AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



MARK SCHEME

4.2.3 STRUCTURE AND BONDING OF CARBON

SCORE	PERCENTAGE
/225	%

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Q1.

(a) 3.6 (cm^3)

1

(b) hydrogen line only

1

(c) both lines

1

(d) graphite has delocalised electrons

1

(e) **cathode** **anode**

zinc (1) chlorine (1)

*do **not** accept chloride*

*allow **1** mark if chlorine and zinc the wrong way around*

1+1

hydrogen (1) bromine (1)

*do **not** accept bromide*

*allow **1** mark if bromine and hydrogen the wrong way around*

1+1

[8]

Q2.

(a) **A**

1

(b) **D**

1

(c) **C**

1

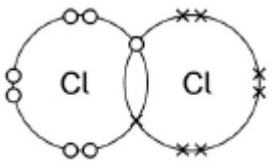
(d) **E**

1

(e) bonding pair of electrons drawn

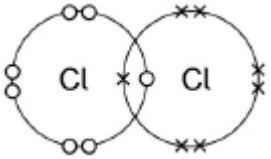
electrons can be dots, crosses or $e^{(-)}$ in any combination

eg

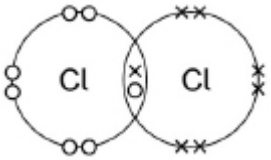


or

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or



*do **not** accept if electrons added to outer shells outside overlap*

1

(f) weak forces between molecules

1

(g) MnO

1

(h) ions move around in the liquid

1

[8]

Q3.

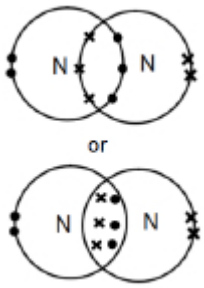
(a) six electrons in the overlap

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

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(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

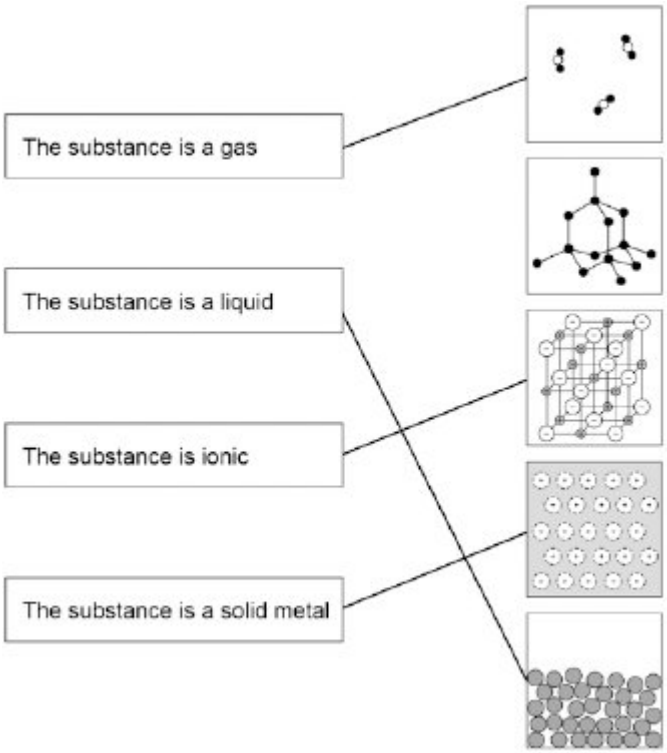
1

[16]

Q4.

(a) **Statement** **Structure**

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more than one line drawn from a variable negates the mark

4

(b) Carbon

1

(c) It has delocalised electrons

1

(d) the atoms / particles / ions are different sizes

*do **not** accept molecules*

1

so there are no rows / layers to slide

accept the layers are disrupted

1

(e) $\frac{2}{27} \times 100$

1

7.4%

1

*allow 7.4% with no working shown for **2** marks*

(f) Mixture

1

[11]

Q5.

