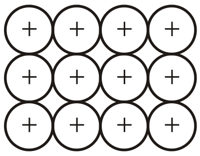
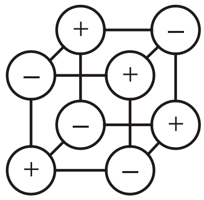
PRACTICE EXAMINATION QUESTIONS FOR TOPIC 3.1 BONDING MS

1. (a)



(1)



(1) 2

[Diagrams must be complete and accurate]

(b) (i) <u>Attraction</u> /electrostatic forces/bonds/attractions between (positive) ions/lattice and <u>delocalised/free</u> electrons/sea of electrons. 1

[Not metallic bonding] *[Not just 'forces']*

(ii) Electrostatic attractions/forces between ions or attractions between (oppositely charged) ions/ Na^+ & Cl 1

[Not ionic bonding]

(iii) (Here) the ionic bonding in NaCl is stronger/requires more energy to break than the metallic bonding in Na 1

QoL *Accept 'bonding/forces of attraction in NaCl is strong<u>er</u> 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 1

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 1

Allow e^- move/carry current/are charge carriers/transfer charge.

[Not 'electrons carry electricity']

[Not 'NaCl has no free charged particles']

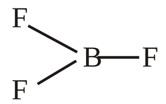
<u>Ions</u> can't move in solid salt 1

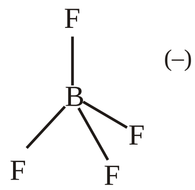
(d) Layers can slide over each other – idea that ions/atoms/particles move 1

[Not molecules] *[Not layers separate]*

[9]

2. (i)





2

(1) **(1)**

[Do not allow shapes which show a lone pair]

BF_3 Trigonal planar/planar triangular 1

[Not plane triangle]

BF_4^- Tetrahedral 1

[Not distorted tetrahedral]

<u>Equal</u> repulsion between (4) <u>bonding</u> pairs/bonds/bonding electrons 1

109(½) ° 1

(ii) Lone pair donated / both electrons supplied by <u>one atom</u> 1

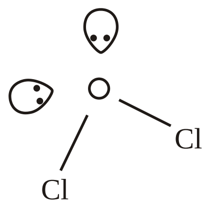
from F^- (to B) 1

[ignore missing charge or fluorine or 'atom']

dative/dative covalent/coordinate bonding 1

[9]

3. 2



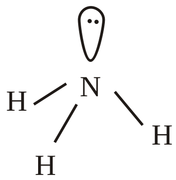
QoL Linear **(1)** beat / V-shaped / angular **(1)** 2

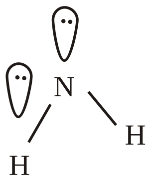
(mark name and shape independently)
(accept (distorted) tetrahedral)
(if balls instead of symbols, lose M1 – can award M2)
(penalise missing 'Cl' once only)
(not 'non-linear')

[4]

4. (a)

(*Missing 'H' penalise once only)* *[NOT dot-and-cross diagrams]*





1

[NOT 90° / 180° angles] *(need 2 lp & 'bent' shape)* 1

(b) 107° 1

(c) More lone pairs on NH_2^-, than on NH_3 1

Lone pairs repel more than bonding pairs *Must be comparison* 1
(Mark separately)
[NOT repulsion between atoms or between bonds]

[5]

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)** 3

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)** 4

(c) more electrons delocalised / more outer shell electrons **(1)**

in aluminium compared with magnesium / reference to
Al^{3+} **and** Mg^{2+} **(1)** 2

[9]

6. (a) tendency / strength / ability / power of an atom / element / nucleus to attract / pull / withdraw electrons / e - density / bonding pair / shared pair 1
in a covalent bond 1

(b) (i) F_2 = van der Waals' / induced/temporary dipole-dipole / dispersion / London forces 1

CH_3F dipole-dipole *(not just 'dipole')* 1

HF = hydrogen bonding *(not just 'H' / 'hydrogen')* 1

(ii) large difference in electronegativity between H and F / F most/very/much more electronegative / values '4' & '2.1' quoted 1

(not just 'higher')

$^{\delta+}H\text{-}F^{\delta-}$ dipole created or dipole clearly implied 1

(accept arguments such as 'uneven charge in bond'/'polar bond'
(F slightly negative/H slightly positive)

attraction/bond formed between δ+H and lone pair on F 1

(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) 1

increase with the increasing M2 / size / mass / N1 of e– / size of e– cloud (in the hydrogen halides) 1

