

Candidate Name

Candidate Number

Centre Name

Centre Number

Paper 2: 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.

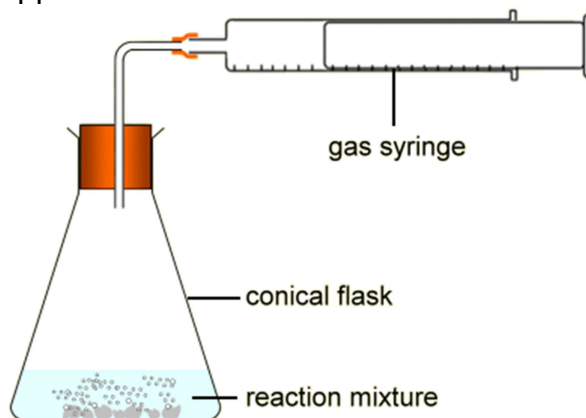
INFORMATION:

- 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)

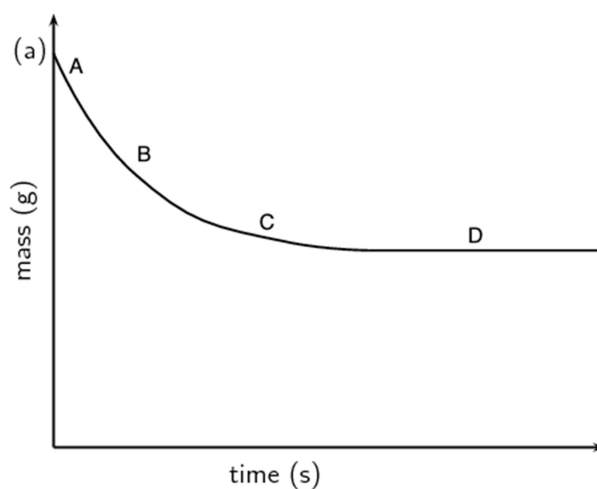
- 1) The rate of reaction can be measured between a metal carbonate and an acid using the following apparatus.



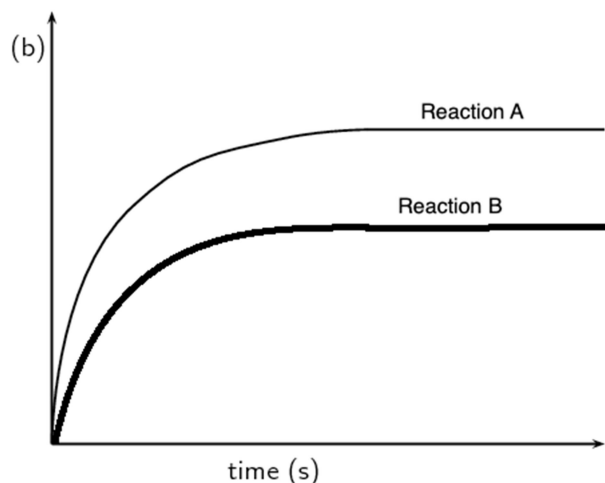
The mass decrease of mass reactants in the reaction is equal to _____ of gas produced.

- A: Mass
- B: Volume
- C: Concentration
- D: Number of moles

2. Rate of reaction varies throughout the reaction, at which part of this reaction would be the lowest rate of successful collisions that is occurring in the reaction.



3. The rate of reaction measured between reaction A and B, using light absorbance as a measure of rate of reaction. One variable was altered, below are the results.



Which variable was most likely altered?

- A: Temperature
- B: Catalyst
- C: Concentration
- D: Surface area.

4. Silver chloride will decompose in the presence of sunlight as part of a photochemical reaction:



Which statement is true?

- A: This reaction is an example of an exothermic reaction.
- B: This reaction is an example of an endothermic reaction
- C: This reaction did not require any activation energy
- D: Silver is oxidized in this reaction

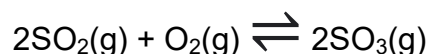
5. A student heated a sample blue copper sulphate until it turned white, and then stopped heating. A gas was given off, using your knowledge gas testing which observation would be correct?

