



THE KING'S SCHOOL

2013
Higher School Certificate
Trial Examination

Chemistry

Disclaimer:

This is a Trial HSC Examination only. Whilst it reflects the topics of the HSC Examination designed by the NSW Board of Studies for the respective sections, there is no guarantee that the content of this exam exactly replicates the actual HSC Examination

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- Write your student number at the top of EVERY page
- Use the multiple choice grid provided for your answers to Part A

Total marks – 100

Section I

Total marks (100)

This section has two parts, Part A and Part B

Part A

Total marks (20)

Attempt questions 1 – 20

Allow about 30 minutes for this part

Part B

Total marks (80)

Attempt questions 21 – 38

Allow about 2 hour 30 minutes for this part

Section II - Page

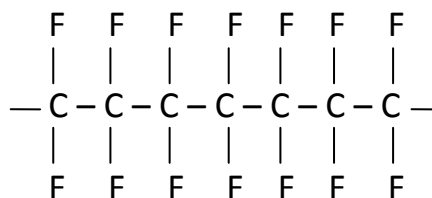
This paper does not contain an Elective question

This paper MUST NOT be removed from the examination room

Section I**Part A****Total marks (20)****Attempt questions 1 – 20****Allow about 30 minutes for this part**

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid provided.

1. Teflon is a strong, heat resistant polymer. Its structure is represented below.



What is the monomer used in the production of Teflon?

- A tetrafluoroethene
 B tetrafluororethane
 C difluorohexene
 D difluoromethane
2. The table shows the recorded values for the heat of combustion of natural gas, from different sources, under standard conditions.

Origin	Heat of combustion MJ/m ³
Algeria	42.00
Canada	38.20
Indonesia	40.60
United Kingdom	39.71
United States	38.42

Which is the most probably explanation for the differences in these values?

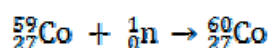
- A experimental uncertainty
 B the pressure and temperature of natural gas varies
 C some countries over-state their results
 D natural gas is a mixture, which varies in composition
-

3. A propane gas stream is to be tested for contamination by propene.

Which is the most suitable procedure to test for the presence of propene?

- A bubble the gas through dilute sulfuric acid
- B bubble the gas through aqueous bromine
- C pass the gas over a bed of calcium hydroxide
- D measure the gas density compared with pure propane

4. The isotope cobalt-60 is used in radiotherapy to treat cancers. It is produced commercially in Australia by the following reaction.



This cobalt-60 decays to a more stable state, releasing radiation (X).

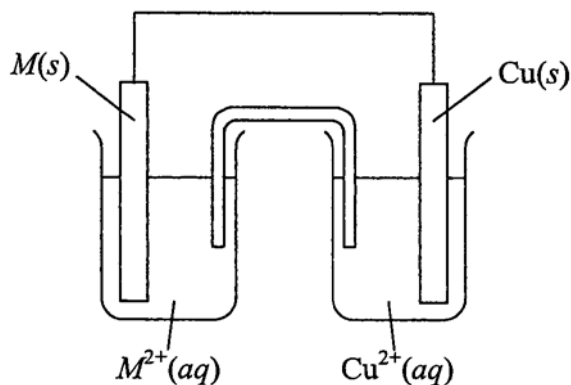
Which of the following is correct?

	Site of commercial production	Nature of radiation (X)
A	a cyclotron	gamma
B	a nuclear reactor	beta
C	a cyclotron	beta
D	a nuclear reactor	gamma

5. Each of the substances below is used by gardeners to condition soil for plant growth. Which substance can be used to raise the pH of an acidic soil?

- A gypsum - $\text{CaSO}_{4(s)}$
- B "lime" - $\text{CaCO}_{3(s)}$
- C ammonium sulfate - $(\text{NH}_4)_2\text{SO}_{4(s)}$
- D superphosphate - $\text{Ca}(\text{H}_2\text{PO}_4)_2$

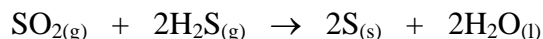
6. A galvanic cell was constructed using copper and metal M, as shown in the diagram.



