

Candidate Name

Candidate Number

Centre Name

Centre Number


**Paper 1: Chemistry**

For Examination June 2023

(2 hours)

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, you must have a soft pencil (preferably of type B or HB), a clean eraser and a dark blue or black pen.

**INSTRUCTIONS:**

- You must write your name, candidate number, centre name and centre number on the answer sheets in the designated spaces.
- Objective section consists of 25 questions, and it is essential that you attempt all of them.
- Each question has four options labelled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple choice answer sheet using a soft pencil.
- Attempt all the questions from subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.

**INFORMATION:**

- This paper has a total of 100 marks.
- In objective section there are 25 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 45 marks are for extended theory and 30 marks for practical component.

The number of marks assigned for every question or its parts is indicated within brackets [ ]

## OBJECTIVE SECTION (MCQ)

- 1) Which of the following correctly describes the change of behaviour of particles as observed in the change of state below:



- A: Particles are in a regular arrangement
- B: The final observed state can be compressed
- C: Particles are no longer near each other
- D: Particles are now mobile

- 2) Pure water has a fixed temperature in which it will change state, if salt is added to it which row correctly represents the effects of adding salt?

	Melting point	Boiling point
A	Decreases	Remains the same
B	Increases	Increases
C	Decreases	Increases
D	Increases	Decreases

- 3) Which of the following can diffusion take place in?

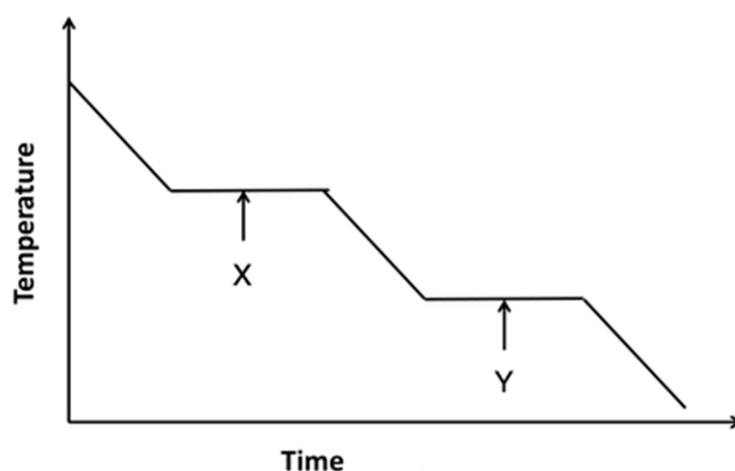
- 1: Solids
- 2. Liquids
- 3. Gases
- 4. Solutions

- A: All of them
- B: 1,2 and 3
- C: 1, 2 and 4
- D: 2,3 and 4.

4) A student has a mixture of oil and water, and wants to separate the two immiscible liquids, which method of separation should they use?

- A: Chromatography
- B: Decanting
- C: Distillation
- D: Crystallization

5) Which is the correct row, describing the changes happening at point X and Y?



	X	Y
A	Freezing	Melting
B	Condensation	Freezing
C	Condensation	Melting
D	Freezing	Condensation

6) All atoms are referred to as electrically neutral due to having the same number of?

- A: Protons and neutrons
- B: Electrons and neutrons
- C: Protons and electrons
- D: Protons, neutrons, and electrons

7) Which description of sub – atomic particles best describe an isotope?

- A: Difference in protons
- B: Difference in electrons
- C: Difference in neutrons
- D: Difference in electron shells

8) What is the correct electron configuration for a magnesium ion?



- A: 2, 8, 8
- B: 2, 8
- C: 2, 8, 2
- D: 2, 8, 8, 6

9) Steel is an example of?

- A: An Element
- B: A Compound
- C: A Molecule
- D: A Mixture

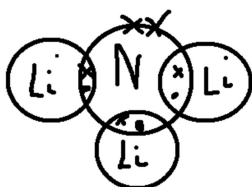
10) Which statement correctly describes the trend in Group 7 elements?