	Test	result
A	Universal indicator paper	Turns purple
B	Cobalt chloride paper	Turns blue
C	Damp litmus paper	Turns red then white
D	Cobalt chloride paper	Turns pink

6. Which one of the following is a correct statement for the term dynamic equilibrium?

- A: Can only occur in a closed system
- B: Concentrations of reactants and products are not fixed.
- C: Forward and reverse reaction take place at the different rates.
- D: Equilibrium of reactions cannot be changed.

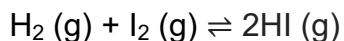
7. During the contact process, which is used to manufacture sulfuric acid, there is an equilibrium reaction that is used to produce sulfur trioxide.



Recall the correct conditions for the process?

	Temperature	Catalyst	Pressure (atm)
A	450	Iron	200
B	200	Nickel	1
C	450	Nickel	200
D	450	Vanadium (V) oxide	1

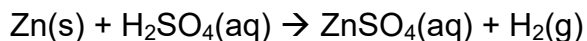
8. In the following reaction:



The reverse reaction is exothermic, which of the following would lead to an increase in the yield of Hydrogen iodide?

- A: Decrease temperature
- B: Use of a catalyst
- C: Decrease in pressure
- D: Increase temperature

9. Chemicals reactions involve the exchange of electrons, below is an example of a redox reaction. State the oxidizing agent of this reaction?



- A: Zn
- B: H_2SO_4
- C: ZnSO_4
- D: H_2

10. A strip of grey magnesium metal was ignited which resulted in a bright light given off to form a white solid. Which half reaction correctly shows what is happening to the magnesium in this reaction?

- A: $\text{Mg}(\text{s}) + 2\text{e}^- \rightarrow \text{Mg}^{2+}$
- B: $\text{Mg}^{2+} \rightarrow \text{Mg}(\text{s}) + 2\text{e}^-$
- C: $\text{Mg}(\text{s}) \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
- D: $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}(\text{s})$

11. Various oxidation states can be observed by using potassium manganate (VII) solution, as a variety of colours are observed depending on acidity or alkalinity. An unknown liquid was added to potassium manganate (VII) and the final colour observed was colourless? Deduce the possible pH of this unknown liquid?

- A: 5
- B: 10
- C: 8
- D: 7

12) Fertilisers are essential to help plants grow, they often contain nitrogen-based compounds. What biological molecule is produced by plants using nitrogen.

- A: Carbohydrates
- B: Lipids
- C: Amino acids
- D: Fatty acids

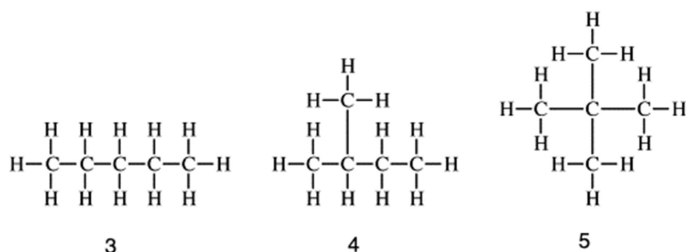
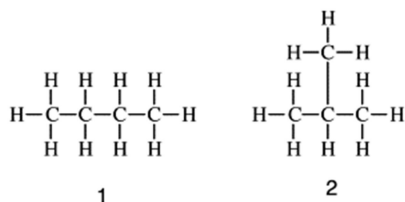
13. Which one of the following is not an industrial use of sulphuric acid?

- A: Galvanizing
- B: Making fertilisers
- C: Making Paints
- D: Making plastics

14. Homologous series compounds have the same general formula, using your knowledge of the organic homologous series deduce the odd one out?

- A: Methanol
- B: Methane
- C: Methene
- D: Methyl aldehyde

15. The display formula of different compounds is shown below:



Which combination of compounds are isomers?

