Assignment: Ionic Crystals- Born-Haber Cycle

1. a. Define the term lattice energy.

b. In the table below are the enthalpy changes needed to calculate the lattice energy of sodium oxide, Na_2O

Enthalpy change	Value (kJ mol^{-1})
enthalpy change of atomization of sodium	+108
1st ionization energy of sodium	+496
enthalpy change of atomization of oxygen, ½ $O_{2\,(g)}$	+249
1st electron affinity of oxygen	– 141
2nd electron affinity of oxygen	+790
enthalpy change of formation of sodium oxide	– 414
lattice energy of sodium oxide	

Using the table above sketch a Born-Haber cycle for sodium oxide.

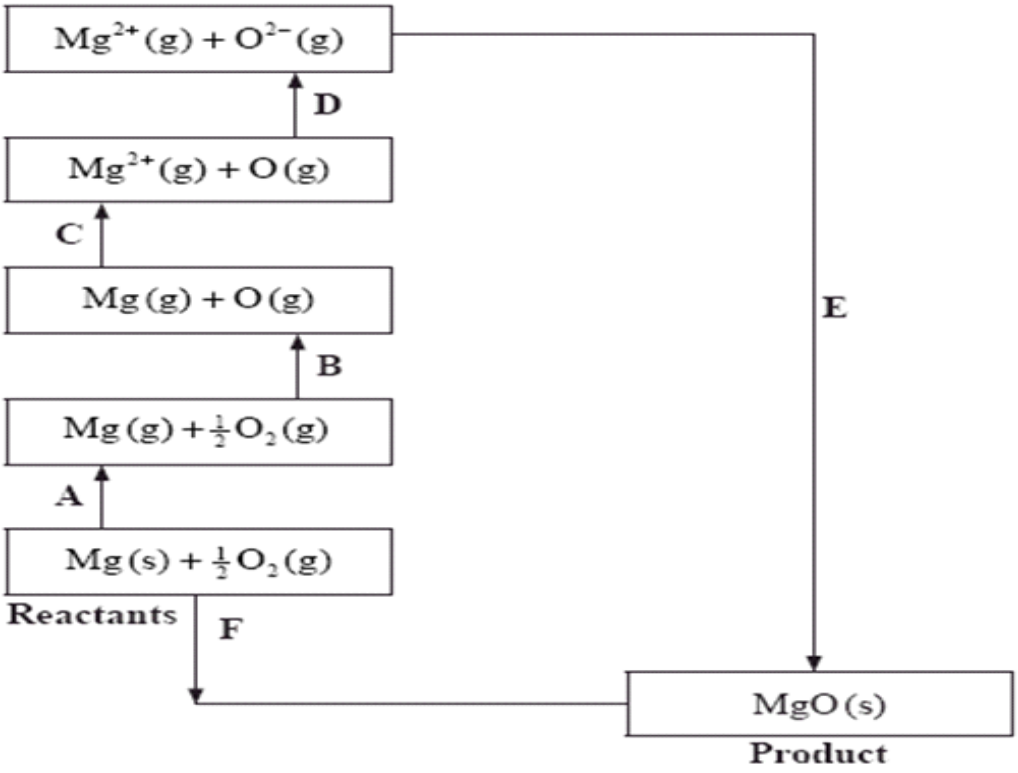
c. Calculate the lattice energy of sodium oxide. (Answer: –2520 kJ mol-[1])

d. Predict whether the lattice energy of magnesium oxide, MgO, is more or less exothermic than the lattice energy of magnesium sulphide, MgS. Justify your answer in terms of the size and the charges of the ions involved.

2. The heat of formation of $KF_{(s)}$ at 25^0C is – 562.58 kJ mol^{-1} . Use the following thermodynamic data at 25 ^{0}C to calculate the lattice energy of $KF_{(s)}$:

ΔH^0 atomisation $K_{(s)}$ = 90.00 kJ/mol
1st ionization energy of $K_{(g)}$ = 424.93 kJ/mol
ΔH^0, Bond dissociation energy $F_{2(g)}$ = 157.99 kJ/mol
1st electron affinity of $F_{(g)}$ = -349.7 kJ/mol. (Answer: -806.8 kJ/mol)

3. The Born- Haber cycle for MgO under standard conditions is shown below:



The values are shown in the table below:

Process	Enthalpy change (kJ mol^{-1})
A	+150
B	+248
C	+736 + (+1450)
D	–142 + (+844)
E	
F	– 602

a. Identify the processes represented by A, B, and D in the cycle.

b. Define the energy change C and D

c. Determine the value of the enthalpy change E

d. Compare the sign expected for the energy change D for the first value and justify the second value in terms of exothermic and endothermic energy change. Explain your justification.

e. Compare the lattice energy of MgO with BaO and with Al_2O_3. Explain which one of these compounds will have a higher melting point and which of these compounds will have a greater solubility in a polar solvent.