M1. (a) NaCl is ionic 1

cubic lattice 1

ions placed correctly 1

electrostatic attraction between ions 1

Covalent bonds between atoms in water 1

Hydrogen bonding between water molecules 1

Tetrahedral representation showing two covalent and two hydrogen bonds 1

2 hydrogen bonds per molecule 1

Attraction between ions in sodium chloride is very strong 1

Covalent bonds in ice are very strong 1

Hydrogen bonds between water molecules in ice are much weaker 1

Consequently, less energy is required to break the hydrogen bonds in ice to form separate water molecules than to break the ionic bonds in sodium chloride and make separate ions 1

(b)

Mark Range	The marking scheme for this part of the question includes an overall assessment for the Quality of Written Communication (QWC). There are no discrete marks for the assessment of QWC but the candidates' QWC in this answer will be one of the criteria used to assign a level and award the marks for this part of the question **Descriptor** an answer will be expected to meet most of the criteria in the level descriptor
3	– claims supported by an appropriate range of evidence – good use of information or ideas about chemistry, going beyond those given in the question – argument well structured with minimal repetition or irrelevant points – accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling
2	– claims partially supported by evidence

	– good use of information or ideas about chemistry given in the question but limited beyond this – the argument shows some attempt at structure – the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling
0-1	– valid points but not clearly linked to an argument structure – limited use of information or ideas about chemistry – unstructured – errors in spelling, punctuation and grammar or lack of fluency

4 bonding electron pairs **1**

and one lone pair **1**

repel as far apart as possible QWC **1**

lone pair - bond pair repulsion > bp—bp QWC **1**

pushes S-F bonds closer together **1**

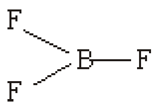
shape is trigonal bipyramidal with lone pair either axial or equatorial QWC **1**

angles <90 **1**

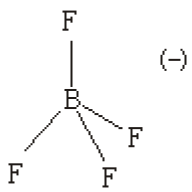
and < 120 **1**

[20]

M2. (i)



(1)



(1)

[Do not allow shapes which show a lone pair] **2**

BF_3 Trigonal planar/planar triangular
[Not plane triangle] 1

BF_4^- Tetrahedral
[Not distorted tetrahedral] 1

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

109(½)° 1

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

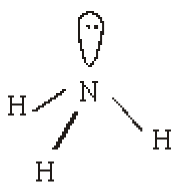
from F^- (to B)
[ignore missing charge or fluorine or 'atom'] 1

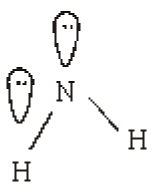
dative/dative covalent/coordinate bonding 1

[9]

M3. (a) (i) $2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2$
(or multiples) 1

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



 1

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

(iii) 107°

1

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

1

Lone pairs repel more than bonding pairs

Must be comparison

(Mark separately)

[NOT repulsion between atoms or between bonds]

1

(b) (i) Simplest ratio of atoms of each element in a compound / substance / species / entity / molecule

1

(ii)

	Mg	N	O	
$\frac{16.2}{(24)}$	$\frac{16.2}{24.3}$	$\frac{18.9}{14}$	$\frac{64.9}{16}$	
(0.675)	0.667	1.37	4.06	
	1	2	6	MgN_2O_6

1

(Mark M1 first. If any wrong A_r used = CE = 0)

(Accept $Mg(NO_3)_2$ for M3 if above working shown)

1

[9]

M4. B

[1]

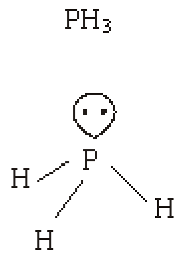
M5. (a) dative / coordinate (covalent) bond;

1

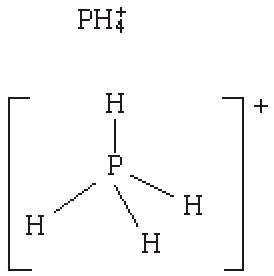
Lone/non-bonding pair / both electrons; **1**

(donated) <u>from P</u> to H^+; **1**

(b)



(1)



(1)

pyramidal *OR* trigonal pyramid 109($^{1/2}$)°;
(accept tetrahedral)

4

[7]

M6. A

[1]

M7. *(penalty for sig fig error =1 mark per question)*

(a) neutron: relative mass = 1 relative charge = 0
(not 'neutral')

1

electron: relative mass = 1/1800 → 0/negligible *or*

5.56 × 10–4 → 0 relative charge = –1

1

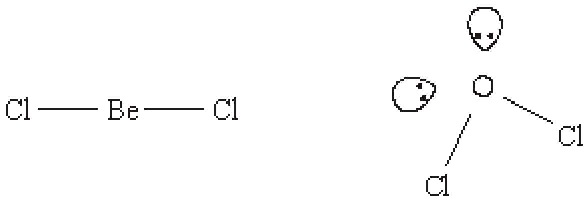
(b) $^{17}O/O^{17}$ mass number (*Do not accept 17.0*) **1**

oxygen symbol 'O'

(if 'oxygen' + — 'mass number = 17'(1))
(if 'oxygen'+ — 'mass number = 17'(0))
(if at N° given but ≠ 8, treat as 'con' for M2)
(if lp on Be, diagram = 0)
(ignore bond angles)
(not dot and cross diagrams)

1

(c)



2

QoL Linear **(1)** bent / 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')

2

(d) M_r $(Mg(NO_3)_2$ = 58(.3) *(if At N° used, lose M1 and M2)* **1**

moles $Mg(OH)_2$ = 0.0172 (conseq on wrong M2) (answer to <u>3+ s.f.</u>) **1**

moles HCl = 2 × 0.0172 = 0.0344 *or* 0.0343 (mol) *(process mark)* **1**

vol HCl = $\frac{0.0343 \times 1000}{1}$ = 34.3 – 34.5 (cm^3) *(unless wrong unit)*

*(if candidate **used** 0.017 or 0.0171 lose M2)*
(just answer with no working, if in range = (4).
if, say, 34 then =(2))
(if not 2:1 ratio, lose M3 and M4)
(if work on HCl, CE = 0/4)

1

[12]