

Theory Questions

Giant Structures

Diamond & Graphite / Silicon(IV) Oxide / Metallic Bonding

Easy (5 questions)	/31
Medium (10 questions)	/87
Hard (7 questions)	/76
Total Marks	/194

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Easy Questions

1 Extended Only

Complete the following table.

type of structure	particles present	electrical conductivity of solid	electrical conductivity of liquid	example
ionic	positive and negative ions	poor
macromolecular	atoms of two different elements in a giant covalent structure	poor	poor
metallic and	good	copper

[6]

(6 marks)

2 (a) Diamond and graphite are different forms of the same element, carbon.

Explain the following in terms of their structure.

Graphite is a soft material which is used as a lubricant.

.....

.....

(2 marks)

(b) Diamond is a very hard material which is used for drilling and cutting.

.....

.....

(2 marks)

(c) Graphite is a good conductor of electricity and diamond is a poor conductor.

.....

.....

(2 marks)

3 (a) For each of the following elements give one physical property and one chemical property.

bromine (Br₂)

physical property

chemical property

.....

.....

(2 marks)

(b) carbon _{graphite} (C)

physical property

chemical property

.....

.....

(2 marks)

(c) manganese (Mn)

physical property

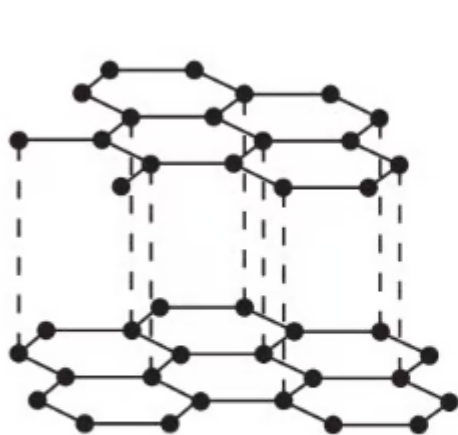
chemical property

.....

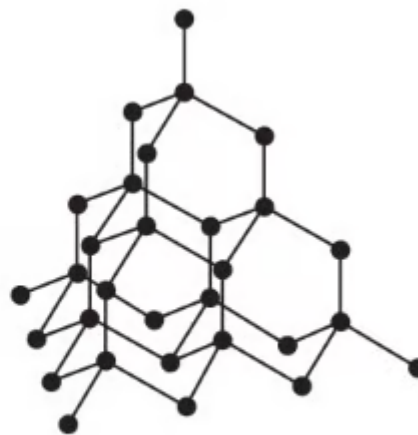
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(2 marks)

4 (a) Two macromolecular forms of carbon are graphite and diamond. The structures of graphite and diamond are given below.



graphite



diamond

Explain in terms of its structure why graphite is soft and is a good conductor of electricity.

.....

.....

.....

(3 marks)

(b) State **one** use of graphite which depend on the above property. It is soft

.....

(1 mark)

(c) **Separate: Chemistry and Extended Only**

Silicon(IV) oxide also has a macromolecular structure.

i) Describe the macromolecular structure of silicon(IV) oxide.

[1]

ii) Predict **two** physical properties which diamond and silicon(IV) oxide have in common.

[2]

.....

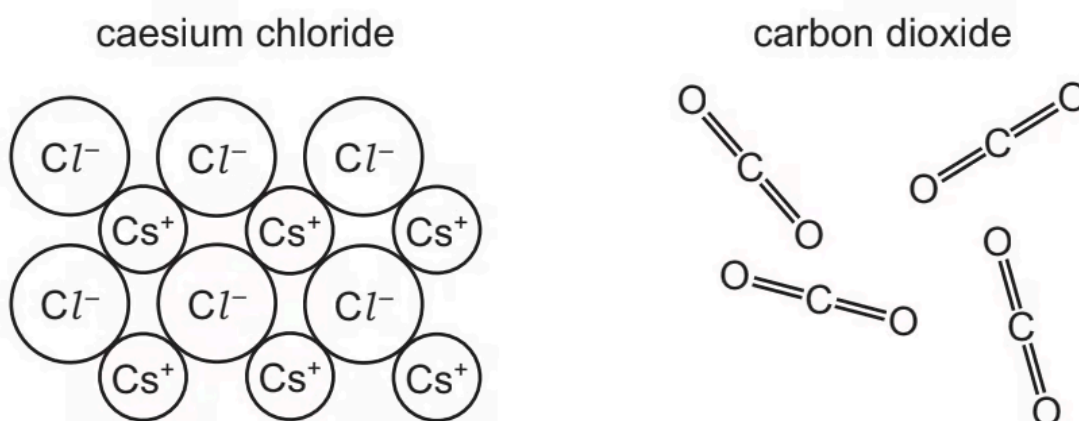
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(3 marks)

5 (a) Extended Only

The diagram shows part of the structures of caesium chloride and carbon dioxide.