(if ionic, or if 'covalent bonds broken' = CE = 0)

(mark M1 and M2 separately)

(ii) hydrogen bonding stronger than van der Waals' attraction/forces 1

(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')

[11]

7. (a) Oxygen more/very/highly electronegative (than hydrogen)
OR oxygen has stronger attraction for bonding electrons / bonding electrons drawn towards oxygen; 1

causes higher e^- density round oxygen atom / causes $H^{\delta+}$ $O^{\delta-}$; 1

(b) van der Waals' forces between oxygen molecules; 1
Hydrogen bonding between methanol molecules; 1
H-B stronger than van der Waals' *OR* stronger IMF in methanol; 1

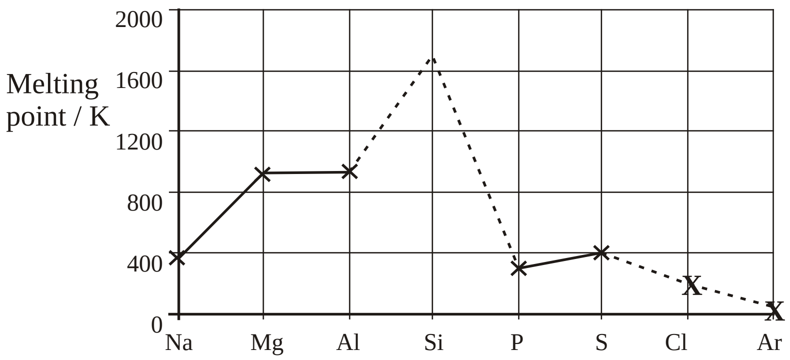
(if dipole-dipole forces in O_2 or methanol, allow comparison, hence max 2)

(if ionic/covalent etc. max 1)

(mention of bond break = CE = 0)

[5]

8. (a) (i)



M1	Si:	cross ≥ 1200	1
M2	Cl:	cross below S	1
M3	Ar:	cross below Cl	1

[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 — 1

Covalent bonds need to be broken/accept 'overcome' — 1

[Not loosened/weakened]

Covalent bonds are strong / many covalent bonds involved/requires much energy/hard to break — 1

[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 — 1

QoL Sulphur has greater M_r / size / surface area/more electrons/more atoms **so** stronger intermolecular forces (comparison) — 1

[Mark separately] [Not 'more shells']

(b) Trend: Decreases — 1

[If trend wrong = CE = 0]

Increase in size of ion/atom / more shells / decrease in charge density / decrease in charge size ratio — 1

Weaker attraction for delocalised/free/sea of electrons / weaker metallic bonding — 1

[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

[3]

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 Mg^{2+} 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

4

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

3

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

1

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

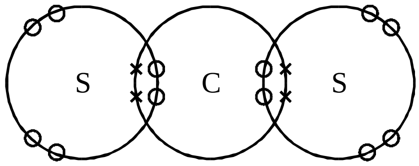
2

[10]

11.

(a) *Bonding in* Na_2S: ionic **(1)**
Bonding in CS_2: covalent **(1)**
ignore other words such as dative / polar / co-ordinate

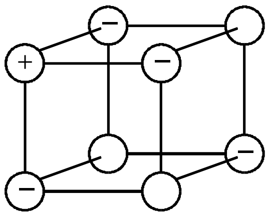
(b) Clear indication of electron transfer from Na to S **(1)**
1 e^- from each (of 2) Na atoms or 2 e^- from 2 Na atoms **(1)**
QL correct English

(c) 

Correct covalent bonds **(1)**
<u>All correct</u> including <u>lone pairs</u> **(1)**
Allow all •s or all ×s
M2 tied to M1
NOT separate e^-s in S• 2 l p

6

[6]

12. (a) (i) 

(1)

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

2

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

1

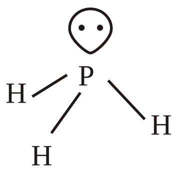
(ii) difference in electronegativity **(1)** 1

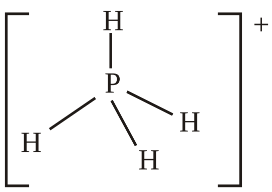
[4]

13. (a) dative / coordinate (covalent) bond; 1
Lone/non-bonding pair / both electrons; 1
(donated) <u>from P</u> to H+; 1

(b)

