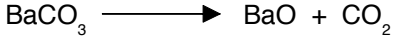
GROUP 2: THERMAL STABILITY OF THE CARBONATES AND NITRATES

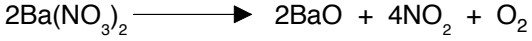
1. a) Both barium carbonate and barium oxide (the product) are white.



b) lower

c) A white solid producing a brown gas and leaving a white solid. (You wouldn't see the oxygen also produced).

Products: barium oxide, nitrogen dioxide (nitrogen(IV) oxide) and oxygen



d) lower

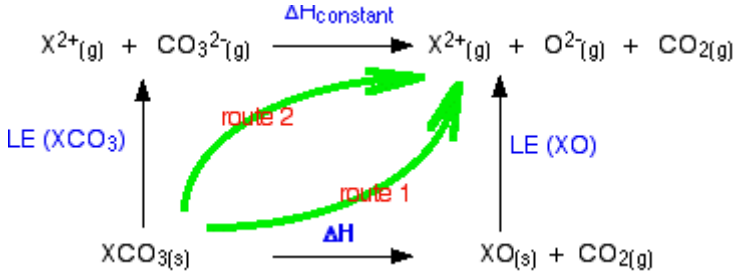
2. a) If you bring a positive ion close to the carbonate ion, the carbonate ion is polarised such that the negative charges tend to move onto the oxygen nearest to the positive ion. That means that you are on the way to getting an oxide ion formed. This effect is greatest if the positive ion has a high charge density.

For positive ions with the same charge, the only thing which affects charge density is the size of the ion. The smaller ions at the top of the group have a higher charge density (the same charge packed into a smaller volume) and so have more effect on the nearby carbonate ions than the bigger ones at the bottom.

b) If the carbonate ion is very polarised, it is well on the way to becoming an oxide ion and releasing carbon dioxide. To complete the process, you will need to add less heat energy at the top of the group where the polarisation is greatest, and increasing more heat energy as you go down the group as the polarisation becomes less.

3. a) All the enthalpy changes are positive, meaning that energy has to be supplied in order for the reactions to happen. As you go down the group the heat needed increases, and therefore the temperature required increases

b) Find two routes around the diagram to equate using Hess's Law.



$$\Delta H + LE(XO) = LE(XCO_3) + \Delta H_{constant}$$

$$\Delta H = LE(XCO_3) - LE(XO) + \Delta H_{constant}$$

c) The size of the lattice enthalpy depends on the distance between the centres of the ions – you can find that from the sum of the ionic radii of the metal ion and the carbonate ion. As you go down the group, the ionic radii of the metal ions increases, and therefore the distance between the centres of the ions increases, and the lattice enthalpy falls.

d) The oxide lattice enthalpy falls faster than the carbonate one. With the oxide (a small negative ion), the contribution of the metal ion to the inter-ionic distance is a greater proportion of the total than it is with the bigger carbonate ion.

So as the metal ion gets bigger, it will have a greater proportional effect on the total inter-ionic distance, and therefore the lattice enthalpy, than in the carbonate case.

e) $\Delta H = LE(XCO_3) - LE(XO) + \Delta H_{constant}$

This is a positive number

The number you are taking away is falling faster than the first number. That means that the overall answer will get more positive.