After a period of time, the blue colour of the copper solution was observed to fade.

Which of the following could be metal M?

- A aluminium
 - B mercury
 - C copper
 - D silver
7. The gases sulfur dioxide and hydrogen sulfide react to form sulfur and water.



What is the role of hydrogen sulfide in the above reaction?

- A a Bronsted-Lowry acid
 - B an Arrhenius acid
 - C an oxidant
 - D a reductant
8. All the silver ions present in a 50.0 mL solution were precipitated by reaction with excess chloride ions. The mass of the dried precipitate was 0.356 g.

What was the concentration of silver in the original solution?

- A 7.1 g L^{-1}
- B 5.40 g L^{-1}
- C 0.002 g L^{-1}
- D 0.27 g L^{-1}

9. A student determined the pH values of 0.1 mol L^{-1} solutions of sulfuric acid, hydrochloric acid, citric acid and acetic acid. Which of the following statements is incorrect?
- A hydrochloric acid is completely ionised and has a pH of 1.0
 - B acetic acid and citric acid are both weak acids and hence have the same pH value which is greater than 1.0
 - C sulfuric acid is diprotic and would have a pH value less than 1.0
 - D acetic acid is monoprotic and would have the highest pH value

10. Five groups of students were asked to find the combining ratio of zinc and iodine, by direct combination of the elements.
They used zinc metal and an iodine-ethanol solution.

The results obtained were:

Group number	1	2	3	4	5
Mass Ratio (Zn:I)	0.23	0.27	0.44	0.22	0.24

In calculating an average of these measurements, which is the correct way to treat the result obtained by Group 3?

- A include the result in the average
 - B remove the result from the table
 - C keep the result, but exclude it from the calculation
 - D change the result to match the average of the other four
11. What are two components required to prepare a buffer solution?
- A a weak acid and a weak base
 - B a weak acid and its conjugate base
 - C a strong acid and a strong base
 - D a strong base and its conjugate acid

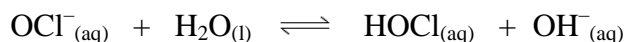
12. The table lists four acid-base indicators and their pH ranges:

Indicator	Bromothymol blue	Litmus	Methyl orange	Phenolphthalein
pH range	6.0 – 7.6	5.0 – 8.0	3.1 – 4.4	9.3 – 10.0
Colour change	yellow → blue	red → blue	red → yellow	colourless → red

The indicators were used to test some common household substances. Which set of results is correct?

	Substance	Bromothymol blue	Litmus	Methyl orange	Phenolphthalein
A	lemon juice	blue	red	red	red
B	aqueous salt	yellow	red	yellow	red
C	ammonia	blue	blue	yellow	red
D	vinegar	yellow	blue	red	colourless

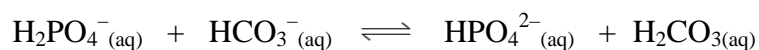
13. The forward reaction in the equilibrium shown below is endothermic.



Which change increases the concentration of hypochlorous acid (HOCl)?

- A add water
 B increase the pH
 C lower the temperature
 D add sodium hypochlorite $\text{NaOCl}_{(\text{s})}$
14. What mass of calcium carbonate is produced when 13.0 L of carbon dioxide gas, measured at 25°C and 100 kPa, reacts completely with solid calcium hydroxide?
- A 23.1 g
 B 38.9 g
 C 52.5 g
 D 57.3 g

15. Which of the following statements applies to the reaction shown below?



- A all four species are acids in this reaction
 B the reactants are a conjugate acid-base pair
 C the hydrogen carbonate ion is a Bronsted-Lowry base
 D the dihydrogen phosphate ion is a Bronsted-Lowry base
16. What information can be obtained from a flame test?
- A the concentrations of metal ions
 B the concentration of hydrogen ions
 C the combustibility of a metal
 D the identities of some metal ions
17. Three samples of a solution of lead(II) nitrate were tested with chloride ions, with sulfate ions and with hydroxide ions.