PH_3 PH_4^+





(1) **(1)**

pyramidal *OR* trigonal pyramid 109(1/2)°; 4
(accept tetrahedral)

[7]

14. (a) Ability (or power) of an atom to attract electron density
(or electrons or -ve charge) **(1)**
in a covalent bond **(1)**
or shared pair
If remove an electron lose first mark

2

(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

3

[5]

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° **(allow 117 - 119°)** **(1)**
Explanation: lone pair **(1)**
repels more than <u>bonding</u> pair **(1)**
Allow EXP if ∠ < 118°
but C.E. = 0 if ∠ ≥ 120°

5

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

2

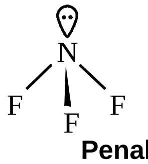
(c) (i) 90° **(1)**

(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

4

(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

2

[13]

16. (a) vibration **(1)**

about a fixed print **(1)**

random **(1)**

(or free to move) 3

(b) {<u>weak intermolecular</u> forces **(1)**

or v.d.w forces

easily broken **(1)**

or requires little energy to break 2

(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 NaC1 - ionic lattice) 4

or Ag insol. <u>in water</u> **(1)**

not ionic **(1)**

or conducts heat **(1)**

deloc. electrons **(1)**

or shines **(1)**

metallic bonding **(1)**

or high density **(1)**

large A_r, 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

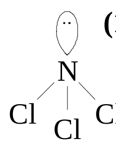
(d)

$BeCl_2$

Cl — Be — Cl **(1)**

180° **(1)**

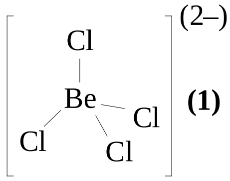
NCl_3



(1)

106 – 108°
(1)

$BeCl_4^{2-}$



(1)

109 – 109.5° **(1)** 6

[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 NCl_3 $BeCl_4^{2-}$ 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)**

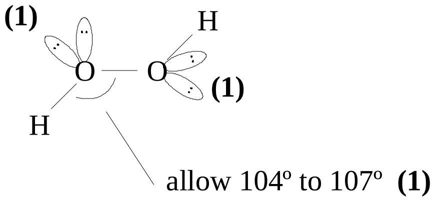
tetrahedral **(1)**

109.5° / 109° / 110° **(1)** 3

[3]

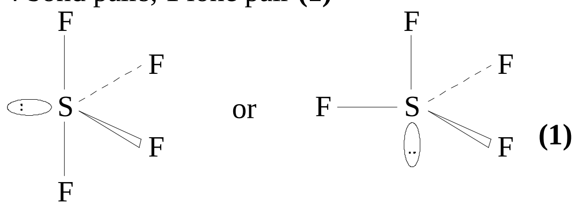
18. (a) more compact **(1)** 1

(b) (i) and (ii)



(iii) hydrogen bond **(1)** 4

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



87° to 90° **(1)** 117° to 120° **(1)** 4

(d) *Type 1* van der Waals' **(1)**
Type 2 dipole – dipole **(1)** 2

[11]

19. (a) electrostatic **(1)** 1

(b) <u>shared</u> electron <u>pair</u> **(1)** 1

(c) {<u>both</u> electrons, electron <u>pair</u> **(1)**

(donated) from {one, the same atom {or molecule, or species **(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)**

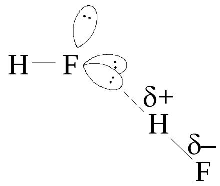
or{chlorine is electronegative, difference in electronegativity

attracts electrons towards C1 **(1)**

allow chloride instead of chlorine

(iii) van der Waals’ **(1)**

or {v.d.w, temp dipole, include dipole, London 5

(f) 

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)

3

(g) bromine not sufficiently electronegative **(1)**

{or lone pair too diffuse

{or bond not polar enough

{or little electronegativity difference

allow bromide

1

[15]

20. (a) van der Waals’ **(1)**

dipole - dipole **(1)**

energy needed to overcome *(intermolecular or vdw or dipole-dipole)* forces **(1)** 3

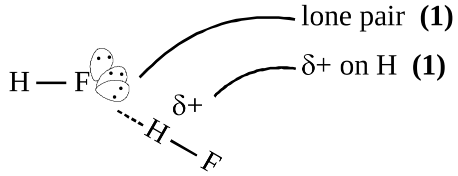
(b) HBr is intermediate in size (or polarisibility) **(1)**

van der Waals’ forces depend on molecular size **(1)** 2

(c) hydrogen bonding in HF **(1)**

stronger than intermolecular forces in HC1 **(1)**

(or strongest intermolecular force) 2

(d) 