Caesium is a metal. Describe two properties that are characteristic of most metals.

.....

.....

(2 marks)

(b) Extended Only

Magnesium is a metal.

Name and describe the bonding in magnesium.

name:

description of bonding:

.....

.....

.....

.....

(4 marks)

Medium Questions

1 (a) Extended Only

For each of the following unfamiliar elements predict one physical and one chemical property.

Caesium (Cs)

Physical property

Chemical property

.....

.....

(2 marks)

(b) Vanadium (V)

Physical property

Chemical property

.....

.....

(2 marks)

(c) Fluorine (F)

Physical property

Chemical property

.....

.....

(2 marks)

2 (a) Extended Only

The following table gives information about six substances.

substance	melting point / °C	boiling point / °C	electrical conductivity as a solid	electrical conductivity as a liquid
A	839	1484	good	good
B	-188	-42	poor	poor
C	776	1497	poor	good
D	-117	78	poor	poor
E	1607	2227	poor	poor
F	-5	102	poor	good

Which substance could be a metal?

.....
(1 mark)

(b) State **all** the substances that are liquid at room temperature.

.....
(1 mark)

(c) Separate: Chemistry and Extended Only

Which substance could have a macromolecular structure similar to that of silicon(IV) oxide?

(1 mark)

(d) Which substance could be propane?

(1 mark)

(e) Which substance could be sodium chloride?

(1 mark)

3 (a) Separate: Chemistry and Extended Only

Carbon dioxide and silicon(IV) oxide are oxides of Group IV elements.

Complete the following table.

	carbon dioxide	silicon (IV) oxide
formula		SiO ₂
melting point / °C	-56	1610
physical state at 25 °C	gas	
conduction of electricity	non-conductor	
structure		macromolecular

.....

.....

.....

.....

(4 marks)

(b) Separate: Chemistry and Extended Only

i) Name the type of bonds that exist between the atoms in silicon(IV) oxide.

[1]

ii) Explain why silicon(IV) oxide has a very high melting point.

[1]

iii) Explain, in terms of attractive forces between particles, why carbon dioxide has a very low melting point.

[1]

iv) Explain, in terms of particles, why carbon dioxide is a non-conductor of electricity.

[1]

.....

.....

.....

.....

(4 marks)

(c) Separate: Chemistry Only

i) Name the type of chemical reaction in which carbon dioxide is produced from fossil fuels.

[1]

ii) Name the chemical process in which green plants convert carbon dioxide into carbohydrates.

[1]

.....

(2 marks)

4 (a) **Separate: Chemistry and Extended Only**

The table below shows the elements in the third period of the Periodic Table, the number of electrons in their outer energy level, their oxidation state in their common compounds and their melting points.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Number of outer electrons	1	2	3	4	5	6	7	8
Oxidation state	+1	+2	+3	+4/-4	-3	-2	-1	0
Melting point / °C	98	650	660	1414	317	115	-101	-189

Describe and explain the variation in oxidation state across the period.

.....

.....

.....

(3 marks)

(b) **Extended Only**

The first three elements, Na, Mg and Al, are metals.

Describe the structure of a typical metal.

.....

.....

.....

(3 marks)

(c) Extended Only

Explain why Na, Mg and Al are good conductors of electricity.

.....
.....
(1 mark)

(d) Which element exists as diatomic molecules of the type X_2 ?

.....
.....
(1 mark)

(e) Separate: Chemistry and Extended Only

Silicon has a similar structure to diamond.

Explain why silicon has the highest melting point in the period.

.....
.....
(2 marks)

(f) Extended Only

Sodium chloride is a crystalline solid with a high melting point. It dissolves in water to give a neutral solution. Phosphorus trichloride is a liquid at room temperature. It reacts with water to form an acidic solution. Suggest an explanation for these differences in properties.

.....
.....
(2 marks)

(g) Describe how you could show that magnesium oxide is a basic oxide and not an amphoteric oxide.

