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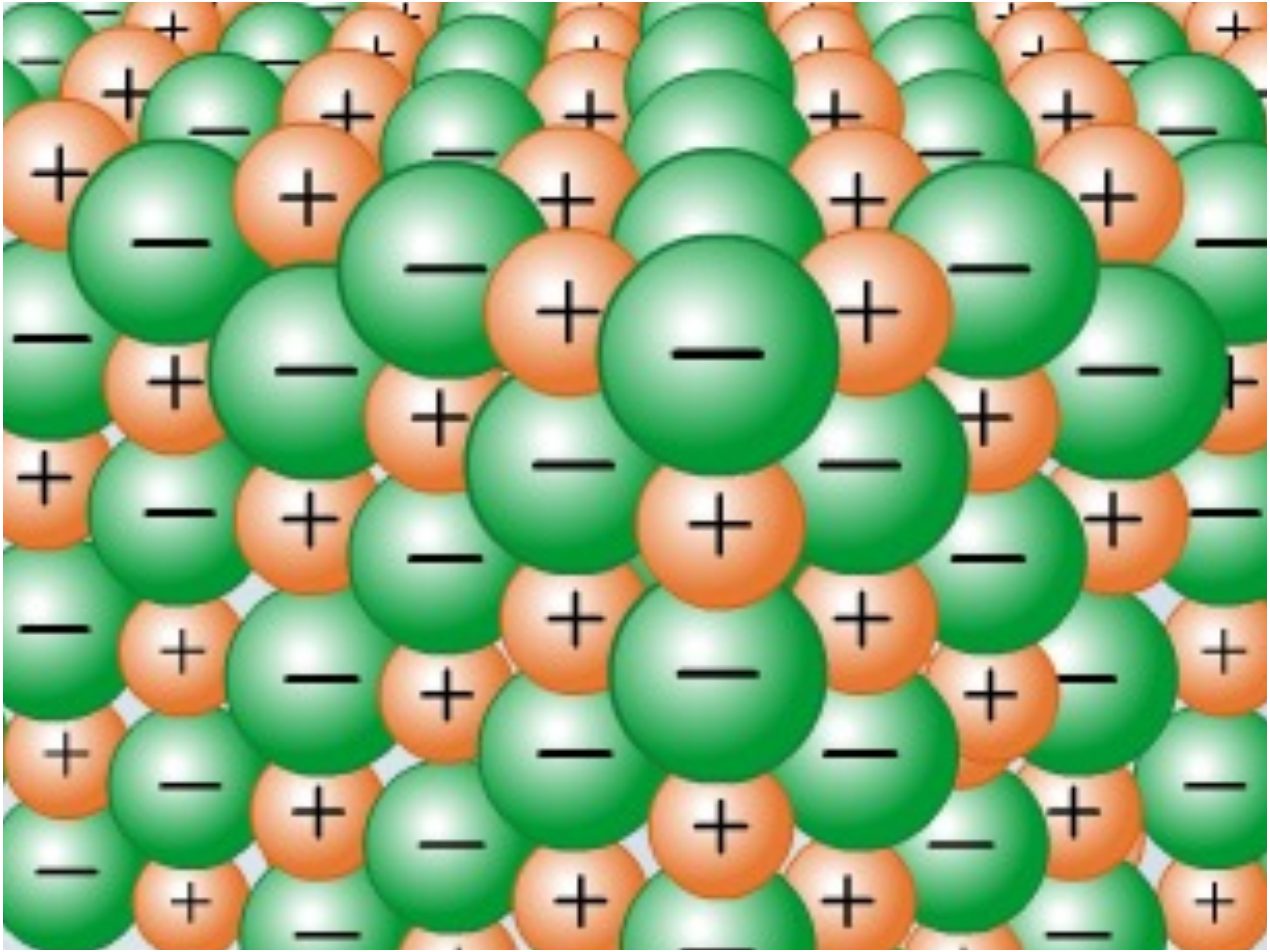
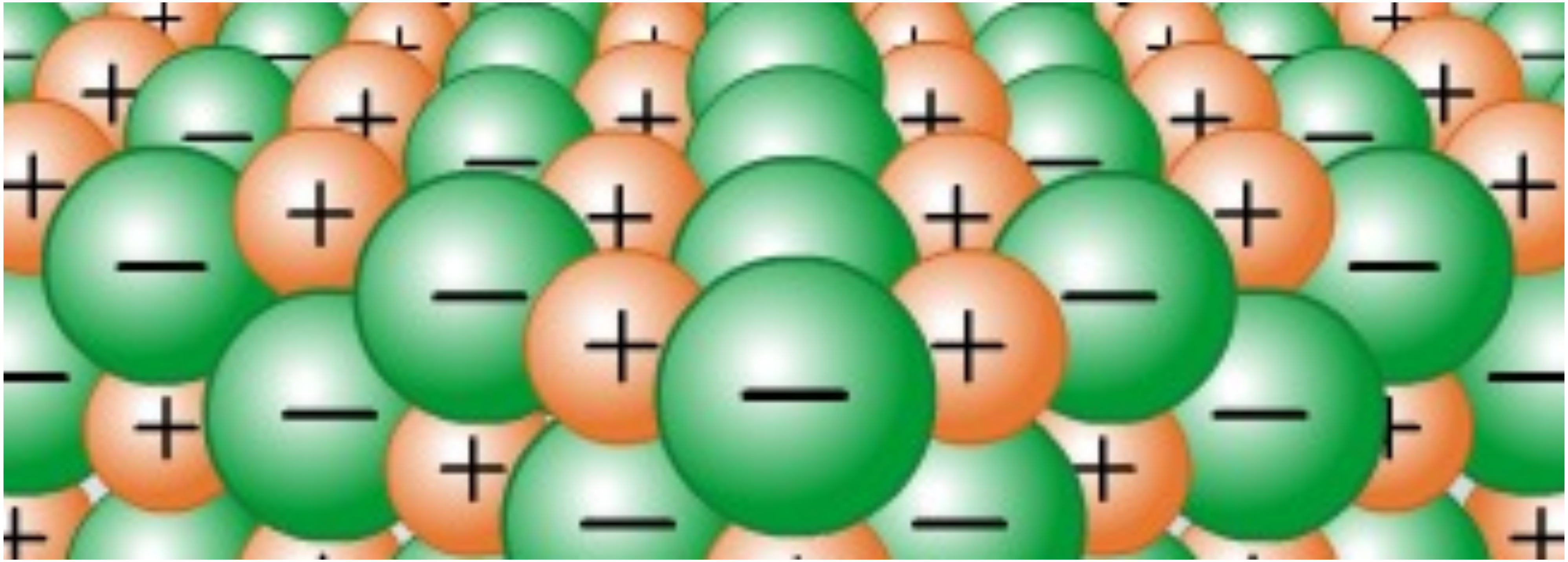
LATTICE ENTHALPY