(a) (i) hard

ignore strong

1

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(ii) hundred

1

(b) (i) Covalent

1

(ii) 3

1

(iii) Soft and slippery

1

(c) (i) cross-links

allow bonds

ignore links

*do **not** accept intermolecular*

1

(ii) melt

1

(iii) any **two** from:

- temperature

  allow heat(ing)
- pressure
- catalyst

2

(d) (i) CH_4

1

(ii) Small molecules

1

[11]

Q6.

(a) has delocalised electrons

accept free (moving) electrons

1

(so electrons) can move through the structure/metal

accept (so electrons) can carry charge through the structure/metal

accept (so electrons) can form a current

1

*reference to incorrect particles **or** incorrect bonding **or** incorrect structure = **max 1***

(b) giant structure

accept lattice

accept each atom forms four bonds (with other carbon atoms)

ignore macromolecular

1

strong bonds

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accept covalent

*do **not** accept ionic*

1

*reference to intermolecular forces/bonds **or** incorrect particles = **max 1***

(c) thermosetting polymers do not melt (when heated)

accept thermosetting polymers do not change shape (when heated)

accept thermosetting polymers have high(er) melting points

ignore thermosetting polymers do not soften (when heated)

1

due to cross-links (between chains)

accept due to bonds between chains

1

*reference to smart polymers = **max 1***

accept converse argument

[6]

Q7.

(a) any **one** from:

- protection / improve lifespan
- improve appearance.

1

(b) (i) Bleach

1

(ii) Hydrogen is less reactive than sodium

1

(iii) 1 bonding pair of electrons 6 unbonded electrons on Cl

accept dot, cross or e or − or any combination

1

(iv) Covalent

1

(v) Hydrogen chloride has a low boiling point.

1

Hydrogen chloride is made of simple molecules.

1

(c) (i) oxygen

accept carbon dioxide

1

(ii) aluminium ions are positive

1

so are attracted (to the negative electrode)

allow opposites attract

1

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(iii) Reduction

1

(iv) slide

allow move

1

(d) (i) C

1

(ii) strong covalent bonds

1

[14]

Q8.

(a) (i) giant lattice

allow each carbon atom is joined to three others

1

atoms in graphene are covalently bonded

*max. **2** marks if any reference to wrong type of bonding*

1

and covalent bonds are strong **or** need a lot of energy to be broken

allow difficult to break

1

(ii) because graphene has delocalised electrons

allow each carbon atom has one free electron

1

which can move throughout the structure

*do **not** accept just electrons can move.*

1

(b) because there are weak forces between molecules

allow no bonds between the layers

1

so layers / molecules can slip / slide.

1

[7]

Q9.

(a) (i) high

1

(ii) hundred

1

(b) hard

1

(c) (i) carbon

1

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(ii) four

1

(iii) covalent

1

(iv) all

1

[7]

Q10.

(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]

Q11.

(a) because atoms / ions / particles in alloy are different (sizes)

*do **not** allow reference to molecules*

ignore reference to compounds

1

so layers distorted

(and layers / atoms / ions / particles) don't slide **or** slide less easily

accept all marking points in a suitably labelled or annotated diagram

1

*if no other mark awarded accept an alloy is a mixture **or** contains different metals / elements for **1** mark*

1

(b) giant structure **or** lattice **or** macromolecule

*max **3** marks if incorrect bonding*

1

strong bonds (between carbon / atoms)

1

covalent (bonds)

1

each carbon / atom forms 4 bonds

accept tetrahedral

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*if no other marks awarded, allow carbon (atoms) for **1** mark*

1

(c) *reference to incorrect bonding = max **3***
*reference to 'weak covalent bonds' = max **2***
allow correctly drawn diagram for first two marking points eg. (tangled) lines with no cross-links

chains **or** large molecules

ignore layers

1

with intermolecular forces **or** forces between chains

allow bonds for forces accept no cross-links

1

that are weak

must relate to 2 nd marking point

1

and are easily overcome/ broken (when heated)

accept molecules / chains can flow / move

1

[11]

Q12.

(a) carbon

allow C

1

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

1

because <u>between</u> the layers there are only weak forces

accept because there are no (covalent) bonds <u>between</u> 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 <u>four</u> (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) <u>covalent</u> bonds are strong

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

1

(iii) because graphite has delocalised electrons

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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]

Q13.