(2 marks)

(h) **Extended Only**

Draw a dot-and-cross diagram showing the bonding in magnesium oxide. Show outer electrons only.

(3 marks)

5 (a) The table shows the melting points, boiling points and electrical properties of five substances, A to E.

Substance	Melting point / °C	Boiling point / °C	Electrical conductivity of solid	Electrical conductivity of liquid
A	-7	59	poor	poor
B	1083	2567	good	good
C	755	1387	poor	good
D	43	181	poor	poor
E	1607	2227	poor	poor

Choose a substance from the table above to match each of the following descriptions. A substance may be used once, more than once or not at all.

Justify each choice with evidence from the table.

One has been completed as an example.

This substance is covalent and is a solid at room temperature (25 °C): D

Evidence: Its melting point is above room temperature. It has a low melting point and it does not conduct as a liquid, so it is covalent.

This substance has a giant covalent structure:

Evidence:

(3 marks)

(b) Extended Only

This substance is a metal:

Evidence:

(2 marks)

(c) This substance is a liquid at room temperature.

(3 marks)

(d) This substance is an ionic solid.

(3 marks)

- 7 (a) Germanium is an element in Group IV. The electron distribution of a germanium atom is $2 + 8 + 18 + 4$. It has oxidation states of +2 and +4.

Germanium forms a series of saturated hydrides similar to the alkanes.

- i) Draw the structural formula of the hydride which contains three germanium atoms per molecule.

[1]

- ii) Predict the general formula of the germanium hydrides.

[1]

(2 marks)

- (b) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound germanium(IV) chloride, GeCl_4 . Use o to represent an electron from a chlorine atom. Use x to represent an electron from a germanium atom.

(2 marks)

(c) **Separate: Chemistry and Extended Only**

Describe the structure of the giant covalent compound germanium(IV) oxide, GeO_2 . It has a similar structure to that of silicon(IV) oxide.

(3 marks)

(d) **Separate: Chemistry and Extended Only**

Is the change GeCl_2 to GeCl_4 reduction, oxidation or neither? Give a reason for your choice.

(2 marks)

8 (a) The first three elements in Group IV are carbon, silicon and germanium. The elements and their compounds have similar properties.

The compound, silicon carbide, has a macromolecular structure similar to that of diamond.

i) A major use of silicon carbide is to reinforce aluminium alloys which are used in the construction of spacecraft. Suggest **three** of its physical properties.

[3]

ii) Complete the following description of the structure of silicon carbide. Each carbon atom is bonded to four atoms. Each silicon atom is bonded to carbon atoms.

[2]

.....

.....

.....

.....

.....

(5 marks)

(b) **Separate: Chemistry and Extended Only**

Germanium(IV) oxide, GeO_2 , has the same macromolecular structure as silicon(IV) oxide. Draw the structural formula of germanium(IV) oxide.

.....

.....

.....

(3 marks)

(c) Germanium forms a series of hydrides comparable to the alkanes.

i) Draw the structural formula of the hydride which contains four germanium atoms per molecule.

[1]

ii) Predict the products of the complete combustion of this hydride.

[2]

(3 marks)

9 (a) The properties of five alkenes at room temperature are shown in **Table 1.1**

