Bonding & Structure 4

Name: _____

Class: _____

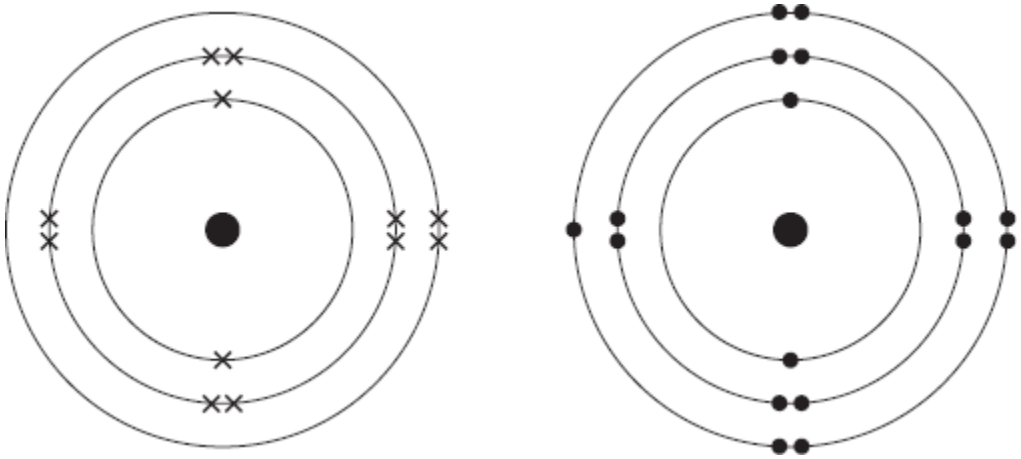
Date: _____

Time: **70 minutes**

Marks: **70 marks**

Comments:

1. (a) The diagram shows an atom of magnesium and an atom of chlorine.



Magnesium **Chlorine**

Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce magnesium chloride ($MgCl_2$).

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Calculate the relative formula mass (M_r) of magnesium chloride ($MgCl_2$).

Relative atomic masses (A_r): magnesium = 24; chlorine = 35.5

_____

_____

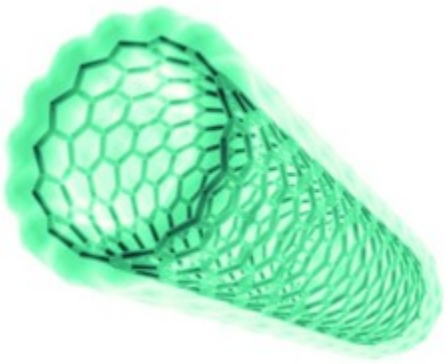
_____

Relative formula mass (M_r) = _____

(2)

(Total 6 marks)

2. Carbon atoms are used to make nanotubes.



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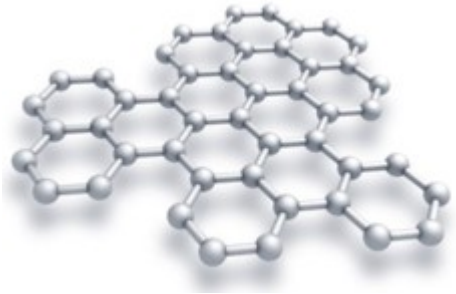
Carbon atoms in a nanotube are bonded like a single layer of graphite.

The figure below shows the structure of a single layer of graphite.



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(a) Suggest why carbon nanotubes are used as lubricants.

_____

_____

_____

_____

(2)

(b) Explain why graphite can conduct electricity.

_____

_____

_____

_____

(2)

(Total 4 marks)

3. Glass is made from silicon dioxide.

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(a) Silicon dioxide has a very high melting point.

Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide.

Suggest why.

_____

_____

(1)

(b) Sodium oxide is one of the substances added to silicon dioxide to make glass.

(i) Sodium oxide contains Na^+ ions and O^{2-} ions.