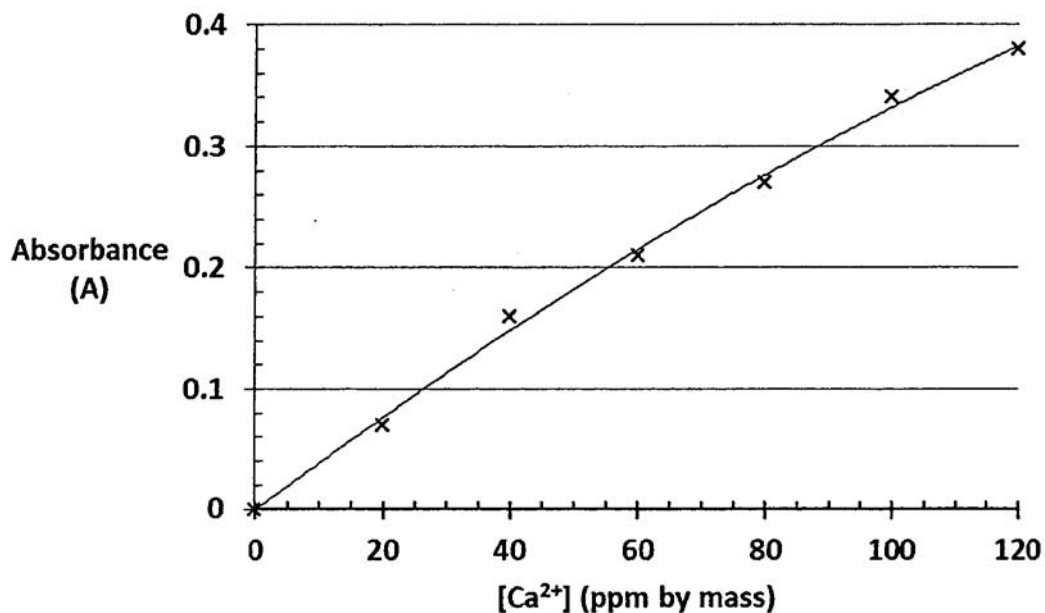
Which row of the following table would represent the results?

	Chloride	Sulfate	Hydroxide
A	precipitate	precipitate	precipitate
B	precipitate	no precipitate	precipitate
C	no precipitate	precipitate	no precipitate
D	precipitate	precipitate	no precipitate

18. Which of the following groups of compounds has the highest ozone depleting potential?
- A methane
 B chloromethane
 C fluoromethane
 D iodomethane

Refer to the following information to answer Questions 19 and 20

Using AAS, a standard calibration graph of absorbance versus calcium ion concentration is prepared, using a calcium chloride solution.



19. What is the independent variable in this investigation?
- A the wavelength of the light
 - B calcium ion concentration
 - C absorbance
 - D chloride ion concentration
20. A sample of human blood plasma is to be tested under the same conditions, as above. The lowest acceptable calcium ion concentration is $2.1 \times 10^{-3} \text{ mol L}^{-1}$.

What is the absorbance at the lowest acceptable calcium ion concentration, assuming that the density of plasma is 1.0 g mL^{-1} ?

- A 0.08
- B 0.16
- C 0.30
- D >0.40

End of Part A

Part B**Total marks (80)****Attempt ALL questions****Allow about 1 hour 45 minutes for this part**

Answer the questions in the spaces provided. The spaces provide guidance for the expected length of response.

Show all relevant working in questions involving calculations.

Question 21 (6 marks)**Marks**

E10 engine fuel is a blend of 10% ethanol and 90% petrol. One of the issues with its use is the absorption of water vapour from the atmosphere.

