

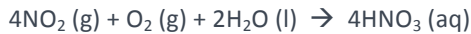
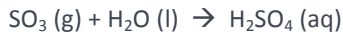
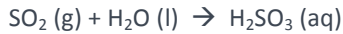
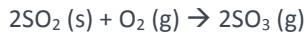
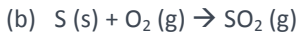


Year 12 Chemistry
Tutorial 9.3.A – Acid/Base Synthesis

Answers

- acidic oxide: sulfur dioxide and basic oxide: magnesium oxide
- Both oxides form acid rain; when it rains they react with water to form acidic solutions.
Sulfur dioxide reacts with water to produce a weak acid solution only, whereas nitrogen dioxide forms a mixture of a weak and strong acid (this will become clearer later in the module when we look at strong and weak acids).
- $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_3(\text{aq})$
 - $\text{K}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{KOH}(\text{aq})$
 - $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq})$
- A substance can act as either an acid or a base.
 - $\text{BeO}(\text{s}) + 2\text{HCl}(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Be}(\text{H}_2\text{O})_4^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq})$ and
 $\text{BeO}(\text{s}) + 2\text{NaOH}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Be}(\text{OH})_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq})$
 - $\text{BeO}(\text{s}) + 2\text{H}^+(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Be}(\text{H}_2\text{O})_4^{2+}(\text{aq})$ and $\text{BeO}(\text{s}) + 2\text{OH}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Be}(\text{OH})_4^{2-}(\text{aq})$
 - in (i) base and (ii) acid
- Inquiry into Urban Air Pollution (commissioned by the Federal Government in 1997) established that there were high levels of sulfur dioxide and nitrogen oxides in the air and that they were having an adverse effect on the health of Australians. Acid rain from these gases has been responsible for accelerating the destruction of many important historical buildings such as the Taj Mahal and the Parthenon. Soil acidification has caused widespread destruction of forests such as the Black Forest in Germany. Lakes in some countries, such as those in Scandinavia, have suffered drops in pH due to the increased output of acidic oxides. In this case of Scandinavia, the acidic oxides have come from countries such as Germany and England.
- In a metal sulfide smelter, the ore is heated in air and converts to a metal oxide, releasing sulfur dioxide.
 $2\text{ZnS}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{ZnO}(\text{s}) + 2\text{SO}_2(\text{g})$
When coal, petroleum or natural gas are burnt, sulfur in sulfur compounds is converted to sulfur dioxide.
 $\text{S}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{SO}_2(\text{g})$
Lightning strikes cause reaction between the two most common gases in the atmosphere.
 $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$
High temperature combustion reactions in furnaces and internal combustion engines produce significant amounts of NO [called nitrogen monoxide, nitric oxide or nitrogen(II) oxide] above 1300°C.
 $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$
Colourless, neutral nitrogen monoxide reacts with oxygen in the air to form brown, acidic nitrogen dioxide [nitrogen(IV) oxide].
 $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
- $2\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HNO}_2(\text{aq}) + \text{HNO}_3(\text{aq})$ and/or $4\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{HNO}_3(\text{aq})$
- $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_3(\text{aq})$ or $\text{SO}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_4(\text{aq})$

9. (a) SO₂ and NO₂



(b) Acid rain causes a cascade of effects that harm or kill individual fish, reduce fish population numbers, completely eliminate fish species from a waterbody, and decrease biodiversity. As acid rain flows through soils, aluminium is released from soils into the lakes and streams located in that area. So, as pH in a lake or stream decreases, aluminum levels increase. Both low pH and increased aluminum levels are directly toxic to fish. In addition, low pH and increased aluminum levels cause chronic stress that may not kill individual fish, but leads to lower body weight and smaller size and makes fish less able to compete for food and habitat.

(c) Test a sample of rainwater with a pH meter to determine the pH. If the pH is less than 5.6 then it is acid rain.

10. (a) boron, iron and manganese

(b) 5.0 – 6.0

(c) The carbonate ions neutralise some of the hydrogen ions in the soil to increase the pH according to the following equation: $2H^+(aq) + CO_3^{2-}(aq) \rightarrow CO_2(g) + H_2O(l)$

11. (a) 1.53 mol

(b) 1.53 L

(c) 19 L

12. 5 L

13. H₂ = 34.4 L and O₂ = 17.2 L

14. 6.4 L

15. H₂O = 15 L and H₂ = 15 L

16. Oxygen 62.5 L : Carbon dioxide 125 L

17. 79 L

18. 100 L and none left over

19. 1.7 L

20. (a) carbon dioxide

(b) 170.89 g

(c) 0.69 g

(d) 0.39 L