PRACTICE EXAMINATION QUESTIONS FOR TOPIC 3.1 BONDING MS

1. (a)

![Diagram](image)

[Diagrams must be complete and accurate]

(b) (i) Attraction /electrostatic forces/bonds/attractions between (positive) ions/lattice and delocalised/free electrons/sea of electrons.

[Not metallic bonding]    [Not just ‘forces’]

(ii) Electrostatic attractions/forces between ions or attractions between (oppositely charged) ions/ Na⁺ & Cl

[Not ionic bonding]

(iii) (Here) the ionic bonding in NaCl is stronger/requires more energy to break than the metallic bonding in Na

QoL. Accept ‘bonding/forces of attraction in NaCl is stronger than in Na’

[If IMF/molecules/van der Waals'/dipole–dipole mentioned in parts(i) or (ii), then CE = 0 for parts (i) and/or(ii) and CE = 0 for part(iii)]

(c) Comparison:

Sodium conducts and sodium chloride does NOT conduct

Allow ‘only Na conducts’

Accept ‘Na conducts, NaCl only conducts when molten’

[Do not accept sodium conducts better than sodium chloride etc.]

Explanation:

(Delocalised) electrons flow though the metal

Allow e⁻ move/carry current/are charge carriers/transfer charge.

[Not ‘electrons carry electricity’]

[Not ‘NaCl has no free charged particles’]

Ions can’t move in solid salt

(d) Layers can slide over each other – idea that ions/atoms/particles move

[Not molecules]    [Not layers separate]
2. (i) 

\[
\begin{align*}
\text{BF}_3 & \quad \text{Trigonal planar/planar triangular} \\
\text{BF}_4^- & \quad \text{Tetrahedral}
\end{align*}
\]

[Do not allow shapes which show a lone pair]

Equal repulsion between (4) bonding pairs/bonds/bonding electrons

\[
109(\frac{1}{2})^\circ
\]

(ii) Lone pair donated / both electrons supplied by one atom

from F⁻ (to B)

[ignore missing charge or fluorine or ‘atom’]

dative/dative covalent/coordinate bonding

3. 

QoL Linear (1) beat / V-shaped / angular (1)

(mark name and shape independently)

(accept (distorted) tetrahedral)

(if balls instead of symbols, lose M1 – can award M2)

(penalise missing ‘Cl’ once only)

(not ‘non-linear’)

4. (a) 

(Missing ‘H’ penalise once only) 

[NOT dot-and-cross diagrams]

\[
\begin{align*}
\text{NH}_3 & \quad \text{[NOT 90° / 180° angles]}
\end{align*}
\]

\[
\begin{align*}
\text{NH}_2^- & \quad \text{(need 2 lp & ‘bent’ shape)}
\end{align*}
\]
(b) 107°

(c) More lone pairs on NH₂⁻, than on NH₃
Lone pairs repel more than bonding pairs  *Must be comparison*  
(Mark separately)  
*[NOT repulsion between atoms or between bonds]*  

5.

(a) (electrostatic forces of) attraction / held together by interactions between (1)
positive ions / cations / nuclei *not* just metal ions (1)
and delocalised or free (outer shell) electrons / ‘sea’ of electrons / cloud of electrons (1)
allow 2 marks for ‘electrons can flow’

(b) *Conductivity* clear indication that electrons are mobile / can move (1)
electrons / carry charge / care charge carriers / move in same direction *not* ‘so current can flow’
allow 2 marks for ‘electrons can flow’
*malleability*: cations / positive ions / atoms in the lattice are all identical / the same size / (planes of) ions (atoms) can slide easily over one another (1)
attractive forces in the lattice are the same whichever ions (atoms) are adjacent / attractive forces remain the same throughout the lattice (1)

(c) more electrons delocalised / more outer shell electrons (1)
in aluminium compared with magnesium / reference to Al³⁺ and Mg²⁺ (1)

6. (a) tendency / strength / ability / power of an atom / element / nucleus to attract / pull / withdraw electrons / e⁻ density / bonding pair / shared pair in a *covalent* bond