2

[9]

21. (a) covalent **(1)**

covalent **(1)**

ionic **(1)** 3

(b) sodium sulphide / Na_2S **(1)**

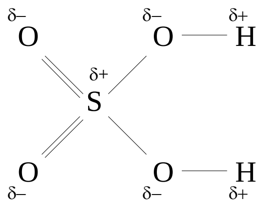
liquid / molten / aqueous solution (independent of first mark) **(1)** 2

[5]

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 1

(b)



at least one of each of the 2 polar bonds correctly labelled for each mark
allow one mark for 2 arrows showing dipole on 2 different bonds 2

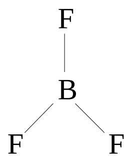
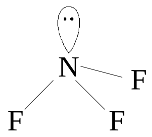
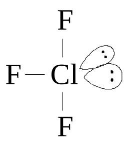
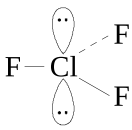
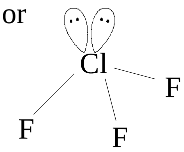
(c) hydrogen bonding **(1)**

attraction between (δ+ of) H atoms and (δ– of) O atoms in adjacent or different molecules (H of one molecule, O of another) **(1)**

mark these points independently 2

[5]

23. (a)

Molecule	Sketch of shape	Bond angle(s)	Name of shape
BF_3	 **(1)**	120° **(1)**	Trigonal planar **(1)**
NF_3	 **(1)**	107° ± 1° **(1)**	Tetrahedral or pyramidal **(1)**
ClF_3	 or  or  **(1)**	87° to 90° and/or 118° to 120° **(1)**	Trigonal bipyramid or trigonal planar or T **(1)**

9

(b) *BF_3* van der Waals' **(1)**

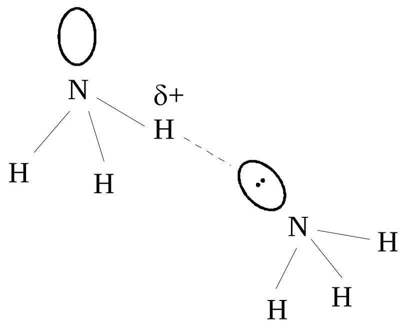
NF_3 van der Waals' **(1)** dipole-dipole **(1)** 3

(c) *Name of bond* co-ordinate **(1)**

Explanation lone pair on N **(1)**
donated (or shared with) to B (or BF_3) **(1)** 3

[15]

24.

(e) 

shape **(1)**

δ + on H **(1)**

δ + attracted

to lone pair **(1)** 3

[3]

25. (a) power of an atom (allow element) to attract electron(s) **(1)**

in a <u>covalent</u> bond **(1)**

not ion or molecule 2

(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 3

(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) 4

[9]

26. (a) shared electron pair **(1)**
both electrons from one atom **(1)** 2

(b) A + : B → A : B (or $NH_3 + H^+ \rightarrow NH_4^+$ etc) equation **(1)**
final species **(1)** 2

(c) chlorine is more electronegative than sodium **(1)**
an electron transfers from sodium to chlorine **(1)** 2

(d) smaller electronegativity difference **(1)**
so more equal sharing **(1)** 2

(e) mobile (free) ions **(1)** 1

(f) carbon forms 4 bonds **(1)**
gives a macromolecule **(1)**
iodine forms only one bond **(1)** 3

[12]

27. (a) strong (accept if reasonably qualified) **(1)**

electrostatic <u>attractions</u> or similar such as "held" **(1)**

between ions <u>held in a lattice</u> **(1)** 3

(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

[8]

28. (a) Shared pair of electrons 1

[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 M_r 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 stonger than in (ii) 2

(accept diagram)

(b) (i) $SO_4^{\ 2-}$ **(1)** 1

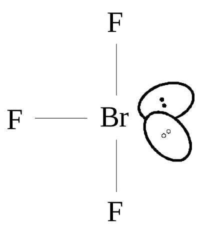
(ii) 109(.5°) **(1)** 1

[8]

30. (a) ionic **(1)**

1

(b) (i)



2 lone pairs **(1)**

shape **(1)**

(allow lone pairs in any position)

trigonal bipyramid **(1)** (or T-shaped etc)

[4]

