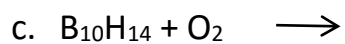
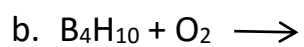
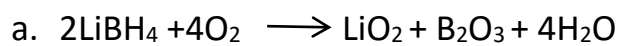


Group 13 Exercises

1. Give examples of compounds which formally contain boron, aluminium or thallium in the +1 oxidation state.
2. Identify the element X in each of the following:
 - a. X forms a chloride XCl_3 which is planar.
 - b. The oxide of X is amphoteric.
 - c. Addition of fluoride to XF_3 gives *only* XF_4
 - d. The hydride X_2H_6 has been discovered to have a low melting point.
 - e. The chloride XCl_3 is oxidising, but XCl is stable and insoluble in water.
3. Explain what is meant by:
 - a. The inert pair effect.
 - b. An amphoteric oxide.
4. Predict the outcomes of the following reactions and write balanced equations:
 - a. $\text{BBr}_3 + \text{H}_2\text{O} \longrightarrow$
 - b. $\text{BCl}_3 + \text{Me}_4\text{N}^+\text{Cl}^- \longrightarrow$
 - c. $\text{Ph}_2\text{PCl} + \text{Li}[\text{AlH}_4] \longrightarrow$
5. Explain why aluminium fluoride is a solid with a high melting point, but aluminium bromide has a low melting point (370 K) and dissolves readily in benzene.
6. Give and examples of (a) an electron deficient molecule and (b) a donor-acceptor complex.
7. Using Wade's rules, predict the structures of the following borane clusters:
 - (a) $[\text{B}_2\text{H}_6]^{2-}$
 - (b) $\text{B}_{10}\text{C}_2\text{H}_{12}$
 - (c) B_4H_{10}
8. Explain why an aqueous solution of aluminium(III) nitrate is acidic but an aqueous solution of thallium(I) nitrate is not.
9. Amorphous boron is obtained by reduction of B_2O_3 using metallic Mg. Write a balanced equation for the reaction.
10. Hydrides of the Group 13 elements are potentially competitors of H_2 as rocket fuels. Balance equations b. and c. below and then compare the energy available for the complete combustion of LiBH_4 , B_4H_{10} and $\text{B}_{10}\text{H}_{14}$

(with excess dioxygen) in kJ g^{-1} . If combustion of H_2 in O_2 produces an energy gain of 143 kJ g^{-1} which boron reaction is competitive?



$\Delta_f H^\circ$ values (kJ mol^{-1}): LiBH_4 (-189), B_2O_3 (-1273), Li_2O (-598), H_2O (-286), B_4H_{10} (+66), $\text{B}_{10}\text{H}_{14}$ (+32)