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(b) (i) \( F_2 = \text{van der Waals'} / \text{induced/temporary dipole-dipole} / \text{dispersion} / \text{London forces} \)
\( \text{CH}_3\text{F} \) dipole-dipole (not just 'dipole')
\( \text{HF} = \text{hydrogen bonding (not just 'H' / 'hydrogen')} \)

(ii) large difference in electronegativity between H and F / F most/very/much more electronegative / values '4' & '2.1' quoted
(not just 'higher')
\( \delta^+\text{H-F}\delta^- \) dipole created or dipole clearly implied
(accept arguments such as 'uneven charge in bond'/'polar bond'
(F slightly negative/H slightly positive)
attraction/bond formed between \( \delta^+\text{H} \) and lone pair on F
(M2/M3 may be scored from a diagram)
(CE if full charges shown - lose M2 and M3)

(c) (i) van der Waals' / induced/temporary dipole-dipole / dispersion / London forces / attractions (ignore references to dipole-dipole)
increase with the increasing M2 / size / mass / N1 of e– / size of e– cloud (in the hydrogen halides)
(if ionic, or if 'covalent bonds broken' = CE = 0)
(mark M1 and M2 separately)

(ii) hydrogen bonding stronger than van der Waals' attraction/forces
(accept hydrogen bonding is very strong / strongest)
(accept arguments such as 'HF has H-bonds, others only have van der Waals')
(not just 'HF has H-bonding')

7. (a) Oxygen more/very/highly electronegative (than hydrogen)
OR oxygen has stronger attraction for bonding electrons / bonding electrons drawn towards oxygen;
causes higher e– density round oxygen atom / causes \( \delta^-\text{O} \delta^+ \);

(b) van der Waals’ forces between oxygen molecules;
Hydrogen bonding between methanol molecules;
H-B stronger than van der Waals’ OR stronger IMF in methanol;
(if dipole-dipole forces in \( \text{O}_2 \) or methanol, allow comparison, hence max 2)
(if ionic/covalent etc. max 1)
(mention of bond break = CE = 0)
8. (a) (i) 

M1  Si:  cross ≥ 1200  
M2  Cl:  cross below S  
M3  Ar:  cross below Cl 

[allow, even if M2 wrong]  
[If Cl cross missing and Ar below S, allow M3]

(ii) Si is macromolecular/giant molecular/giant covalent/ giant atomic  
Covalent bonds need to be broken/accept ‘overcome’ 
[Not loosened/weakened]  
Covalent bonds are strong / many covalent bonds involved/requires much energy/hard to break 
[Tied to ‘break’ or near miss in M2]  [Not ‘structure’ is broken]  
[Must mention ‘covalent’ somewhere in part (a)(ii) to earn M2/M3]  

[If van der Waals’/IMF mentioned M2/M3 = CE = 0.  
If ions mentioned M1/M2/M3 = CE = 0]

(iii) Intermolecular force = van der Waals’/induced dipole–dipole/dispersion forces  
QoL  Sulphur has greater M / size / surface area/more electrons/more atoms so stronger intermolecular forces (comparison)  
[Mark separately]  [Not ‘more shells’]

(b) Trend:  Decreases  
[If trend wrong = CE = 0]

Increase in size of ion/atom / more shells / decrease in charge density / decrease in charge size ratio  
Weaker attraction for delocalised/free/sea of electrons / weaker metallic bonding  
[Ignore shielding] [van der Waals’ etc. = CE = 0 for M2 and M3]  

[11]
9. trend: increases; 1
   more protons / higher charge on cation / more delocalised e⁻ / smaller
   atomic/ionic radius; 1
   stronger attraction between (cat)ions and delocalised/free/mobile e⁻
   OR
   stronger metallic bonding; 1

10. (a) (i) positive ions (1)
    (attract) delocalised electrons (1) (or sea of or free or mobile) (1)
    Confusion with -ve ions
    or ionic lattice C.E. = 0

    (ii) more protons (1) (or Mg²⁺ more charge than Na⁺)
    attracts delocalised (or bonding) electrons more strongly (1)
    Delocalised: can be brought forward from (a) (i)
    OR more delocalised electrons (1)
    Attacks positive ions more (1)
    Metallic bonding is stronger scores one mark, only given if
    no other marks awarded