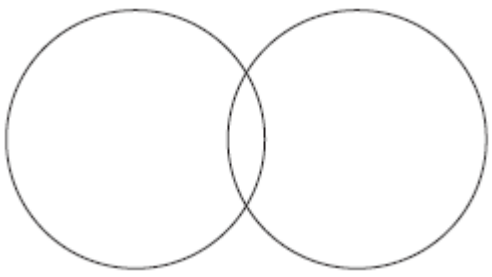
Give the formula of sodium oxide.

_____

(1)

(ii) Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O_2).



(2)

(c) Glass can be coloured using tiny particles of gold. Gold is a metal.

Describe the structure of a metal.

_____

_____

_____

_____

_____

_____

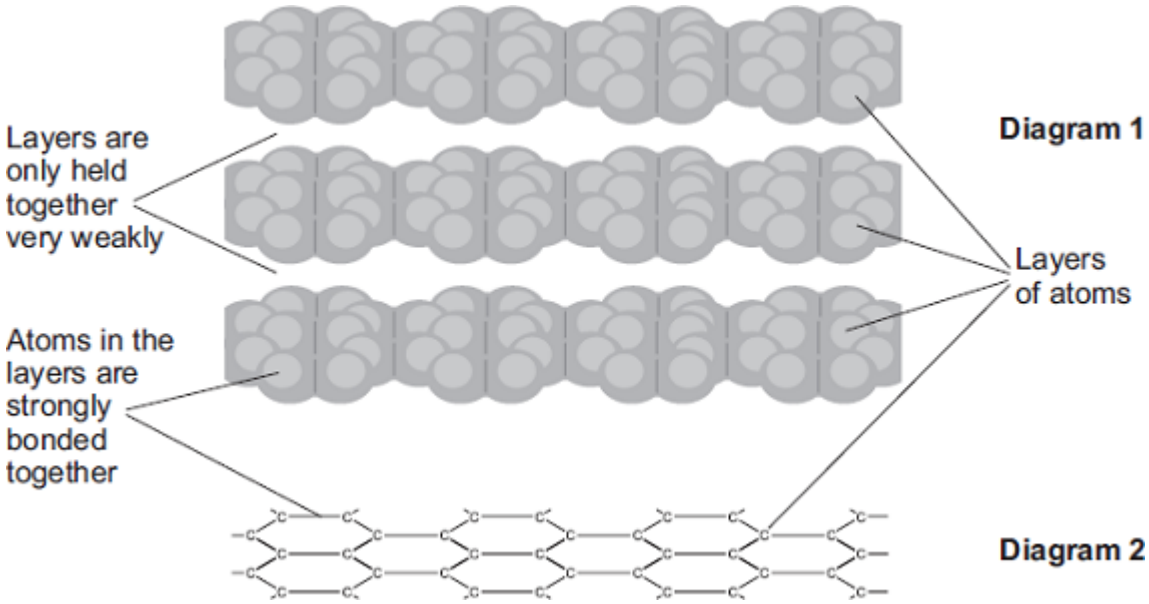
(3)

(Total 7 marks)

4. The picture shows a student filling in a multiple choice answer sheet using a pencil.

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 the diagrams to help you explain why graphite can rub off the pencil onto the paper.

_____

_____

_____

_____

(2)

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

covalent **ionic** **metallic**

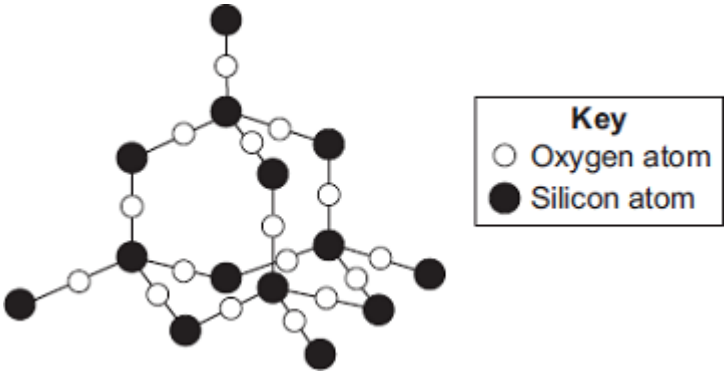
(1)

(Total 3 marks)

5. Silicon dioxide is used as a lining for furnaces.

Furnaces can be used to melt iron for recycling.

