REDSPOT New Solutions . New Minds

About

CHEMISTRY
ALTERNATIVE TO PRACTICAL
(PAPER 4) (YEARLY)

About Thinking Process

When solving problems, we first analyse the questions and then gather relevant information until we are able to determine the answers. But for presentation reason, we need to organise, rearrange and then present ONLY the required workings and solutions.

Thinking process reveals the extra but relevant information which is not required as part of the solutions.

period	**2008 to 2022**
contents	**June & November, Paper 4, Worked Solutions**
form	**Yearly**
compiled for	**O Levels**
special features	**Thinking Process**

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'O' Level Chemistry (Alternative To Practical) 5070 (Yearly)

CONTENTS

NONEMBER 2022

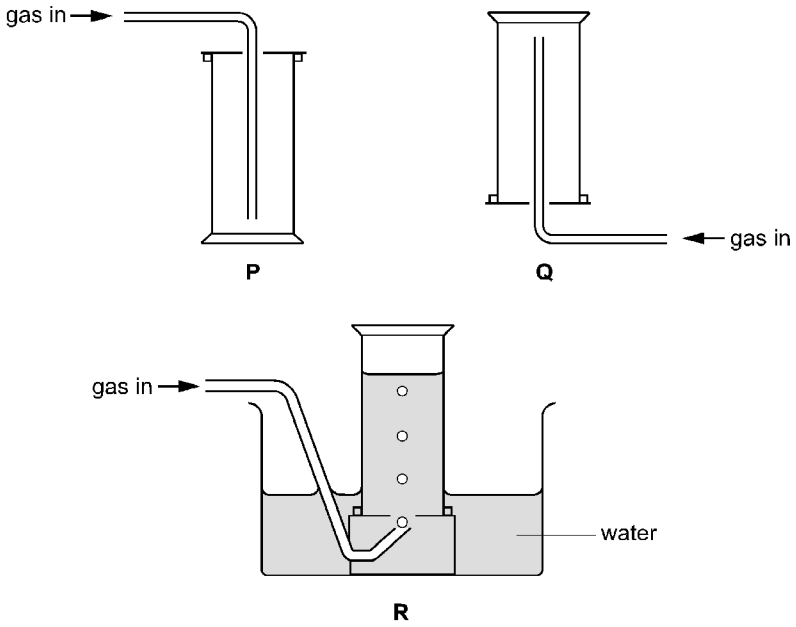
Answer **all** questions.

Question 1

Three colourless gases **A**, **B** and **C** have the properties shown.

gas	density	solubility in water
A	more dense than air	soluble
B	more dense than air	insoluble
C	less dense than air	soluble

Some sets of apparatus, **P**, **Q** and **R**, used to collect gases are shown.



(a) State which set of apparatus **P**, **Q** or **R** is most suitable to collect gas **A**.

..... [1]

(b) **R** is used to collect gas **B**.

(i) State why **Q** is **not** used to collect gas **B**.

..... [1]

(ii) State why **R** is more suitable than **P** to collect gas **B**.

..... [1]

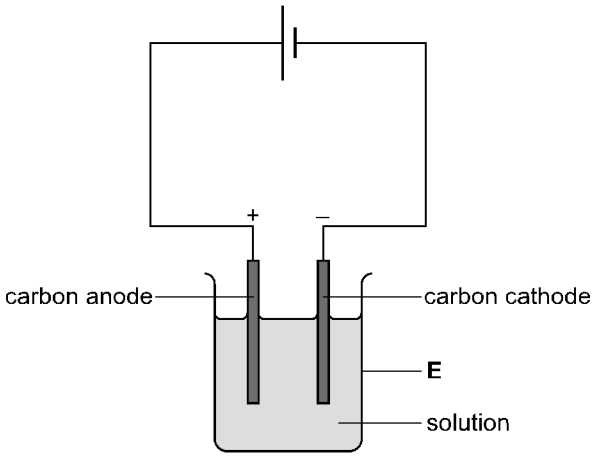
(c) State why **R** is **not** used to collect gas **C**.

..... [1]

[Total: 4]

Question 2

A student electrolyses two aqueous solutions using the apparatus shown.



(a) Name apparatus **E**.

