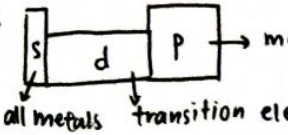
PERIODICITY

TOPIC 9

PERIODICITY

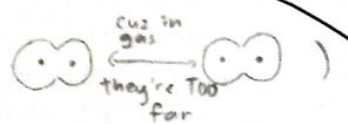
→ the recurrence of similar properties at regular intervals when elements are arranged in increasing atomic number order



→ mainly non metals

ATOMIC RADIUS

→ Atomic (covalent) radius
↳ for gaseous molecules



↳ ½ the internuclear distance between two like atoms bonded only by a single bond.

→ Atomic (van der Waal's) radius
↳ for solids
↳ ½ the average distance between adjacent non-bonded atoms.

→ Van der Waals' radius always > than covalent radius (cuz not exactly a "bond")

SIZE OF ATOMS

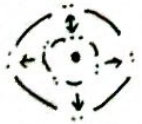
→ Factors:
↳ attraction of the +ve nucleus for electrons
↳ sheilding effect. (mutual repulsion of e⁻)

→

across period, atomic radius ↓
↳ ∵ nuclear charge ↑, weak sheilding effect (e⁻ added to same quantum shell)
↳ outer e⁻ more strongly attracted, little change in the shielding effect

→

The decrease in atomic radius becomes smaller with increasing atomic number
↳ due to increased repulsion between electrons in the outer shell



IONIC RADIUS

→ Cations smaller than their atoms
→ one shell less ∴ outer e⁻ more strongly attracted

→ Anions larger than their atoms
→ more e⁻ than protons
→ attractive force on outer e⁻ ↓
→ ∴ outer e⁻ less strongly attracted

→ Anions bigger than cations (same period)
→ one more shell of e⁻ ∴ outer e⁻ less strongly attracted

→ in isoelectronic series (eg. $Na^+ \rightarrow Si^{4+}$)
→ ionic radius ↓ as proton no. ↑
↳ because same number of e⁻ attracted more strongly by ↑ nuclear charge

→ Down ↓ a group
→ atomic radius ↑, cuz e⁻ shell ↑
→ sheilding effect outweighs increased nuclear charge.

ELECTRICAL CONDUCTIVITY

→ Across period, metals → metalloids → non metals
→ decreasing atomic radius,
→ force of attraction of nucleus & e⁻ ↑
→ ∴ less able to give up e⁻ for metallic bonds.

→ Electrical conductivity ↑ from Na to Al
→ number of valence e⁻ contributed to delocalised e⁻ cloud ↑

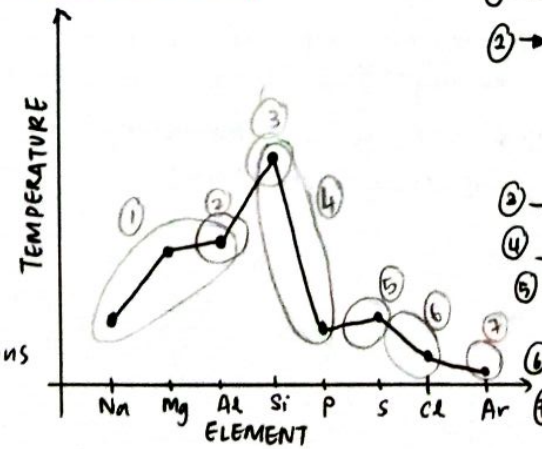
ELECTRONEGATIVITY

→ measure of the relative tendency of an atom in a covalent bond to attract a bonding pair of e⁻

→ down a group, electronegativity ↓
→ cuz atomic size ↑, sheilding effect ↑ (nucleus can't attract)

→ across a period, electronegativity ↑
→ cuz nuclear charge ↑, atomic radius ↓

MELTING TEMP



(Generally increase then decrease)

① → Na - Al mp ↑ cuz charge ↑, size ↓ = charge density ↑

② → Mp. of Al only slightly higher than Mg cuz metallic bond only slightly stronger
↳ Al^{3+} has high charge density ∴ attracts e⁻ to itself ∴ reduces no. of valence e⁻ in e⁻ cloud

③ → mp ↑ cuz Si has giant molecular structure

④ → mp ↓ cuz simple molecular structure

⑤ → S_8 molecules bigger than P_4 molecules, ∴ no. of e⁻ ↑, vdw ↑

⑥ → linear diatomic molecule, no. of e⁻ ↓ ∴ vdw ↓

⑦ → Ar small atoms, no. of e⁻ ↓, ∴ vdw ↓

* Bp ↑ than Mp, all bonds & forces broken ∴ free atoms

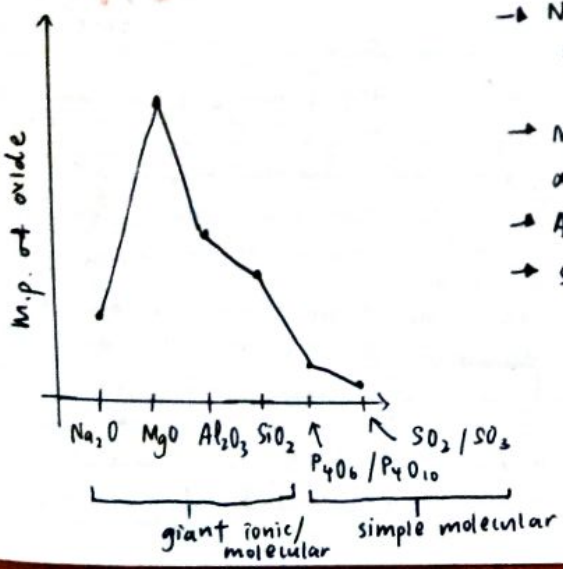
PERIODICITY

REACTIONS W/ H_2O (or steam)

→ Na
- → violent
- → $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ (with cold water)
- → effervescence
  - solid becomes smaller
  - solution becomes warm

→ Mg
- → slow
- → $Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$ (with cold water)
  - sparingly soluble
  - weakly alkaline
- → effervescence
  - solid becomes smaller * X solution becomes warm (slow reaction)
- → vigorous
- → $Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$ (with steam)

MP OF OXIDES



→ Na_2O, MgO, Al_2O_3 ⇒ giant ionic
↳ large amounts of energy to break strong ionic bonds in lattice

→ MgO mp > than Na_2O mp cuz electrostatic attraction by Mg^{2+} ↑ ∴ stronger ionic bond

→ Al_2O_3 mp ↓ cuz covalent character

→ SiO_2 → giant covalent structure.

* - oxides w/ H_2O
- chlorides

} ref class notes

$MgCl_2 + H_2O$

→ $MgCl_2$ dissolves in water with slight hydrolysis (broke water)

→ this is due to the larger polarising power of Mg^{2+} ions

→ this gives a slightly acidic solution

$$MgCl_2(s) + aq \rightarrow [Mg(H_2O)_6]^{2+} + 2Cl^-$$

$$[Mg(H_2O)_6]^{2+} \rightleftharpoons [Mg(H_2O)_5OH]^+ + H^+$$

$AlCl_3 + H_2O$

→ Al^{3+} is a highly charged cation and polarizes the H_2O molecules bonded to it.

→ it causes H_2O to lose H^+, which makes the solution acidic. ↑ (hydrolysis)

$$AlCl_3(s) + aq \rightarrow [Al(H_2O)_6]^{3+} + 3Cl^-$$

$$[Al(H_2O)_6]^{3+} \rightarrow [Al(H_2O)_5OH]^{2+} + H^+$$