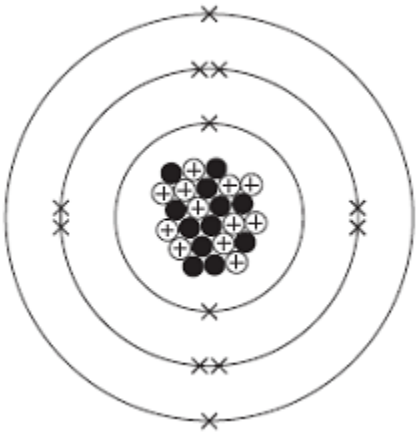
The diagram shows a small part of the structure of silicon dioxide.



Explain why silicon dioxide is a suitable material for lining furnaces.

(Total 4 marks)

6. The diagram represents a magnesium atom.



(a) Use words from the box to answer these questions.

electron	**neutron**	**nucleus**	**proton**

(i) What is the name of the central part of the atom? _____

(1)

(ii) What is the name of the particle with no charge? _____

(1)

(iii) What is the name of the particle with a negative charge? _____

(1)

(b) Use the diagram above to help you answer these questions.

(i) Draw a ring around the atomic (proton) number of this magnesium atom.

12 **24** **36**

(1)

(ii) Draw a ring around the mass number of this magnesium atom.

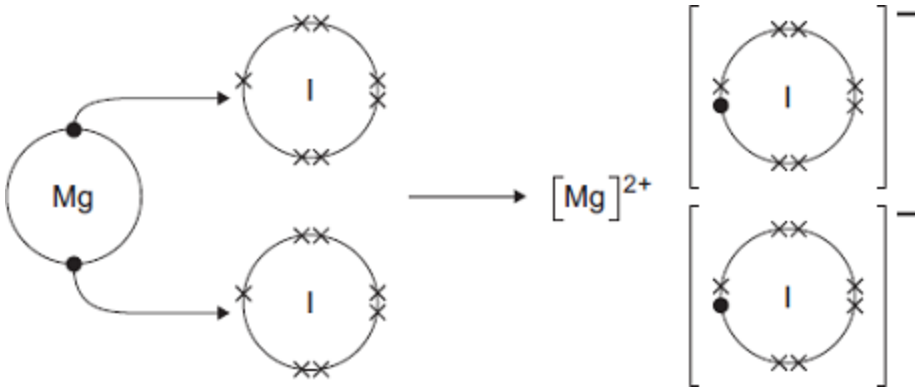
12 **24** **36**

(1)

(c) The diagram shows how magnesium and iodine atoms form magnesium iodide.

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.

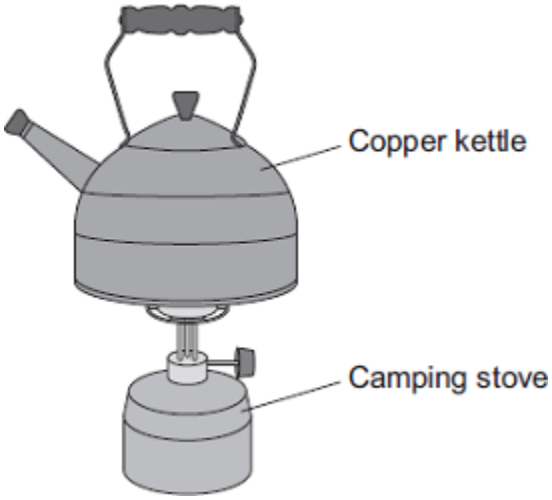
(4)

(Total 9 marks)

7. The picture shows a copper kettle being heated on a camping stove.

Copper is a good material for making a kettle because:

- it has a high melting point
- it is a very good conductor of heat.



(a) Explain why copper, like many other metals, has a high melting point.