- A: They become darker as you move up the group
- B: Their melting point decreases up the group.
- C: Their boiling points increase up the group.
- D: They become more reactive down the group

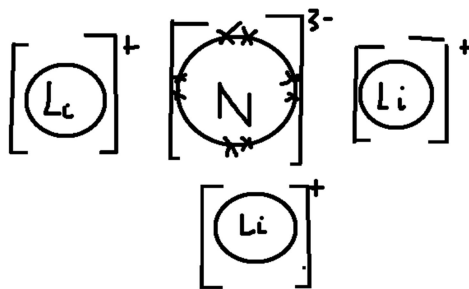
11) An unknown substance has a very high melting point and cannot conduct electricity as a liquid. Which type of substance could it be?

- A: Ionic compound
- B: Metal
- C: Giant covalent
- D: Simple covalent

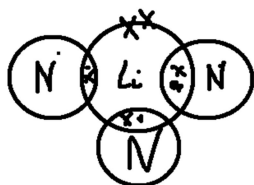
12) Which image correctly represents the bonding of Lithium nitride?



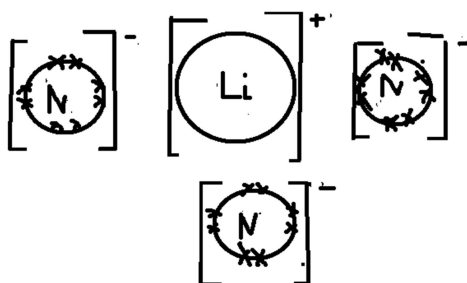
A



C



B



D

13) Which of the following statements is an incorrect description of all noble gases?

- A: All noble gases follow the octet rule
- B: All noble gases are monatomic
- C: All noble gases are unreactive
- D: Noble gas density increases down the group

14) Which one of the following transition metals can be used in thermometers?

- A: Ag
- B: Hg
- C: Me
- D: Pb

15) Determine the number of electrons in an element atom located in group 3, period 2?

- A: 3
- B: 6
- C: 13
- D: 27

16) After adding solid potassium to water, a chemical reaction occurs to form a solution. What ions will determine the chemical nature of this solution?

- A:  $\text{CO}_3^{2-}$
- B:  $\text{H}^+$
- C:  $\text{Li}^+$
- D:  $\text{OH}^-$

17) A compound formed between a group 2 element X and group 7 element Y, deduce the chemical formula of this compound?

- A:  $\text{X}_2\text{Y}$
- B:  $\text{XY}_2$
- C:  $\text{X}_2\text{Y}_2$
- D:  $\text{XY}$

18)Metals are good conductors of electricity, which statement explains why metals are good conductors?

- A: Free delocalized ions
- B: Free delocalized positive nuclei
- C: Free delocalized electrons
- D: Free delocalized neutrons

19)What is the correct name given to different versions of the same element that have a distinctively different molecular formula?

- A: Allotropes
- B: Isomers
- C: Polymers
- D: Isotopes

20)Describe the correct chemical property of zinc oxide?

- A: Neutral
- B: Basic
- C: Acidic
- D: Amphoteric

21)Chemical testing occurred on an unknown salt, a student deduced this to be lithium chloride, which would be the correct observed results that led to this conclusion?

	Colour observed from flame test	Test for gas produced	Observed result
A	Red	Damp blue litmus paper	Turns red then white.
B	Orange	Damp red litmus paper	Turns blue
C	Lilac	Burning splint	Squeaky pop
D	Red	Limewater	Milky white

22) A student adds 5cm<sup>3</sup> of an unknown solution to sodium hydroxide solution and observed the formation of a green precipitate? What would the correct chemical formula be of the product?

- A: Fe(II)(OH)<sub>2</sub>
- B: Fe (III)(OH)<sub>3</sub>
- C: Ba(II)(OH)<sub>2</sub>
- D: Ba(III)(OH)<sub>3</sub>

23) Using electrolysis to separate copper chloride solution, state the gas that is formed at the cathode?

- A: Oxygen
- B: Hydrogen
- C: Chlorine
- D: Water vapour

24) Iron can be extracted from its ore hematite by using a blast furnace, what type of reaction is hematite involved in?

- A: Combustion
- B: Oxidation
- C: Reduction
- D: Thermal decomposition

25) Aluminum is a metal used in a variety of materials, which one of the following is not a common use for of Aluminum.

- A: Soda cans
- B: Car chassis
- C: Aero plane parts
- D: Foil

*End of MCQ [25 marks]*



## **Part 2: Extended Theory:**

1a) Particles have energy, an example of this which can be observed is through Brownian motion.