- A: 1,2 and 4
- B: 2, 3, and 4
- C: 2, 3 and 5
- D: 3, 4 and 5

16. Petroleum is a mixture containing many varieties of hydrocarbons, these compounds can be separated into pure substances referred to as fractions during fractional distillation. The mixture of substances separates using this process due to having different _____?

- A: Flammability
- B: Viscosity
- C: Chain length
- D: Boiling point

17. Kerosene is one of the fractions of petroleum that is separated during fractional distillation, what is the use of kerosene?

- A: Fuel for aeroplanes
- B: Fuel for automobiles
- C: Fuel for ships
- D: Making plastics

18. Oil companies may use a process known as cracking to produce smaller products based on demand, compared to supply of hydrocarbons produced from fractional distillation.

What the products what can be formed by the process of cracking?

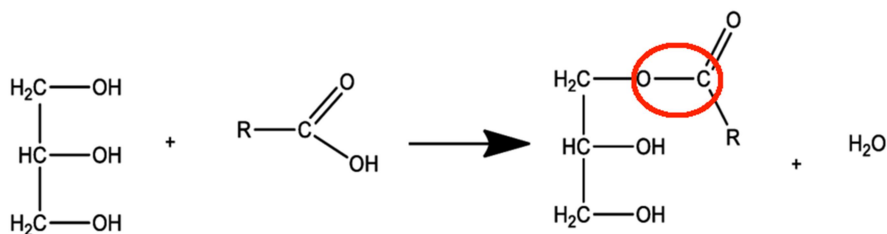
1. *Alkanes*
2. *Carbon dioxide*
3. *Alkenes*
4. *Water*
5. *Hydrogen*

- A: 1,2 and 5
- B: 1, 3 and 5
- C: 1, 3 and 4
- D: All of them

19. A chemical test using bromine water can determine whether a hydrogen is saturated or unsaturated based on the observation. If propane was passed through bromine water what would the expected colour observed be?

- A: Colourless
- B: Orange
- C: White
- D: Grey-green

20. A condensation reaction occurs between an alcohol and carboxylic acid, as shown below:



Correctly identify the name of the bond formed circled.

- A: Peptide
- B: Glycosidic
- C: Ester
- D: Carboxylic

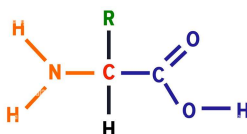
21. The image below shows the display formula of a hydrocarbon.



State the name of this hydrocarbon

- A: Ethane
- B: Ethene
- C: Polyethane
- D: Polyethene

22. Below is an image of a biological molecule.



Which term best describes this molecule?

- A: Macromolecule
- B: Monomer
- C: Polymer
- D: Monoglyceride

23. The atmosphere is a mixture of gases, which method of separation is used to obtain pure nitrogen from there atmosphere?

- A: Nitrogen fixation
- B: Nitrification
- C: Fractional distillation
- D: Series of redox reactions

24. Which process results in carbon reservoir in living organisms?

- A: Photosynthesis
- B: Respiration
- C: Decomposition
- D: Combustion

25. Which element is often used in the galvanising of iron?

- A: Steel
- B: Copper:
- C: Tin
- D: Zinc

End of MCQ [25 marks]

Extended Theory:

Q1) A student set's up their equipment to investigate the rate of reaction between finely powdered magnesium and dilute nitric acid.