..... [1]

(b) Complete the table.

	anode (+)		cathode (–)	
solution	name of product	observation	name of product	observation
aqueous potassium iodide	iodine		hydrogen	
dilute sulfuric acid	oxygen			bubbles of colourless gas

[4]

(c) Describe the test used to identify oxygen gas.

test .....

observation .....

[2]

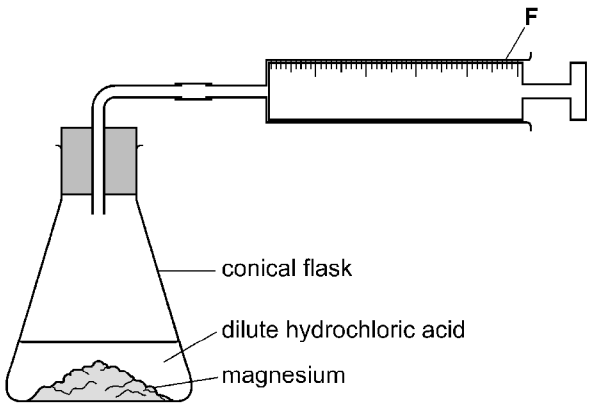
[Total: 7]

Question 3

The equation for the reaction of magnesium with dilute hydrochloric acid is shown.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

A student investigates the rate of this reaction at three different temperatures.



In each experiment the student adds dilute hydrochloric acid to magnesium. The volume of hydrogen in apparatus **F** is recorded every 30 seconds.

(a) Name apparatus **F**.

..... [1]

(b) Name a piece of apparatus that the student could use to keep the temperature of the conical flask and its contents constant.

..... [1]

(c) Hydrogen gas is a product of the reaction.

(i) Describe the test used to identify hydrogen.

test .....

observation .....

[2]

(ii) The student uses the measurement of volume as time increases to determine the rate of this reaction.

State a **different** measurement that the student could make as time increases to determine the rate of this reaction.

..... [1]

(d) In each of the three experiments the contents of the flask are at a different temperature.

All other variables are kept constant.

The three experiments are labelled **X**, **Y** and **Z**.

experiment	temperature / °C
X	20
Y	40
Z	60

The hydrochloric acid is in excess in each of the three experiments.

A catalyst is not used.

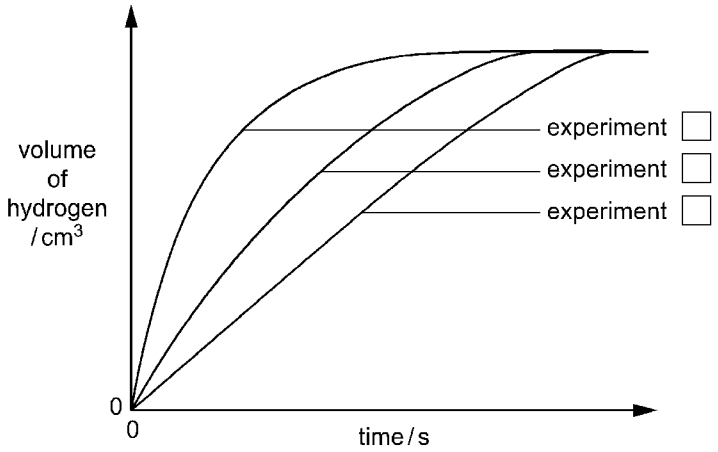
Identify two variables that are kept constant in this investigation.

1 .....

2 .....

[2]

(e) The student plots a graph of the results.



(i) Describe how the graph is used to decide which experiment has the greatest rate.

.....

..... [1]

(ii) Write a letter in each box on the graph to identify experiments **X**, **Y** and **Z**. [1]

(iii) Describe how the graph shows that the reactions stop.

..... [1]

(iv) Explain why the reactions stop.

..... [1]

[Total: 11]

Question 4

A student is provided with two bottles labelled **A** and **B** and a supply of water.

One of the bottles contains 1.00 g of solid potassium chloride, KCl.

The other bottle contains 1.00 g of solid calcium chloride, $CaCl_2$.

When potassium chloride dissolves in water the change is endothermic.

When calcium chloride dissolves in water the change is exothermic.

Plan experiments, based on dissolving the solids in water, to decide:

- which compound is in each bottle
- which compound produces the greatest heat change per gram of solid.

