

PRACTICE QUESTIONS FOR CHEMISTRY WA3

Name: () Year 4 Date: Titration Question

P is a solution that has been made by mixing dilute hydrochloric acid with dilute sulfuric acid.

You are to determine the concentration of hydrogen ions in **P** by titrating this solution with aqueous sodium hydroxide, **Q**.

Read all the instructions below carefully before starting the experiment.

You are going to carry out a titration experiment.

P - mixture of hydrochloric acid and sulfuric acid

Q - 0.450 mol/dm³ sodium hydroxide solution

(a) (i) Put **P** into the burette.

Pipette a 25.0 cm³ portion of **Q** into a flask and titrate with **P**, using the indicator provided.

Record your results in a suitable format, repeating the titrations as many times as you consider necessary to achieve consistent results.

Results:

Titration number	1	2
Final burette reading / cm ³	19.00	38.00
Initial burette reading / cm ³	0.00	19.00
Volume of P used / cm ³	19.00	19.00
Best titration results (✓)	✓	✓

[5]

(ii) From your titration results, obtain an average volume of **P** to be used in your calculations.

Show clearly how you obtained this volume.

$$\text{Average volume of P} = (19.00 + 19.00) \div 2 = 19.00 \text{ cm}^3$$

Working for the average must be shown

PRACTICE QUESTIONS FOR CHEMISTRY WA3

$$\text{NaOH} + \text{H}^+ \rightarrow \text{Na}^+ + \text{H}_2\text{O}$$

No. of moles of H^+ = 0.01125 mol [1]

$$\begin{aligned} &= 0.01125 \div 1000 \\ &= 0.59211 \text{ mol/dm}^3 \text{ (5 s.f.)} \\ &= 0.592 \text{ mol/dm}^3 \text{ (3 s.f.) [1]} \end{aligned}$$

concentration of hydrogen ions in P0.592 mol/dm³ [2]

The concentration of hydrochloric acid in **P** is 0.110 mol/dm^3 . Using your answer from (i), calculate the number of moles of hydrogen ions in 1 dm^3 of solution **P** due to sulfuric acid.

number of moles of hydrogen ions in 1 dm³ of solution **P** due to sulfuric acid.... **0.482 mol** [1]

$$= 0.241 \text{ mol/dm}^3 (3 \text{ s.f.})$$

concentration of sulfuric acid present in **P** ... 0.241 mol/dm³ [1]

- (c) A student repeated the experiment and accidentally used a 20.0 cm³ pipette to measure solution **Q** into the flask for each titration. The student thought that he has used a 25.0 cm³ pipette.

Describe and explain the effect this would have on the calculated number of moles of hydrogen ions in 1 dm³ of solution **P** due to sulfuric acid in **b(ii)**.

- Volume of **P** needed in the titration will be lower than actual. [1]
- Calculated concentration of hydrogen ions in **P** in b(i) will be higher than expected, [1]
- Hence the calculated number of moles of hydrogen ions in 1dm³ of **P** due to sulfuric acid in b(ii) will also be higher than actual. [2]

PRACTICE QUESTIONS FOR CHEMISTRY WA3

Planning Question

R is a nitric acid solution. Describe a method you could use to determine its concentration. You can assume that all the apparatus and reagents normally found in a school laboratory are available.

You should include the measurements you would take and how you would use your results to calculate the concentration of the acid in **R**.

You may not use a titration method.

Method 1

Procedures

1. Measure a known volume of **R** using a pipette/burette and place it into a conical flask.
2. Add excess calcium carbonate or other carbonate to the flask.
3. Collect all the carbon dioxide produced using a graduated gas syringe.
4. Record the total volume of carbon dioxide collected at r.t.p

Data Processing



1. Number of moles of CO₂ = volume of CO₂ in dm³ ÷ molar volume in dm³
= volume of CO₂ ÷ 24
2. From equation, number of moles of HNO₃ = 2 x no. of moles of CO₂
3. Concentration of HNO₃ in **R** in mol/dm³
= no. of moles of HNO₃ ÷ volume of **R** in dm³

Method 2

Procedures

1. Measure a known volume of R using a pipette/burette and place it into a conical flask.
2. Place the conical flask on an electronic mass balance. Record the total mass of the flask and **R**. Let this mass be m_1 g.
3. Add a known mass (m_2 g) of calcium carbonate or other carbonate (in excess) to the flask. Place a loose plug of cotton wool over the mouth of the flask to prevent loss of acid spray.
4. Record the final total mass of the flask and its content when the total mass does not decrease further. Let this total mass be m_3 g.

PRACTICE QUESTIONS FOR CHEMISTRY WA3

Data Processing



1. Mass of CO_2 produced = $(m_1 + m_2 - m_3)\text{g}$
2. Number of moles of CO_2 = mass of CO_2 in g $\div$ molar mass of CO_2 in g/mol
3. From equation, number of moles of HNO_3 = 2 x no. of moles of CO_2
4. Concentration of HNO_3 in **R** in mol/dm^3
= no. of moles of $\text{HNO}_3 \div$ volume of **R** in dm^3

Note: The reaction between a metal and nitric acid is not suitable as the products formed depend on the concentration of the acid and the nature of the metal. Oxides of nitrogen (NO , NO_2) may be formed instead of hydrogen gas.