Mark schemes

1

(a) **4**LiH + $AlCl_3$ → $LiAlH_4$ + **3**LiCl

1

(b) H^- = $1s^2$ **or** $1s_2$

1

(c) Tetrahedral or diagram

(Not distorted tetrahedral)

1

(Equal) repulsion

1

between four bonding pairs / bonds

(Not repulsion between H atoms loses M2 and M3)

(Not 'separate as far as possible')

('4' may be inferred from a correct diagram)

1

(d) Dative (covalent) or coordinate

1

Lone pair **or** non-bonding pair of electron **or** both e^-

1

QoL Donated from H^- to Al **or** shared between H and Al

(tied to M2)

(Not 'from H atom') (Not 'to Al ion') (Not 'e $^-$s transferred')

1

[8]

2

(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^0 given but ≠ 8, treat as 'con' for M2)

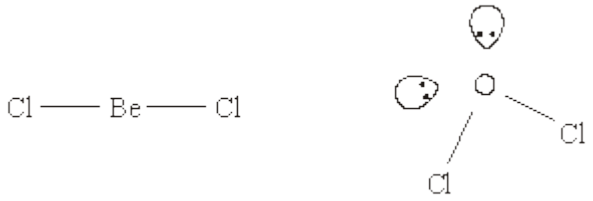
(if lp on Be, diagram = 0)

(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^0 used, lose M1 and M2)*

1

moles $Mg(OH)_2$ = 0.0172 (conseq on wrong M2) (answer to 3+ s.f.)

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

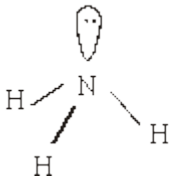
[12]

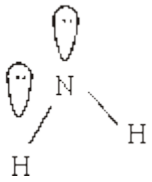
3 (a) (i) $2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2$

(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) <u>107°</u>

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) <u>Simplest ratio of atoms of each element</u> 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

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

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

1

[9]

4 (a) $C(s) + 2F_2(g) \longrightarrow CF_4(g)$

State symbols essential

1

(b) Around carbon there are 4 bonding pairs of electrons (and no lone pairs)

1

Therefore, these repel equally and spread as far apart as possible

1

(c) $\Delta H = \Sigma\ \Delta_f H$ products $- \Sigma\ \Delta_f H$ reactants or a correct cycle

1

Hence = (2 × –680) + (6 × –269) – (x) = –2889

1

x = 2889 – 1360 – 1614 = –85 (kJ mol^{-1})

1

Score 1 mark only for +85 (kJ mol^{-1})

(d) Bonds broken = 4(C–H) + 4(F–F) = 4 × 412 + 4 × F–F

Bonds formed = 4(C–F) + 4(H–F) = 4 × 484 + 4 × 562

Both required

1

–1904 = [4 × 412 + 4(F–F)] – [4 × 484 + 4 × 562]

4(F–F) = –1904 – 4 × 412 + [4 × 484 + 4 × 562] = 632

1

F–F = 632 / 4 = 158 (kJ mol^{-1})

1

The student is correct because the F–F bond energy is much less than the C–H or other covalent bonds, therefore the F–F bond is weak / easily broken

Relevant comment comparing to other bonds

(Low activation energy needed to break the F–F bond)

1

[10]

5 (a) (i) The power of an <u>atom</u> or <u>nucleus</u> to withdraw or attract electrons ***OR*** electron density ***OR*** a pair of electrons (towards itself)

Ignore retain

1

In a <u>covalent</u> bond

1

(ii) More protons / bigger nuclear charge

1

Same or similar shielding / electrons in the same shell or principal energy level / atoms get smaller

Not same sub–shell

Ignore more electrons

1

(b) Ionic

If not ionic then CE = 0 / 3
If blank lose M1 and mark on

1

Strong or many or lots of (electrostatic) attractions (between ions)

If molecules / IMF / metallic / atoms lose M2 + M3, penalise incorrect ions by 1 mark

1

Between + and − ions / between Li^+ and F^- ions / oppositely charged ions

Allow strong (ionic) bonds for max 1 out of M2 and M3

1

(c) Small electronegativity difference / difference = 0.5

Must be comparative

Allow 2 non-metals

1

(d) (i) (simple) molecular

Ignore simple covalent

1

(ii) $OF_2 + H_2O \longrightarrow O_2 + 2HF$

Ignore state symbols
Allow multiples
Allow OF_2 written as F_2O

1

(iii) 45.7% O

1

(O F)
(45.7 54.3)
(16 19)

If students get M2 upside down lose M2 + M3
Check that students who get correct answer divide by 16 and 19 (not 8 and 9). If dividing by 8 and 9 lose M2 and M3 but could allocate M4 ie max 2

1

(2.85 2.85)
(1 1)

EF = OF or FO

Calculation of OF by other correct method = 3 marks
Penalise Fl by 1 mark

1

MF (= 70.0 / 35) = O_2F_2 or F_2O_2

1

[14]

6

Structures

M1 Bromine is (simple) molecular / simple molecules

Chemical Error penalties

1

M2 Magnesium is metallic / consists of (positive) ions in a (sea) of delocalised electrons

If Br_2 (covalent) bonds broken lose M3 and M4

1

Strength

M3 Br_2 has weak (van der Waals) forces between the molecules / weak IMFs

If eg Mg molecules or Mg ionic bonds lose M2 and M4

1

M4 so more energy is needed to overcome the Stronger (metallic) bonds or converse. The comparison could be direct or implied.

1

Liquid range

M5 Mg has a much greater liquid range because forces of attraction in liquid / molten metal are strong(er) OR converse argument for Br_2

Must refer to liquid range to score M5

1

[5]

7

(a) Correct diagram of NH_3 including LP on N

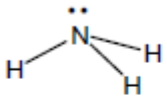
1

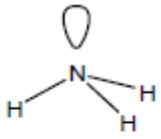
Correct diagram of $AlCl_3$

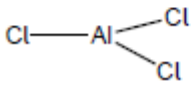
1

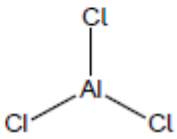
Bond angles in range 106-108° and bond angle of 120°

1









Ignore shape names

(b) Dative (covalent) /co-ordinate bond

Wrong bond CE=0 but mark on if covalent quoted

1

Shared pair of / both electrons come from the $N(H_3)$

1

(c) Aluminium is now surrounded by 4 electron pairs/bonds or is tetrahedral

Independent

1

Therefore Cl-Al-Cl bond angle decreases / changes
(from 120° in $AlCl_3$) to allow range 107-111° in H_3NAlCl_3

1

[7]