- (a) Referring to its molecular structure, explain how ethanol is able to blend with petrol and also cause water retention in the fuel blend.

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- (b) Discuss the basis of the claim that ethanol as a fuel is carbon-neutral (ie: having net zero carbon emission), and does not increase atmospheric CO₂.

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Question 22 (5 marks)**Marks**

During your study of oxidation-reduction reactions, you carried out investigations of TWO commercially available cells.

Compulsory cell	EITHER a dry-cell OR a lead-acid cell
Optional cell	A cell of your choice from a range of cells. These include a button cell, fuel cell, vanadium redox cell, lithium cell and a liquid junction photovoltaic device

- (a) Identify the optional cell you investigated.

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Draw a labelled diagram to show the structure of this cell. Ensure that you have identified the anode, cathode and electrolyte.

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- (b) Write an equation for the overall cell reaction.

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- (c) Discuss the advantages of this cell for society when compared with the use of a dry-cell or a lead-acid cell.

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Question 23 (4 marks)**Marks**

Gold nanoparticles, containing the radioactive Au-198 isotope, have been used to treat prostate cancer. The nanoparticles incorporate an extract from green tea, which attaches the nanoparticles to the cancer cells.

Au-198 has a half-life of 2.7 days. The β radiation emitted has a range of about 11 mm in the prostate gland, limiting its effect to local tissue.

- (a) Identify the isotope produced by the beta decay of Au-198. **1**

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- (b) Write an equation to show how Au-198 can be produced from the stable isotope Au-197 in a nuclear reactor. **1**

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- (c) Explain why isotopes emitting alpha or gamma radiation would be less effective for this treatment. **2**

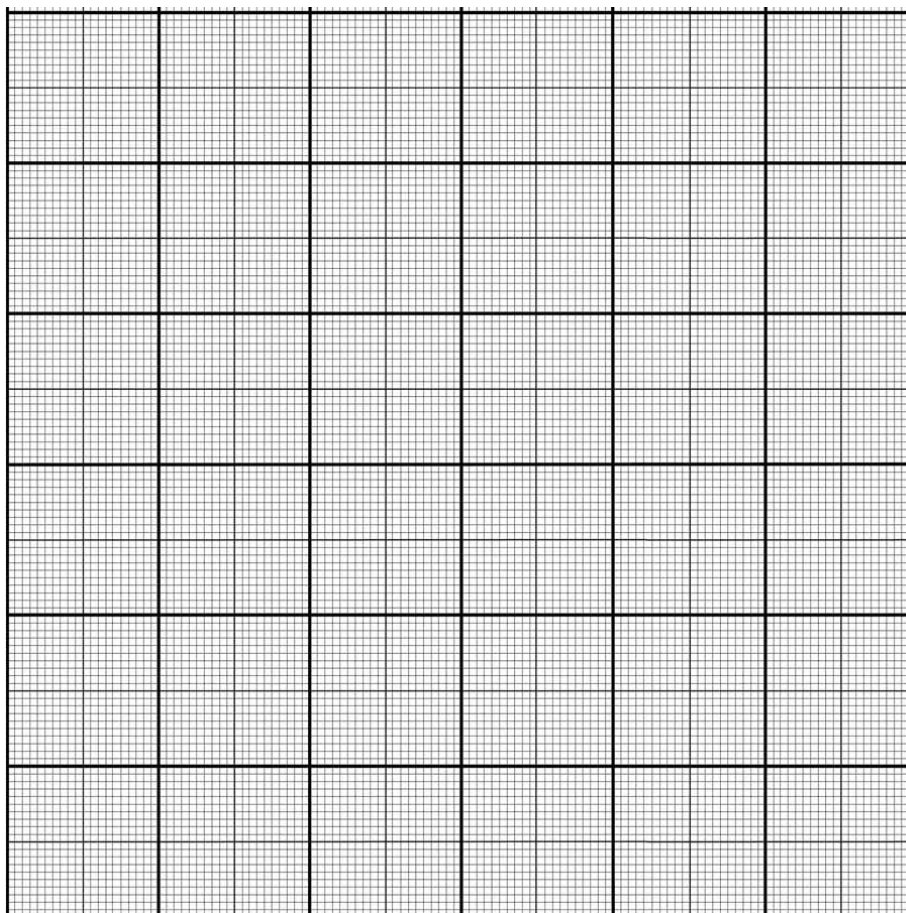
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Question 24 (4 marks)**Marks**

