

83 Classify the following oxides as acidic, basic, amphoteric, or neutral:

- (a) CO₂: acidic (b) K₂O: basic (c) CaO: basic (d) N₂O₅: acidic (e) CO: neutral
(f) NO: neutral (g) SnO₂: amphoteric (h) SO₃: acidic (i) Al₂O₃: amphoteric (j) BaO: basic

84 Write equations for the reactions between:

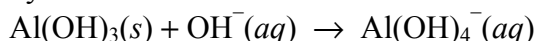
- (a) CO₂ (g) + 2 NaOH (aq) → Na₂CO₃ (aq) + H₂O (l)
(b) Na₂O (s) + 2 HNO₃ (aq) → 2 NaNO₃ (aq) + H₂O (l)

87 Zn(OH)₂ is an amphoteric oxide. Write balanced ionic equations to show its reaction with (a) HCl and b) NaOH

- (a) 2HCl(aq) + Zn(OH)₂(s) → ZnCl₂(aq) + 2H₂O(l)
(b) 2OH⁻(aq) + Zn(OH)₂(s) → Zn(OH)₄²⁻(aq)

88 Al(OH)₃ is insoluble; it dissolves in excess NaOH. Write a balanced ionic equation; what kind of a reaction is it?

Al(OH)₃ is an amphoteric hydroxide. The reaction is:



This is a Lewis acid-base reaction. Can you identify the acid and base?

90 What must be present for a molecule to act as a Lewis acid? A Lewis Base?

To be a Lewis acid, a molecule or ion must contain an electron deficiency, such as the empty p-orbital in sp² hybridized BX₃ or the empty 1s orbital of H⁺. To be a Lewis base, molecule or ion must contain a non-bonded pair of electrons to donate, such as the lone pair of electrons on NH₃ or one of the lone pairs on OH⁻.

91 Classify each of the following species as a Lewis acid or a Lewis base:

- (a) CO₂: Lewis acid; see the reaction with water shown in Section 12 of the text.
(b) H₂O: Lewis base; water combines with H⁺ to form H₃O⁺.
(c) I⁻: Lewis base.
(d) Lewis acid; SO₂ reacts with water to form H₂SO₃. Compare to CO₂ above. Actually, SO₂ can also act as a Lewis base under some circumstances.
(e) NH₃: Lewis base; see the reaction with H⁺ to form ammonium ion.
(f) OH⁻: Lewis base; see the reaction with H⁺ to form water.
(g) Lewis acid; does H⁺ have any electron pairs to donate?
(h) Fe³⁺: Lewis acid; compare to the example of NH₃ reacting with BF₃.

92 Describe the reaction AlCl₃(s) + Cl⁻(aq) → AlCl₄⁻(aq) in terms of the Lewis theory of acids and bases.

AlCl₃ is a Lewis acid with an incomplete octet of electrons on the central Al³⁺ and Cl⁻ is the Lewis base donating a pair of electrons.