Your plan may use any of the apparatus normally found in a chemistry laboratory but no other chemicals.

Your plan must state all the measurements you need to make.

Your plan must use the same experimental procedure for each solid.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

Question 5

Solution **K** is dilute sulfuric acid, H_2SO_4.

A student determines the concentration of solution **K** using a method that involves titration.

The student measures 20.0 cm^3 of solution **K** using a pipette.

The student makes up the solution to 250 cm^3 with distilled water. This is solution **L**.

(a) Name another piece of apparatus that could be used instead of a pipette to accurately measure 20.0 cm^3 of solution **K**.

..... [1]

(b) Name the container in which solution **L** is made.

..... [1]

(c) A pipette is used to transfer 25.0 cm^3 of solution **L** into a conical flask.

Name the other piece of apparatus that is used with the pipette.

..... [1]

(d) The student adds three drops of methyl orange to solution **L** in the conical flask and then places the flask on a white tile.

The student fills a burette with 0.100 mol / dm^3 potassium hydroxide, KOH(aq).

The KOH(aq) is added to the flask until there is a colour change.

(i) State which liquid should be used to wash out the burette before filling the burette with KOH(aq) for use in the titration.

..... [1]

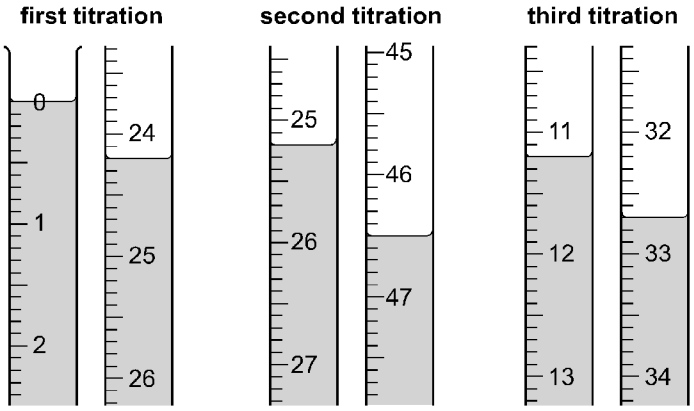
(ii) Explain why the conical flask is placed on a white tile.

..... [1]

(iii) State the colour change of the methyl orange indicator at the end-point.

The colour changes from ..... to ..... . [1]

(e) The student does three titrations. The diagrams below show parts of the burette with the liquid levels both at the beginning and at the end of each titration.



Use the diagrams to complete the following table.

titration number	1	2	3
final burette reading / cm^3			
initial burette reading / cm^3			
volume of KOH(aq) added / cm^3			
best titration results (✓)			

Tick (✓) the best titration results in the table.

Use the best titration results to calculate the average volume of KOH(aq) used.

..... cm^3

[4]

(f) Calculate the number of moles of KOH in the average volume of 0.100 mol / dm^3 of KOH(aq) used in **(e)**.

..... mol [1]

(g) The equation for the reaction of potassium hydroxide with sulfuric acid is shown.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

Use this equation to calculate the number of moles of H_2SO_4 in 25.0 cm^3 of solution **L**.

..... mol [1]

(h) Calculate the number of moles of H_2SO_4 in 250 cm^3 of solution **L**.

..... mol [1]

(i) Deduce the number of moles of H_2SO_4 in 20.0 cm^3 of solution **K**.

..... mol [1]

(j) Calculate the concentration of solution **K** in mol / dm^3.

..... mol / dm^3 [1]

(k) A different student does the same experiment using 30 drops of methyl orange instead of 3 drops of methyl orange.

Methyl orange is acidic.

State if the average titration volume of KOH(aq) is smaller, larger, or unchanged when 30 drops of methyl orange are used.

Explain your answer.

.....

.....

..... [2]

[Total: 17]

SOLUTIONS - NOVEMBER 2022

Q1 - Solution

(a) **P**

(b) **(i)** **B** is denser than air.

(ii) As gas **B** is insoluble in water, it will displace water and collect in the gas jar. In setup **R**, it is possible to tell when the gas jar is full.

(c) **C** is soluble in water and will dissolve in the gas jar.

COMMENT on **ANSWER**

❝ **(a)** A gas which is denser than air is collected in the gas jar while for a gas which is less dense than air, the gas jar is inverted to collect the gas. ❞

Q2 - Solution

(a) Beaker.

