ACID-BASE THEORIES

1. a) What is the Arrhenius definition of an acid? Give an example of an acid according to this theory.

   b) What is the Arrhenius definition of a base? Give an example of a base according to this theory.

2. a) Give the definitions of an acid and a base on the Bronsted-Lowry theory.

   b) Use the Bronsted-Lowry theory to explain the reactions which happen when

   (i) hydrogen chloride gas dissolves in water;

   (ii) hydrogen chloride gas and ammonia gas react;

   (iii) ammonia gas reacts with a solution containing hydroxonium ions;

   (iv) copper(II) oxide reacts with dilute sulphuric acid to give copper(II) sulphate and water.

3. a) When ethanoic acid is added to water, it reacts reversibly to give ethanoate ions and hydroxonium ions.

   $$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

   Use this reaction to explain the meaning of the terms *conjugate acid* and *conjugate base*, clearly picking out the conjugate pairs.

   b) Carbonate ions react slightly with water to give hydrogencarbonate ions and hydroxide ions.

   $$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$$

   Identify the conjugate pairs in this reaction, in each case stating which is the conjugate acid and which the conjugate base.

4. Use the following equations to help you to explain what is meant by the statement that "water is amphoteric".

   $$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

   $$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

5. a) Define the terms *Lewis acid* and *Lewis base*.

   b) Draw a dots-and-crosses diagram of a *molecule* of aluminium chloride, $AlCl_3$, showing outer electrons only. Would you expect this to behave as a Lewis acid, a Lewis base, or neither, or both? Explain your answer.

c) A magnesium ion, Mg^{2+}, forms a complex ion, $[Mg(H_2O)_6]^{2+}$, when it comes into contact with water. Explain why this can be considered an acid-base reaction on the Lewis theory of acids and bases.

d) Which of the following might act as a Lewis base: NH_3 CH_4 F^- OH^- ? Explain your answer.