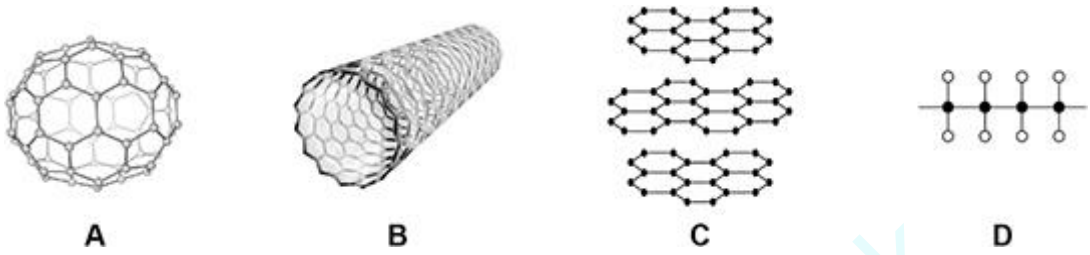
Q1.

This question is about carbon and compounds of carbon.

Figure 1 shows diagrams that represent different structures.

Figure 1



Use **Figure 1** to answer parts (a) and (b).

(a) Which diagram represents graphite?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which diagram represents poly(ethene)?

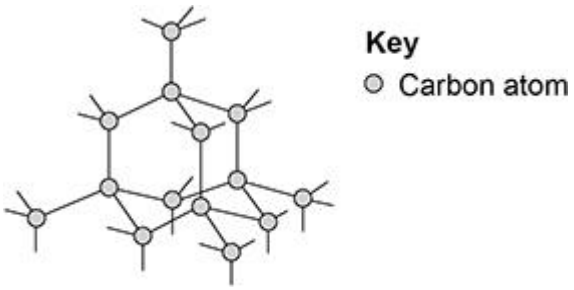
Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

Figure 2 represents the structure of diamond.

Figure 2



(c) How many covalent bonds does each carbon atom form in diamond?

_____

(1)

(d) Which is a property of diamond?

Tick (✓) **one** box.

Conducts electricity ☐

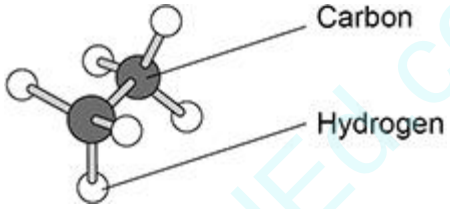
Low melting point ☐

Very hard ☐

(1)

(e) **Figure 3** shows a model of a molecule.

Figure 3



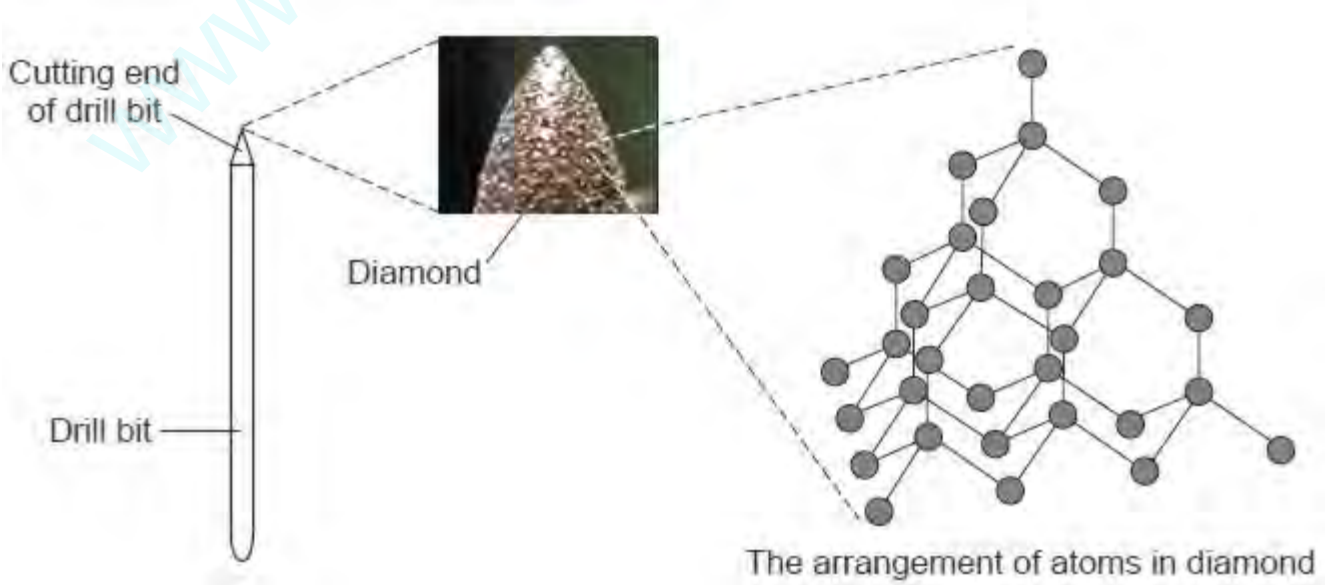
Complete the molecular formula of the molecule.