(a) (i) C

1

(ii) C **or** D

1

(iii) A

1

(b) covalent

1

(c) layers

1

can slide / move over each other

accept are weakly bonded (owtte)
allow no bonds between layers
ignore slip / rub

1

[6]

Q14.

(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 <u>per atom</u> linked to first marking point

accept because three <u>electrons per atom</u> used (in bonding)
accept because one electron <u>per atom</u> not used (in bonding)

1

(b) opaque (owtte)

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eg could not see through them

or layers slide
or layers not aligned

ignore thick

1

[6]

Q15.

(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]

Q16.

(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

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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]

Q17.

(a) carbon

1

(b) each atom is joined to four other atoms

1

It has a giant structure

1

(c) very small

1

[4]

Q18.

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 <u>four</u> others

  accept each atom / carbon forms <u>four</u> bonds

3

[3]

Q19.

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(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]

Q20.

(a) the diameter of the tube is very small

1

(b) (i) three

1

(ii) covalent

1

(iii) bonds

1

[4]

Q21.

(a) any **four** from:

*max **3** marks if any reference made to covalent / ionic bonding / molecules or intermolecular forces **or** graphite / diamond **or** forces of attraction between electrons and then ignore throughout*

- giant structure / lattice

  ignore layers

- <u>positive</u> ions

- sea of electrons **or** delocalised / free electrons

  ignore electrons can move

- awareness of <u>outer shell</u> / highest energy level electrons are involved

- (electrostatic) attractions / bonds between electrons and <u>positive</u> ions

- bonds / attractions (between atoms/ ions) are strong

  allow hard to break for strong

  ignore forces unqualified

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- a lot of energy / heat is needed to break these bonds / attractions
  ignore high temperature

4

(b) (i) that they are very small
accept tiny / really small / a lot smaller / any indication of very small
eg microscopic, smaller than the eye can see

or

1–100 nanometres **or** a few (hundred) atoms
ignore incorrect numerical values if very small is given

1

(ii) any **2** from:

- one (non-bonded) electron from each atom
- delocalised / free electrons
  allow sea of electrons
  ignore electrons can move
- electron carry / form / pass current / charge
  ignore carry electricity

2

[7]

Q22.

(a) carbon

1

(b) all

1

(c) covalent

1

(d) four

1

(e) hard

1

[5]

Q23.

(a) 2,4 (drawn as crosses) on shells
accept dots / e / - etc.

1

(b) (i) hard
allow rigid / high melting point
*do **not** allow references to bonding*
ignore strong

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ignore unreactive
ignore structure

1

(ii) any **three** from

*max **2** if ionic / metallic / molecule / intermolecular bonds **or** incorrect number of bonds*

- giant structure / lattice / macromolecular
  allow many bonds
- covalent (bonds)
- (covalent) bonds are strong
  accept needs lots of energy to break bonds (owtte)
- (each) carbon / atom forms four bonds

  or

  (each) carbon / atom bonded to four other atoms

3

(c) any **three** from:

*max **2** if ionic / ions / metallic / molecule*
'it' needs to be qualified

graphite

- has delocalised / free electrons
  *do **not** accept the electrons move unless qualified (around structure etc)*

  or

  electrons that can move through / around the structure
- each carbon is joined to three other carbon atoms
  allow graphite has three bonds

  or

  one electron from each atom is free / delocalised

diamond

- has no free / delocalised electrons
  *do **not** accept the electrons do not move*

  or

  no electrons that move around the structure
- all the electrons are used for bonding
  allow diamond has 4 bonds

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or

each carbon joined to four other carbon atoms

3

[8]

Q24.

(a) reduce wear of metal ie don't get damaged

or *other sensible answer*

or

stop / reduce <u>friction</u>

accept stop metal heating up

accept move more smoothly

ignore make it slippery / rub more smoothly

or

prevent seizing

accept can move freely

1

(b) (i) carbon

1

(ii) layers (of atoms)

1

can slide / slip over each other

allow slip off

or

weak forces of attraction / weak bonds (between layers)

allow no bonds

accept there are weak forces of attraction for ***1*** *mark even when there is no reference to layers*

accept atoms slide over each other (for ***1*** *mark)*

an answer which ***only*** *states there are weak bonds would gain* ***0*** *mark when there is no reference to layers*

weak covalent bonds = ***0*** *marks*

1

[4]

Q25.

