Centre Number	Candidate Number	Candidate Name

NAMIBIA SENIOR SECONDARY CERTIFICATE

CHEMISTRY ADVANCED SUBSIDIARY LEVEL 8224/3

PAPER 3 Advanced Practical Skills 2 hours

Marks 40 **2022**

Additional Materials: As per instructions to subject teacher
Non-programmable calculator

INSTRUCTIONS AND INFORMATION TO CANDIDATES

- Candidates answer on the Question Paper in the spaces provided.
- Write your Centre Number, Candidate Number and Name in the spaces at the top of this page.
- Write in dark blue or black pen.
- You may use a soft pencil for any diagrams, graphs or rough working.
- Do not use correction fluid.
- Do not write in the margin *For Examiner's Use*.

- Answer **all** questions.

- The number of marks is given in brackets [ ] at the end of each question or part question.
- Qualitative Analysis Notes are printed on pages 11 and 12.
- The Periodic Table is printed on page 13.

For Examiner`s Use	
1	
2	
3	
Total	
Marker	
Checker	

This document consists of **13** printed pages and **3** blank pages.

Republic of Namibia

MINISTRY OF EDUCATION, ARTS AND CULTURE

For Examiner's Use

Quantitative Analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show your working and appropriate significant figures in the final answer to **each** step of your calculations.

1 In this experiment you will determine the concentration of a solution of hydrochloric acid by titration with sodium hydroxide.

You are provided with the following:

A is a solution containing 4.00 g dm^{-3} of sodium hydroxide, NaOH,

B is hydrochloric acid

methyl orange indicator

(a) Method

Dilution of B

- Pipette 25.0 cm^3 of **B** into the 250 cm^3 volumetric flask.
- Make the solution up to the mark using distilled water.
- Insert the flask 20 times to ensure the solution is fully mixed.
- This solution of hydrochloric acid is **C**. Label the volumetric flask **C**.
- Rinse the pipette thoroughly.

Titration

- Rinse out the burette with a small amount of **C**.
- Fill the burette with **C** up to the 0.00 cm^3 mark.
- Pipette 25.0 cm^3 of **A** into a conical flask.
- Add a few drops of methyl orange.
- Perform a rough titration and record your burette readings in the space below.

The rough titre is ..... cm^3

- Carry out as many accurate titrations as you think necessary to obtain consistent results.
- Make sure any recorded results show the precision of your practical work.
- Draw a suitable table and record all of your burette readings and the volume of **C** added in each accurate titration.

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I	
II	
III	
IV	
V	
VI	
VII	

[7]

(b) From your accurate titration results, calculate a suitable value of the volume of **C** to be used in your calculations.

Show clearly how you calculated this value.

25.0 cm^3 of **A** require .....cm^3 of **C**. [1]

(c) Calculations

(i) Give your answers to **(ii)**, **(iii)** and **(iv)** to the appropriate number of significant figures. [1]

(ii) Calculate the number of moles of sodium hydroxide, NaOH, in the volume of **A** calculated in **(b)**.

moles of NaOH = ... mol [1]

(iii) Write the equation for the neutralisation of hydrochloric acid with sodium hydroxide. Include state symbols.

.....

Deduce the number of moles of hydrochloric acid that reacted with the sodium hydroxide in **(ii)**.

moles of hydrochloric acid = ... mol [1]

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(iv) Calculate the concentration, in mol dm^{-3} of hydrochloric acid in **B** in mol dm^{-3}.

concentration = ... mol dm^{-3} [2]

[Total:13]

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2 In this experiment you will determine the enthalpy change, ΔH, for the reaction shown.

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$

You will determine the enthalpy changes for the reactions of calcium oxide and calcium carbonate with hydrochloric acid. Excess hydrochloric acid will be used in each reaction.

B is hydrochloric acid

D is calcium oxide, CaO

E is calcium carbonate, $CaCO_3$

(a) Determination of the enthalpy change for the reaction of calcium oxide, **D**, with hydrochloric acid, **B**.

Method

For this question you will need to draw suitable table(s) for your results.

- Support a polystyrene cup in the 250 cm^3 beaker.
- Use the 50 cm^3 measuring cylinder to transfer 50 cm^3 of **B** into the polystyrene cup.
- Measure and record the initial temperature of the solution.
- Weigh the container with **D**. Record the mass.
- Add all the **D** from the container to the **B** in the polystyrene cup. **B** is in excess.
- Stir constantly until the maximum temperature is reached.
- Measure and record the maximum temperature.
- Weigh the container with any **D** remaining. Record the mass.
- Calculate and record the mass of **D** used.
- Calculate and record the temperature rise.