    (b) macromolecular (1) (or giant molecule etc)
    covalent (1)
    strong covalent bonds (1)
    or bonds require much energy to break

    (c) delocalised (OR free or sea of or mobile) electrons (1)

    (d) Planes (1)
    weak (bonds) forces between planes (1)
    or vdw forces between planes

11. (a) Bonding in Na₂S: ionic (1)
    Bonding in CS₂:  covalent (1)
    ignore other words such as dative / polar / co-ordinate

    (b) Clear indication of electron transfer from Na to S (1)
    1 e⁻ from each (of 2) Na atoms or 2 e⁻ from 2 Na atoms (1)
    QL correct English
12. (a) (i) [Diagram]

(ii) vibrate faster (1)
Or bigger amplitude or more
NOT start to vibrate or other type of motion esp. Translation
Ignore rotation

(b) (i) from sodium (1)
Allow from sodium ion, also from metal

(ii) difference in electronegativity (1)

13. (a) dative / coordinate (covalent) bond;
Lone/non-bonding pair / both electrons;
(donated) from P to H+;

(b) \( \text{PH}_3 \) \( \text{PH}_4^+ \)

\[ \text{P} \quad \text{H} \quad \text{H} \quad \text{H} \] \[ \text{H} \quad \text{H} \quad \text{P} \quad \text{H} \quad \text{H} \]

(1) (1)

pyramidal OR trigonal pyramid \( 109(1/2)^\circ \);
14. (a) Ability (or power) of an atom to attract electron density (or electrons or -ve charge) \( \text{(1)} \) in a covalent bond (1) 
   or shared pair  
   If remove an electron lose first mark

   (b) Trend: increases (1)  
       Explanation: nuclear charge (number of protons) increases (1)  
       electrons in same shell (1)  
       OR similar shielding  
       OR atoms similar size or smaller

15. (a) (i) 3 (bonding) pairs of electrons (1)  
           allow 3 bonds  
           repel equally (1) (or as much as possible)  
           Or get as far apart as possible

   (ii) Predicted bond angle: \( 118^\circ \) (allow 117 - 119\(^\circ\)) (1)  
        Explanation: lone pair (1)  
        repels more than bonding pair (1)  
        Allow EXP if \( \angle < 118^\circ \)  
        but C.E. = 0 if \( \angle \geq 120^\circ \)

   (b) Name of shape: Tetrahedral (1)  
       Example: CH4 etc (1)  
       Allow correct ion

   (c) (i) 90\(^\circ\) (1)

   (ii) lone pairs (or they) repel more than bonding pairs (or most) (1)  
        (so are) as far apart as possible (1)  
        Mark independently

   (iii) square planar (1)  
        allow square

   (d) 3 bonds + 1 lone pair (1)  
        correct shape (1)  
        only give this mark if first mark also given  
        Penalise sticks (i.e. N-) once but N must be shown

16. (a) vibration (1)
   about a fixed print (1)
   random (1)
   (or free to move)  

(b) weak intermolecular forces (1)
   v.d.w forces
   easily broken (1)
   or requires little energy to break

(c) conducts electricity (1)
   delocalised electrons (1)
   (or converse argument for sodium chloride - no mobile charges)
   malleable (1)
   or ductile, softer
   planes of atoms slide (1)
   (or converse argument for NaCl - ionic lattice)
   or Ag insol. in water (1)
   not ionic (1)
   or conducts heat (1)
   deloc. electrons (1)
   or shines (1)
   metallic bonding (1)
   or high density (1)
   large Ar, close packed (1)
   or sonorous (1)
   metal (1)

   **Note** 1. If property of NaCl given instead of Ag can score reason mark
               2. for reasons can allow reason why NaCl is different

(d) BeCl₂  NCl₃  BeCl₄²⁻

   Cl—Be—Cl (1)
   N—Cl—Cl (1)
   180° (1)
   106 – 108° (1)

   Cl
   Cl
   Cl
   Cl
   109 – 109.5° (1)

   [15]