The table below lists the heat of combustion for some carbon compounds and the proportion of oxygen in each substance.

Compound	Proportion of oxygen (%)	Heat of combustion MJ kg ⁻¹
Ethane	0	52
Ethanol	35	30
1-propanol	27	31
1-butanol	22	33
1-pentanol	18	34
Acetic acid	53	15

(a) Construct a graph of these data.

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(b) Using your graph, predict the heat of combustion of ethyl acetate (CH₃COO.C₂H₅)

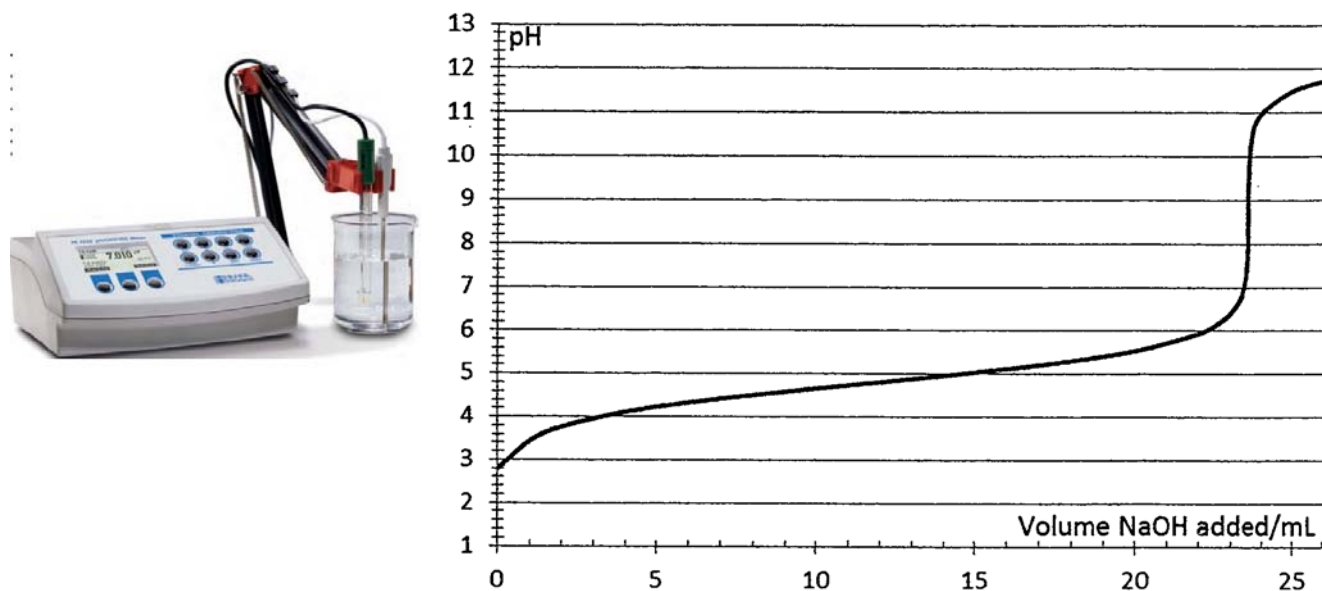
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Question 25 (6 marks)**Marks**

A chemist titrated 25.00 mL of diluted (1:10) household vinegar against a standardised solution of 0.112 mol L^{-1} sodium hydroxide solution.

