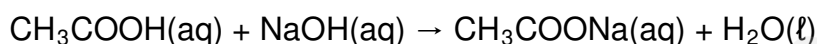




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QUESTION 7 (Start on a new page.)

A Grade 12 class wants to determine the percentage of ethanoic acid in a certain bottle of vinegar. They titrate a sample taken from the bottle of vinegar with a standard solution of sodium hydroxide. The equation for the reaction is:



- 7.1 Define an *acid* in terms of the Arrhenius theory. (2)
- 7.2 Give a reason why ethanoic acid is classified as a weak acid. (1)
- 7.3 Explain the meaning of *standard solution*. (1)
- 7.4 Write down the names of TWO items of apparatus needed to measure accurate volumes of the acid and the base in this titration. (2)
- 7.5 It is found that 40 ml of a 0,5 mol·dm⁻³ sodium hydroxide solution is needed to neutralise 20 ml of the vinegar.
- Calculate the:
- 7.5.1 pH of the sodium hydroxide solution (4)
- 7.5.2 Percentage of ethanoic acid by mass present in the vinegar
(Assume that 1 ml of vinegar has a mass of 1 g.) (7)
- 7.6 The sodium ethanoate (CH₃COONa) formed during the above neutralisation reaction undergoes hydrolysis to form an alkaline solution. Write down an equation for this hydrolysis reaction. (3)

[20]

QUESTION 7 (Start on a new page.)

7.1 Nitric acid (HNO_3), an important acid used in industry, is a strong acid.

7.1.1 Give a reason why nitric acid is classified as a strong acid. (1)

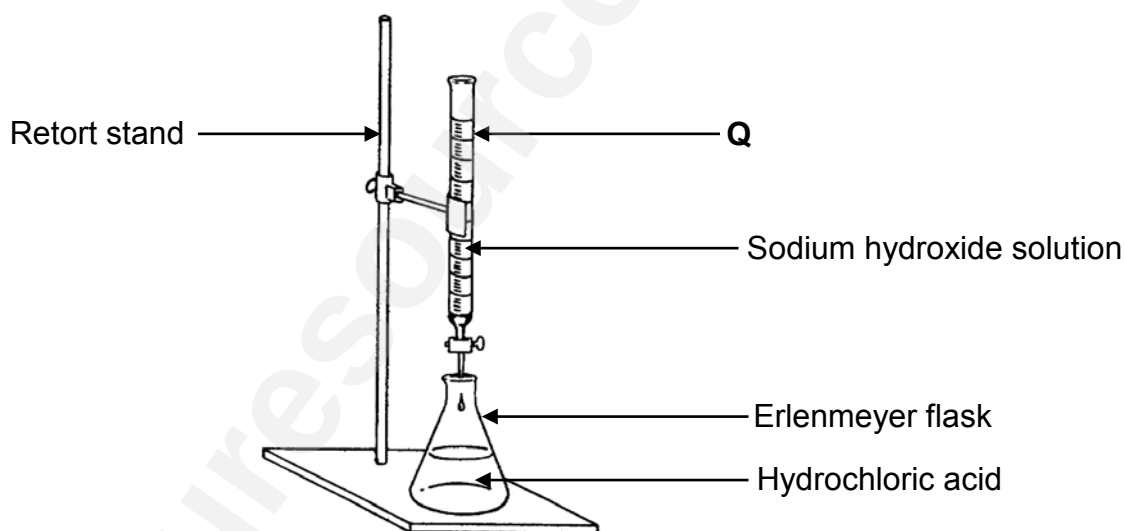
7.1.2 Write down the NAME or FORMULA of the conjugate base of nitric acid. (1)

7.1.3 Calculate the pH of a $0,3 \text{ mol} \cdot \text{dm}^{-3}$ nitric acid solution. (3)

7.2 A laboratory technician wants to determine the percentage purity of magnesium oxide. He dissolves a 4,5 g sample of the magnesium oxide in 100 cm^3 hydrochloric acid of concentration $2 \text{ mol} \cdot \text{dm}^{-3}$.