Molecular formula = C__ H__

(1)

Q2.

A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



Draw a ring around the correct word in each box.

(a) Diamond is made from [carbon / nitrogen / oxygen] atoms.

(1)

(b) Diamond has a giant structure in which [none / some / all] of the atoms are joined together.

(1)

(c) The atoms in diamond are joined together by [covalent / ionic / metallic] bonds.

(1)

(d) In diamond each atom is joined to [two / three / four] other atoms.

(1)

(e) Diamond is suitable for the cutting end of a drill bit because it is [hard. / shiny. / soft]

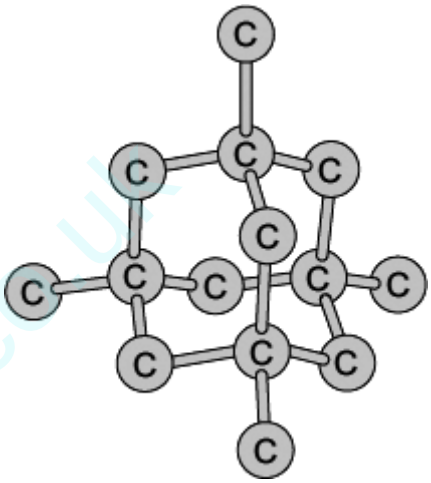
(1)

(Total 5 marks)

Q3.

Liquids containing nanoparticles of diamond are used as abrasives.
Nanoparticles of diamond can be used to grind down surfaces to give them a very smooth polished finish.

Abrasive liquid containing nanoparticles of diamond



Model of part of the diamond structure

(a) Diamond is made of one element.
Draw a ring around the name of this element.

calcium **carbon** **chromium** **cobalt**

(1)

(b) Tick (✓) **two** statements in the table which explain why diamond is hard.

Statement	Tick (✓)
It is made of layers.	
It has weak covalent bonds.	
Each atom is joined to four other atoms.	
It has a giant structure.	
It has strong ionic bonds.	

(2)

(c) Draw a ring around the correct answer to complete the sentence.

Nanoparticles of diamond are

very small.
large.
very large.

(1)

(Total 4 marks)

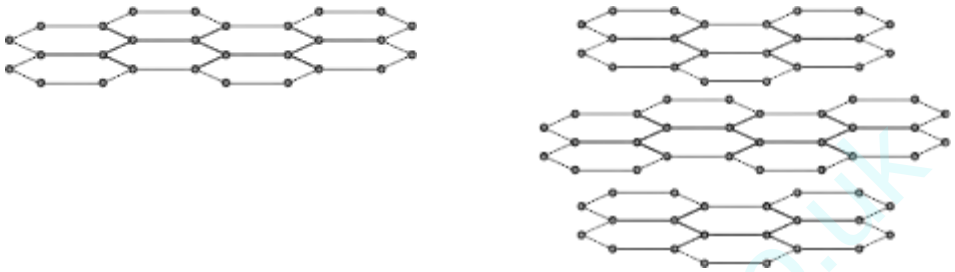
Q4.

Read the information

Graphene

Scientists have made a new substance called graphene.
The bonding and structure of graphene are similar to graphite.

Graphene is made of a single layer of the same atoms as graphite.



Graphene **Graphite**

Use the information above and your knowledge of graphite to answer the questions.

(a) This part of the question is about graphene.

Choose the correct answer to complete each sentence.

(i)

ionic	**covalent**	**metallic**

The bonds between the atoms in graphene are _____

(1)

(ii)

chromium	**carbon**	**chlorine**

Graphene is made of _____ atoms.

(1)

(iii)

2	**3**	**4**

In graphene each atom bonds to _____ other atoms.

(1)

(b) This part of the question is about graphite.

Graphite is used in pencils.

Explain why. Use the diagrams to help you.