I	
II	
III	
IV	

[4]

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(b) Calculations

(i) Calculate the energy produced during this reaction.
(Assume that 4.2 J are needed to raise the temperature of 1.0 cm^3 of solution by 1.0°C).

energy produced = ... J [1]

(ii) Calculate the number of moles of CaO used.

moles of CaO used = ... mol [1]

(iii) Calculate the enthalpy change, in kJ mol^{-1}, for the reaction below.

$$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$$

enthalpy change = ... kJ mol^{-1} [1]
sign *value*

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(c) Determination of the enthalpy change for the reaction of calcium carbonate, **E**, with hydrochloric acid, **B**.

(i) Method

For this question you will need to draw suitable table(s) for your results.

- Support the second polystyrene cup in the 250 cm^3 beaker.
- Use the 50 cm^3 measuring cylinder to transfer 50 cm^3 of **B** into the polystyrene cup.
- Measure and record the initial temperature of the solution.
- Weigh the container with **E**. Record the mass.
- Add all the **E** from the container to the **B** in the polystyrene cup. **B** is in excess.
- Stir constantly until the maximum temperature is reached.
- Measure and record the maximum temperature.
- Weigh the container with any **E** remaining. Record the mass.
- Calculate and record the mass of **E** used.
- Calculate and record the temperature rise.

[2]

(ii) Apart from the change in temperature, state **two** observations you made during the reaction.

.....

..... [1]

(iii) Calculation

Calculate the enthalpy change for this reaction.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

enthalpy change = ... kJ mol^{-1} [1]
sign *value*

For Examiner's Use

(d) Use your values for the enthalpy changes calculated in **(b)(iii)** and **(c)(iii)** to calculate the enthalpy change for the reaction.

$$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$$

enthalpy change = ... kJ mol^{-1} [1]
sign *value*

(e) A student suggests that the experiment in **(c)** would be more accurate if a taller polystyrene cup of the same diameter was used.

State whether you agree with the student and justify your statement.

Statement .....

Justification .....

..... [1]

(f) Give the error in a single balance reading.

error = ± ..... g

Tick (✓) the row which represents the greater percentage error.

	The percentage error in the mass of calcium oxide used.
	The percentage error in the mass of calcium carbonate used.

Calculate the **greater** percentage error.

greater % error = ... %

[2]

[Total:15]

For Examiner's Use

3 Qualitative Analysis

Instructions

At each stage of any test you are to:

- Record details of the following:
  - colour changes seen
  - the formation of any precipitate
  - the solubility of such precipitates in an excess of the reagent added.
- Where reagents are selected for use in a test, the **name** or **correct formula** of the element or compound must be given.
- Where gases are released, they should be identified by a test, described in the **appropriate place in your observations**.
- You should indicate clearly at what stage in a test a change occurs.
- **No additional tests for ions present should be attempted**.
- **If any solution is warmed, a boiling tube MUST be used**.

Rinse and reuse test-tubes and boiling tubes where possible.

(a) You will investigate **F**.

To all your sample of **F** in a boiling tube add 4 cm depth of distilled water.
Shake the boiling tube until all the solid gas dissolved.
The solution produced is **G**.

Carry out the tests described using separate portions of solution **G**.

Test	Observations
(i) To a 1 cm depth of solution in a test-tube, add a few drops of aqueous sodium hydroxide,	
then add excess aqueous sodium hydroxide.	
To a 1 cm depth of solution in a test-tube, add an excess of aqueous ammonia.	
To a 1 cm depth of solution in a boiling tube, add aluminium foil and aqueous sodium hydroxide, then warm gently.	

[5]

(ii) Use your observations from the table to identify **two** ions present in solution **G**.

1 .....

2 ..... [2]

(iii) Give the ionic equation for one precipitation reaction observed in **(i)**. Include state symbols.

..... [1]

(iv) State **one** safety precaution you have considered while doing this experiment.

..... [1]

(b) A student is given an unlabelled bottle containing a colourless liquid that is either ethanol, CH_3CH_2OH, or ethanoic acid, CH_3COOH.

In a suitable table, describe the tests for each liquid and expected positive results for each of the tests that would be carried out to allow the student to confirm the identity of each liquid.

[3]

[Total:12]

Qualitative Analysis Notes

1 Reactions of aqueous cations

ion	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
aluminium (Al^{3+})	white ppt., soluble in excess	white ppt., insoluble in excess
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt.
barium (Ba^{2+})	faint white ppt. is nearly always observed unless reagents are pure	no ppt.
ammonium (NH_4^+)	no ppt. ammonia produced on warming	–
chromium(III) (Cr^{3+})	grey-green ppt. soluble in excess	grey-green ppt. insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
magnesium (Mg^{2+})	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese (II) (Mn^{2+})	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc (Zn^{2+})	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt. (soluble in dilute ammonia)
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt. (partially soluble in dilute ammonia)
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt (insoluble in dilute ammonia)
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
nitrite (NO_2^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium chloride/nitrate	white ppt, insoluble in excess dilute strong acids
sulfite (SO_3^{2-}) [in solution]	acidify with dilute nitric acid, then add barium chloride/nitrate	white ppt, soluble in dilute strong acids