   **Note** 1. Mark angles independently
               BUT wrong number of electron pairs on diagram CE=O
               2. penalise “sticks” (i.e no Cl) once only
               3. accept ‘dot-cross’ diagram for BeCl₂ - only for NCl₃ BeCl₄²⁻ if clear.
17. diagram showing a tetrahedral arrangement of four oxygen atoms around a central silicon atom (must include attempt at a 3-d representation) (1) tetrahedral (1) 109.5° / 109° / 110° (1) [3]

18. (a) more compact (1) 1
(b) (i) and (ii)

(c) 4 bond pairs, 1 lone pair (1) 4

(d) Type 1 van der Waals’ (1) Type 2 dipole – dipole (1) 2 [11]

19. (a) electrostatic (1) 1
(b) shared electron pair (1) 1

(c) both electrons, electron pair (1) 2
(d) (positive) ions (or atoms) (1)
delocalised electron (1) (or sea of, or mobile, or free)
(mention of ionic, covalent bonding or molecules CE=O) 2

(e) (i) Charge separation (or unequal sharing of electrons) (1)
leading to δ+ & δ– ends (1)
also gains first mark

(ii) chlorine more electronegative then H (1)
or chlorine is electronegative, difference in electronegativity
attracts electrons towards C1 (1)
allow chloride instead of chlorine

(iii) van der Waals’ (1)

or {v.d.w, temp dipole, include dipole, London

(f) \[ \text{H—F} \]

\[ \begin{array}{c}
\text{δ}^+ \\
\text{H} \\
\text{δ}^-
\end{array} \]

3 lone pairs on F (1)

δ+ on H (1)

H (δ+) adjacent to lone pair on F (1)

(note H⁺—F⁻ CE = max 1)

(g) bromine not sufficiently electronegative (1)

{or lone pair too diffuse

{or bond not polar enough

{or little electronegativity difference

allow bromide

20. (a) van der Waals’ (1)

dipole - dipole (1)

energy needed to overcome (intermolecular or vdw or dipole-dipole) forces (1)
21. (a) covalent (1)  
covalent (1)  
ionic (1)  
(b) sodium sulphide / Na₂S (1)  
liquid / molten / aqueous solution (independent of first mark) (1)  

22. (a) partial charges on atoms of bond / centres of positive and negative charges do not coincide / bonding pair shared unequally (1)  
not just bond between elements of different electronegativity  
not just ‘bond with dipole’  
allow clarification by diagram, but not just a diagram  

(b)  
\[ \text{\[5\]} \]

[c]  
hydrogen bonding (1)  
attraction between (\(\delta^+\) of) H atoms and (\(\delta^-\) of) O atoms in adjacent or different molecules (H of one molecule, O of another) (1)  
mark these points independently  

\[ \text{\[5\]} \]
23. (a)

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Sketch of shape</th>
<th>Bond angle(s)</th>
<th>Name of shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>BF\textsubscript{3}</td>
<td>![Sketch of BF\textsubscript{3}]</td>
<td>120° (1)</td>
<td>Trigonal planar (1)</td>
</tr>
<tr>
<td>NF\textsubscript{3}</td>
<td>![Sketch of NF\textsubscript{3}]</td>
<td>107° ± 1° (1)</td>
<td>Tetrahedral or pyramidal (1)</td>
</tr>
<tr>
<td>ClF\textsubscript{3} or Trigonal bipyramid or trigonal planar</td>
<td>![Sketch of ClF\textsubscript{3}]</td>
<td>87° to 90° and/or 118° to 120°</td>
<td>(1)</td>
</tr>
</tbody>
</table>

(b) \textit{BF\textsubscript{3}} van der Waals’ (1)
\textit{NF\textsubscript{3}} van der Waals’ (1) dipole-dipole (1)  

(c) \textit{Name of bond} co-ordinate (1)
\textit{Explanation} lone pair on N (1)
donated (or shared with) to B (or BF\textsubscript{3}) (1)  

24.

