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| 1. | (a) | Electronegativity increases across Period 3 (M1)  Atoms hold on to bonding electrons more strongly (M2)  Bonding electrons are less likely to be delocalised (M3) | | |
|  | (b) | Electronegativity decreases down Group 4 (M4)  Atoms hold on to bonding electrons less strongly (M5)  Bonding electrons more likely to be delocalised (M6)  [max 5] | | |
| **2.** | (a) | Either  F more electronegative than Cl (M1)  So electronegativity difference between Al and F larger than difference between Al and Cl (M2)  The larger the electronegativity difference, the more ionic the bond (M3) | | Or  Cl- larger than F- (M1)  Cl more polarisable then F- (M2)  Al3+ can distort the charge cloud of Cl-, but not F-, (M3) |
|  | (b) | Either  B more electronegative than Al (M1)  So electronegativity difference between Al and F larger than difference between B and F (M2)  The larger the electronegativity difference, the more ionic the bond (M3) | | Or  B3+ smaller than Al3+ (M1)  B3+ has more polarising power than Al3+ (M2)  B3+ can distort the charge cloud of F-, but Al3+ cannot (M3)  [max 5] |
| **3.** | Al2O3(s) + 2NaOH(aq) + 3H2O(l) 🡪 2NaAl(OH)4(aq) or suitable equation (M1)  NaAl(OH)4(aq) 🡪 Al(OH)3(s) + NaOH(aq) or suitable seeding equation (M2)  2Al(OH)3(s) 🡪 Al2O3(s) + 3H2O(g) (M3)   * pure aluminium oxide is dissolved in molten cryolite (Na3AlF6) and electrolysed (M4) * using graphite electrodes (M5)   2Al2O3(cry) 🡪 4Al(l) + 3O2(g) or two half-equations Al3+ + 3e 🡪 Al and 2O2- 🡪 O2 + 4e (M6)  [max 5] | | | |
| **4.** | (a) | Trigonal planar and molecular (M1)  Dative π-bond from F to B (M2)  Resonance causes all three bonds to be of equal length (M3) | | |
|  | (b) | B has an empty 2 p orbital which can accept an electron pair (M4)  Eg BF3 + NH3 🡪 BF3NH3 (M5)  [5] | | |
| **5.** | [https://upload.wikimedia.org/wikipedia/commons/thumb/d/db/Diborane_02.svg/220px-Diborane_02.svg.png](https://en.wikipedia.org/wiki/File:Diborane_02.svg) | | molecular and covalent (M1) (covalent can be shown in diagram)  diagram showing two BHB banana bonds (M2)  diagram showing remaining B-H bonds correctly (M3)  two-electron three atom bonds involving B-H-B (M4)  evidence of 3D structure around both B atoms (M5)  [5] | |

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| **6.** | (a) | Tl+ forms +1 ions (M1) Due to the inert pair effect (M2)  Tl+ ions have low charge density/low polarising power or reacts with water to form TlOH or react with acids to form salts eg TlNO3 or Tl2SO4 or Tl2CO3 or TlOH thermally stable or decomposition of TlNO3 gives TlNO2 (M3) |
|  | (b) | Suggest why Tl2O is basic but Tl2O3 is amphoteric.  Tl3+ more highly polarising than Tl+  Tl2O3 more covalent than Tl2O  Covalent character gives oxide more acidic properties (M3)  Max [5] |
| **7.** | CO2 contains C=O bonds but SiO2 contains Si-O bonds  Because C and O similar in size and small so good π-orbital overlap possible (ORA)  So 1 double bond energetically favourable to 2 single bonds  CO2 is linear but SiO2 is tetrahedral  CO2 is molecular but SiO2 is giant covalent  [5] | |
| **8.** | (a) | SiCl4 has empty 3d orbitals of low energy (M1)  Which can accept lone pairs of electrons from O in H2O (M2)  CCl4 does not have empty orbitals of low energy as it is in Period 2 (M3) |
|  | (b) | Si larger than C (M4)  So π-orbital overlap is poor (M5)  [5] |
| **9.** | (a) | Pb more stable in +2 oxidation state than +4 oxidation state but Sn more stable in +4 oxidation state than +2 oxidation state (M1)  Inert pair effect more significant in Pb than Sn (M2)  So lead (IV) compounds are good electron acceptors but tin (IV) compounds are not (M3) |
|  | (b) | PbO2 + H2SO4 + 2H+ + 2e- 🡪 PbSO4 + 2H2O and Pb + H2SO4 🡪 PbSO4 + 2H+ + 2e (M4)  0 and 4 forming +2, suggesting that +2 is the most stable oxidation state of Pb (M5)  [5] |