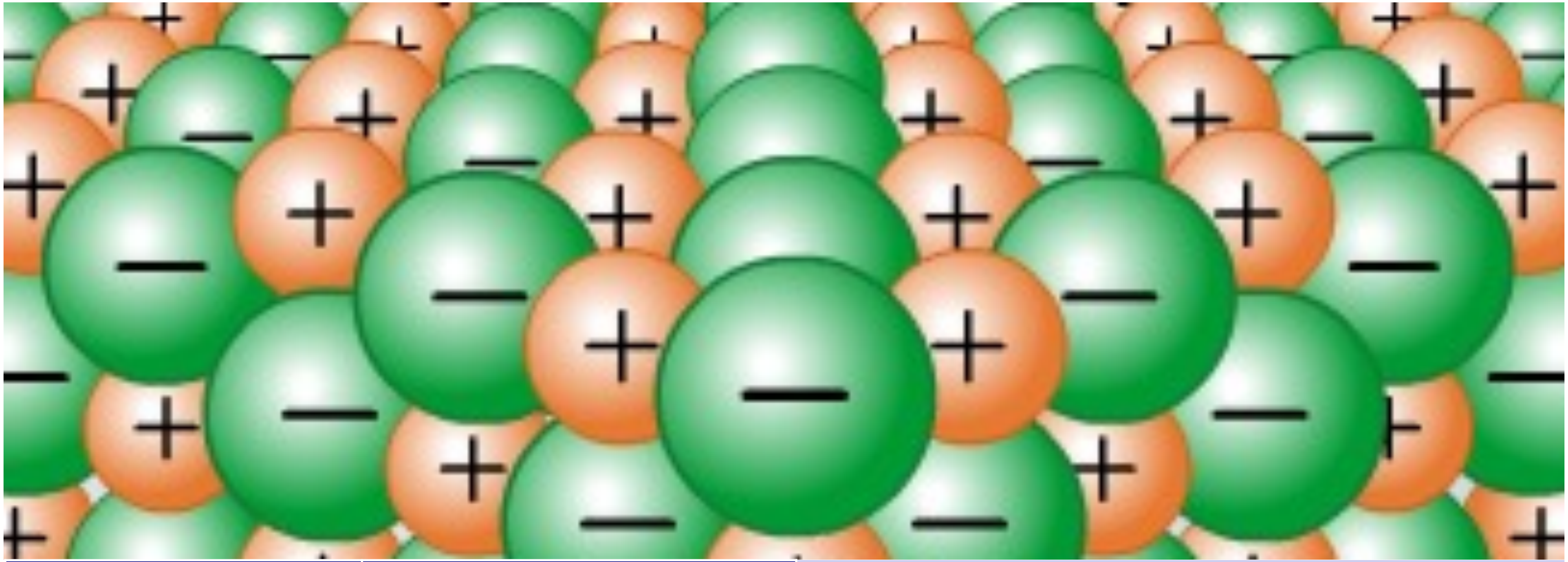
Lattice enthalpy of dissociation +771 kJ mol^{-1}