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 H_2S much weaker / in H_2O are stronger **(1)**
than the hydrogen bonding in water / so less energy needed to overcome forces **(1)**
not more bonds in H_2O 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 $–H^{\delta+}$ and $= O^{\delta-}$ 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

[9]

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 / Mg^{2+} smaller than Na / Na^+ metallic radius smaller / Mg close packed **(1)**
Mg / Mg^{2+} 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

[10]

33. (a) large difference in electronegativity → ionic **(1)**

small difference in electronegativity → covalent **(1)** 2

(b) ionic **(1)** 1

[3]

34. (a) 105° (allow 104–106°) **(1)** 1

(b) 4 electron pairs round O **(1)**
tetrahedral (or 109°) **(1)**
lone pairs repel more than bonding pairs **(1)**
$\therefore$ angle < 109° (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° (or increases) **(1)**

Explanation lone pair more like bonding pair
$\therefore$ does not repel so strongly **(1)** 2

[10]

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

[6]

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; *(not diamond stronger than graphite)*	1
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; *(M9 tied to M8)*	1

Other difference

M10	diamond is non-conductor of electricity, graphite is conductor *OR* appropriate difference in appearance;	1

[9]

37. **QoL** Bonding Both covalent *(linked statement)* 1

Structure Iodine = molecular /I_2 *(stated or in diagram)* 1

[treat incorrect diagram as contradiction]

Diamond = giant molecular/macromolecular/giant covalent / giant atomic (stated only) 1

Reference to van der Waals' /dipole-dipole = contradiction

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

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 I_2 lose M2 & M4; for diamond lose M3,M5&M6]

[6]

38. giant lattice (1)

of covalent bonds (1)

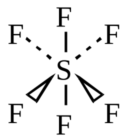
need to break covalent bonds to melt red phosophorus (1)

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]

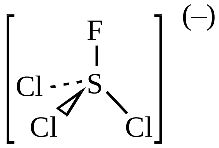
39. (a) SF_6 shown as octahedral / square based bipyramid **(1)**
Bond angle: 90° **or** 180° and 90° **(1)**
Shape = octahedral **(1)**
If lone pair shown then C.E.= 0 / 4



Wrong symbols - no diagram mark

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

$AlCl_4^-$ 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

8

(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)** 4

[12]

40. (a) I_2 sublimes when heated / has low melting point <u>AND</u> graphite has (very) high melting point **(1)**

I_2 is (simple) molecular / I_2 / I-I **(1)**

CE = 0 if 'ionic'
loses M2, M3, M4
Max 1 if I-I bond broken

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

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

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

min 3 correctly fused rings – ignore diagram unless no description offered
CE = 0 if 'ionic' or 'metallic'   loses M5, M6, M7

(Many) covalent bonds need to be <u>broken</u> **(1)**

covalent may be inferred from structure

Which takes much energy / bonds are strong **(1)**

Only graphite conducts **(1)**

NOT just graphite is a better conductor

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

All e^- in iodine are used in bonding and lone pairs
<u>OR</u> as it has no delocalised / free / mobile e^- **(1)** Max 9

M9 and M10 tied to correct statements about graphite = conductor and iodine = non-conductor

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

CE = 0 if lone pair(s) on Be, loses M1 and M2

(Equal) <u>repulsion</u> between 2 <u>bonding</u> pairs / bonds **(1)**

'2' may be inferred from a correct diag

NOT repulsion between Cl atoms

2

[11]

41. (a) Macromolecular **or** giant structure **(1)** 7

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 <u>break</u> bonds **Or** <u>many</u> bonds to be <u>broken</u> **(1)**

Mark <u>tied</u> to earning 'covalent' M2 *If explanation is <u>clearly</u> 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)**

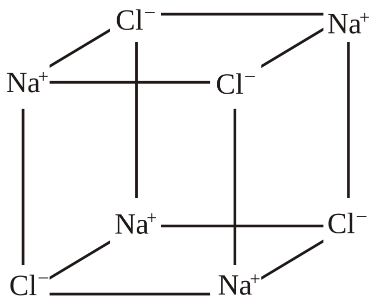
Description must be of the <u>molecules</u> of P and S

P_4 **or** $M_r = 124$ **(1)** S_8 **or** $M_r = 256$ **(1)**

If M6 (i.e. P_4) and M7 (i.e. S_8) are <u>not attempted</u>, allow S <u>molecule</u> bigger /more surface area than P molecule for 1 mark

(b) Diagram NaCl = cubic **(1)**

Allow if 3 full faces shown correctly



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** 4

Not just: *'ionic bonds are strong' / 'need much energy to break bonding'*

[11]

42.