(e) H N H δ+ H 

shape (1)
δ + on H (1)
d δ + attracted to lone pair (1)
25. (a) power of an atom (allow element) to attract electron(s) (1)
in a covalent bond (1)

*not ion or molecule*

(b) increases (1)
nuclear charge increases (1)
attracting electrons in same shell (1)
(or similar shielding)

do not allow size arguments

trend must be correct to score 'explanation' marks

(c) ionic (1)
big difference in electronegativity (1)
or idea of magnitude of difference

covalent (1)

smaller electronegativity difference (1)
or similar electronegativity or e.neg (S) > e.neg (Na)

26. (a) shared electron pair (1)
both electrons from one atom (1)

(b) \[ A + : B \rightarrow A : B \] (or \[ \text{NH}_3 + \text{H}^+ \rightarrow \text{NH}_4^+ \text{etc} \]) equation (1)
final species (1)

(c) chlorine is more electronegative than sodium (1)
an electron transfers from sodium to chlorine (1)

(d) smaller electronegativity difference (1)
so more equal sharing (1)

(e) mobile (free) ions (1)

(f) carbon forms 4 bonds (1)
gives a macromolecule (1)
iodine forms only one bond (1)

27. (a) strong (accept if reasonably qualified) (1)
electrostatic attractions or similar such as “held” (1)

between ions held in a lattice (1)
(b) vibrations (1)
increase (1)
as temperature increases until the vibrations are so violent that
the ions break free at the melting point.
(some indication of translational movement of the particles) (1) 3

(c) high melting point/boiling point (1)
electrical conductivity when molten (or in solution) (1) 2

28. (a) Shared pair of electrons 1

29. (a) (i) power / tendency / ability to attract electrons [must be plural]
not gain (1)
in a covalent bond / from a bonding pair / bonding electrons (1) 2
(ii) van der Waals’ forces / induced dipole - induced dipole / intermolecular
attractions increase (1)
as Mr increases / number of electrons increases (1)
size / radius / number of shells increase 2

(iii) higher due to hydrogen bonding / (strong) dipole - dipole attractions (1)
caused by large (difference in) electronegativity of fluorine / clear
indication (1)
that intermolecular forces in HF are stronger than in (ii) 2
(accept diagram)

(b) (i) SO$_4^{2-}$ (1) 1
(ii) 109.5° (1) 1

30. (a) ionic (1)

(b) (i) 2 lone pairs (1) (allow lone pairs in any position)

shape (1)

trigonal bipyramid (1) (or T-shaped etc)
31. (a) (i) hydrogen atom bonded to highly electronegative atom / to N, O or F / hydrogen containing molecule with a strong dipole (1) condone mention of Cl if with other correct atoms 1
(ii) van der Waals’ / (induced or temporary) dipole-dipole (1) sulphur not sufficiently electronegative / too large / only small difference in electronegativity (1) 2
(iii) intermolecular attractions in H₂S much weaker / in H₂O are stronger (1) than the hydrogen bonding in water / so less energy needed to overcome forces (1) not more bonds in H₂O 2

(b) (i) both C=O and N–H bond polar / correct polarity of both bonds shown (1) since electronegativity N>H and O>C (1) H– bonding between –Hδ⁺ and = Oδ⁻ in different molecules (can allow H– bonding in same molecules if clear that folding / higher order structure is being referred to) (1) using lone pair of electrons on O atom (could be on diagram) (1) 4

32. (a) (lattice of) metal ions / positive charges / cations not nuclei (1) with a ‘sea’ of delocalised electrons not cloud (1) held together by (electrostatic) attraction / forces between ions / nuclei and electrons / opposite charges (not negative ions) (1) 3
(b) Mg / Mg²⁺ smaller than Na / Na⁺ metallic radius smaller / Mg close packed (1) Mg / Mg²⁺ higher charge than Na / Na⁺ (1) magnesium contributes more electrons than Na (1) therefore stronger (electrostatic) attractions / stronger metallic bond(ing) (1) max 3
(c) sodium and graphite conduct, diamond does not (1) delocalised or free electrons in graphite (1) single bonded structure of diamond / diamond has no free or delocalised e⁻ (1) conduction due to delocalised electrons flowing (1) 4

33. (a) large difference in electronegativity → ionic (1) small difference in electronegativity → covalent (1) 2

(b) ionic (1) 1

34. (a) 105° (allow 104–106°) (1) 1
(b)  4 electron pairs round O (1)
    tetrahedral (or \(109^\circ\)) (1)
    lone pairs repel more than bonding pairs (1)
    \(\therefore\) angle < \(109^\circ\) (or less than tetrahedral angle) (1) 4