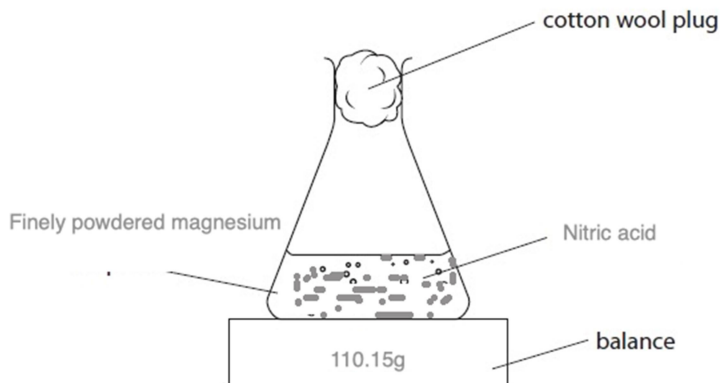


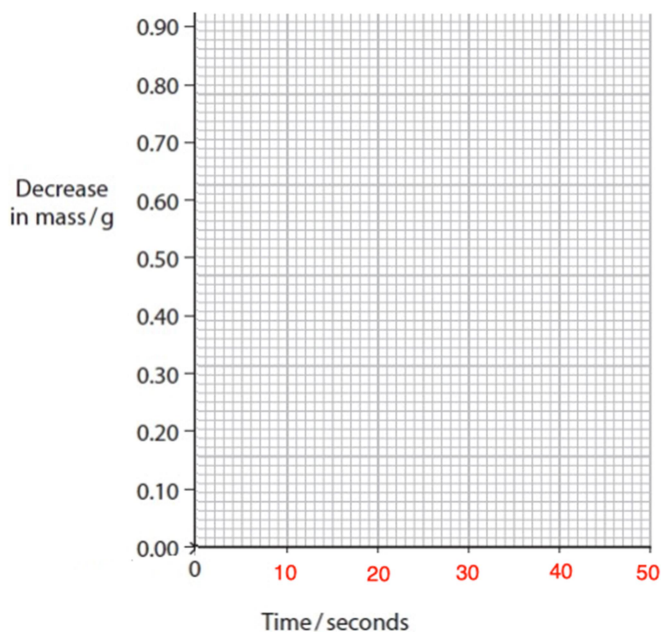
Fig 1

Every 10 seconds the student records the reading on the balance.

- (a) Cotton wool is placed in the neck of the conical flask for safety and spillage. Explain how the results could be affected without the cotton wool influence the results? [2 marks]
- (b) Write the balanced chemical equation for this reaction, include state symbols. [3 marks]
- ci) Calculate the mass decrease of this reaction using the students' measurements. [2 mark]

Time (s)	Mass reading (g)	Mass decrease (g)
0	111.30	
10	111.00	
20	110.80	
30	110.70	
40	110.65	
50	110.65	

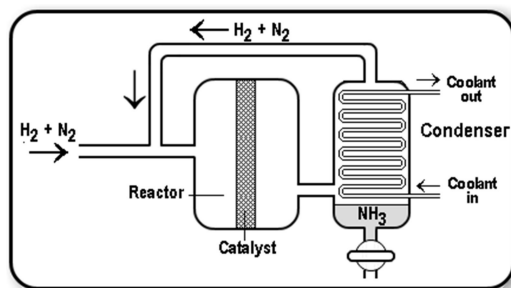
- cii) Plot the graph based on the student's data. [2 marks]



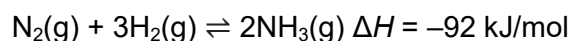
- ciii) Give a reason why there is no visible magnesium powder remaining in the flask when the reaction stops? [1 mark]
- civ) Suggest how a student could increase the surface area in this reaction? [1 mark]
- cv) Explain, in terms of particle collision theory, how increasing the surface area affects the rate of a reaction. [3 marks]
- cvi) State how the student would know that all the acid had been reacted? [1 mark]
- cvi) Use the graph to determine the amount, in moles, of hydrogen produced during the reaction. [1 mark]
- cvi) Use the graph to calculate the rate of reaction, at time 30 seconds. Give the unit. [2 marks]

[Total 18 marks]

Q2) The reaction conditions used are a temperature of 450°C.



This is the equation for the reaction.