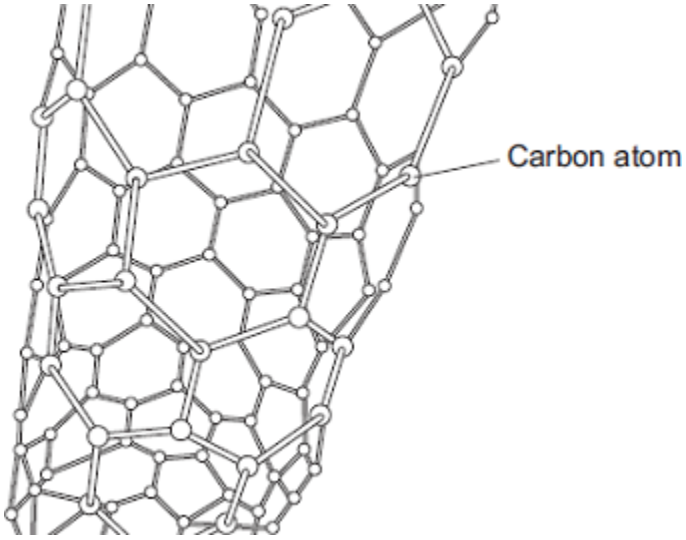
Your answer should describe the structure and bonding of a metal.

(4)

(b) Aeroplanes contain many miles of electrical wiring made from copper. This adds to the mass of the aeroplane.

It has been suggested that the electrical wiring made from copper could be replaced by carbon nanotubes which are less dense than copper.

The diagram shows the structure of a carbon nanotube.



(i) What does the term ‘nano’ tell you about the carbon nanotubes?

_____

_____

(1)

(ii) Like graphite, each carbon atom in the carbon nanotube is joined to three other carbon atoms.

Explain why the carbon nanotube can conduct electricity.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

8. Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

Relative atomic masses (A_r): H = 1; N = 14

_____

_____

_____

_____

_____

Mass of nitrogen = _____ tonnes

(3)

(ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

_____

_____

Percentage yield of ammonia = _____ %

(2)

(iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

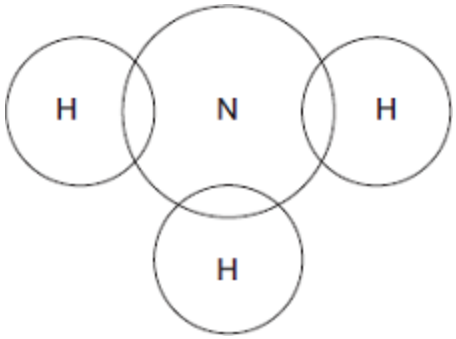
_____

_____

(1)

(b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (●) and crosses (x) to represent the electrons.



(2)

(c) Ammonia dissolves in water to produce an alkaline solution.

(i) Which ion makes ammonia solution alkaline?

_____

(1)

(ii) Name the type of reaction between aqueous ammonia solution and an acid.

_____

(1)

(iii) Name the acid needed to produce ammonium nitrate.

_____

(1)

(iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

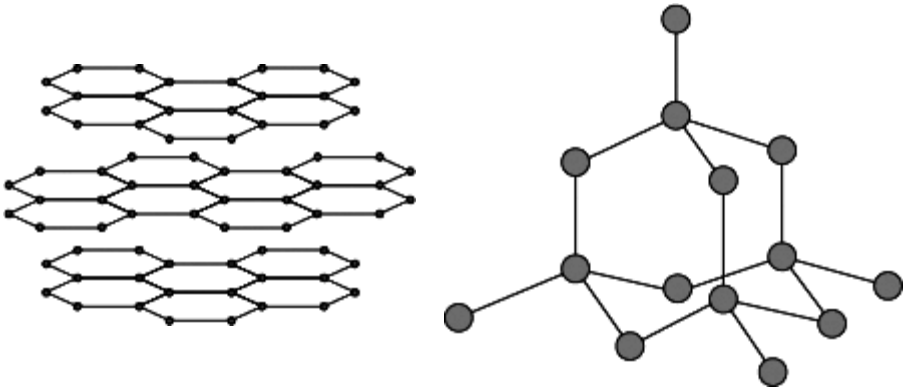
_____

(1)

(Total 12 marks)

9. Graphite and diamond are different forms of the element carbon.
Graphite and diamond have different properties.

The structures of graphite and diamond are shown below.