(c)  hydrogen bonding (1) 1

d)  F more electronegative than H (1)
    pulls electrons from H (1) 2

(e)  Prediction  > \(105^\circ\) (or increases) (1)
    Explanation  lone pair more like bonding pair
    \(\therefore\) does not repel so strongly (1) 2

35.  (a)  Element with lowest melting point  neon (1)
    Explanation  free atoms (1)
    weak van der Waals forces (1) 3

(b)  *Element with highest melting point*  silicon (1)
    Explanation  macromolecular (1)
    covalent bonds (1) 3
36. **Structure and hardness**

- **M1** Q of L: both macromolecular/giant atomic/giant covalent/giant molecular; 1
- **M2** C atoms in diamond joined to 4 other C atoms / diagram with min 5 C atoms i.e. shows tetrahedral shape / coordination number = 4; 1
- **M3** C atoms in graphite joined to 3 other C atoms diagram with clear extended hexagonal plane/pattern i.e. shows trigonal planar shape / coordination number = 3; 1
- **M4** diamond hard / crystal strong; 1
  
  *not diamond stronger than graphite*
- **M5** because of 3-D structure / rigid structure / not layered; 1
- **M6** graphite (soft) as layer can slide over each other; 1
- **M7** Q of L: as only (weak) van der Waals’ forces between layers; 1

**Melting point (for either allotrope)**

- **M8** covalent bonds must be broken / overcome; 1
- **M9** which are strong / many / hard to break; 1

*(M9 tied to M8)*

**Other difference**

- **M10** diamond is non-conductor of electricity, graphite is conductor 1

*OR appropriate difference in appearance;*

37. **QoL**

**Bonding** Both covalent *(linked statement)* 1

**Structure** Iodine = molecular /I₂ (stated or in diagram) 1

*[treat incorrect diagram as contradiction]*

Diamond = giant molecular/macromolecular/giant covalent / giant atomic (stated only)

*Reference to van der Waals’/dipole-dipole = contradiction*

**QoL** Iodine Weak van der Waals’ forces / induced dipole-induced 1
dipole

Diamond Covalent bonds would need to be broken 1
Many / strong covalent bonds **OR** much energy needed 1

*Tied to M5 or near miss*

*[If ionic/metallic structure suggested then CE for that substance]*

*[If hydrogen bonding suggested, for I₂ lose M2 & M4; for diamond lose M3,M5&M6]*
38. giant lattice (1) of covalent bonds (1)
need to break covalent bonds to melt red phosphorus (1)
need to break Van der Waal’s forces to melt white phosphorus (1)
covalent bonds are stronger than Van der Waal’s forces (1) [5]

39. (a) SF₆ shown as octahedral / square based bipyramid (1)
Bond angle: 90° or 180° and 90° (1)
Shape = octahedral (1)
If lone pair shown then C.E.= 0 / 4

Wrong symbols - no diagram mark

Equal repulsion between 6 bonding or shared electron pairs QoL (1)

AlCl₄⁻ shape shown as tetrahedral (1)
Bond angle = 109° to 109.5° (1)
Shape = tetrahedral (1)
If lone pair shown then C.E = 0/4

(Equal repulsion between) 4 bonding pairs or shared electron pairs (1)
QoL may be awarded here also
Mark all points independently

(b) Solvent has low bp or weak intermolecular forces or evaporates quickly (1)
(Solvent) needs energy to evaporate (to overcome intermolecular forces)
or valid reference to latent heat of vaporisation (or evaporation is endothermic) (1)
OR higher energy or faster molecules more likely escape
so mean energy (and hence temperature) falls
Energy taken from the skin (and so it cools) (1)
Fragrance or perfume (molecule) slowly spreads (through the room) (1)
By random movement or diffusion (of the perfume / fragrance) (1) [12]
40. (a) I\textsubscript{2} sublimes when heated / has low melting point AND graphite has (very) high melting point (1)

I\textsubscript{2} is (simple) molecular / I\textsubscript{2} / I-I (1)

\[ CE = 0 \text{ if ‘ionic’} \]
\[ \text{loses } M2, M3, M4 \]
\[ \text{Max 1 if I-I bond broken} \]

