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| **1.** | 2Al + 6HNO3 🡪 Al(NO3)3 + 3H2 (M1), Tl + 2HNO3 🡪 2TlNO3 + H2 (M2), O.N. of Al = +3 (M3), O.N. of Tl = +1 (M4), Due to inert pair effect in Tl (M5) [5] |
| **2.** |  | Al forms Al2Cl6 dimer (M1), two dative σ-bonds from Cl on one monomer to Al on the other (M2), dative π-bond from F to B in BF3 (M3) stabilised by resonance (M4)M1 – M4 can be obtained from suitable diagramsB-F π-bond stronger than Al-Cl π-bond due to better orbital overlap (M5)[5] |
| **3.** | (a) | Al2O3 + 6HCl 🡪 2AlCl3 + 3H2O, Al2O3 + 2NaOH + 3H2O 🡪 2Al(OH)4 OR Al2O3 + 6NaOH + 3H2O 🡪 2Al(OH)6 (species correct in both M1, first equation balanced M2, second equation balanced M3, allow ionic equations |
|  | (b) | B2O3 is acidic (M4) as it is covalent (M5) [5] |
| **4.** | https://upload.wikimedia.org/wikipedia/commons/thumb/d/db/Diborane_02.svg/220px-Diborane_02.svg.png | molecular and covalent (M1), two BHB banana bonds (M2), four other B-H bonds (M3), evidence of 3D structure around both B atoms (M4)M1 – M4 can be obtained from a suitable diagramtwo-electron three atom bonds involving B-H-B (M5) [5] |
| **5.** | (a) | C can form strong π-bonds with O (M1) due to good p-orbital overlap (M2), so C≡O bond very strong (M3), clear diagram showing triple bond, either dative from O to C or with a C- and O+ (M4) (max 3) |
|  | (b) | SiCl4 + 2H2O 🡪 SiO2 + 4HCl (M5), Si has empty low energy 3d orbitals (ORA) (M6), which can accept a pair of electrons from water (M7) [max 5] |
| **6.** | Diamond sp3 or tetrahedral (M1), graphite sp2 or planar (M2)both giant covalent or macromolecular, graphite forms layers, graphite layers held together by Van der Waal’s forces, but diamond 3D macromolecular (any 3 = 2, any 2 = 1) (M3, M4)one electron per atom in graphite delocalised, due to p-orbital overlap, but no electrons in diamond delocalised (any 3 = 2, any 2 = 1) (M5, M6)any of above marks available from suitable diagrams [max 5] |
| **7.** | (a) | Pb more stable in +2 oxidation state (M1) due to inert pair effect (M2), so lead (IV) compounds are electron acceptors or can get reduced (M3) |
|  | (b) | PbO2 + 4HCl 🡪 PbCl2 + Cl2 + 2H2O (M4), redox reaction (M5) SnO2 + 4HCl 🡪 SnCl4 + 2H2O(M6), acid-base reaction (M7) [max 5] |
| **8.** | (a) | C-C bond stronger than Si-Si bond (M1) due to smaller size (M2) |
|  | (b) | Si=O bond not strong, so Si forms tetrahedral structure with O, with two O atoms bridging (max 2) (M3, M4), C=O bond strong, CO32- stabilised by resonance, strong p-orbital overlap between C and O or not between Si and O (max 2) (M5, M6) [max 5] |