

7. Equilibria

7.2 Brønsted–Lowry theory of acids and bases

Paper 2

Question Paper

1 Species such as NH_4^+ , CO_3^{2-} and PO_4^{3-} are examples of molecular ions.

(c) NH_4^+ is a Brønsted–Lowry acid.

(i) Define Brønsted–Lowry acid.

.....
..... [1]

(ii) When $\text{NH}_4^+(\text{aq})$ is heated with $\text{NaOH}(\text{aq})$, a pungent gas is produced.

Write an ionic equation for this reaction.

..... [1]

2 Phosphorus, sulfur and chlorine can all react with oxygen to form oxides.

(b) The two most common oxides of sulfur are SO_2 and SO_3 .

When SO_2 dissolves in water, a small proportion of it reacts with water to form a weak Brønsted–Lowry acid.

(i) Explain the meaning of the term *weak Brønsted–Lowry acid*.

.....
..... [2]

3 Nitrogen molecules, $N_2(g)$, contain two atoms attracted to each other by a triple covalent bond.

(d) 25 cm^3 of 0.10 mol dm^{-3} $HCl(aq)$ is added to a beaker and its pH is recorded.

50 cm^3 of 0.10 mol dm^{-3} $NH_3(aq)$ is added to the $HCl(aq)$ in 5 cm^3 portions.

The pH of the mixture is monitored until all the $NH_3(aq)$ is added.

HCl is a strong Brønsted–Lowry acid.

(i) Describe what is meant by a strong Brønsted–Lowry acid.

.....
 [2]

(ii) NH_3 is a weak base.

Construct an equation that shows the behaviour of NH_3 as a weak Brønsted–Lowry base when dissolved in water.

..... [1]

(iii) On Fig. 2.1 sketch a graph to show the change in pH which occurs when $HCl(aq)$ is titrated with $NH_3(aq)$ as described in **(d)**.

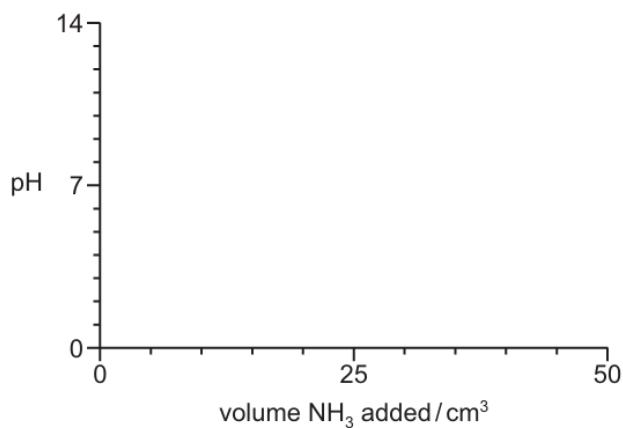


Fig. 2.1

[2]

4 Sulfides are compounds that contain sulfur but not oxygen.

(c) Hydrogen sulfide gas, $\text{H}_2\text{S}(\text{g})$, is slightly soluble in water. It acts as a weak acid in aqueous solution.

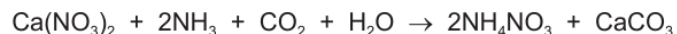
(i) State the meaning of *weak acid*.

.....
 [1]

(ii) Give the formula of the conjugate base of H_2S .

..... [1]

5 Calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, reacts with ammonia, carbon dioxide and water to form a mixture of ammonium nitrate and calcium carbonate.



(a) Explain why ammonia is described as a Brønsted–Lowry base in this reaction.

..... [1]

6 Group 17 elements are commonly referred to as the halogens.

(c) Hydrogen chloride reacts with water.



(i) In this reaction, one of the reactants behaves as a Brønsted–Lowry acid.

What is meant by the term *Brønsted–Lowry acid*?

.....
 [1]

(ii) Identify the reactant behaving as an acid and its conjugate base.

acid

conjugate base

[1]