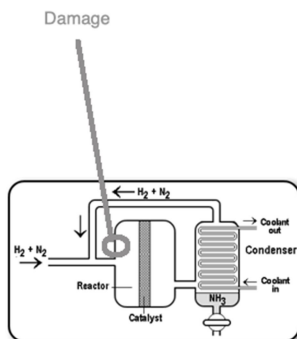


(a)(i) What is the name given to this process? [1 mark]

(ii) Give the reason for using a catalyst. [2 marks]

bi) Describe and explain the effect on yield and rate of reaction of ammonia if the temperature was increased? [6 marks]

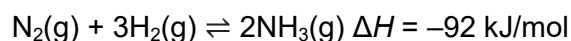
There was significant damage to the reactor due to an earthquake. A hole has formed the reactor near the input pipes for nitrogen and hydrogen. The reactor is still able to maintain a constant temperature of 450 degrees.



Bii) Describe and explain the effect this has on the conditions of the reaction and how this will affect the yield of ammonia produced in this reaction? [4 marks]

c) Using the information provided and your own knowledge, draw an energy level diagram for the reaction between nitrogen and hydrogen. [3 marks]

d) At the start of the reaction, 168 dm³ of hydrogen at room temperature.



[molar volume of any gas at rtp = 24 dm³]

Deduce the percentage yield of this reaction, if the yield of ammonia collected was 32 dm³ [3 marks]

[Total 19 marks]

Q3) The atmosphere is made up of a mixture of gases, including nitrogen, oxygen, argon, carbon dioxide and other small trace amounts of gases such as water vapour, hydrogen, etc.

- a) Draw a pie chart with the correct proportions of the Earth's atmosphere, simplified to three sections. [2 marks]
- b) Acid rain is caused by human activities, name Sulphur dioxide as the main contributing gas to acid rain, name another and their source. [1 mark]

Sulphur dioxide reacts with oxygen to form sulphur trioxide in the atmosphere. Sulphur trioxide then reacts with rainwater to form sulfuric acid $\text{H}_2\text{SO}_4(\text{aq})$.

Acid rain can lead to leaching of metals from the soil, which eventually end up in the rivers, lakes, and oceans as well as their acidification.

When lakes and rivers have a high concentration of sulfuric acid, farmers can add a solid called slaked lime $\text{Ca}(\text{OH})_2(\text{aq})$ to neutralize the acid.



- ci) Explain why $\text{Ca}(\text{OH})_2$ is better at neutralizing than NaOH . [1 mark]

A solid is formed from this reaction which can be collected and removed from the waterway after its application.

- cii) Deduce the name and chemical formula of the solid product of this reaction? [1 mark]

The farmer accidentally used sodium hydroxide to treat their pond, no solid was formed.

- d) Write the balanced ionic equation for using sodium hydroxide to treat acidified lakes due to acid rain caused by sulfur dioxide? [3 marks]

[Total 8 marks]

End of Extended Theory [Total 45 marks]

Practical Theory: 30 marks:

Q1) A student wishes to test the different energy content contained within the fuel's methanol, ethanol and propanol using spirit burners.

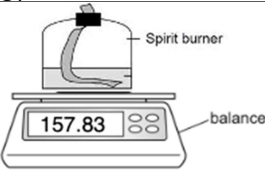
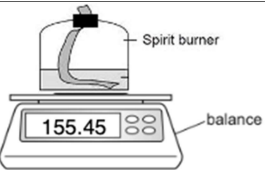
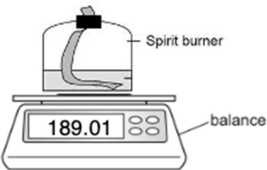
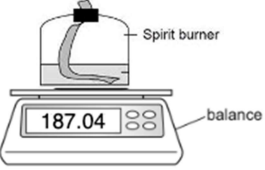
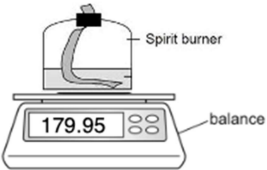
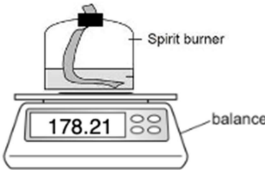
a) Draw a suitable labelled diagram, include all apparatus. [3 marks]