Van der Waals forces / induced or temporary dipole-dipole / London forces (1)

Which are weak or easily overcome (so low melting point) (1)

Graphite is macromolecular / giant covalent / giant molecular / giant atomic / (1)

Diagram

\[ \text{min 3 correctly fused rings – ignore diagram unless no description offered} \]
\[ CE = 0 \text{ if ‘ionic’ or ‘metallic’ loses } M5, M6, M7 \]

(Many) covalent bonds need to be broken (1)

\[ \text{covalent may be inferred from structure} \]

Which takes much energy / bonds are strong (1)

Only graphite conducts (1)

\[ \text{NOT just graphite is a better conductor} \]

As it has delocalised / free / mobile electrons (1)

All e\textsuperscript{-} in iodine are used in bonding and lone pairs

OR as it has no delocalised / free / mobile e\textsuperscript{-} (1) Max 9

\[ M9 \text{ and } M10 \text{ tied to correct statements about graphite = conductor and iodine = non-conductor} \]

(b) Diagram Cl–Be–Cl (clearly linear) (1)

\[ CE = 0 \text{ if lone pair(s) on Be, loses } M1 \text{ and } M2 \]

(Equal) repulsion between 2 bonding pairs / bonds (1)

\[ ‘2’ \text{ may be inferred from a correct diag} \]
\[ NOT \text{ repulsion between Cl atoms} \]

2
41. (a) Macromolecular or giant structure (1)
   Accept diamond shaped lattice
   Intermolecular forces / molecular lattice / comparison to
   graphite structure, = ‘con’
   Held together by covalent bonds (1)
   ‘Giant covalent structure’ earns both M1 and M2
   (Much) energy needed to break bonds  Or many bonds to be broken (1)
   Mark tied to earning ‘covalent’ M2 If explanation is clearly of ionic bonding = CE
   Vand der Waal / temporary induced dipole-dipole / London / disperse forces (1)
   Forces increase with size or with number of electrons or with surface area etc. (1)
   Description must be of the molecules of P and S
   \[ P_4 \text{ or } M_r = 124 \text{ (1)} \]
   \[ S_8 \text{ or } M_r = 256 \text{ (1)} \]
   If M6 (i.e. P₄) and M7 (i.e. S₈) are not attempted, allow
   S molecule bigger /more surface area than P molecule for 1 mark

(b) Diagram NaCl = cubic (1)
   Allow if 3 full faces shown correctly
   \[
   \begin{array}{c}
   \text{Cl}^- \\
   \text{Na}^+ \\
   \text{Cl}^- \\
   \text{Na}^+ \\
   \text{Cl}^- \\
   \text{Na}^+ \\
   \end{array}
   \]
   Ions identified and placed properly (1)
   If diagram shows ‘+’ and ‘−’ signs rather than symbols for ions,
   identification of the ions could be from the text
   (Bonding) identified in writing as being ionic (1)
   Not ionic molecule
   Due to strong electrostatic attractions or similar description
   about attraction between oppositely charged ions. (1) QoL
   Not just: ‘ionic bonds are strong’ / ‘need much energy to break
   bonding’
Pattern in the change in the properties of a row of elements (1)
OR Trend in the properties of elements across period
Repeated in the next row (1)
OR element underneath (or in same group) has similar properties

atomic radius
decreases across the row (1)
CE if trend is wrong
number of protons increases (1) (or nuclear charge increases)
more attraction for electrons in the same shell (1)

electronegativity
increases across the row (1)
number of protons increases (1) (or nuclear charge)
atomic radius decreases (1) (or shielding remains the same or electrons in the same shell) more attraction for bonding or shared electrons (1)

conductivity
decreases row (1)
OR significant drop from Al to Si
Na–Al metals (1)
OR metallic bonding or description of metallic bonding
Two of Si - Ar non metals (1)
OR molecular or covalent
EITHER electrons free to move (delocalised) in metals
OR electrons unable to move in non-metals (1)
43. (a) Ionic (1) lattice (1) e.g. NaCl (1) conducts when molten (1) due to mobile ions (1) 