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

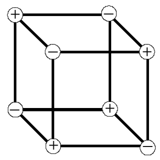
Na–Al metals **(1)**
OR metallic bonding or description of metallic bonding

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)** 13

[13]

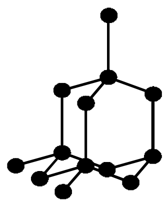
43. (a) Ionic **(1)**
lattice **(1)**
e.g. NaCl **(1)**
conducts when molten **(1)**
due to mobile ions **(1)**



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)**

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



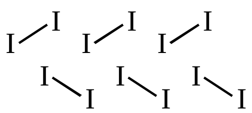
sketch scores **(2)** max 6

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)**



sketch scores **(1)**

regular array of molecules

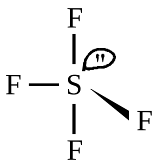
example of a metal (eg Mg) **(1)**
metallic bonding (or stated to be a metal) **(1)**
positive ions (or atoms) **(1)**
surrounded by delocalised electrons **(1)**
conducts when solid **(1)**
due to delocalised electrons **(1)**

sketch scores [1]

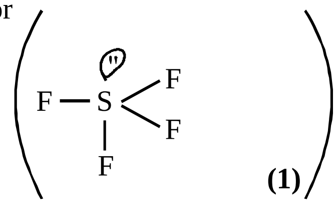
e.g. 

Note if candidate deals with two crystals of the same type
eg diamond & graphite, award max 3 for worst of the two answers max 6

(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)**

shape is 

(1)

or 

(1)

angles <90 **(1)** and <120 **(1)** or (<90 **(1)** and 120 **(1)**)
(85 – 89) (115 – 119) (85 – 89) (115 – 120)

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

[26]

44. From the graph:
Mg above Na **(1)**
Al similar to or above Mg **(1)**
Si above Na and Mg **(1)**
P lower than Mg, Al and Si **(1)**
S above P, lower than Si **(1)**
Ar lowest **(1)** 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

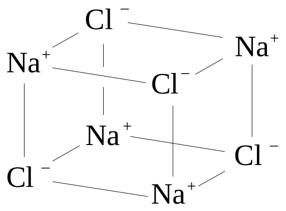
Silicon has covalent bonds **(1)**
Macromolecule **(1)**
Many strong bonds to be broken **(1)** 3

S_8 **(1)**
P_4 **(1)**
$C1_2$ **(1)**
weak intermolecular forces **(1)**
van derWaals' **(1)**
Stronger between larger molecules **(1)** 6

Argon consists of free atoms with weak van der Waals' forces between atoms **(1)** 1

[21]

45. (a)



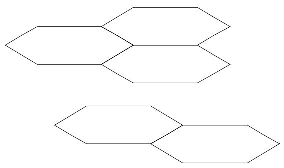
from diag (cubic **(1)** ions (or Na, Cl or +,–) placed correctly **(1)**
(minimum of 4 species)

from diag or stated (ionic **(1)** lattice **(1)**

high mpt **(1)** due to <u>strong</u> ionic bonds **(1)**

conducts when molten (or in solution) **(1)** mobile ions **(1)**

[<u>OR</u> 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)**

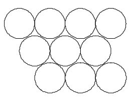
must be stated: covalent **(1)**

high mpt **(1)** due to strong covalent bonds **(1)**

conducts when solid **(1)** delocalised electrons **(1)**

Note if free not delocalised mentioned penalise <u>once only</u>: for quality of language

8



from diagram: spheres close together **(1)**

stated or from diagram (hexagonal in one plane or lattice **(1)**
ions **(1)** delocalised electrons **(1)**

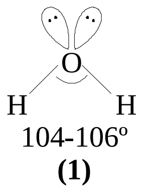
high mpt **(1)** <u>strong</u> metallic bonds **(1)**

conducts **(1)** delocalised electrons **(1)** 8

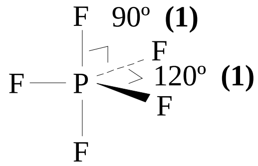
Max 23

(b) electron <u>pairs</u> repel as far apart as possible **(1)**

lone pairs repel more **(1)**



shape **(1)**



(1)

Note if angles not drawn on diagram penalise once only

7

[30]