Mark Scheme - 1.4 Bonding

1.

(a) iodine force is Van der Waals/ induced dipole-induced dipole (1)

diamond force is covalent bond/ description of attractive forces in a covalent bond (1) [2]

(b) diamond would have a higher sublimation temperature because it has stronger forces/ forces are harder to break [1]

2.

(a) Any 3 from 4 points:

Bonding is metallic (1)

This is **attraction** between the sea/ delocalised electrons and the positive ions (1)

Al^{3+} has more electrons in the sea than Na^+ / Al^{3+} has a higher charge density than Na^+ (1)

More energy is needed to overcome forces in Al (1) [3]

QWC: legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning [1]

(b) (Brown) iodine is formed (1)

Equation: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ / $Cl_2 + 2KI \rightarrow 2KCl + I_2$ (ignore state symbols) (1)

Chlorine is a better oxidising agent than iod**ine**/ has a greater affinity for the electron/ chlorine has oxidised iod**ide** (1) [3]

(c) Ammonia is easily liquefied because it has a high boiling temperature (compared with ethane) (1)

Ammonia contains hydrogen bonds (1)

Ethane has van der Waals forces/ induced dipole-induced dipole forces (1)

Hydrogen bonds are stronger than van der Waals forces (1) [4]

(d) Reaction produces a mixture of halogenocompounds/ more than one halogen can be substituted / ethane (1)

The mechanism is (free) radical (1)

Any equation with product a polychloromethane/ ethane (1) [3]

QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [15]

3. 8 electrons in outer shell of all species/ 8 in two F and 0 in Ca (1)

2+ on calcium ion and 1- on fluoride ions (1) [2]

4.

(a)
- BCl_3 is trigonal planar or clear diagram.
- NCl_3 is pyramidal or clear diagram.
- BCl_3 has 3 bonded pairs
- NCl_3 has 3 bonded pairs
- NCl_3 has a lone pair
- BCl_3 has no lone pair
- Electron pairs repel to be as far from each other as possible / position of minimum repulsion.
- Lone pairs repel more than bonded pairs.

First two points and any other 4 for (1) each up to 6 max [6]

- *QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter.[1]*
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- *QWC: legibility of text, accuracy of spelling, punctuation and grammar, clarity of meaning.[1]* [2]

(b)

accept crosses and dots exchanged (1)

Electron deficient: outer shell of boron has less than 8 electrons / is not full.(1) [2]

(c) NH_3 can form hydrogen bonds with water molecules (so it dissolves) (1)
NCl_3 cannot form hydrogen bonding. (1) [2]

(d)
- Covalent has a pair of shared electrons one from each atom (1)
- Coordinate has a pair of shared electrons both electrons from same atom (1)

[2]

5.

(a) (i) all ionisation energies showing gradual increase and one large jump (1)

large jump after 8 electrons (1) **[2]**

(ii) eighth and ninth electrons come from different shells (1)

ninth electron is closer to nucleus / has less or no shielding / has greater effective nuclear charge (1) **[2]**

(b) the compound formation has the noble gas atom being ionised (1)

ionisation energy of argon is much higher than that of xenon (1)

because the outer electron in argon is closer to the nucleus / has greater effective nuclear charge / shielding (1) - 2 max **[2]**

(c) electrons move from lower energy levels to higher energy levels (1)

by absorbing **specific frequencies** of light (1) **[2]**

(d) 1 mol of XeO_3 released 2.5 mol gas products (1)

2.5 mol of gas occupies 24.0 x 2.5 = 60.0 dm^3 (1) – follow through error (ft)

if candidates calculate the volumes of the two gases separately, then (1) for one gas volume correct and (1) for total volume correct **[2]**

Total [10]

6.

(a) (i) Chlorine – gas
Iodine – solid **[1]**

(ii) Chlorine – brown/orange solution (1)
Iodine – no change / no reaction (1)
$Cl_2 + 2KBr \longrightarrow Br_2 + 2KCl$ (1) **[3]**
(Accept ionic equation)

(b) Oxygen loses electrons therefore oxidised / oxidation state changes from -2 to 0 therefore is oxidised (1)

Chlorine gains electrons therefore reduced / oxidation state changes from 0 to -1 therefore is reduced (1) **[2]**

(c) (i) Boiling temperatures increase as relative molecular mass increases / number of electrons increases / down group (1)

HF has a higher boiling point than expected (1) **[2]**

(ii) Group 7 hydrides contain more dipole–dipole forces as group descended (1)

but HF contains hydrogen bonding between molecules (1)

Hydrogen bonds are stronger therefore HF's boiling temperature is greater / need more energy to break (1) **[3]**

QWC Selection of a form and style of writing appropriate to purpose and to complexity of subject matter *QWC* **[1]**

(iii) HCl more polar than SiH_4 therefore intermolecular forces are stronger / dipole greater in HCl / Cl more electronegative than Si **[1]**

Total [13]

7.

(a) both contain metallic bonds/ positive ions and delocalised electrons labelled on diagram (1)

those in magnesium are stronger/ harder to break/ need more energy to break (1)

because **2** electrons are involved in delocalisation/ attraction to the positive ions (1) [3]

(b) reaction is hydrolysis of halogenoalkane/ nucleophilic substitution of halogenoalkane (1)

$C_4H_9X + OH^- \rightarrow C_4H_9OH + X^-$ X can be Cl or Br (1)

(white precipitate is) silver chloride and (cream precipitate is) silver bromide (1)

$Ag^+(aq) + X^-(aq) \rightarrow AgX(s)$ or $AgNO_3 + X^- \rightarrow AgX + NO_3^-$ (1)

- state symbols ignored [4]

QWC selection of form and style of writing appropriate to purpose and to complexity of subject matter [1]

(c) caesium ions are bigger than sodium ions – accept 'atoms' (1)

co-ordination number 6 : 6 for sodium and 8 : 8 for caesium (1)

both cubic (1) [3]

(d) reaction is electrophilic addition (1)

two possible products are 1-bromopropane and 2-bromopropane (1)

more 2-bromopropane formed (1)

because of greater stability of intermediate positive ion/ 2° carbocation (1)
[4]

QWC legibility of text; accuracy of spelling, grammar and punctuation, clarity of meaning [1]

Total [16]

8.