_____

_____

_____

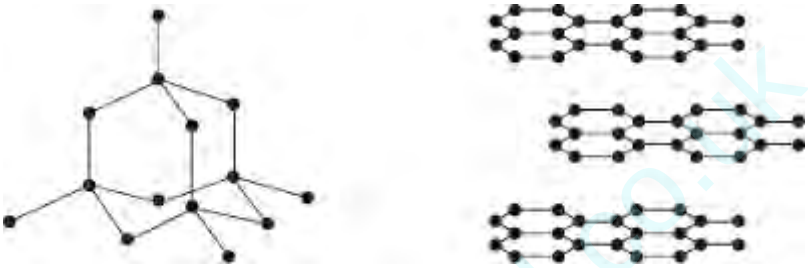
_____

(2)

(Total 5 marks)

Q5.

The diagrams show the structures of diamond and graphite.



Diamond **Graphite**

(a) Diamond and graphite both contain the same element.

What is the name of this element? _____

(1)

(b) Use the diagrams above and your knowledge of structure and bonding to explain why:

(i) graphite is very soft

_____

_____

_____

_____

(2)

(ii) diamond is very hard

_____

_____

_____

_____

(2)

(iii) graphite conducts electricity.

(2)

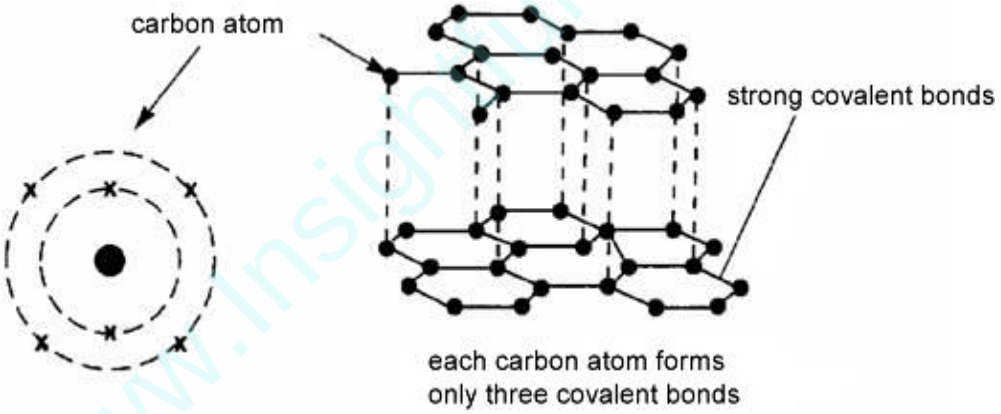
(Total 7 marks)

Q6.

(a) Copper is a metal.
Explain how it conducts electricity.

(2)

(b) Graphite is a non-metal.



Use the information to explain why graphite conducts electricity.

(3)

(Total 5 marks)

Q7.

This question is about diamonds.

Draw a ring around the correct answer to complete each sentence.

(a) Diamonds are found in meteorites.

(i) Meteorites get very hot when they pass through the Earth's atmosphere, but the diamonds do not melt.

Diamond has a | high / low / very low | melting point.

(1)

(ii) Most diamonds found in meteorites are nanodiamonds.

A nanodiamond contains a few | hundred / thousand / million. | atoms

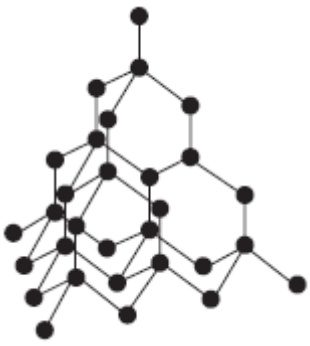
(1)

(b) Diamonds are used for the cutting end of drill bits.

Diamonds can be used for drill bits because they are | hard. / shiny. / soft.

(1)

(c) The figure below shows the arrangement of atoms in diamond.



(i) Diamond is made from [carbon / nitrogen / oxygen] atoms.

(1)

(ii) Each atom in diamond is bonded to [three / four / five] other atoms.

(1)

(iii) Diamond has a giant [covalent / ionic / metallic] structure.

(1)

(iv) In diamond [all / none / some] of the atoms are bonded together.

(1)

(Total 7 marks)

Q8.

This question is about substances containing carbon atoms.

(a) Diamond is made of carbon atoms.

(i) Diamond is used for tips of drills.

Figure 1 shows a drill.

Figure 1

© Kershawj/iStock

Give **one** reason why diamond is used for tips of drills.