(breaking ions of opposite charge apart)

$$NaCl(s) \rightleftharpoons Na^{+}(g) + Cl^{-}(g)$$

Lattice enthalpy of formation –771 kJ mol^{-1}

(bringing ions of opposite charge together)



Compound	Lattice enthalpy (kJ mol^{-1})
NaCl	771
NaF	902
$MgCl_2$	2493
MgO	3889
CaO	3513
Al_2O_3	15421

The magnitude of the lattice enthalpy is a measure of the strength of the ionic bonding

Increasing strength of ionic bonding

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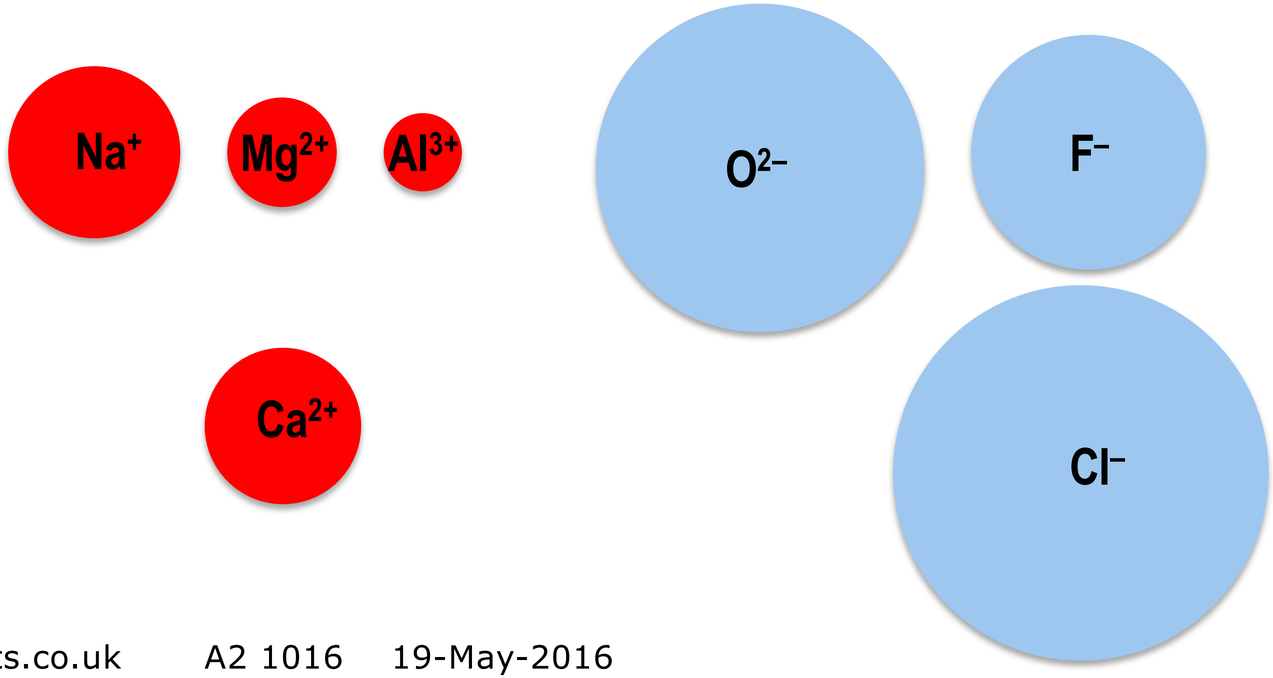
Stronger attractions with

- **smaller ions**
- **higher charged ions**



Predict which of these pairs of compounds has the strongest ionic bonding and the greatest lattice enthalpy?