Ai) Describe an example of observable Brownian motion? [1 mark]

Aii) Draw a diagram to describe a particles movement by Brownian motion? [2 marks]

Aiii) Explain the theory behind the movement of particles by Brownian motion? [2 marks]

b) Another type of particle movement is diffusion, to support the kinetic particle theory.

Bi) Describe how four different factors affect diffusion? [4 marks]

Below is a typical experiment used to observe various diffusion rates. Using hydrochloric acid and ammonia solutions placed on cotton wool.

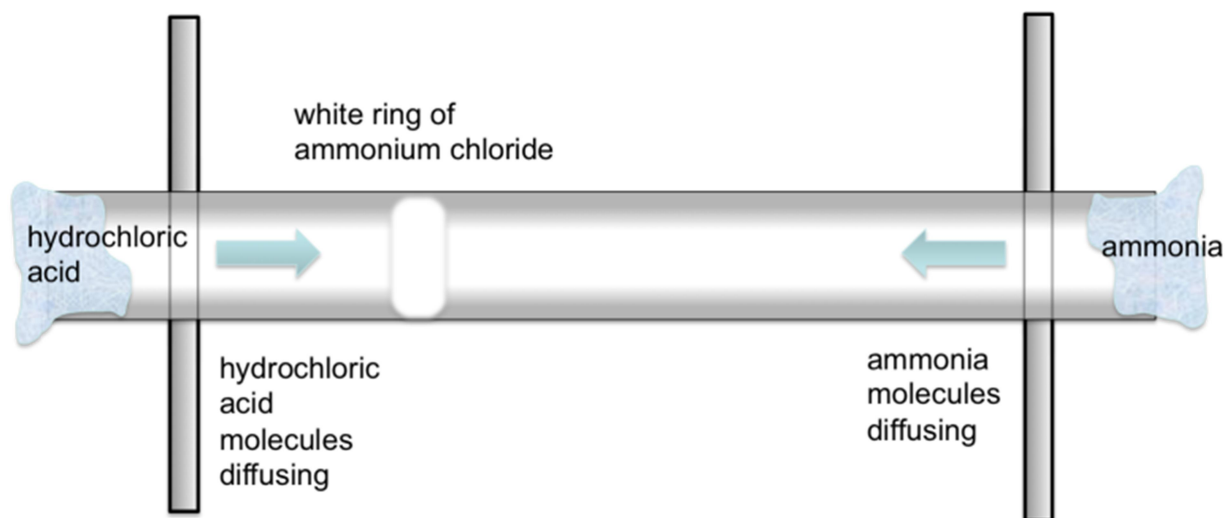


Figure 1:

Bii) Other than diffusion, state the physical reaction and chemical reaction that occurs to be able to obtain the observed result? [1 mark]

biii) Write the balanced chemical equation for this experiment? [3 marks]

c) Assuming all other factors have been kept the same, compare and explain the rate of diffusion between carbon monoxide (CO) and Nitrogen gas (N<sub>2</sub>). [2 marks]

[Total 15 marks]

Q2 The Periodic table is a representation of all known atoms to human knowledge, the current version by Dmitri Mendeleev, by organizing atoms according to their subatomic particles and their properties.

The diagram shows a simplified periodic table layout. It consists of several blocks of cells. On the left, there is a vertical column of 6 cells. To its right is a block of 18 cells, which is highlighted in yellow. This highlighted block is 3 rows high and 6 columns wide, with an additional 2 columns extending from the bottom row. To the right of the highlighted block is another block of 18 cells, arranged in 3 rows and 6 columns. The entire structure is symmetrical around the central highlighted d-block.

(Figure 2)

- a) How were elements in the periodic table ordered? [1 mark]
- b) What is the common name for the highlighted area of figure 2? [1 mark]
- c) Name four chemical properties of elements contained within the highlighted area. [4 marks]
- d) Magnesium is in group 2 of the periodic table, and is a metal describe how the bonding occurs in a metal such as Magnesium? [3 marks]
- e) Describe with examples how the change of metallic character across the period? [6 marks]

[Total 15 marks]

Q3) A sample of a chlorofluorocarbon (CFC) contains 0.48 g of carbon, 1.52 g of fluorine and 2.84g of chlorine.

ai) Deduce the empirical formula of the CFC? [3 marks]

Aii) Complete the table below by completing drawing of the follow:

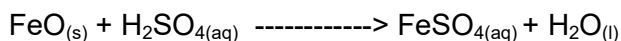
Display formula [1 mark]	Dot and cross diagram [2 marks]

(b) The relative formula mass of this CFC is 484. Deduce the molecular formula of the CFC. [1 mark]

[Total 7 marks]

Q4)

A student prepares a sample of Iron (II) sulfate crystals using this reaction.