Graphite **Diamond**

(a) Graphite is softer than diamond.

Explain why.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Graphite conducts electricity, but diamond does not.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

10. This question is about gold (Au).

(a) An atom of gold is represented as:

$$^{197}_{79}Au$$

How many neutrons are in this atom of gold? _____

(1)

(b) Gold ions are used as a catalyst.

How does a gold atom (Au) become a gold ion (Au^{3+})?

_____

_____

_____

_____

(2)

(c) A gold catalyst can be used when carbon monoxide reacts with oxygen to make carbon dioxide.

(i) Complete and balance the equation for this reaction.

__ CO + _____ → ___ CO_2

(2)

(ii) Carbon dioxide has a very low boiling point.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(d) Gold is used as a catalyst in industrial processes. Gold is rare and increasingly expensive.

Suggest **three** reasons why gold is still used in industrial processes.

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

1. (a) magnesium loses electrons

there are four ideas here that need to be linked in two pairs.

1

two electrons

1

chlorine gains electrons

*magnesium loses electrons and chlorine gains electrons scores **2** marks.*

1

two atoms of chlorine

magnesium loses two electrons and two chlorines each gain one electron will score full marks.

1

(b) 95

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow 24 + 35.5 + 35.5 for **1** mark*

2

[6]

2. (a) nanotubes can slide (over each other)

allow nanotubes can roll (over each other)

1

because no (covalent) bonds between the nanotubes

*accept weak forces between the nanotubes **or** weak intermolecular forces*

allow layers for nanotubes throughout

1

(b) delocalised electrons

accept free electrons

1

so (delocalised) electrons can move through the graphite

accept so (delocalised) electrons can carry charge through the graphite

1

[4]

3. (a) *weaker bonds*

allow (other substances) react with the silicon dioxide

or

fewer bonds

ignore weaker / fewer forces

or

disruption to lattice

*do **not** accept reference to intermolecular forces / bonds*

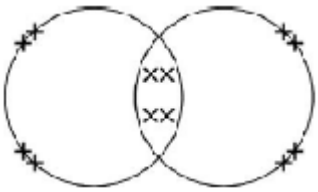
1

(b) (i) Na_2O

*do **not** accept brackets or charges in the formula*

1

(ii)



electrons can be shown as dots, crosses, e or any combination

2 bonding pairs

accept 4 electrons within the overlap

1

2 lone pairs on each oxygen

accept 4 non-bonding electrons on each oxygen

1

(c) *lattice / regular pattern / layers / giant structure / close-packed arrangement*

1

(of) positive ions **or** (of) atoms

1

(with) delocalised / free electrons

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = max **2***

1

[7]

4. (a) <u>layers</u>

which have weak forces / attractions / bonds between them

second mark must be linked to layers

1

or

which can slide over each other **or** separate

ignore references to rubbing

1

(b) covalent

1

[3]

5. high melting point

*reference to incorrect bonding **or** incorrect particles **or** incorrect structure = max **3***

accept will not melt (at high temperatures)
ignore withstand high temperatures

1

because a lot of energy needed to break bonds

1

because it is covalent **or** has strong bonds

accept bonds are hard to break

1

and because it is a giant structure **or** a macromolecule **or** a lattice

ignore many bonds

1

[4]

6. (a) (i) nucleus

1

(ii) neutron

1

(iii) electron

1

(b) (i) 12

1

(ii) 24

1

(c) any **four** from:

*sharing / covalent / metallic = max **3***

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

  allow iodine ion
- iodide has negative charge / is a negative ion / particle

  allow iodine

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

  *allow **1** mark for unqualified reference to ion formation or ionic bonding*

4

[9]