(a) any **two** from:

- conducts electricity
- soft

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- slippery
- high melting point

ignore hardwearing / does not stick

apply list principle

2

(b) (i) three

1

covalent

1

(ii) it is made of layers of atoms

1

[5]

Q26.

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]

Q27.

(a) electric current / electricity

1

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plus **one** from:

- is passed through ionic compound / substance / electrolyte
- passed through molten/aqueous compound / substance

  must be linked to electricity

  allow liquid compound / substance

  *do **not** allow solution / liquid alone*
- causing decomposition

  accept split up / breakdown / breaking up owtte

  ignore separated

  accept elements are formed

  ignore new substances form

1

(b) hydrogen

accept H_2

*do **not** accept H / H^2*

1

(c) one electron from each atom

accept each carbon is bonded to three other carbon atoms leaving one (unbonded) electron owtte

1

is delocalised / free (to move)

must be linked to electrons

*answers of delocalised / free electrons only, gains **1** mark*

*accept each carbon is bonded to three other carbon atoms leaving delocalised / free electrons = **2** marks*

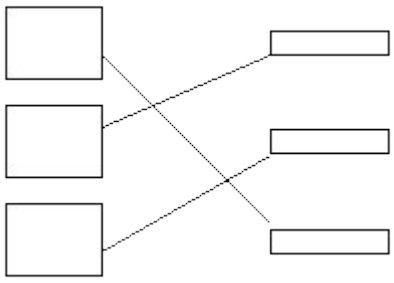
***maximum 1** mark if graphite described as a metal / giant ionic lattice*

1

[5]

Q28.

(a)



*all three lines correct gains **2** marks*

*one or two correct gains **1** mark*

if there are more than 3 lines then lose mark for each extra line

2

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(b) (i) covalent

1

(ii) four

1

(iii) hard

1

(iv) three

1

(v) soft

1

(c) carbon

accept C

1

Q29.

(a) M_r (SiO_2) = 60

if M_r incorrect ecf for max 2

1

60 g SiO_2 → 28 g Si

*correct answer for **3** marks*

1

2.14 g SiO_2 → 1 g Si

allow 2, 2.1, 2.14 (or anything rounding to 2.14), 2.16 or 2.2

a unit is not required but an incorrect unit loses the third mark

OR M_r (SiO_2) = 60 (1)

moles if silicon needed = $\frac{1}{28}$ = 0.0357

mass of SiO_2 needed = 0.0357 × 60 (1)

= 2.14 g (1)

allow 2, 2.1, 2.14 (or anything rounding to 2.14), 2.16 or 2.2

OR M_r (SiO_2) = 60 (1)

mass SiO_2 = 1 × $\left(\frac{60}{28}\right)$ (1)

= 2.14 g (1)

allow 2, 2.1, 2.4 (or anything rounding to 2.14), 2.16 or 2.2

3

(b) (i) $MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$

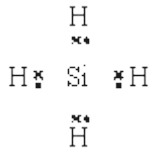
*penalise incorrect symbols correctly balanced equation for **1** mark state symbols for **1** mark*

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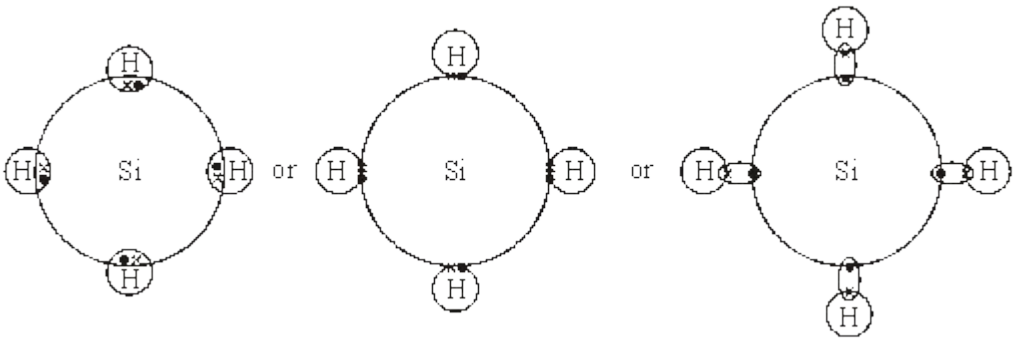
allow correct multiples / fractions