(b)

	anode (+)		cathode (–)	
solution	name of product	observation	name of product	observation
aqueous potassium iodide	iodine	**Brown liquid is observed**	hydrogen	**Bubbles of colorless gas are observed**
dilute sulfuric acid	oxygen	**Bubbles of colorless gas are observed**	**Hydrogen**	bubbles of colourless gas

(c) Test: A glowing splint is brought near the gas sample.
Observation: If the glowing splint relights, the gas is oxygen.

Q3 - Solution

(a) Gas syringe.

(b) Thermostatically controlled water bath can be used to control the temperature of the setup.

(c) **(i)** Test: A burning splint is brought near the gas sample.
Observation: A pop sound is made if the gas is hydrogen.

(ii) The change in the mass of the flask and its contents can be measured with respect to time to measure the rate of reaction.

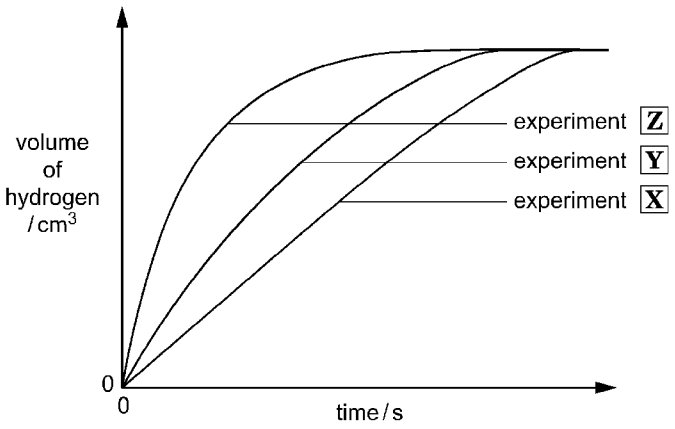
(d) 1. Concentration and Volume of the acid.
2. Mass and particle size of Magnesium.

COMMENT on **ANSWER**

❝ **(d)** In order to study the effect of temperature, it is important to keep the other factors that effect the rate of reaction constant. For instance, the surface area of Magnesium needs to be constant for all experiments. ❞

(e) (i) The curve with steepest gradient that levels off first has the greatest rate.

(ii)



COMMENT on **ANSWER**

❝ (e) The experiment performed at highest temperature shows the greatest rate and the steepest curve on the graph. ❞

(iii) As the graph levels off, the volume of hydrogen produced becomes constant which shows that the reaction has stopped.

(iv) When all the Magnesium has been used up, the reaction stops.

Q4 - Solution

In order to measure the temperature change when the solids are dissolved in water, a thermometer is used. The thermometer is inserted inside the bottles to measure the heat change. The initial temperature of each bottle is recorded. Equal volume of water is added in both the bottles. The solutions are stirred and the temperature change is measured. The bottle in which the temperature increases, the solid is identified as calcium chloride. On the other hand, the bottle in which the temperature falls is potassium chloride. The heat change is calculated by subtracting the initial temperature from the final temperature. The bottle with largest temperature change gives us the compound with the greatest heat change per gram.

Q5 - Solution

(a) A burette is also suitable to measure 20.0 cm^3 of solution.

(b) Graduated or volumetric flask.

(c) A pipette filler is used along with the pipette.

(d) (i) Potassium Hydroxide.

(ii) In order to see the color change of the indicator clearly, a white tile is used.

(iii) The colour changes from Red to orange.

COMMENT on **ANSWER**

❝ (d) (i) It is a good lab practice to wash the burette with water and then with the solution to be added in it before adding the solution. ❞

(e)

titration number	1	2	3
final burette reading / cm^3	**24.2**	**46.5**	**32.7**
initial burette reading / cm^3	**0.0**	**25.2**	**11.2**
volume of KOH(aq) added / cm^3	**24.2**	**21.3**	**21.5**
best titration results (✓)		✓	✓

Average volume of KOH = $\frac{(21.3 + 21.5)}{2} = 21.4\ cm^3$

(f) Moles of KOH $= 0.100 \times \dfrac{21.4}{1000} = 0.00214$ mol

(g) Ratio of $KOH : H_2SO_4 = 2 : 1$

$\therefore$ Moles of $H_2SO_4 = \dfrac{0.00214}{2} = 0.00107$ mol

(h) Moles of H_2SO_4 in 250 $cm^3 = 0.00107 \times 10$
$= 0.0107$ mol

(i) Moles of H_2SO_4 in 20.0 cm^3 of K = 0.0107 mol

(j) Concentration of solution **K** $= \dfrac{0.0107}{(20 \times 10^{-3})} = 0.535$ mol / dm^3

(k) As methyl orange is acidic, so more KOH is used to neutralise the solution. Therefore, the titration volume of KOH will be larger when 30 drops of methyl orange are added.