(a) $1Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ [1]

(b) Oxidation state of carbon at start = +2 and at end = +4 so it has been oxidised (1)
Oxidation state of iron at start = +3 and at end = 0 so it has been reduced (1)
Credit 1 mark if all oxidation states are given correctly with incorrect or no reference to what has been oxidised/reduced [2]

(c) (i) 6:6 [1]

(ii)

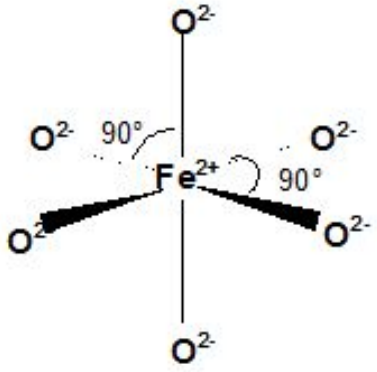


Diagram must be unambiguous, either by showing 3 dimensions, bond angles or through labelling, must identify iron and oxide as ions

[1]

(d) Moles FeO = 20,000 ÷ (55.8 +16) = 278.6 mol (1)
Moles Fe = moles FeO = 278.6 mol (1)
Mass Fe = 278.6 × 55.8/1000 = 15.5 kg (1) [3]

(e) Pair of shared electrons in both (1)

Covalent – 1 electron from each atom **and**
Co-ordinate – 2 electrons from same atom (1) [2]

(f) Lattice / regular arrangement of positive ions (1)
Sea of delocalised electrons (1)
Electrons can move to form an electrical current (1)
Strong forces / bonds between the delocalised electrons and the metal ions require a lot of energy to break / high temperature to overcome (1) [4]
QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

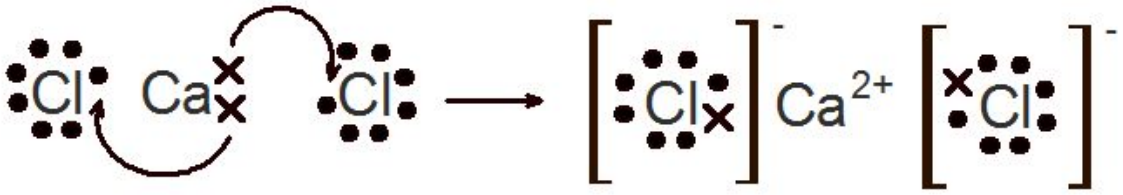
Total [15]

9.

(a) $\delta-$ N—H $\delta+$ $\delta-$ O—Cl $\delta+$ both for 1 mark [1]

(b) Difference in electronegativity is larger in aluminium oxide (so it is ionic) / the difference is smaller in aluminium chloride (so it is covalent) [1]

1 mark showing movement of electrons; 1 mark showing dot and cross of $CaCl_2$ [2]



10.

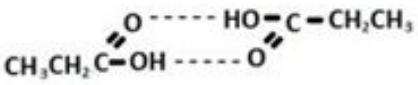
(a) (i) 165 ± 5 °C [1]

(ii) As the number of carbon atoms in the acids increase the boiling temperature increases (1)
This is due to an increase in induced dipole-induced dipole / Van der Waals forces (1) between molecules (1) [3]

(iii) As the molecules increase in size the relative importance of the —COOH group decreases (1)
There is therefore less of a tendency to hydrogen bond **with water** (becoming less soluble) (1) [2]

(b) (i) Acidified (potassium) dichromate (accept H^+, $Cr_2O_7^{2-}$) / Acidified (potassium) manganate(VII) (accept H^+, MnO_4^-) [1]

(ii)



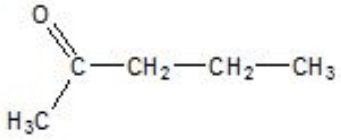
[1]

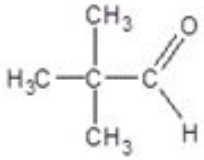
(iii) I 0.050 [1]

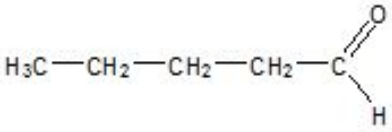
II 0.025 [1]

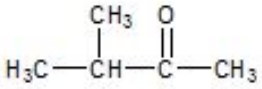
III 0.025 × 186 = 4.65 (g) [1]

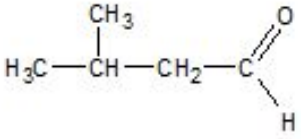
(iv) Any 2 of the following:

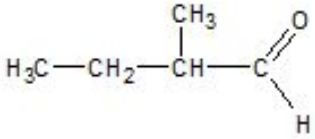












[2]

(c) (i) $\frac{49.3}{12} = 4.11$ $\frac{43.8}{16} = 2.74$ (1) Ratio of C:O is 3:2 (1) [2]

(ii) There are four oxygen atoms per molecule ∴ 6 carbon atoms (and 4 oxygen atoms)

∴ n = 6 – 2 in the acid groups ∴ n = 4 [1]

Total [16]

11.

(a) $Cl^{\delta+}$— $F^{\delta-}$

Electronegativity decreases down the group / fluorine is more electronegative (than chlorine) / chlorine is less electronegative (than fluorine) [1]

(b) [1]