Module 2.2: Electrons, bonding and structure
2.1 Electron structure

(a) the number of electrons that can fill the first four shells					
(b) atomic orbitals, including: **(i)** as a region around the nucleus that can hold up to two electrons, with opposite spins **(ii)** the shapes of s- and p-orbitals **(iii)** the number of orbitals making up s-, p- and d-sub-shells, and the number of electrons that can fill s-, p- and d-sub-shells					
(c) filling of orbitals: **(i)** for the first three shells and the 4s and 4p orbitals in order of increasing energy **(ii)** for orbitals with the same energy, occupation singly before pairing					
(d) deduction of the electron configurations of: **(i)** atoms, given the atomic number, up to $Z = 36$ **(ii)** ions, given the atomic number and ionic charge, limited to s- and p-blocks up to $Z = 36$.					

2.2.2 Bonding and structure

(a) ionic bonding as electrostatic attraction between positive and negative ions, and the construction of '*dot-and-cross*' diagrams					
(b) explanation of the solid structures of giant ionic lattices, resulting from oppositely charged ions strongly attracted in all directions e.g. NaC*l*					
(c) explanation of the effect of structure and bonding on the physical properties of ionic compounds, including melting and boiling points, solubility and electrical conductivity in solid, liquid and aqueous states					
(d) covalent bond as the strong electrostatic attraction between a shared pair of electrons and the nuclei of the bonded atoms					
(e) construction of '*dot-and-cross*' diagrams of molecules and ions to describe: **(i)** single covalent bonding **(ii)** multiple covalent bonding **(iii)** dative covalent (coordinate) bonding					
(f) use of the term *average bond enthalpy* as a measurement of covalent bond strength					
(g) the shapes of, and bond angles in, molecules and ions with up to six electron pairs (including lone pairs) surrounding the central atom as predicted by electron pair repulsion, including the relative repulsive strengths of bonded pairs and lone pairs of electrons					
(h) electron pair repulsion to explain the following shapes of molecules and ions: linear, non-linear, trigonal planar, pyramidal, tetrahedral and octahedral					
(i) electronegativity as the ability of an atom to attract the bonding electrons in a covalent bond; interpretation of Pauling electronegativity values					
(j) explanation of: polar bond and permanent dipole within molecules containing covalently-bonded atoms with different electronegativities **(ii)** a polar molecule and overall dipole in terms of permanent dipole(s) and molecular shape					
(k) intermolecular forces based on permanent dipole–dipole interactions and induced dipole– dipole interactions					
(l) hydrogen bonding as intermolecular bonding between molecules containing N, O or F and the H atom of –NH, –OH or HF					
(m) explanation of anomalous properties of H_2O resulting from hydrogen bonding, e.g.: **(i)** the density of ice compared with water **(ii)** its relatively high melting and boiling points					
(n) explanation of the solid structures of simple molecular lattices, as covalently bonded molecules attracted by intermolecular forces, e.g. I_2, ice					
(o) explanation of the effect of structure and bonding on the physical properties of covalent compounds with simple molecular lattice structures including melting and boiling points, solubility and electrical conductivity					