_____

_____

(1)

(ii) Diamond nanoparticles can be made.

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

hundred	**million**	**thousand**

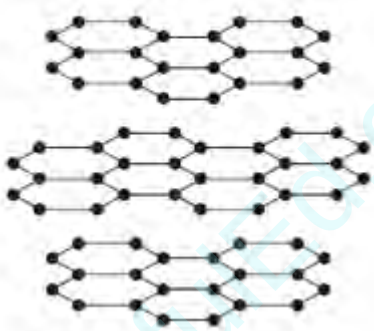
Nanoparticles contain a few _____ atoms.

(1)

(b) Graphite is made of carbon atoms.

Figure 2 shows the structure of graphite.

Figure 2



(i) What type of bonding does graphite have?

Tick (✔) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(ii) How many carbon atoms does each carbon atom bond to in graphite?

Tick (✔) **one** box.

1 ☐

2 ☐

3 ☐

4 ☐

(1)

(iii) What is a property of graphite?

Tick (✔) **one** box.

Dissolves in water ☐

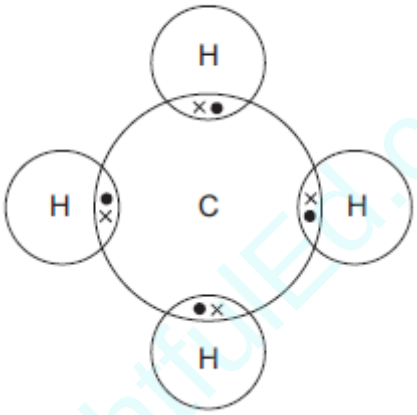
Has a low melting point ☐

Soft and slippery ☐

(1)

(d) **Figure 4** shows how the atoms are bonded in methane.

Figure 4



(i) What is the formula for methane?

Tick (✔) **one** box.

C_4H ☐

CH_4 ☐

C_4H_4 ☐

(1)

(ii) Methane has a low boiling point.

What does methane consist of?

Tick (✔) **one** box.

Charged ions ☐

A giant lattice ☐

Small molecules ☐

(1)

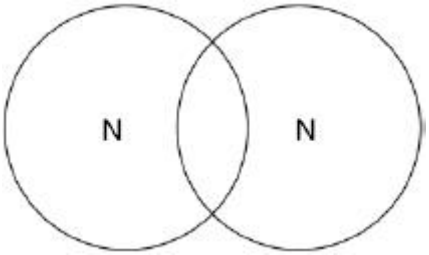
(Total 11 marks)

Q9.

This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, N_2

Show only the electrons in the outer shell.



(2)

(b) Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

_____

_____

_____

_____

_____

_____

(3)

(c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties.

Answer in terms of structure and bonding.

_____

_____

_____

_____

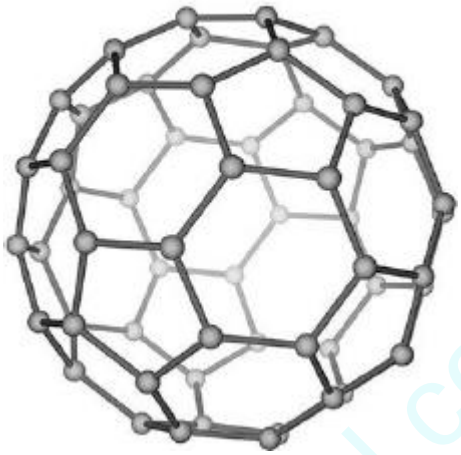
_____

_____

(4)

(d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

Figure 1



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant.

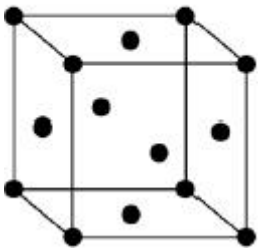
Use **Figure 1**.

(2)

Silver can form cubic nanocrystals.

Figure 2 represents a silver nanocrystal.

Figure 2



(e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

Surface area to volume ratio = _____

(3)

(f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

(2)

(Total 16 marks)

Q10.

