Lattice Energy Answers

1) In each of the following use the formula to work out the charge on the metal ion and then use that to predict the formula of the second compound

a) The formula for samarium oxide is Sm_2O_3. The formula for the chloride of samarium would be: $SmCl_3$

b) The formula for a compound of Manganese is MnF_4. The formula of the oxide of Mn is expected to be MnO_2

c) The formula of praseodymium nitrate is $Pr(NO_3)_4$. The formula of calcium arsenate is $Ca_3(AsO_4)_2$. The formula of praseodymium arsenate is $Pr_3(AsO_4)_4$

2)

a) Put these positive ions in order of their size from smallest to largest:

Mg^{2+} Na^+ Ca^{2+} Li^+ Al^{3+} K^+

Li^+, Al^{3+}, Mg^{2+}, Na^+, Ca^{2+}, K^+

b) Do the same for these:

Cl^- O^{2-} F^- N^{3-} S^{2-} Ar

F^-, O^{2-}, N^{3-}, Ar, Cl^-, S^{2-}

c) Which combination of these ions would be expected to give the highest lattice energy? Why?
ALN, biggest difference between charges (3+ and 3-) so strongest ionic bond

d) And the lowest?
Why?
KCl there are a couple of possibilities where ion charges are +1 and -1, but these are the biggest ions with that difference.

3)

a) Write the equation to show the lattice energy of sodium oxide

$Na_2O_{(s)} \longrightarrow 2Na^+_{(g)} + O^{2-}_{(g)}$

b) Would you expect sodium oxide to have a more endothermic lattice energy than magnesium oxide? Justify your answer in terms of both charge and size of ions.

No. Although the Mg^{2+} is very slightly smaller than Na^+, the charge on Na is only +1, whereas Mg is +2 and this means the strength of the ionic bond is stronger in MgO and therefore it has a more endothermic lattice enthalpy. (please note, you need to have said something about ion size, even though it doesn't affect it as much, RTQ)

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4) Five compounds (A-E) have the following lattice energies (in KJ/mol)

A	B	C	D	E
817	2161	3832	2258	2957

The compounds are known to be Rubidium Oxide, Potassium Fluoride, Calcium Chloride, Magnesium Fluoride and Beryllium Sulphide.
Identify A-E
A: KF
B: Rb_2O
C: BeS
D: $CaCl_2$
E: MgF_2
Based on your answers does charge or size have a greater effect on lattice energy?
Charge

5) For the five compounds in question 4, put them in order of increasing amount of distortion (least distorted first). Explain your reasoning.
Rb_2O, KF, MgF_2, $CaCl_2$, BeS
BeS: is most since the Be is small and 2+ so is good at distorting and the S^{2-} is relatively large so easy to distort.
Rb_2O :is least since Rb is only 1+, and large, so pants at distorting, and O^{2-} is small and therefore hard to distort.
KF: second lowest since F^- hard to distort, but K is smaller than Rb, so slightly better at distorting.
MgF_2, $CaCl_2$: Mg and Ca are both 2+ so they distort more than K^+, but Mg^{2+} is smaller than Ca^{2+}, so is better at distorting. Also, F^- is harder to distort than Cl^-

6) The table gives both experimental and theoretical lattice energies for a series of silver halides. A comparision of the values gives an insight into the level of distortion

	Experimental (KJ/mol)	Theoretical (KJ/mol)
AgF	967	953
AgCl	915	864
AgBr	904	830
AgI	889	808

a) State and explain the trend in experimental values for AgF to AgI

Become less endothermic. The halide ion is getting bigger AgF to AgI so distance between ions increases, therefore attraction to Ag^+ decreases, so bond weakens, less energy needed to break, lower lattice energy.

b) For each compound calculate the difference between the experimental and theoretical values. Is there a trend? If so, why?
The bigger the halide ion, the larger the gap. The larger the halide ion the easier it is to distort, so further away from the hard sphere model, so bigger disagreement between experimental and theoretical.