1) Consider the four diagrams of a monoprotic acid ionising in water.
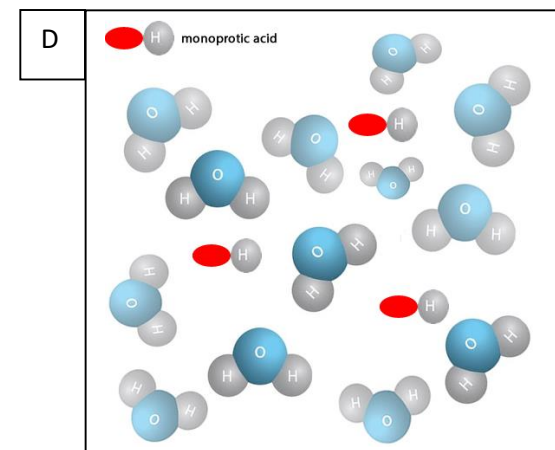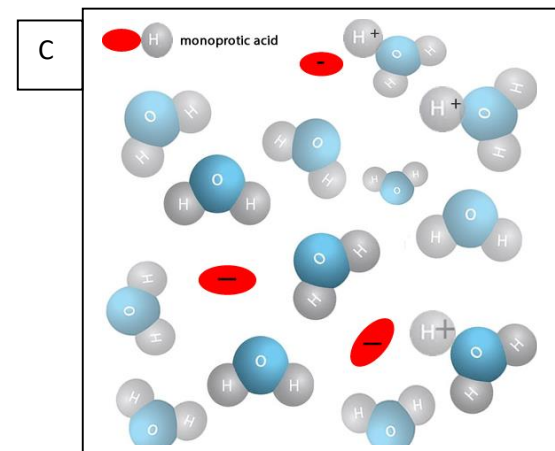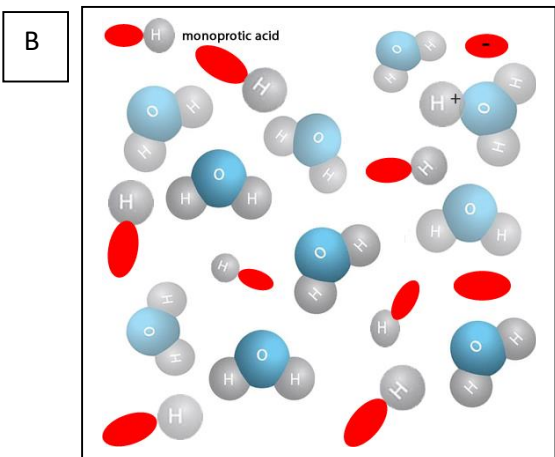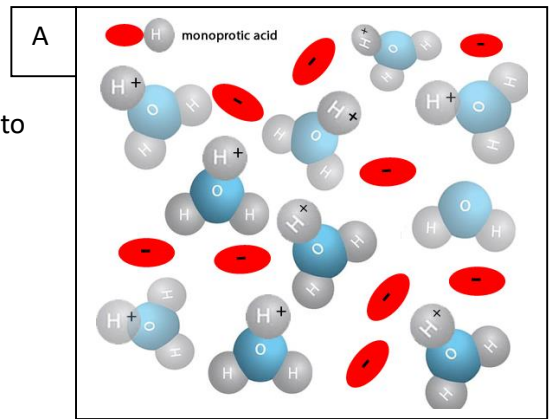
Identify the diagram on the right and give a reason as to which one represents:

- a dilute solution of a weak acid

- a concentrated solution of a strong acid

- a dilute solution of a strong acid

- a concentrated solution of a weak acid

2) Calculate the pH of the following solutions with the given concentration of hydronium or hydroxide ions. Use the formulae on the right.

$$pH = -\log_{10}[H_3O^+]$$

$$10^{-14} = [H_3O^+][OH^-]$$

   a. $[H_3O^+] = 0.100M$

   b. $[H_3O^+] = 0.00100M$

   c. $[H_3O^+] = 0.500M$

   d. $[H_3O^+] = 0.0703M$

   e. $[H_3O^+] = 3.45 \times 10^{-6} M$

3) Calculate the $[OH^-]$ of the solutions given in a) above if the solution is at 25°C.
   a. $[H_3O^+] = 0.100M$
      $[OH^-] =$
   b. $[H_3O^+] = 0.00100M$
      $[OH^-] =$
   c. $[H_3O^+] = 0.500M$
      $[OH^-] =$
   d. $[H_3O^+] = 0.0703M$
      $[OH^-] =$
   f. $[H_3O^+] = 3.45 \times 10^{-6} M$
      $[OH^-] =$

4) Consider a solution made by dissolving 3.65g of pure HCl in a 250mL volumetric flask using distilled water.
   a. Calculate the $[OH^-]$ of the solution. Show all calculations.

   b. Find the pH of the solution. Show all calculations.

5) Find the pH of the following solutions given their $[OH^-]$
   a. $[OH^-] = 0.00100M$

   b. $[OH^-] = 0.900M$


   c. $[OH^-] = 5.00 \times 10^{-4}$

6) 9.60 grams of a weak, monoprotic acid, known as acetic acid ($C_2H_4O_2$), was dissolved in 200 mL of distilled water.
   a. Explain why it is not possible to determine accurately the pH of the resulting solution.

   b. The solution was neutralised by the addition of NaOH.
      i.   Write the balanced overall equation for the reaction between acetic acid and NaOH.

      ii.   Write the balanced ionic equation for the reaction in i. above.

7) 0.400 grams of NaOH was totally dissolved in 500 mL of distilled water.
   a. Calculate the [OH⁻] of the resulting solution.

   b. Calculate the pH of the solution.

8) An acidic solution was formed by dissolving HNO_3 in water.
   a. Give the overall equation of the reaction that takes place between the acid and the water

   b. Indicate the conjugate pairs in question a. above.

   c. Which of the following are acid/base **conjugate** pairs?

      i. HSO_4^- / SO_4^{-2}
      ii. H_2SO_4/SO_4^{-2}
      iii. H_2CO_3/CO_3^{-2}
      iv. NH_4^+/NH_3
      v. HCO_3^-/CO_3^{-2}
      vi. CO_3^{-2}/CO_2
      vii. $H_3PO_4/H_2PO_4^-$

d. Write balanced equations to the reactions taking place and label the reactatns and products with the labels provided below. The first one is labelled for you.
Weak acid, weak base, weak conjugate acid, weak conjugate base.
Carbonic acid ionises when placed in water
$H_2CO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HCO_3^-(aq)$
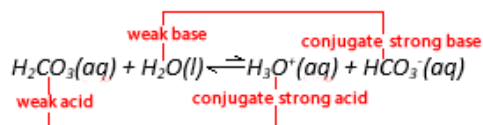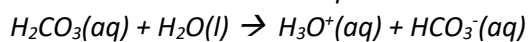
i.   Acetic acid (CH$_3$COOH) ionises in water

ii.   HCl ionises in water

iii. Ammonia (NH$_3$) acts as a base and ionises in water.