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)

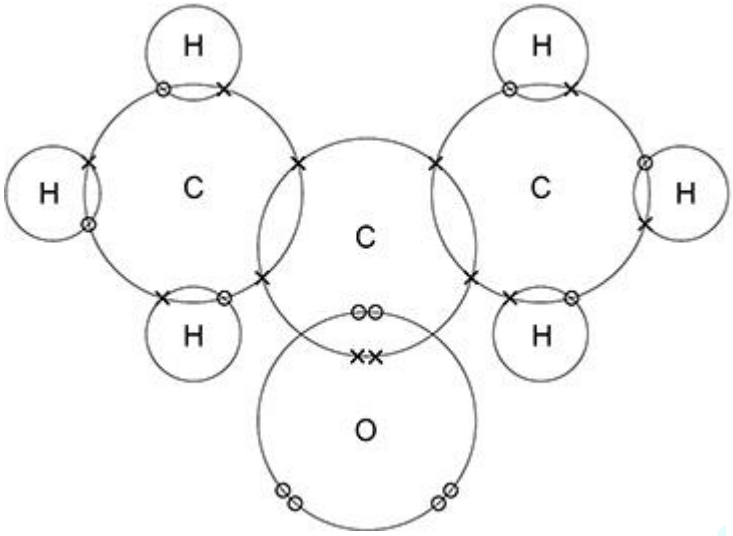
(b) Give **one** use of a fullerene.

(1)

Propanone is a compound of carbon, hydrogen and oxygen.

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

Figure 1

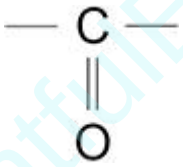


(c) Complete **Figure 2** to show a propanone molecule.

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. ☐

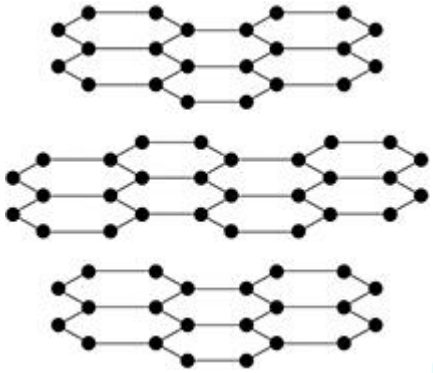
The intermolecular forces are strong. ☐

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)

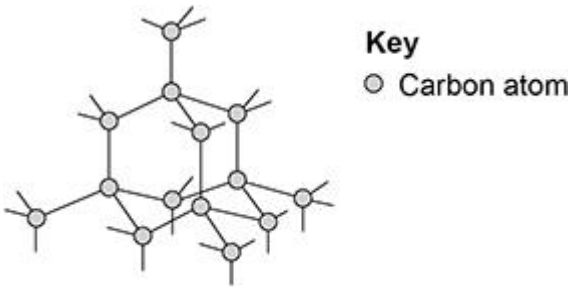
(Total 11 marks)

Q11.

This question is about different forms of carbon.

Figure 1 represents the structure of diamond.

Figure 1



(a) Describe the structure and bonding of diamond.

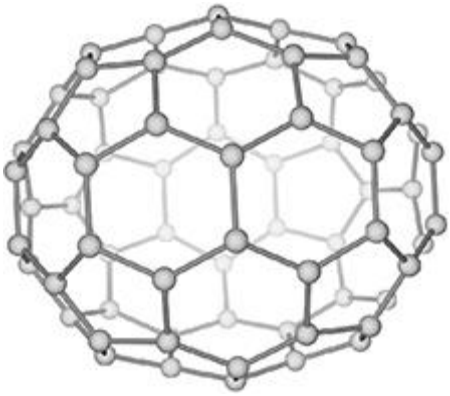
(3)

(b) Explain why diamond has a very high melting point.

(3)

Figure 2 represents the molecule C_{70}

Figure 2



(c) What is the name of this type of molecule?

Tick (✓) **one** box.

Fullerene ☐

Graphene ☐

Nanotube ☐

Polymer ☐

(1)

(d) Molecules such as C_{70} can be used in medicine to move drugs around the body.

Suggest **one** reason why the C_{70} molecule is suitable for this use.

_____

_____

(1)

Mark schemes

Q1.

(a) **C** **1**

(b) **D** **1**

(c) 4 / four **1**

(d) very hard **1**

(e) C_2H_6 **1**

Q2.

(a) carbon **1**

(b) all **1**

(c) covalent **1**

(d) four **1**

(e) hard **1**

[5]

Q3.

(a) carbon **1**

(b) each atom is joined to four other atoms **1**

It has a giant structure **1**

(c) very small **1**

[4]

Q4.

(a) (i) covalent

*two different answers indicated gains **0** marks*

1

(ii) carbon

*two different answers indicated gains **0** marks*

1

(iii) 3

*two different answers indicated gains **0** marks*

1

(b) layers can slide / slip

1

because there are no bonds between layers

accept because weak forces / bonds between layers

or so (pieces of) graphite rubs / breaks off

or graphite left on the paper

1

[5]

Q5.