He obtains the crystals from the solution formed.

He records this information about the reactants he uses.

Mass of iron (II) oxide = 5.4 g  
volume of sulfuric acid = 50 cm<sup>3</sup>  
concentration of sulfuric acid = 1.02 mol/dm<sup>3</sup>

- (i) Calculate the amount, in moles, of Iron (II) oxide used. [2 marks]
- (ii) Calculate the amount, in moles, of sulfuric acid used. [2 marks]
- (iii) Why is it important for iron (II) oxide to be greater than the amount of sulfuric acid? [1 mark]
- (iv) Draw a diagram of the apparatus that the student should use to remove the excess copper (II) oxide from the reaction mixture.
- (v) Calculate the mass of the excess iron oxide that is removed. Give your answer to 3 Significant figures [2 mark]

[Total 8 marks]

*End of Extended Theory [Total 45 marks]*

### **Part 3: Practical theory**

Q1) A student carries out a titration to find the concentration of some dilute sulfuric acid.

They use the following method to do the titration.

- Step 1 Add 25.0 cm<sup>3</sup> of 0.8 mol/dm<sup>3</sup> sodium hydroxide solution to a conical flask.
- Step 2 Add drops of phenolphthalein indicator to the conical flask.
- Step 3 Fill a burette with the sulfuric acid.
- Step 4 Add the sulfuric acid to the conical flask until the phenolphthalein indicator just changes colour.

a) Complete the table below relating to variables. [3 marks]

Independent variable	Dependent variable	State 1: Control variable

- b) Name the piece of apparatus that the student should use to add the sodium hydroxide solution in step 1. [1 mark]
- c) Describe the colour change of the phenolphthalein indicator in step 4? [1 mark]
- d) Why is Universal indicator not suitable for this experiment? [1 mark]

e) Use the diagram below to complete the table:



Use the readings to complete the table, entering all values to the nearest 0.1 cm<sup>3</sup>. [2 marks]

Burette reading in cm <sup>3</sup> before adding the acid	
Burette reading in cm <sup>3</sup> after adding the acid	
Volume of acid added in cm <sup>3</sup>	

(f) The student found an empty bottle in the Science lab; they wondered if this was the same as sulfuric acid solution they had used. The bottle showed a label stating the concentration of was 0.5 mol/dm<sup>3</sup>. The student decided to repeat the test a further 4 times. To try and determine if this is the correct concentration of the sample.

The table below shows their results:

Burette reading in cm <sup>3</sup> before adding the acid	.....	21.5	0.1	.....
Burette reading in cm <sup>3</sup> after adding the acid	21.5	41.7	.....	40.3
Volume of acid added in cm <sup>3</sup>	21.0	.....	19.5	18.9

fi) Complete the missing information from the table. [2 mark]

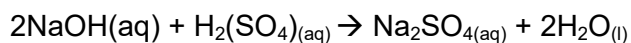
fii) Including the initial experiment state the 3 volumes of acid that are concordant that different from each other by  $0.70\text{cm}^3$  or less. [1 mark]

fiii) Using the values of part eii) calculate the average volume of acid added? [1 mark]

fv) Describe how using concordant results improves the accuracy of the experiment? [1 mark]

fv) Describe how repeating the experiment 5 times and calculating the average improves the accuracy of the experiment? [1 mark]

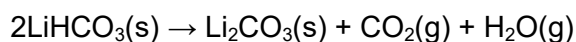
g) The balanced chemical reaction for this experiment is written below,



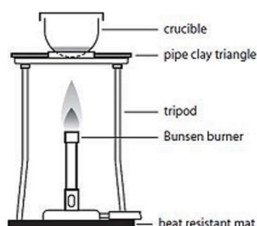
Using the Step 1 and your answer from part eiii) Deduce if this is likely that this bottle contained the same sulfuric acid. [4 marks]

[Total 18 marks]

Q2) Lithium hydrogen carbonate ( $\text{LiHCO}_3$ ) is used in the production of ceramics and glass. This is the equation for the reaction that takes place when baking soda is heated.



