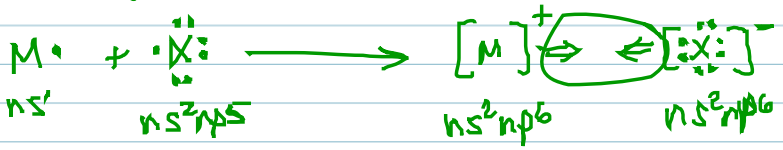
CHAPTER 9

Dot structure [X] ·X· :X:

IONIC BONDING

→ an electrostatic force of attraction that holds oppositely charged ions together



processes

1) $M \rightarrow M^+ + e^-$ IE
2) $X + e^- \rightarrow X^-$ EA

} watch physical states

BOND STRENGTH → a measure of the force necessary to separate 2 atoms or ions bonded together

the stronger the bond ⇒ the more E needed to break it

BOND BREAKING IS ALWAYS ENDOTHERMIC

bond formation is exothermic

BOND STRENGTH ≈ BOND ENTHALPY

* always measured as "per mole" and with gaseous substances

– in liquids or solids, neighbor atoms/ions affect stability

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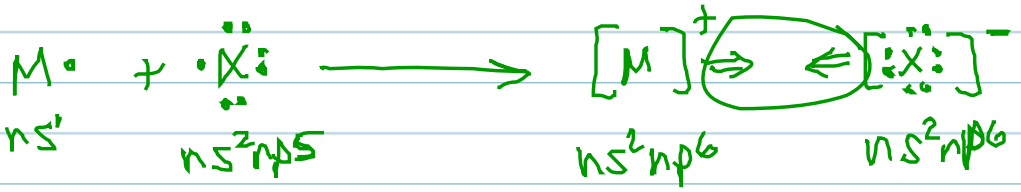

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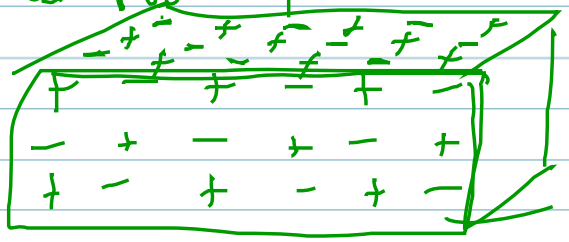
E → H–Ö–H → H–Ö: + •H

→ bond enthalpy

BUT → all ionic compounds are solids at room T



3D shape "lattice"

LATTICE ENERGY instead of "bond strength" (kJ/mol)

Coulomb's Law

$$E \propto \frac{Q_{cation} Q_{anion}}{r}$$

$$F_{attraction} = k \frac{Q_1 Q_2}{r^2}$$

a Q↑, F↑ "stronger bond"

as r↑, F↓ "weaker bond"

- the larger the ionic charges the stronger the bond, the greater the bond energy

- the smaller the ions, the shorter the bond length (r), the stronger the bond, the greater the bond energy

BORN-HABER CYCLE – an indirect method of calculating lattice E

– use Hess's Law

need to know
1) IE of metal
2) EA of nonmetal
– if they need B.E. of X_2
3) ΔH_{SUB} M
4) $\Delta H_{overall}$ (ΔH_f "heat of formation")

ΔH_{SUB} K = 79.2 kJ/mol BE Cl_2 = 243 kJ/mol

IE K (g) = 418.7 kJ/mol

EA Cl (g) = −349 kJ/mol $K_{(s)} + \frac{1}{2}Cl_{2(g)} \rightarrow KCl_{(s)}$

ΔH_f KCl = −435.87 kJ/mol

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step ① $M_{(s)} \rightarrow M_{(g)}$
$K_{(s)} \rightarrow K_{(g)}$ ΔH_1 = 79.2 kJ/mol

step ② $\frac{1}{2}X_{2(g)} \rightarrow X_{(g)}$
$\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)}$ $\Delta H_2 = \frac{243 \text{ kJ/mol}}{2} = 122$ kJ/mol

step ③ $M_{(g)} \rightarrow M^+_{(g)} + e^-$
$K_{(g)} \rightarrow K^+_{(g)} + e^-$ ΔH_3 = IE = 418.7 kJ/mol

step ④ $Cl_{(g)} + e^- \rightarrow Cl^-_{(g)}$ ΔH_4 = EA = −349 kJ/mol (−)
$X_{(g)} + e^- \rightarrow X^-_{(g)}$

step ⑤ $M^+_{(g)} + X^-_{(g)} \rightarrow MX_{(s)}$ ΔH_5 = LATTICE ENERGY = ??
$K^+_{(g)} + Cl^-_{(g)} \rightarrow KCl_{(s)}$

$K_{(s)} + \frac{1}{2}Cl_{2(g)} \rightarrow KCl_{(s)}$ $\Delta H_{overall}$ = −435.87 kJ/mol

$\Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5 = \Delta H_{overall}$

ΔH_5 = LATTICE ENERGY

$\Delta H_5 = -707$ kJ/mol

LATTICE ENERGY ⇓ BOND STRENGTH

evidence: melting point