3 Tests for gases

gas	*test and test result*
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater 'milky'
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	‘pops’ with a lighted splint
oxygen (O_2)	relights a glowing splint

The Periodic Table of the Elements

Group

1	2											13	14	15	16	17	18
							1.0 **H** Hydrogen 1										4.0 **He** Helium 2
6.9 **Li** Lithium 3	9.0 **Be** Beryllium 4											10.8 **B** Boron 5	12.0 **C** Carbon 6	14.0 N Nitrogen 7	16.0 **O** Oxygen 8	19.0 **F** Fluorine 9	20.2 **Ne** Neon 10
23.0 **Na** Sodium 11	24.3 **Mg** Magnesium 12	3	4	5	6	7	8	9	10	11	12	27.0 **Al** Aluminium 13	28.1 **Si** Silicon 14	31.0 **P** Phosphorus 15	32.1 **S** Sulfur 16	35,5 **Cl** Chlorine 17	39.9 **Ar** Argon 18
39.1 **K** Potassium 19	40.1 **Ca** Calcium 20	45.0 **Sc** Scandium 21	47.9 **Ti** Titanium 22	50.9 **V** Vanadium 23	52.0 **Cr** Chromium 24	54.9 **Mn** Manganese 25	55.8 **Fe** Iron 26	58.9 **Co** Cobalt 27	58.7 **Ni** Nickel 28	63.5 **Cu** Copper 29	65.4 **Zn** Zinc 30	69.7 **Ga** Gallium 31	72.6 **Ge** Germanium 32	74.9 **As** Arsenic 33	79.0 **Se** Selenium 34	79.9 **Br** Bromine 35	83.8 **Kr** Krypton 36
85.5 **Rb** Rubidium 37	87.6 **Sr** Strontium 38	88.9 **Y** Yttrium 39	91.2 **Zr** Zirconium 40	92.9 **Nb** Niobium 41	95.9 **Mo** Molybdenum 42	- **Tc** Technetium 43	101.1 **Ru** Ruthenium 44	102.9 **Rh** Rhodium 45	106.4 **Pd** Palladium 46	107.9 **Ag** Silver 47	112.4 **Cd** Cadmium 48	114.8 **In** Indium 49	118.7 **Sn** Tin 50	121.8 **Sb** Antimony 51	127.6 **Te** Tellurium 52	126.9 **I** Iodine 53	131.3 **Xe** Xenon 54
132.9 **Cs** Caesium 55	137.3 **Ba** Barium 56	138.9 **La** Lanthanum 57 *	178.5 **Hf** Hafnium 72	180.9 **Ta** Tantalum 73	183.8 **W** Tungsten 74	186.2 **Re** Rhenium 75	190.2 **Os** Osmium 76	192.2 **Ir** Iridium 77	195.1 **Pt** Platinum 78	197.0 **Au** Gold 79	200.6 **Hg** Mercury 80	204.4 **Tl** Thallium 81	207.2 **Pb** Lead 82	209.0 **Bi** Bismuth 83	- **Po** Polonium 84	- **At** Astatine 85	- **Rn** Radon 86
- **Fr** Francium 87	- **Ra** Radium 88	actinoids 89 – 103	- **Rf** Rutherfordium 104	- **Db** Dubnium 105	- **Sg** Seaborgium 106	- **Bh** Bohrium 107	- **Hs** Hassium 108	- **Mt** Meitnerium 109	- **Ds** Darmstadtium 110	- **Rg** Roentgenium 111	- **Cn** Copernicium 112		- **Fl** Flerovium 114		- **Lv** Livermorium 116		

Key

A = relative atomic mass
X = atomic symbol
z = proton (atomic) number

*													
Lanthanoid	140.1 **Ce** Cerium 58	140.9 **Pr** Praseodymium 59	144.4 **Nd** Neodymium 60	- **Pm** Promethium 61	150.4 **Sm** Samarium 62	152.0 **Eu** Europium 63	157.3 **Gd** Gadolinium 64	158.9 **Tb** Terbium 65	162.5 **Dy** Dysprosium 66	164.9 **Ho** Holmium 67	167.3 **Er** Erbium 68	168.9 **Tm** Thulium 69	173.1 **Yb** Ytterbium 70	175.0 **Lu** Lutetium 71
Actinoid	232.0 **Th** Thorium 90	231.0 **Pa** Protactinium 91	238.0 **U** Uranium 92	- **Np** Neptunium 93	- **Pu** Plutonium 94	- **Am** Americium 95	- **Cm** Curium 96	- **Bk** Berkelium 97	- **Cf** Californium 98	- **Es** Einsteinium 99	- **Fm** Fermium 100	- **Md** Mendelevium 101	- **No** Nobelium 102	- **Lr** Lawrencium 103

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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