Table 1.1

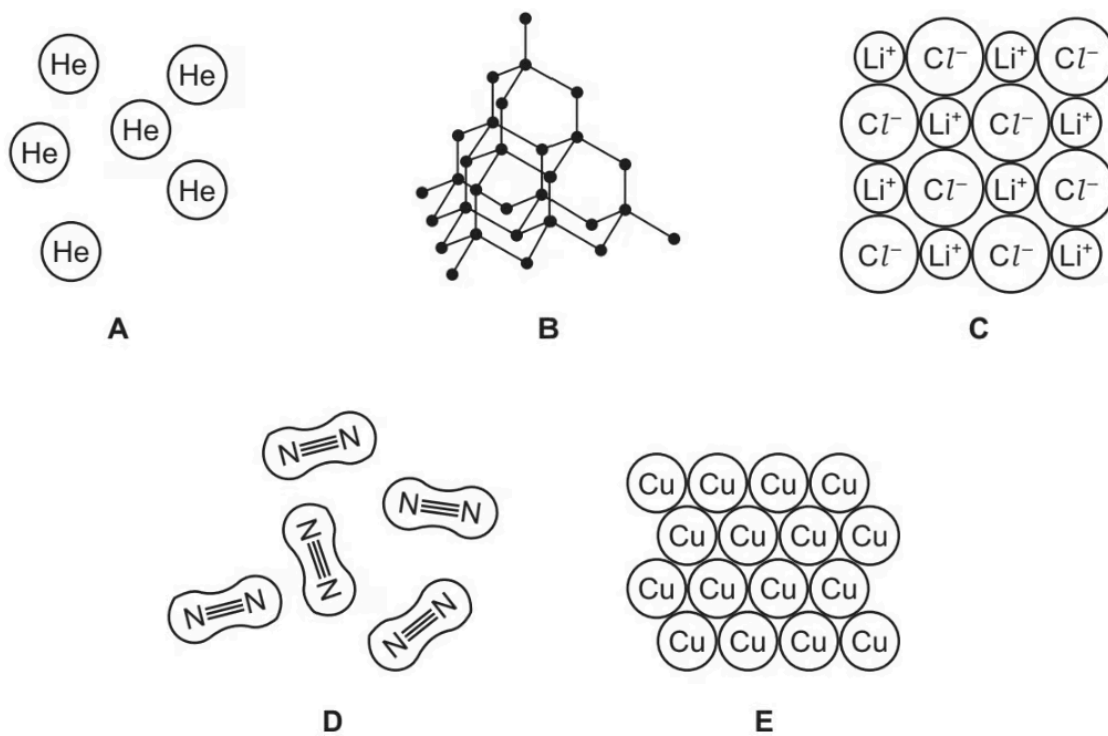
alkene	number of carbon atoms in a molecule	state at room temperature	density in g / cm ³	boiling point / °C
ethene	2	gas	0.0012	-104
propene	3	gas	0.0018	-47
butene	4	gas	0.0024	
pentene	5	liquid	0.64	30
hexene	6	liquid	0.67	63

Answer this question using only the information in the table.

Suggest why the densities of the first three alkenes are much lower than the density of pentene and hexene.

(1 mark)

(b) The diagrams show part of the structures of five substances, A, B, C, D and E.

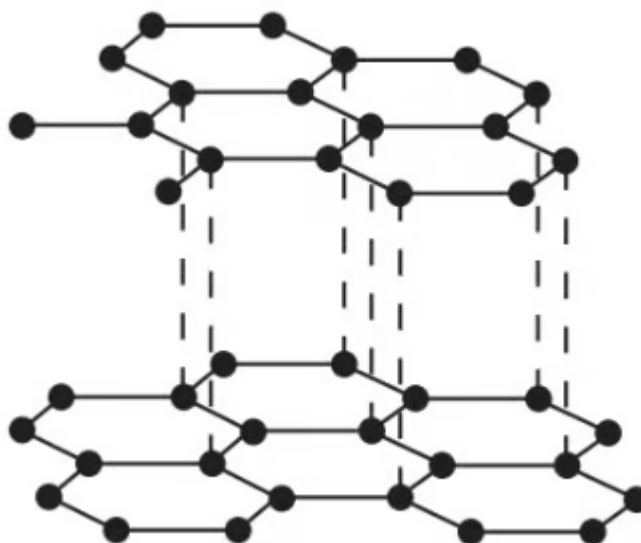


Answer the following question about these structures.

Which one of these structures, A, B, C, D or E, is used in cutting tools?

(1 mark)

(c) Part of the structure of graphite is shown.



Use the information from the diagram to explain why graphite is used as a lubricant.

(1 mark)

10 (a) **Separate: Chemistry and Extended Only**

The names of eight substances are given.

aluminium oxide calcium oxide ethanol nitrogen
iron(III) oxide methane oxygen silicon(IV) oxide

State which substance is a macromolecular solid.

.....
(1 mark)

(b) Carbon is an element which exists in different forms. Name two forms of the element carbon that have giant covalent structures.

.....
.....
(2 marks)

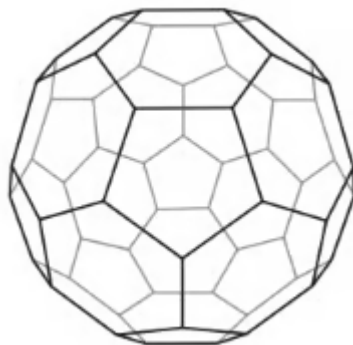
(c) **Extended Only**

Magnesium is a metal. Describe the structure and bonding of metals. Include a labelled diagram in your answer.