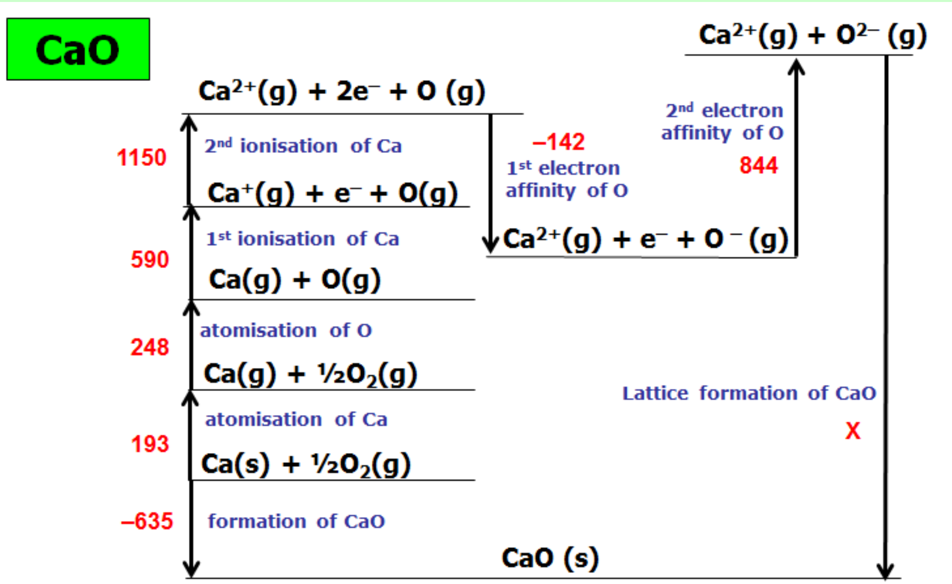
1) KBr v KI — KBr – Br^- smaller than I^-

1) MgS v MgO — MgO – O^{2-} smaller than S^{2-}

1) NaBr v $MgBr_2$ — $MgBr_2$ – Mg^{2+} smaller <u>and</u> higher charge than Na^+

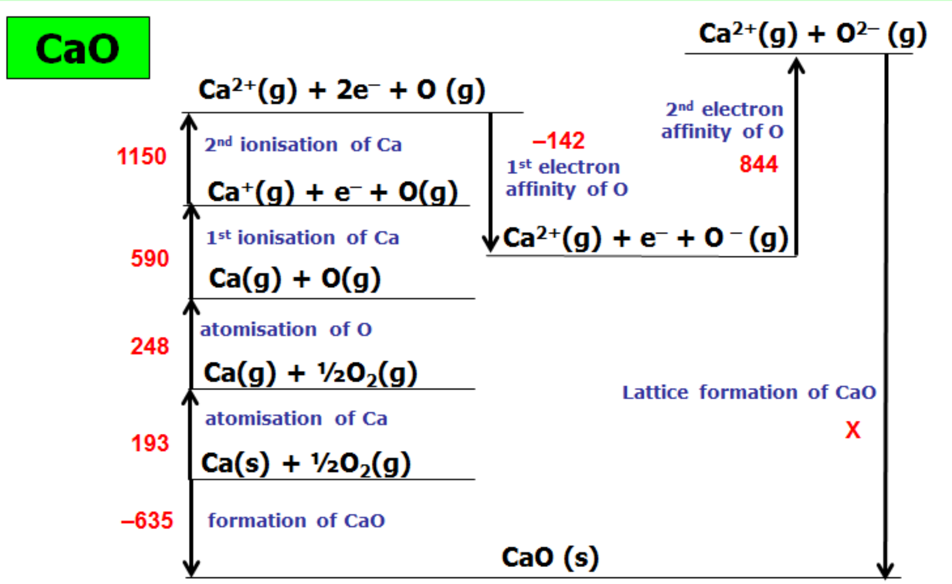
2) $MgCl_2$ v $CaCl_2$ — $MgCl_2$ – Mg^{2+} smaller than Ca^{2+}

Measured (true) lattice enthalpy	Theoretical lattice enthalpy
From a Born-Haber cycle using data measured from experiment	From a theoretical calculation where we assume it has a perfect ionic structure



$$E = -\frac{N_A M z^+ z^- q_e^2}{4\pi\varepsilon_0 r_0}\left(1 - \frac{1}{n}\right)$$

Measured (true) lattice enthalpy	Theoretical lattice enthalpy



$$E = -\frac{N_A M z^+ z^- q_e^2}{4\pi\varepsilon_0 r_0}\left(1 - \frac{1}{n}\right)$$

–3518 kJ mol^{-1} | **–3477 kJ mol^{-1}**

The smaller the difference, the closer to having a perfect ionic structure

The bigger the difference, the more covalent character (distorted ions)

Compound	NaCl	LiCl	LiI	MgO	AgCl	Al_2O_3
Experimental value	-771	-846	-744	-3513	-905	-15421
Theoretical value	-766	-833	-728	-3477	-770	-14910
% difference	0.6%	1.5%	2.2%	1.0%	14.9%	3.3%

The smaller the difference, the closer to having a perfect ionic structure

The bigger the difference, the more covalent character (distorted ions)

The bigger the lattice enthalpy

↓

Stronger ionic bonding

The bigger the difference between experimental and theoretical values

↓

More covalent character

Compound	AgCl	Al_2O_3
Experimental value	-905	-15421
Theoretical value	-770	-14910
% difference	14.9%	3.3%

AgCl has more covalent character

Al_2O_3 has stronger ionic bonding