A student will be using 100cm^3 of water and allowing the spirit burner to heat water up to 30 degrees Celsius before measuring the mass change and temperature change.

b) Suggest suitable control variables of this experiment? [2 marks]


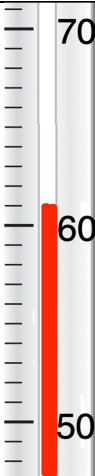



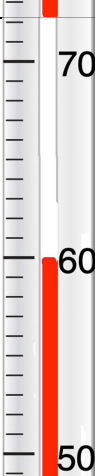
A student carryout the experiment and recorded the mass of the spirit burner before and after the experiment.

c) Below is the student's measurements for mass change, complete the table. [1 mark]

Fuel type	Start mass of fuel (g)	Final mass (g)	Mass change (g)
Methanol			
Ethanol			
Propanol			

cii) With reference to the data, suggest a reason why the difference in mass change is different between the fuels? [3 mark]

d) Below are the students measures for temperature change, complete the table.
[1 mark]

Fuel type	Start temp (Degree C)	Final temp (Degree C)	Temp Change (Degree C)
Methanol			
Ethanol			
Propanol			

- e) Suggest a reason why temperature change and mass change is used instead of final mass and final temperature when investigating energy content of a fuel? [1 mark]
- f) Using all the information throughout the question complete the calculation for energy released during each experiment: [3 marks]

Provide your answer to 3sfg

$$\text{energy released per gram of alcohol (J)} = \frac{\text{mass of water (g)} \times \text{temperature change (}^{\circ}\text{C)} \times 4.2}{\text{mass of alcohol (g)}}$$

Fuel type	Energy released per gram kJ/g
Methanol	
Ethanol	
Propanol	

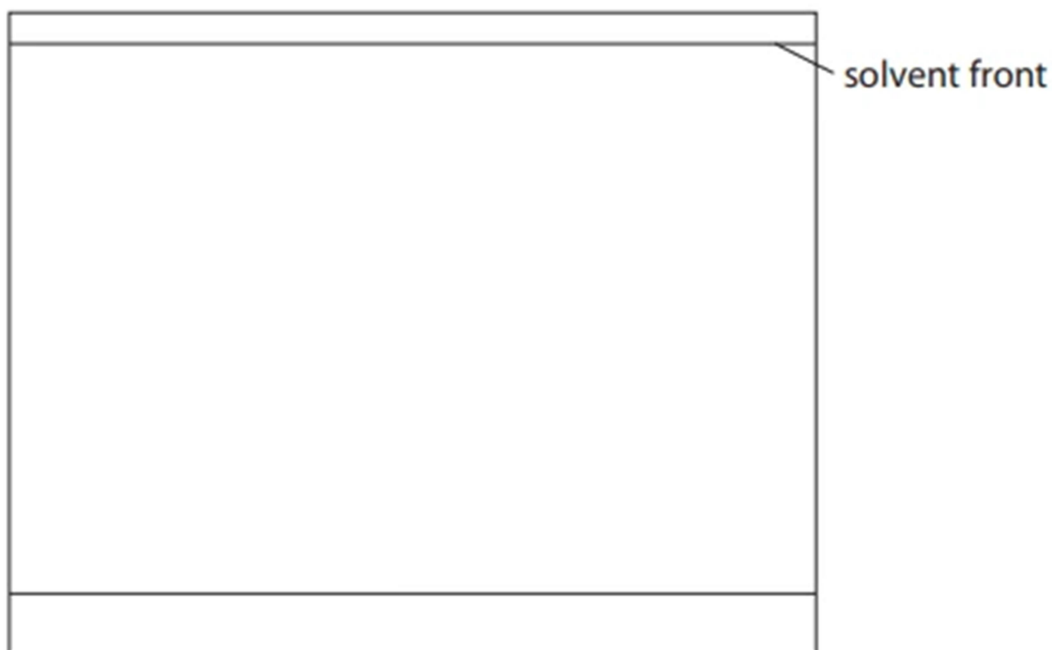
- g) Incomplete combustion can occur when there is a lack of oxygen to completely oxidise the reaction. Write the balance chemical equation for incomplete combustion of ethanol ($\text{C}_2\text{H}_5\text{OH}$)? [2 marks]
- h) Ethanol has a varied use in multiple industries and is a key reactant in making ethanoic acid. State the two methods in which ethanol is produced commercially. [2 marks]