.....
.....
.....
(3 marks)

Hard Questions

- 1 (a) In 1985 the fullerenes were discovered. They are solid forms of the element carbon. The structure of the C_{60} fullerene is given below.



- i) In the C_{60} fullerene, how many other carbon atoms is each carbon atom bonded to?

[1]

- ii) Another fullerene has a relative molecular mass of 840. How many carbon atoms are there in one molecule of this fullerene?

[1]

(2 marks)

- (b) Fullerenes are soluble in liquid hydrocarbons such as octane. The other solid forms of carbon are insoluble.

Describe how you could obtain crystals of fullerenes from soot which is a mixture of fullerenes and other solid forms of carbon.

(3 marks)

(c) **Extended Only**

A mixture of a fullerene and potassium is an excellent conductor of electricity.

i) Which other form of solid carbon is a good conductor of electricity?

[1]

ii) Explain why metals, such as potassium, are good conductors of electricity.

[2]

iii) The mixture of fullerene and potassium has to be stored out of contact with air. There are substances in unpolluted air which will react with potassium. Name **two** potassium compounds which could be formed when potassium is exposed to air.

[2]

(5 marks)

2 (a) **Extended Only**

It was reported from America that a turbine engine, the size of a button, might replace batteries. The engine would be built from silicon which has suitable properties for this purpose.

The engine will run on a small pack of jet fuel. What other chemical is needed to burn this fuel?

(1 mark)

(b) **Extended Only**

Silicon has the same type of macromolecular structure as diamond.

i) Explain why one atom of either element can form four covalent bonds.

[2]

ii) Predict **two** physical properties of silicon.

[2]

iii) Name a different element that has a similar structure and properties to silicon.

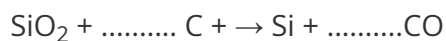
[1]

(5 marks)

(c) Separate: Chemistry and Extended Only

Silicon is made by the carbon reduction of the macromolecular compound, silicon(IV) oxide.

i) Balance the equation for the reduction of silicon(IV) oxide.



[1]

ii) Explain why the silicon(IV) oxide is said to be reduced.

[1]

iii) Describe the structure of silicon(IV) oxide. You may use a diagram.

[3]

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.....

.....

.....

.....

(5 marks)

3 (a) There are three types of giant structure – ionic, metallic and macromolecular.

Sodium nitride is an ionic compound. Draw a diagram that shows the formula of the compound, the charges on the ions and the arrangement of the valency electrons around the negative ion.

Use x to represent an electron from a sodium atom. Use o to represent an electron from a nitrogen atom.

(3 marks)

(b) i) Describe metallic bonding.

[3]

ii) Use the above ideas to explain why: metals are good conductors of electricity, metals are malleable.

[3]

(6 marks)

(c) **Separate: Chemistry and Extended Only**

Silicon(IV) oxide has a macromolecular structure.

i) Describe the structure of silicon(IV) oxide (a diagram is not acceptable).

[3]

ii) Diamond has a similar structure and consequently similar properties. Give **two** physical properties common to both diamond and silicon(IV) oxide.

[2]

.....

.....

.....

.....

.....

(5 marks)

4 (a) Carbon and silicon are elements in Group IV. Both elements have macromolecular structures.

Diamond and graphite are two forms of the element carbon.

i) Explain why diamond is a very hard substance.

[2]

ii) Give **one** use of diamond.

[1]

iii) Explain why graphite is a soft material.

[2]

iv) Give **one** use of graphite.

[1]

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(6 marks)

(b) Separate: Chemistry and Extended Only

Two of the oxides of these elements are carbon dioxide, CO_2 , and silicon(IV) oxide, SiO_2 .

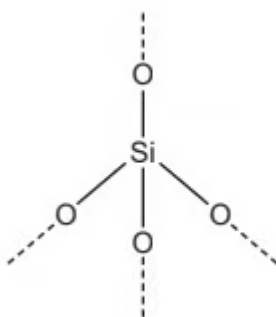
i) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.

Use o to represent an electron from a carbon atom. Use x to represent an electron from an oxygen atom.

[3]

ii) A section of the macromolecular structure of silicon(IV) oxide is given below.

[2]



Use this diagram to explain why the formula is SiO_2 not SiO_4 .

iii) Predict **two** differences in the physical properties of these two oxides.