7. (a) *reference to incorrect bonding **or** incorrect structure **or** incorrect particles = max **3***

giant structure / lattice

ignore many bonds

1

made up of positive ions surrounded by delocalized / free electrons

allow positive ions surrounded by a sea of electons

1

with strong bonds / attractions

allow hard to break for strong

1

so a lot of energy is needed to break these bonds / attractions / forces

ignore high temperature

ignore heat

1

(b) (i) that they are very small

or

1-100 nanometres **or** a few(hundred) atoms

accept tiny / really small / a lot smaller / any indication of very small eg. microscopic, smaller than the eye can see

ignore incorrect numerical values if very small is given

1

(ii) delocalised / free electrons

allow sea of electrons

1

one non-bonded electron from each atom

accept electron(s) moving through the structure / nanotube

allow electron(s) carry / form / pass current / charge

1

[7]

8. (a) (i) M_r of NH_3 = 17

*correct answer with or without working gains **3** marks*

accept correct rounding of intermediate answers

can be credited from correct substitution from step 2

1

or

2 (moles of) NH_3 = 34

or

14 → 17

or

28 → 34

(28/34) × 6.8

allow ecf from step 1

1

or

(14/17) × 6.8

= 5.6

allow ecf from step 1

1

(ii) 61.8

accept 61.76 ***or*** *62* ***or*** *61.76…*

correct answer with or without working gains ***2*** *marks*

if answer is not correct evidence of 4.2 / 6.8 × 100 gains ***1*** *mark*

if answer not correct 0.618 or 0.62 gains ***1*** *mark*

2

(iii) reaction is reversible

accept reaction reaches equilibrium

allow reaction does not reach completion

ignore some is lost

1

(b) 3 bonding pairs

do ***not*** *accept extra electrons on hydrogen*

1

1 lone pair

accept 2 non-bonding electrons on outer shell of nitrogen

1

(c) (i) hydroxide / OH^-

accept phonetic spelling

1

(ii) neutralisation

accept acid-base

allow exothermic

1

(iii) nitric (acid)

allow HNO_3

ignore incorrect formula

1

(iv) $(NH_4)_2 SO_4$

allow $(NH_4^+)_2 SO_4^{2-}$

1

[12]

9. (a) **Graphite:**

because the layers (of carbon atoms) in graphite can move / slide

it = graphite

1

this is because there are only weak intermolecular forces **or** weak forces between layers

accept Van der Waals' forces allow no <u>*covalent*</u> *bonds between layers*

1

Diamond:

however, in diamond, each carbon atom is (strongly / covalently) bonded to 4 others

allow diamond has three dimensional / tetrahedral structure

1

so no carbon / atoms able to move / slide

*allow so no layers to slide **or** so diamond is rigid*

1

(b) because graphite has delocalised electrons / sea of electrons

allow free / mobile / roaming electrons

1

which can carry charge / current **or** move <u>through the structure</u>

1

however, diamond has no delocalised electrons

accept however, diamond has all (outer) electrons used in bonding

1

[7]

10. (a) 118

1

(b) it loses / transfers electrons

it = Au / gold atom

1

three electrons

*sharing / covalency = max **1** mark*

1

(c) (i) O_2

1

2 CO and **2** CO_2
or
correct balancing of equation from O

accept correct multiples / fractions throughout

1

(ii) *reference to incorrect bonding = **1** mark max*

because carbon dioxide is simple molecular / small molecules

1

there are <u>*intermolecular*</u> forces (between the molecules)

allow <u>intermolecular</u> bonds

1

so a small amount of energy needed (to separate molecules) **or** (*intermolecular forces*) are weak

1

(d) any **three** from:

- gold is the only catalyst for some reactions
- catalysts are not used up
- improves speed of reaction

  reduces amount of energy **or** process needs low(er) temperature

  *if no mark awarded, allow catalyst reduce costs (of the process) for **1** mark*

- only small quantities (of catalyst) needed

3

[11]