Structure + Bonding Carbon

Mark Scheme

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.2 Bonding Structure + Props Matter
Sub-Topic	Structure + Bonding Carbon
Difficulty Level	Gold Level
Booklet	Mark Scheme

Time Allowed: **50 minutes**

Score: **/50**

Percentage: **/100**

Grade Boundaries:

M1.Level 3 (5–6 marks):

A detailed and coherent explanation applying knowledge of the properties of nanotubes, with
clear and logical links to reasons why carbon nanotubes have these properties

Level 2 (3–4 marks):
Description contains relevant statements that demonstrate clear knowledge of the properties of nanotubes. Attempt made to link properties to explanation of why these properties occur, but
logic may be unclear

Level 1 (1–2 marks):
Simple relevant statements of the properties of nanotubes, demonstrating knowledge, but no linking to an explanation of why these properties occur.

0 marks:
No relevant content.

Indicative content

properties:

- high tensile strength
- high electrical / thermal conductivity
- high melting point

explanations:

- nanotubes are fullerenes based on hexagonal rings of carbon atoms
- which means that each carbon forms three covalent bonds with three other carbon atoms
- covalent bonds are strong **or** need a lot of energy to break them
- so nanotubes are strong / have high tensile strength
- and have a high melting point
- the structure means that one electron from each carbon atom is delocalised
- as in metals and graphite, the delocalised electrons can move throughout the structure
- allowing the carbon nanotube / fullerene to conduct thermal energy and electricity

[6]

M2. (a) (i) *ionic / molecules / metallic / (inter)molecular = max **2***

because graphene / it has a giant structure / lattice / macromolecular
accept <u>all</u> / <u>every</u> / <u>each</u> atom is <u>bonded to</u> 3 other atoms

1

because graphene / it has covalent bonds / is covalent

1

because in graphene / the bonds are strong **or**
a lot of energy needed / hard to break the bonds

1

(ii) there are delocalised / free electrons

1

because one (delocalised / free) electron per atom linked to first marking point

accept because three electrons per atom used (in bonding)

accept because one electron per atom not used (in bonding)

1

(b) opaque (owtte)

eg could not see through them

or layers slide
or layers not aligned

ignore thick

1

[6]

M3. (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 covalent 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 through the structure

1

however, diamond has no delocalised electrons

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

1

[7]

M4. any **three** from:

any reference to incorrect bonding = max 2

- giant structure / lattice / macromolecule
- covalent (bonds)

- bonds are (very) strong
  allow bonds difficult to break
  ***or** takes a lot of energy to break bonds*
- each atom / carbon joined to four others
  accept each atom / carbon forms four bonds

3

[3]

M5. **five** ideas from the following for one mark each

- each carbon / atom joined / bonded to three other carbon / atoms **or** each carbon forms 3 bonds
- in layers
- only weak forces (of attraction) / bonds between layers
  allow weak electrostatic / intermolecular forces /bonds between layers
- layers / atoms can slide over each other
- one electron on each carbon is not used for bonding
- electrons delocalised **or** electrons free
  allow 'sea' of electrons
- electrons carry the charge / current
- giant structure / lattice
- covalent (bonds)
- strong bonds **or** a lot of energy needed to break bonds
  *reference to ionic bonding = **max 4***
  diagrams could be used:
  - *to show layered structure*
  - *to show that each carbon is bonded to three other carbon atoms*
  - *to show giant structure (at least 3 rings required)*

[5]

M6. (a) made of layers
of carbon atoms
weak forces of attraction between layers (owtte) / weak
vertical bonds i.e.
candidate refers to the diagram
layers can slide over each other
layers peel off
each for 1 mark

(b) because there are electrons
which are free (to move)
reason for free electrons / each carbon atom has 3 covalent bonds
each for 1 mark
to max 5

[5]

M7. (a) Quality of written communication: All scientific words used correctly (covalent, bonds, atoms)

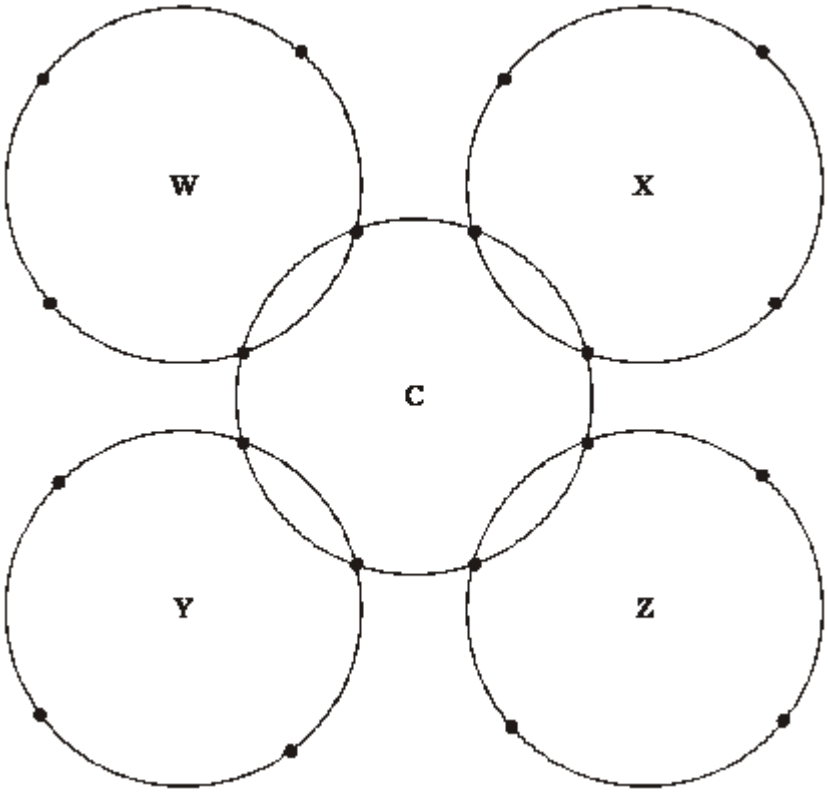
1

any **two** from

- large numbers of covalent bonds
  allow giant lattice / structure
- between atoms
  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]

M8. (a) 2 Na + Cl_2 → 2 NaCl

allow 2 Na^+ Cl^- for 1 mark

(allow Na + ½Cl_2 → Na Cl)

1

(b) (i) *idea that*

- it has strong (attractive) forces/bonds between ions / charged particles

for 1 mark

(not '..it has a rigid structure'- this defines a solid or '...particles close together' – they are in a liquid)

1

(ii) *ideas that*

- there is increased vibration of ions / particles on heating
- ions have sufficient energy to overcome attractive forces / to break out of the
- rigid structure / to move about

(must be in terms of increased energy of particles lions)

each for 1 mark

2

(iii)
- ions can go to electrodes / ions are free to move

for 1 mark
[do not credit 'ions carry charges']

1

(c) *ideas that*

- it has stronger attractive forces between atoms/particles *(not 'ions')*
- each carbon atom forms covalent bonds with neighbouring atoms

each for 1 mark

2

[7]

M9. (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]