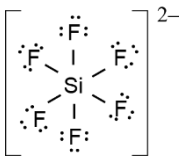


Things to remember in the last hour before the exam: Level 3 thermochemical principles and the properties of particles and substances

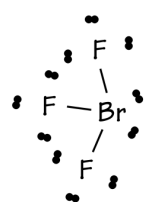
(This is not a revision sheet – you’ve done that by now – it’s a list of things you might want to remind yourself about... and it can’t possibly cover everything – although it has a very good try!)

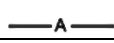












- Electron configuration, s,p,d notation. Order of orbitals filling: 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p. Transition metals lose 4s electrons before 3d when forming ions, e.g. V^{3+} : $[Ar]3d^2$. Watch out for anomalous Cr $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ and Cu $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$.
- Periodic trends - atomic radius: Across a period, atomic radii ↓ as atomic number ↑; nuclear charge increases, electrons are added to same energy level. Shielding remains the same BUT nuclear charge increases; “greater effective nuclear charge” – so attracts electrons more.
- Periodic trends – first ionisation energy; (general) trend across a period is increase (GENC = more attraction for valence e^- , harder to remove, higher I.E.) and decrease down a group (despite increased nuclear charge there is more shielding/screening by additional energy level(s), e^- easier to remove).
- Electronegativity – “attraction of a bonded atom for a bonding pair of electrons”.
 - Periodic trends – electronegativity increase L → R across P. table (GENC); electrostatic attraction between the nucleus and the bonded electron. Decrease in EN ↓ a group (more shielding); weaker electrostatic attraction between the nucleus and the bonded electrons.
- Ionic radii: K^+ ion has a smaller radius than K atom, as ion formed when atom lost an electron from the valence/outer energy level, and therefore ion has fewer shells. Cl^- ion is larger than Cl atom as extra electron in valence shell increases repulsion between electrons in valence shell so electrons move further apart / outwards.
- Attractive forces between ions, atoms and molecules.
 - ionic bonds: between metal cations and non-metal anions *exception $AlCl_3$ and similar compounds with covalent properties
 - covalent bonds: between non-metal atoms; molecular covalent e.g. H_2O & covalent network e.g. diamond
 - between molecules - weak intermolecular attractions. The lower the m.pt or b.pt, the weaker the attraction between particles.
 - Weakest - only have temporary / instantaneous dipoles-induced dipole attractions e.g. between nonpolar Cl_2 molecules. (As molar mass increases, the size of the electron cloud increases, these type of attractions get stronger – but remember the shape of a molecule also matters; e.g. straight chain alkane vs branched chain).
 - Slightly stronger – have temporary dipoles PLUS permanent dipoles e.g. between polar HCl molecules
 - Strongest of weak intermolecular forces - have temporary dipoles PLUS hydrogen bonding (the strongest type of permanent dipole-permanent dipole attraction). Between H covalently bonded to F, O or N (F-H, O-H, N-H) and one of these 3 most EN elements on another molecule. E.g. $H-F \cdots H-F$. A hydrogen bond tends to be stronger than van der Waals forces, but weaker than covalent bonds or ionic bonds.
- Melting point (S→L), boiling point (L→G): When molecules are heated they gain E_k and temperature rises except during a phase change. There is NO increase in temperature while a substance melts or boils - the supplied energy is used to break/overcome the intermolecular forces between molecules, not increase the E_k of the molecules.
- Lewis structures: count valence electrons, add / subtract electron(s) if ion. Any “surplus” electrons are placed on central atom. If an ion, put structure in square brackets and write charge outside e.g. SiF_6^{2-} .


- Shapes (up to 6 electron pairs around central atom)

Around the central atom there are ___ regions of electron density which repel to get as far apart as possible to minimise repulsion taking up a _____ shape. ___ regions are bonding and ___ regions are non-bonding so the overall shape of the molecule is _____.

e.g. BrF_3 has 5 regions of electron density around Br atom which repel to get as far apart as possible to minimise repulsion taking up a trigonal bipyramidal shape. 3 regions are bonding and 2 regions are non-bonding so the overall shape of the molecule is T-shaped.



