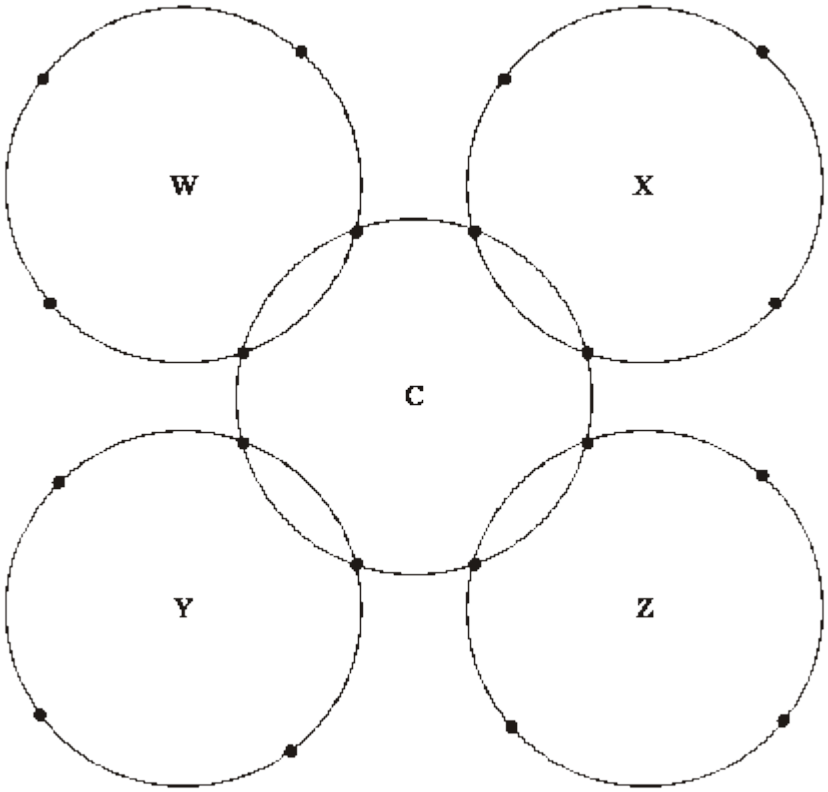
  do not accept between molecules

- (covalent) bonds strong

  accept need much energy to break

2

(b)



each carbon has 4 electrons

1

one shared pair

1

four shared pairs

1

[6]

10. (a) *idea that*
some of the outer electrons of the atoms are free to move
can move anywhere across the (giant) structure
the flow of electricity is a stream of electrons

each for 1 mark

or electrons carry a (negative electrical) charge

3

(b) <u>metal element</u>
[shiny] appearance

[high] melting point
forms an oxide that reacts with acids to make a salt

1 of these for 1 mark

<u>non metal element</u>
forms an oxide that reacts with alkalis

with chlorine forms a molecular chloride

1 of these for 1 mark

semi-conductor suggests in between

this, or any other for 1further mark

[NB Maximum of 2 for arguing metal/non-metal only]
Under each head
1 wrong reason → maximum of 1 available
2 wrong reasons → no mark available]

3

[6]