2

(ii)



or



ignore inner shell electrons of silicon
allow correct drawings without symbols
must clearly indicate four shared pairs of electrons with one electron from each atom

(iii) **Si** **H**

$\frac{1.4}{28}$ $\frac{0.15}{1}$

1

= 0.05 = 0.15

1

1 3

for whole number ratio can be implied

1

SiH_3

*accept H_3Si **or** any correct formula with 1:3 ratio*
if in step 1 they get either of ratios incorrect they lose first 2 marks but can be ecf for 3rd and 4th mark
evidence of mass / A_r ***1*** *mark*
proportions of each ***1*** *mark*
whole number ratio ***1*** *mark*
correct formula ***1*** *mark*

1

(iv) **C**

accept c

1

(c) any **four** from:

- giant structure / macromolecule / lattice / giant molecule
  allow giant molecular / giant atomic structure

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- each silicon atom joined to four other atoms
  (or diagram)
- covalent bonds
- bonds are strong **or** large amount of energy needed to break bonds
  accept hard to break bonds
- large number of bonds to be broken
  *mention of giant **ionic** structure **or** intermolecular forces **or** intermolecular bonds max **1** mark*
  *diamond **or** carbon discussion max **3** marks unless clearly linked to silicon*

4

[15]

Q30.

(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]

Q31.

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

1

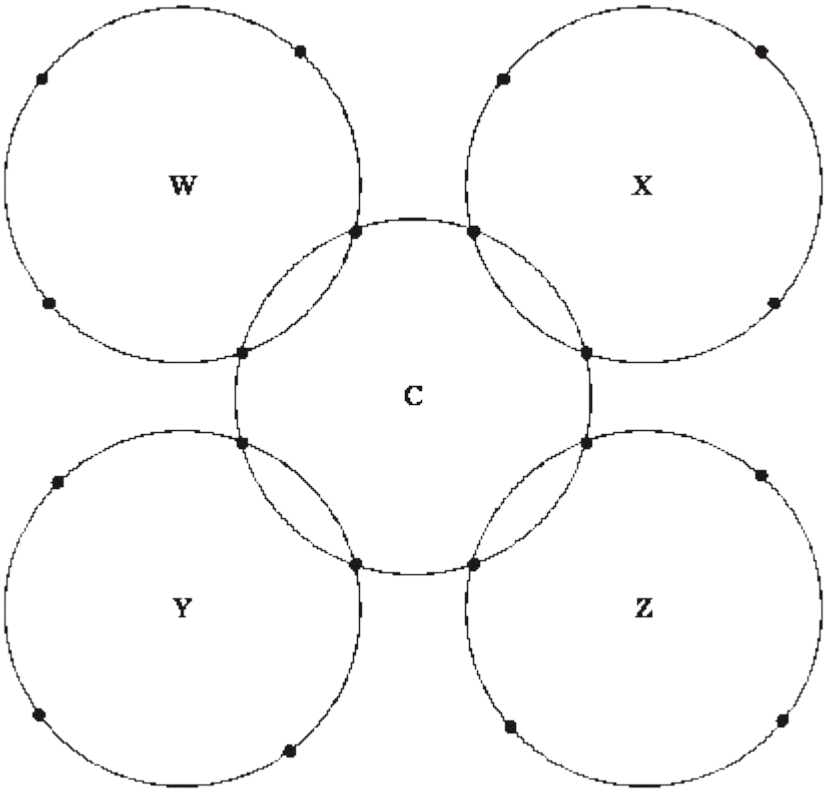
any **two** from

- 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)

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each carbon has 4 electrons

1

one shared pair

1

four shared pairs

1

[6]

Q32.

(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

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- 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]

Q33.

(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]

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