A student uses this apparatus to investigate the reaction that takes place when sodium hydrogen carbonate is heated.



This is the student's method.

Step 1: Using a balance to measure the mass of an empty crucible and lid.

Step 2: Put coiled strip of freshly cleaned magnesium ribbon in the crucible

Step 3: Measure the mass of the crucible, lid, and ribbon

Step 4: Heat the crucible strongly for 3 minutes, using a roaring blue flame, lifting the lid and quickly replacing it several times.

Step 5: Heat the crucible and contents again for a further 3 minutes.

Step 6: Leave to cool and measure the mass again.

- a) Name the chemical reaction occurring in this reaction? [1 mark]
- b) Give a reason why the crucible and contents are heated for a further three minutes. [1 mark]
- c) Why did the student use a lid on their crucible in their method? [1 mark]
- d) State the risk that has been solved from this practical in the method? [1 mark]

The table shows some of the student's results.

Mass of empty crucible in grams	25.50
Mass of lid in grams	1.15
Mass of crucible, lid, and lithium hydrogen carbonate in grams	30.40



- e)
- (i) Calculate the mass of lithium hydrogen carbonate that they used.? [1 mark]
  - (ii) Deduce the maximum mass of lithium carbonate that could form in this reaction? [4 marks]
- f) The student repeated the experiment but predicted that they should produce 5.20g of lithium carbonate. However, after measuring the product the mass of lithium carbonate collected was 4.94g. Calculate the percentage yield from the experiment? [2 marks]
- g) Suggest a reason for the lower actual yield than estimated? [1 mark]

[Total 12 marks]

*End of Extended Theory [Total 30 marks]*

Mark scheme for multiple choice:

1. D
2. C
3. D
4. B
5. B
6. C
7. C
8. B
9. D
10. B
11. C
12. C
13. A
14. B
15. C
16. D
17. B
18. C
19. A
20. D
21. A
22. A
23. B
24. C
25. B

### Extended Theory Mark Scheme:

1ai) Dust in air / clay in water / toothpaste in water.

Aii) Image should show random irregular movement.

- Irregular and zig zag [1]
- Needs an arrow to show directional movement. [1]

Aiii)

- MP1 Visible particles [1]
- MP2 Collided / bombarded by smaller non-visible particles [1]

Bi ) 1 mark per factor + description of how it affects diffusion. Only needs one correct effect / description not both.

#### Temperature

- High temperature increased rate of diffusion
- Low Temperature slower rate of diffusion

#### Molecular mass

- Bigger Mr slower rate of diffusion
- Smaller Mr faster rate of diffusion

#### Concentration:

- Higher concentration higher rate of diffusion
- Lower concentration lower rate of diffusion

#### Surface area:

- Larger surface area faster the rate of diffusion
- Lower surface area slower rate of diffusion.

#### AVP:

##### Presence of membrane:

- Slower with membrane
- Faster without

##### State of matter:

- Faster in gases
- Slower in liquid

Bii)

Physical reaction: Evaporation / vaporization

Chemical reaction: Precipitation / Neutralization / Redox reaction

Both needed for 1 mark

Biii) 1 mark both reactants, 1-mark products and 1 mark for start of matter.



c) MP1 - They have the same / no difference in rate of diffusion

MP2 – As they have the same Molecular Mass / Mr.

2a) In order / increasing of proton number.

b) Transition metals

c) 1 marking point for each

- Form coloured compounds

- Form complex ions

- Good Catalysts

- Less reactive than other groups of metals.

- Have more than one oxidation state / can form different ions / Accept example ions (chemical formula)

- Accept Max 1 mark for a suitable example of any named chemical property / example

d) MP1 – Positive ions

MP2 – floating in a sea of delocalized/ mobile electrons.

MP3 – Electrostatic forces of attraction between positive ions and electrons.

e.)

MP1 – elements become less metallic across the period.

MP2 – elements change from basic to acidic across the period.

MP3 – Melting point/boiling point decreases across the period

MP4 – Electrical conductivity decreases across the period.

MP5 – Chemical reactivity decreases across the period.

MP6: - Density increases across the period.