7.2.1 Calculate the number of moles of hydrochloric acid added to the magnesium oxide. (3)

He then uses the apparatus below to titrate the EXCESS hydrochloric acid in the above solution against a sodium hydroxide solution.



7.2.2 Write down the name of apparatus **Q** in the above diagram. (1)

7.2.3 The following indicators are available for the titration:

INDICATOR	pH RANGE
A	3,1 – 4,4
B	6,0 – 7,6
C	8,3 – 10,0

Which ONE of the above indicators (**A**, **B** or **C**) is most suitable to indicate the exact endpoint in this titration? Give a reason for the answer. (3)

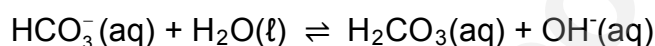
QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid is a diprotic acid.

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Give a reason why sulphuric acid is referred to as a *diprotic acid*. (1)

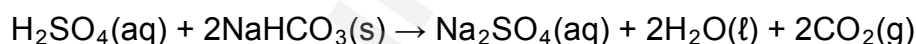
7.2 The hydrogen carbonate ion can act as both an acid and a base. It reacts with water according to the following balanced equation:



7.2.1 Write down ONE word for the underlined phrase. (1)

7.2.2 $\text{HCO}_3^-(\text{aq})$ acts as base in the above reaction. Write down the formula of the conjugate acid of $\text{HCO}_3^-(\text{aq})$. (1)

7.3 A learner accidentally spills some sulphuric acid of concentration $6 \text{ mol}\cdot\text{dm}^{-3}$ from a flask on the laboratory bench. Her teacher tells her to neutralise the spilled acid by sprinkling sodium hydrogen carbonate powder onto it. The reaction that takes place is: (Assume that the H_2SO_4 ionises completely.)



The fizzing, due to the formation of carbon dioxide, stops after the learner has added 27 g sodium hydrogen carbonate to the spilled acid.

7.3.1 Calculate the volume of sulphuric acid that spilled. Assume that all the sodium hydrogen carbonate reacts with all the acid. (6)

The learner now dilutes some of the $6 \text{ mol}\cdot\text{dm}^{-3}$ sulphuric acid solution in the flask to $0,1 \text{ mol}\cdot\text{dm}^{-3}$.

7.3.2 Calculate the volume of the $6 \text{ mol}\cdot\text{dm}^{-3}$ sulphuric acid solution needed to prepare 1 dm^3 of the dilute acid. (2)

During a titration 25 cm^3 of the $0,1 \text{ mol}\cdot\text{dm}^{-3}$ sulphuric acid solution is added to an Erlenmeyer flask and titrated with a $0,1 \text{ mol}\cdot\text{dm}^{-3}$ sodium hydroxide solution.

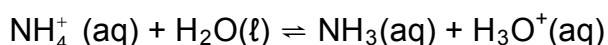
7.3.3 The learner uses bromothymol blue as indicator. What is the purpose of this indicator? (1)

7.3.4 Calculate the pH of the solution in the flask after the addition of 30 cm^3 of sodium hydroxide. The endpoint of the titration is not yet reached at this point. (8)

[22]

QUESTION 7 (Start on a new page.)

- 7.1 Ammonium chloride crystals, $\text{NH}_4\text{Cl}(\text{s})$, dissolve in water to form ammonium and chloride ions. The ammonium ions react with water according to the balanced equation below:



- 7.1.1 Write down the name of the process described by the underlined sentence. (1)

- 7.1.2 Is ammonium chloride ACIDIC or BASIC in aqueous solution? Give a reason for the answer. (2)

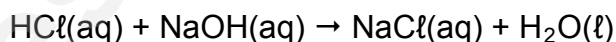
- 7.2 A certain fertiliser consists of 92% ammonium chloride. A sample of mass x g of this fertiliser is dissolved in 100 cm^3 of a $0,10 \text{ mol}\cdot\text{dm}^{-3}$ sodium hydroxide solution, $\text{NaOH}(\text{aq})$. The NaOH is in excess.