The chemist used a pH meter, attached to a graphical data recorder. The right-hand diagram shows the output of the data recorder.



An extract of the chemist's notebook showed:

Volume diluted vinegar for titration = 25.00 mL (by pipette)
 Concentration of standard NaOH solution = 0.112 mol L^{-1}
 Equivalence Point = 23.6 mL, pH = 9.1

- (a) Determine the concentration of acid in the diluted vinegar.

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Question 25 continues on the next page

*Question 25 continued ...***Marks**

- (b) Explain what the initial pH and equivalence point pH suggest about the acidic properties of vinegar.

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- (c) The chemist needs to use the same pipette to dilute the vinegar AND to measure out a 25.00 mL sample for titration.

Describe the procedure that should be followed between these two steps.

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- (d) Outline ONE advantage of using a computer-based technology for recording this type of measurement.

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Question 26 (5 marks)

Marks

A news article, published in June 2012, included the following commentary:

A 2012 global acidification study found that in the USA, Canada and Western Europe, sulfur dioxide emissions have declined considerably. In China, sulfur dioxide emissions are now reaching levels that haven't been seen in the USA since 1970.

With reference to this report, discuss the decline in emissions of some countries and the reasons for concern about rising emissions in other countries.

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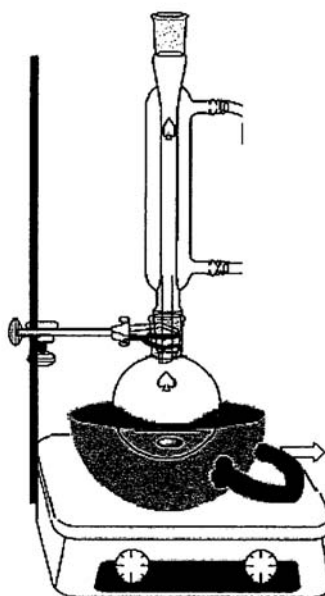
Question 27 (4 marks)**Marks**

- (a) In the space below, draw the structural formula for each reactant required to produce pentyl acetate in the laboratory.
Name each reactant.

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- (b) The image below shows the equipment used for this reaction.



Explain reasons for using the apparatus above in this technique.

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Question 28 (4 marks)**Marks**

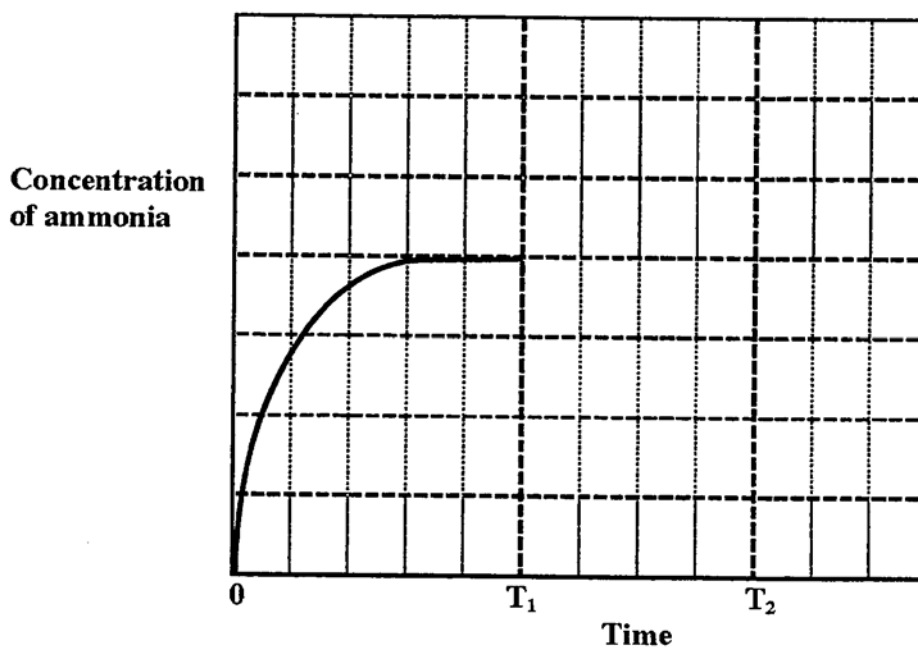
An experiment was conducted to investigate the formation of ammonia in the Haber process.