AVP: Metallic bonding changes to covalent

3a) Correct calculations showing

MP1 : Mass / Ar

C = 0.04 F = 0.08 and Cl = 0.08

MP2: Showing ratio 1 : 2 : 2

MP3 =  $\text{CF}_2\text{Cl}_2$

Allow 3 marks for correct answer without working.

Max: 1 mark for ecf if Ar for Carbon was used instead of Chlorine resulting in  $\text{CFCl}$  or  $\text{CF}_2\text{Cl}$

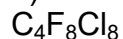
ii) 1 mark for display formula

Dot and cross diagram MP1 = showing single covalent bond with a X and O a total of 4 of them.

MP2 the correct number of lone pairs on the F and Cl atoms to complete full outershell.

Display formula [1 mark]	Dot and cross diagram [2 marks]
$  \begin{array}{c}  \text{F} \\    \\  \text{Cl} - \text{C} - \text{Cl} \\    \\  \text{F}  \end{array}  $	

b)



Allow error carried forward if any to aii) is multiplied by 4.

4a)

MP1 : calculation used mass / Mr

MP2: 0.075 moles

ii)

MP1: Evidence of calculation used moles \* Conc

MP2: 0.051 moles

iii)

MP1 Ensure all the acid is reacted / no acid left

iv) correctly sketched image of filtration with funnel, filter paper

Accept without or with beaker present.

v) 2 marks awarded if answer is 1.73g without calculation evidenced.

MP1 - Correct calculation of 3.672g reacted.

MP2: Difference 5.4g – 3.672g

1.73g (3sfg)

Accept MP2 if mass calculated – original

Max 1 mark if full answer 1.782g

Part 3: Practical Theory:

Q1)

a) Complete the table below relating to variables. [3 marks]

Independent variable	Dependent variable	State 1: Control variable
Volume of acid	pH Change	Temperature / drops of indicator

b) Measuring cylinder

c) Changes from pink to colourless

Must include the start colour and final colour, reject final colour only.

d) Difficulty seeing end point / point of neutralization / Accept valid descriptions of colour

e)

Burette reading in $\text{cm}^3$ before adding the acid	0.2
Burette reading in $\text{cm}^3$ after adding the acid	22.2
Volume of acid added in $\text{cm}^3$	22.0

1 mark for readings

1 mark for volume of acid to 1 decimal place.

Fi)

All 4 values correct 2 mark

2 values correct 1 mark

Burette reading in $\text{cm}^3$ before adding the acid	0.5	21.5	0.1	21.4
Burette reading in $\text{cm}^3$ after adding the acid	21.5	41.7	19.6	40.3
Volume of acid added in $\text{cm}^3$	21.0	20.2	19.5	18.9

fii)  $20.0 \text{ cm}^3$ ,  $20.2 \text{ cm}^3$ ,  $19.5 \text{ cm}^3$

fiii)  $19.9 \text{ cm}^3$  [1 mark]

fiv) Increases precision.

fv) Increases reliability.

g.)

MP1 = Calculating number of moles in NaOH =  $0.08 \times 0.025$

Evidence of moles = vol \* conc

= 0.02 moles of NaOH

MP2 = application of molar ratio  $0.02/2$  therefore 0.01 moles of  $\text{H}_2\text{SO}_4$

MP3 = concentration of  $\text{H}_2\text{SO}_4$  determined by  $0.01/0.0199$

=  $0.5 \text{ mol/dm}^3$

MP4 = Yes, it is the same concentration / likely to be the bottle

Accept max 2 marks for ECF if forgotten to use  $\text{dm}^3$  conversation but showed appropriate method of deduction.

Q2)

- a) Thermal decomposition / Reduction
- b) Reaction is completed / finished / achieve a constant mass / all reactant reacted.
- c) Stop / prevent solid spitting / ejecting from crucible / avoid loss of reactant.
- d) Getting burned / burnt / burns skin. Ignore idea of its hot / Bunsen / referenced to hazard.

Ei) 3.55g

Eii) M1 3.55 / 68 (RFM)

MP2 0.05 moles / 0.0522 moles of  $\text{LiHCO}_3$

MP3 0.025 moles / 0.0266 of  $\text{Li}_2\text{CO}_3$

MP4 Deduced maximum mass of 0.025 mols \* 74 = 1.85g – 1.97g

e) MP1 (Calculation obtained mass / maximum mass) \* 100\

(4.94g / 5.20) \* 100

MP2: 95%

f) Spillages / Impurities. (Reject human error)