Q6 - Solution

(a)

aqueous solutions			
reagents	copper(II) chloride	zinc sulfate	**X**
aqueous sodium hydroxide	**Blue Precipitate observed**	**White precipitate observed**	green precipitate
aqueous sodium hydroxide in excess	**The precipitate remains insoluble in excess NaOH**	**Precipitate dissolve in excess NaOH**	precipitate remains
aqueous ammonia	**Blue precipitate observed**	**White precipitate observed**	green precipitate
aqueous ammonia in excess	**Deep blue solution formed as the precipitate dissolve in excess ammonia**	**Colourless solution formed as the precipitate dissolve in excess ammonia**	precipitate remains
aqueous silver nitrate and dilute nitric acid	**White precipitate observed**	**No change**	yellow precipitate
aqueous barium nitrate and dilute nitric acid	**No change**	**White precipitate observed**	no change

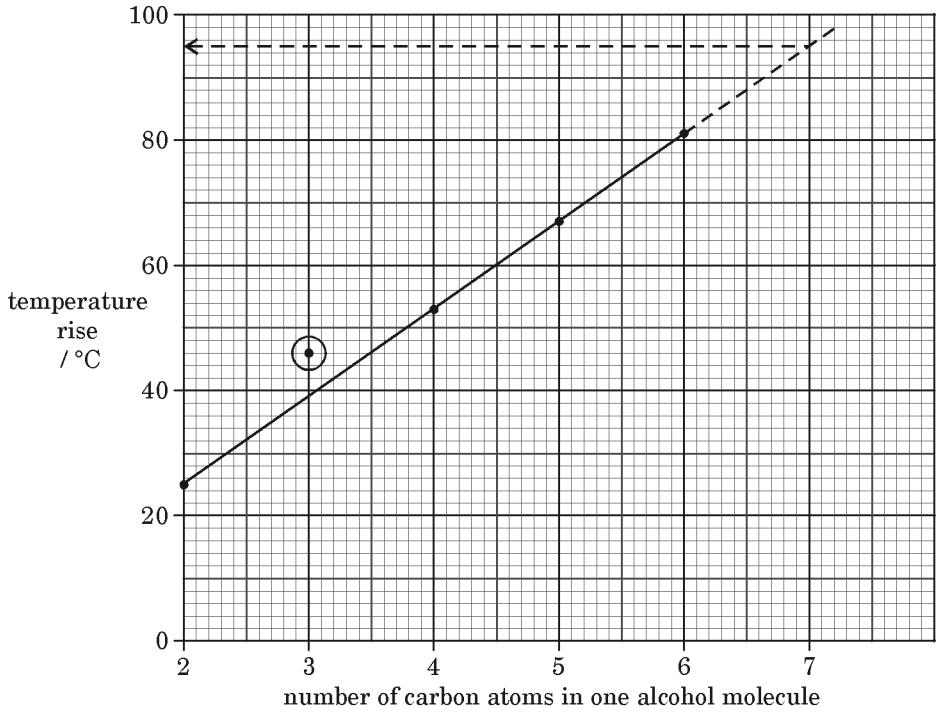
(b) Iron(II) Iodide (FeI_2)

COMMENT on **ANSWER**

❝ **(b)** The appearance of green precipitates on addition of NaOH and NH_3, suggests the presence of Fe^{2+} ions. On the other hand, the presence of yellow precipitates indicates the presence of Iodide ions. ❞

Q7 - Solution

(a)



(b) (i) 95 °C

(ii) If the initial temperature of water is 15 °C, the final temperature in this experiment will reach above 100 °C at which the water boils.

(iii) Use water at a temperature below 4 °C (Use ice instead).