(a) carbon

allow C

1

(b) (i) (atoms are in) layers (that) can slide over each other

1

because between the layers there are only weak forces

accept because there are no (covalent) bonds between the layers

accept Van der Waals forces between the layers

*do **not** allow intermolecular bonds between the layers*

*if no other marks are awarded allow weak intermolecular forces for **1** mark*

1

(ii) because each atom forms four (covalent) bonds **or** (diamond is a) giant (covalent) structure **or** lattice **or** macromolecular

*any reference to ionic / metallic bonding or intermolecular forces scores a maximum of **1** mark*

accept carbon forms a tetrahedral shape

1

(and) covalent bonds are strong

accept covalent bonds need a lot of energy / difficult to break

1

(iii) because graphite has delocalised electrons

allow sea of electrons

allow each carbon atom has one free electron

1

which can move <u>through the whole structure</u> (and carry the current / charge / electricity)

1

[7]

Q6.

(a) *idea that*

- copper has free electrons / electrons that move throughout the structure

  gains 1 mark

but

- in copper, electrons from the highest (occupied) energy level /outer shell, are free / can move throughout the structure

  gains 2 marks

2

(b) *idea that*

- in graphite, only three bonds are formed by each carbon atom

  for 1 mark

- one outer electron (per atom), free to move

  for 1 mark

- an electric current is a flow of (free) electrons*

  for 1 mark

(this mark to be given in **either** (a) **or** (b) but not in both)*

3

[5]

Q7.

(a) (i) high

1

(ii) hundred

1

(b) hard

1

(c) (i) carbon

1

(ii) four

1

(iii) covalent

1

(iv) all

1

[7]

Q8.

(a) (i) hard

ignore strong

1

(ii) hundred

1

(b) (i) Covalent

1

(ii) 3

1

(iii) Soft and slippery

1

(d) (i) CH_4

1

(ii) Small molecules

1

[11]

Q9.

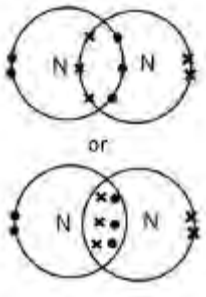
(a) six electrons in the overlap

allow dots, crosses or $e^{(-)}$ for electrons

1

2 non-bonding electrons on each nitrogen atom

***2** marks for an answer of:*



1

(b) weak forces

1

between molecules

or

intermolecular

do not allow references to covalent bonding between molecules

1

(which) need little energy to overcome

1

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

1

forming layers (of hexagonal rings)

1

(soft)
(because) layers can slide over each other

1

(conducts electricity)
(because of) delocalised electrons

1

(d) molecules are spherical

1

(so molecules) will roll

1

(e) surface area (= 20 × 20 × 6) = 2400 (nm^2)

1

volume (= 20^3) = 8000 (nm^3)

1

ratio = 0.3 (nm^3): 1 (nm^3)
ratio = 0.3 (nm^3): 1 (nm^3)
or
1 (nm^3): 3.33 (nm^3)

1

(f) (nanoparticles) have a larger surface area to volume ratio

1

so less can be used for the same effect

1

[16]

Q10.

(a) spherical

allow ball-shaped
ignore round / circular

1

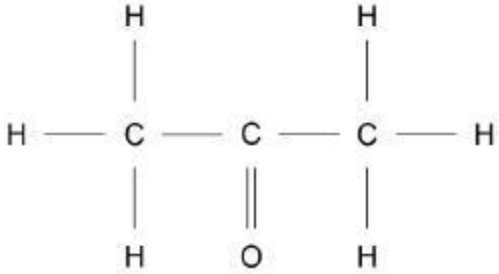
(b) any **one** from:

- 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]

Q11.

(a) giant structure

allow macromolecular

allow (giant) lattice

1

covalent (bonds)

1

four bonds per carbon / atom

1

(b) (covalent) bonds are strong

1

(and many covalent) bonds must be broken

1

(so) a lot of energy is required

1

(c) fullerene

1

(d) any **one** from:

- (C_{70} is) hollow

  allow (C_{70}) acts as a cage

  allow (C_{70}) traps the drug
- (C_{70} is) unreactive
- (C_{70} is) not toxic
- (C_{70} has) a large surface area to volume ratio

  ignore references to ease of movement around the body

1