Regions -ve charge	# of nonbonding (NB) electron pairs			
	0	1	2	3
2	Linear (180°) 			
3	Trigonal planar (120°) 	Bent 		
4	Tetrahedral (109°) 	Trigonal pyramid 	Bent 	
5	Trigonal bipyramid (90° and 120°) 	Seesaw / distorted tetrahedron 	T-shaped 	Linear 
6	Octahedral (90°) 	Square pyramid 	Square planar 	3 nonbonding regions would be T-shaped (and 4 nonbonding regions would be linear)

- Pairs of e^- : in terms of repulsion $NB-NB > NB-B > B-B$ so bond angle in NH_3 nearer to 107° than 109° due to the NB pair.
- Polarity of molecules: Consider EN of atoms in bonds and mark in δ^- & δ^+ or use \rightarrow over the atoms. If molecule is symmetrical, dipoles cancel out, molecule is non-polar. If molecule is unsymmetrical dipoles will NOT cancel out, molecule is polar.
- Solubility: "like dissolves like" *explains nothing* but helps you remember that nonpolar substances dissolve in other nonpolar substances, and (many) ionic solids dissolve in polar solvents e.g. water and ethanol. (Level 2)
- Enthalpy and entropy changes associated with spontaneity. Some chemical reactions or processes occur even if process is endothermic. E.g. dissolve (some) solids in water or thermal decomposition of solids (need to heat them!)
 - dissolving solid in water - endothermic ($+\Delta H$), energy is needed to overcome attraction between oppositely charged ions BUT this is offset by the ions in solution having higher entropy due to increase in dispersal of matter / degree of disorder.
 - thermal decomposition of a solid releasing a gas - endothermic ($+\Delta H$) BUT entropy of the **system** increases due to greater dispersal of matter - random motion of gases is higher. E.g. of system is $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$
 - Entropy of **surroundings** decreases whenever heat is transferred from the surroundings - due to less random motion of the particles in the surroundings.
- Specific heat capacity $Q=mc\Delta T$, where Q is energy (in J or kJ), m is (normally) mass (in g) of water being heated (e.g. by burning fuel) or mass of solution in which temp change occurs (e.g. Zn in $CuSO_4(aq)$), c is specific heat capacity of water (will be given, $4.18 J^\circ C^{-1} g^{-1}$) and ΔT is temperature change ($^\circ C$). Our experimental values don't match quoted values – not standard conditions and/or heat loss to surroundings.
- Phase changes: $\Delta_{vap}H^\circ$ (vaporisation) Enthalpy change when one mole of liquid water is converted to gaseous water under standard conditions. $H_2O(l) \rightarrow H_2O(g)$. Be able to write similar definitions for $\Delta_{sub}H^\circ$ (sublimation), and $\Delta_{fus}H^\circ$ (fusion / melting). $\Delta_{vap}H^\circ(H_2O) \gg \Delta_{fus}H^\circ(H_2O)$ since less energy needed to overcome attractive forces to turn solid \rightarrow liquid, as only some of the forces need to be broken. More energy is required to fully break all the forces between molecules in liquid phase to turn it into a gas. Bond breaking is $+\Delta H$, bond making is $-\Delta H$.
- Hess's Law: Can use $\Delta_r H^\circ = \sum \Delta_f H^\circ(\text{products}) - \sum \Delta_f H^\circ(\text{reactants})$ but only use this if you have $\Delta_f H^\circ$ data. Σ is sum of. Remember $\Delta_f H^\circ$ of element = 0. Otherwise use 'triangle method' or 'cancelling equations method' as taught!
- $\Delta_c H^\circ$ is the enthalpy change when one mole of substance is completely burnt in oxygen under standard conditions. $\Delta_f H^\circ$ is the enthalpy change when one mole of substance is formed from its elements, under standard conditions. $\Delta_r H^\circ$ is the enthalpy change for the quantities in the reaction. All three definitions are "per mol".