![Ionic lattice diagram]

sketch scores (2) { 4 ions placed correctly in a square (1) 
{ extended to 3 dimensions (1) max 6

macromolecular (1) covalent (1) e.g. diamond (or graphite) (1) conductor (or conducts when solid) (1) electrons localised in covalent bonds (or delocalised electrons in rings) (1)

diamond graphite 
tetrahedral round a C (1) 2 ‘fused’ hexagons (1)
extended from other Cs (1) 2 layers (planes) (1)

![Graphite and Diamond Diagrams]

max 6

molecular (1) or molecules

covalent (1) e.g. iodine (1) etc 
weak (van der Waals) forces between molecules (1) non conductor (1) electrons localised (1)

![Molecular Structure Diagram]

regular array of molecules

example of a metal (eg Mg) (1) metallic bonding (or stated to be a metal) (1) positive ions (or atoms) (1) surrounded by delocalised electrons (1) conducts when solid (1) due to delocalised electrons (1)
sketch scores \[1\]

e.g. \[ \begin{array}{c}
\text{Note if candidate deals with two crystals of the same type eg diamond & graphite, award max 3 for worst of the two answers} \quad \text{max 6}
\end{array} \]

(b) 5 electron pairs \(1\)
including one lone pair \(1\)
repel as far apart as possible \(1\)
lone pair – bond pair repulsion > bp – bp \(1\)
pushes S–F bonds closer together \(1\)

\[
\text{shape is } \quad \begin{array}{c}
F \quad \text{or} \quad \begin{array}{c}
F \\
S \\
F
\end{array}
\end{array}
\]

angles \(<90 \quad \text{or} <120 \quad \text{or} \quad (<90 \text{ and } 120)\) \(1\)
\(\begin{array}{c}
(85 – 89) \\
(115 – 119)
\end{array} \quad \begin{array}{c}
(85 – 89) \\
(115 – 120)
\end{array}\)

\text{N.B. if not 5 pairs of electrons can score only 3rd & 4th marks} \quad \text{max 8}

44. From the graph:
\begin{itemize}
\item Mg above Na \(1\)
\item Al similar to or above Mg \(1\)
\item Si above Na and Mg \(1\)
\item P lower than Mg, Al and Si \(1\)
\item S above P, lower than Si \(1\)
\item Ar lowest \(1\)
\end{itemize}
\(7\)

Sodium, magnesium and Al metallic \(1\)
Strength of metal-metal bonds increases from Na to Al \(1\)
More protons (or bigger charge on ion or more delocalised electrons) \(1\)
Ions attract delocalised electrons more strongly \(1\)
\(4\)

Silicon has covalent bonds \(1\)
Macromolecule \(1\)
Many strong bonds to be broken \(1\)
\(3\)

\begin{itemize}
\item S\(_8\) \(1\)
\item P\(_4\) \(1\)
\item Cl\(_2\) \(1\)
\end{itemize}
weak intermolecular forces \(1\)
van der Waals’ \(1\)
Stronger between larger molecules \(1\)
\(6\)
Argon consists of free atoms with weak van der Waals’ forces between atoms \(1\)
\(1\)

[26]

[21]
from diag (cubic (1) ions (or Na, Cl or +,–) placed correctly (1) 
(minimum of 4 species) 
from diag or stated (ionic (1) lattice (1) 
high mpt (1) due to strong ionic bonds (1) 
conducts when molten (or in solution) (1) mobile ions (1)  
[OR non conductor when solid (1) no mobile ions (or electrons) (1)] 8

from diag (3 hexagons in any one layer (1) planes (1)) 
stated or from diag: macromolecular (1) 
must be stated: covalent (1) 
high mpt (1) due to strong covalent bonds (1) 
conducts when solid (1) delocalised electrons (1)  
Note if free not delocalised mentioned penalise 
once only: for quality of language

from diagram: spheres close together (1) 
stated or from diagram (hexagonal in one plane or lattice (1) 
ions (1) delocalised electrons (1) 
high mpt (1) strong metallic bonds (1) 
conducts (1) delocalised electrons (1) 8

Max 23

(b) electron pairs repel as far apart as possible (1) 
lone pairs repel more (1)
Note if angles not drawn on diagram penalise once only