[Total 18 marks]

Q2) Chromatography is a method used to separate mixtures into pure substances.

- a) Amino acids are colourless, describe and explain the additional step which is needed compared to chromatography of inks. [2]
- b.) A group of students have a sample of an unknown amino acid but believes it could be lysine. Describe how the student could use chromatography to confirm their hypothesis. [3 marks]
- c) The R_f values of 5 amino acids, have been calculate. Draw on the chromatogram where the student who have seen the deposits of amino acids? The distance from base line to solvent front was 5 cm [2 marks]

Amino acid	R_f value
arginine	0.20
asparagine	0.5
leucine	0.73
lysine	0.14
Unknown amino acid X	0.14



- d) What is the uncertainty value of using the ruler used during this experiment? [1 mark]

[Total 8 marks]

Q3) A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy.

The formation of this precipitate can be used to show how fast the reaction proceeds.

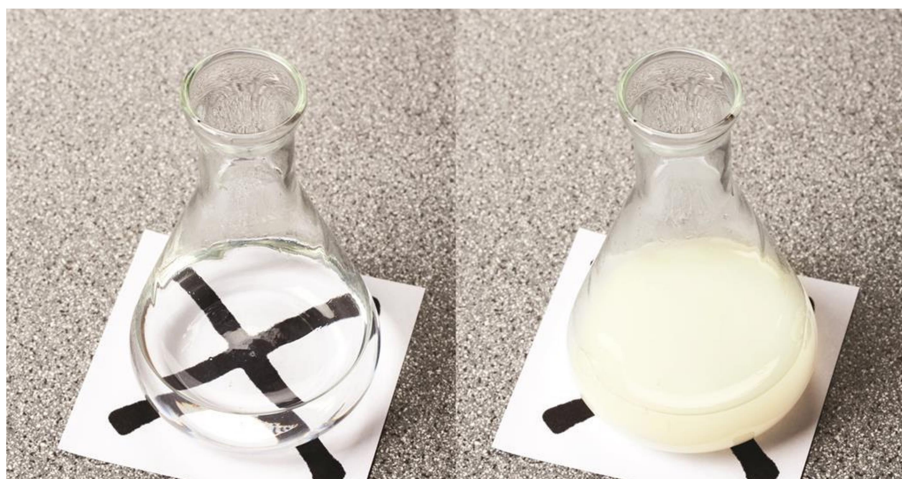
Step 1: A large measuring cylinder was used to pour 50cm³ of aqueous sodium thiosulfate into a 250cm³ conical flask. The conical flask was placed on a printed sheet of paper.

Step 2: 10cm³ of dilute hydrochloric acid was added to the solution in the conical flask.

Step 3: A timer was started immediately, and the mixture was swirled.

Step 4: The time taken for the printed X to disappear was measured.

This method was repeated at different concentrations of 10,20,30 and 40 cm³.



a) State the independent variable of this experiment? [1 mark]

Below are the students results:

Volume of sodium thiosulphate (cm ³)	Time taken (s)
10	25
20	34
30	47
40	70
50	210

From the results the students concludes that the rate of reaction was faster when there was a smaller volume of sodium thiosulfate.

b) Evaluate the validity of the conclusion of this experiment? [3 marks]

[Total 4 marks]