The balanced equation for the reaction is:



- 7.2.1 Calculate the number of moles of sodium hydroxide in which the sample is dissolved. (3)

During a titration, 25 cm^3 of the excess sodium hydroxide solution is titrated with a $0,11 \text{ mol}\cdot\text{dm}^{-3}$ hydrochloric acid solution, $\text{HCl}(\text{aq})$. At the endpoint it is found that $14,55 \text{ cm}^3$ of the hydrochloric acid was used to neutralise the sodium hydroxide solution according to the following balanced equation:



- 7.2.2 Calculate the mass x (in grams) of the fertiliser sample used. (8)

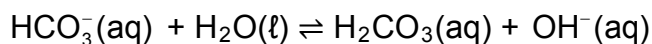
- 7.3 Calculate the pH of a $0,5 \text{ mol}\cdot\text{dm}^{-3}$ sodium hydroxide solution at 25°C . (4)
[18]

QUESTION 7 (Start on a new page.)

- 7.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)
- 7.2 Carbonated water is an aqueous solution of carbonic acid, H_2CO_3 . $\text{H}_2\text{CO}_3(\text{aq})$ ionises in two steps when it dissolves in water.
- 7.2.1 Write down the FORMULA of the conjugate base of $\text{H}_2\text{CO}_3(\text{aq})$. (1)
- 7.2.2 Write down a balanced equation for the first step in the ionisation of carbonic acid. (3)
- 7.2.3 The pH of a carbonic acid solution at 25°C is 3,4. Calculate the hydroxide ion concentration in the solution. (5)
- 7.3 **X** is a monoprotic acid.
- 7.3.1 State the meaning of the term *monoprotic*. (1)
- 7.3.2 A sample of acid **X** is titrated with a standard sodium hydroxide solution using a suitable indicator.
- At the endpoint it is found that 25 cm^3 of acid **X** is neutralised by $27,5\text{ cm}^3$ of the sodium hydroxide solution of concentration $0,1\text{ mol}\cdot\text{dm}^{-3}$.
- Calculate the concentration of acid **X**. (5)
- 7.3.3 The concentration of H_3O^+ ions in the sample of acid **X** is $2,4 \times 10^{-4}\text{ mol}\cdot\text{dm}^{-3}$.
- Is acid **X** a WEAK or a STRONG acid? Explain the answer by referring to the answer in QUESTION 7.3.2. (3)
- [20]**

QUESTION 7 (Start on a new page.)

- 7.1 Hydrogen carbonate ions react with water according to the following balanced equation:



7.1.1 Define an *acid* according to the Lowry-Brønsted theory. (2)

7.1.2 Write down the FORMULAE of the two acids in the equation above. (2)

7.1.3 Write down the formula of a substance in the reaction above that can act as an ampholyte. (1)

- 7.2 During an experiment $0,50 \text{ dm}^3$ of a $0,10 \text{ mol} \cdot \text{dm}^{-3}$ HCl solution is added to $0,80 \text{ dm}^3$ of a NaHCO_3 solution of concentration $0,25 \text{ mol} \cdot \text{dm}^{-3}$. The balanced equation for the reaction is:



Calculate the:

7.2.1 Concentration of the hydroxide ions in the solution on completion of the reaction (8)

7.2.2 pH of the solution on completion of the reaction (4)
[17]

QUESTION 7 (Start on a new page.)

- 7.1 A learner dissolves ammonium chloride (NH_4Cl) crystals in water and measures the pH of the solution.

7.1.1 Define the term *hydrolysis* of a salt. (2)

7.1.2 Will the pH of the solution be GREATER THAN, SMALLER THAN or EQUAL TO 7? Write a relevant equation to support your answer. (3)

- 7.2 A sulphuric acid solution is prepared by dissolving 7,35 g of $\text{H}_2\text{SO}_4(\ell)$ in 500 cm^3 of water.

7.2.1 Calculate the number of moles of H_2SO_4 present in this solution. (2)

Sodium hydroxide (NaOH) pellets are added to the 500 cm^3 H_2SO_4 solution.

The balanced equation for the reaction is:



After completion of the reaction, the pH of the solution was found to be 1,3. Assume complete ionisation of H_2SO_4 .

7.2.2 Calculate the mass of NaOH added to the H_2SO_4 solution. Assume that the volume of the solution does not change. (9)

[16]