[2]

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(7 marks)

5 (a) The first three elements in Group IV are

Carbon

Silicon

Germanium

The element germanium has a diamond-type structure. Describe the structure of germanium. A diagram is acceptable.

(2 marks)

(b) Unlike diamond, graphite is soft and is a good conductor of electricity.

i) Explain why graphite has these properties.

[3]

ii) Give a use of graphite that depends on one of these properties.

Property

Use

[1]

(4 marks)

(c) **Separate: Chemistry and Extended Only**

Carbon dioxide and silicon(IV) oxide have similar formulae but different types of structure.

i) Give the formulae of these oxides.

[1]

ii) How are their structures different?

[2]

(3 marks)

6 (a) Extended Only

Lead is an excellent roofing material. It is malleable and resistant to corrosion. Lead rapidly becomes coated with basic lead carbonate which protects it from further corrosion.

Lead has a typical metallic structure which is a lattice of lead ions surrounded by a 'sea' of mobile electrons. This structure is held together by attractive forces called a metallic bond.

i) Explain why there are attractive forces in a metallic structure.

[2]

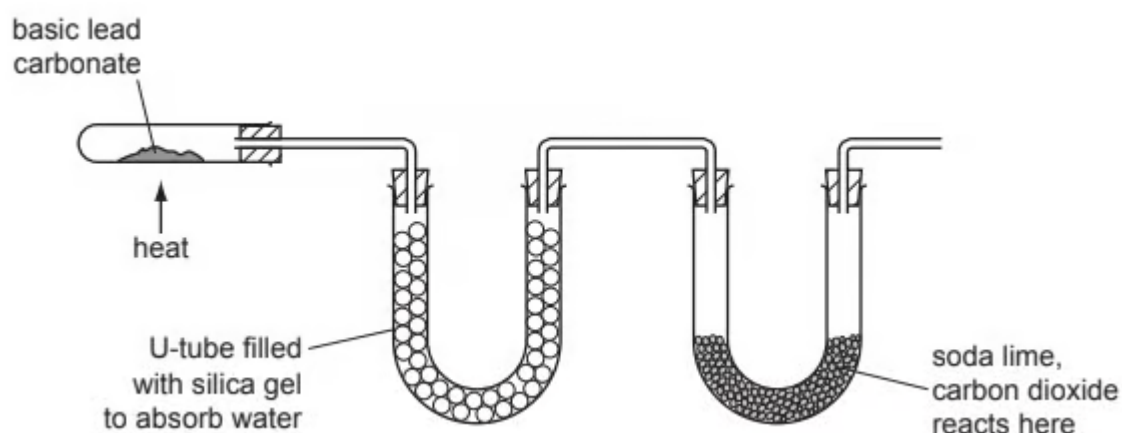
ii) Explain why a metal, such as lead, is malleable.

[2]

(4 marks)

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon

dioxide are produced.



Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink. Suggest a reason.

(1 mark)

(c) Separate: Chemistry and Extended Only

Basic lead(II) carbonate has a formula of the type $x\text{PbCO}_3 \cdot y\text{Pb(OH)}_2$ where x and y are whole numbers. Determine x and y from the following information.



When heated, the basic lead(II) carbonate gave 2.112 g of carbon dioxide and 0.432 g of water. Mass of one mole of $\text{CO}_2 = 44 \text{ g}$ Mass of one mole of $\text{H}_2\text{O} = 18 \text{ g}$ Number of moles of CO_2 formed =

[1]

Number of moles of H_2O formed =

[1]

$x = \dots\dots\dots$ and $y = \dots\dots\dots$

Formula of basic lead(II) carbonate is

[1]

(3 marks)

7 (a) Extended Only

An ore of the important metal zinc is zinc blende, ZnS. This is changed into zinc oxide which is reduced to the impure metal by carbon reduction.

i) How is zinc oxide obtained from zinc sulfide?

[2]

ii) Write a balanced equation for the reduction of zinc oxide by carbon.

[1]

iii) The major impurity in the zinc is cadmium. The boiling point of zinc is 907°C and that of cadmium is 767°C .

Name a technique which could be used to separate these two metals.

[2]

(5 marks)

(b) In common with most metals, zinc is a good conductor of electricity. It is used as an electrode in cells.

i) Give two other uses of zinc.

[2]

ii) Describe the metallic bonding in zinc and then explain why it is a good conductor of electricity.

[4]

(6 marks)