- (a) Write a balanced chemical equation, including states that represent this process. 1

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- (b) The graph below shows the system reaching equilibrium after a mixture of the reactants was injected into the reaction vessel at time 0.

At time T_1 , the volume of the reaction vessel is doubled.



- (i) Draw a line on this graph to sketch the concentration of ammonia from time T_1 to T_2 , when equilibrium is re-established, at the same temperature. 2

- (ii) Referring to your graph, justify the use of high pressure in the Haber Process. 1

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Question 29 (4 marks)**Marks**

A student as asked to determine the mass, in grams, of calcium carbonate present in a 0.125 g sample of chalk.

The student placed the chalk sample in a 250 mL conical flask and added 50.00 mL of 0.200 mol L⁻¹ hydrochloric acid solution, using a pipette. The excess HCl was then titrated with 0.250 mol L⁻¹ NaOH which had been recently prepared and standardised. The average NaOH titre was 32.12 mL.

Calculate the mass of calcium carbonate, in grams, present in the chalk sample.

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Question 30 (2 marks)

Use Lewis electron dot notation to demonstrate a coordinate covalent bond in a NAMED molecule or ion.

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Question 31 (4 marks)

Marks

The disposal of untreated human sewage waste into waterways is common in some countries.

- (a) Define the term biochemical oxygen demand (BOD) and describe how this is affected by the release of sewage into a waterway. **2**

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- (b) Sewage may also affect turbidity in waterways.

- (i) Define turbidity. **1**

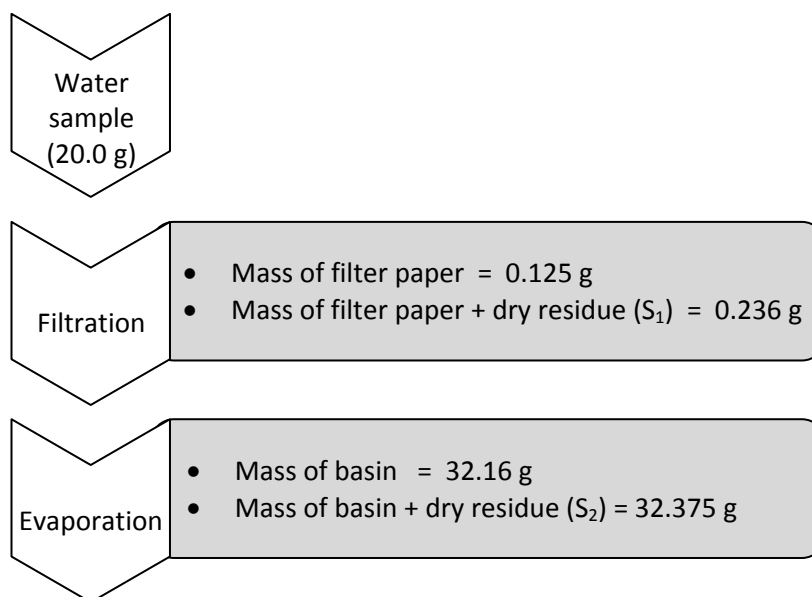
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- (ii) Identify an instrument used to measure turbidity. **1**

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Question 32 (7 marks)**Marks**

A 20.0 g sample of water from a local river was analysed in the following way:



- (a) Calculate the percentages, by mass, of dissolved salts and undissolved solids in this sample.

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Question 32 continues on the next page

Question 32 continued ...

Marks

- (b) Describe the use of a membrane filter to purify river water from this locality. **2**

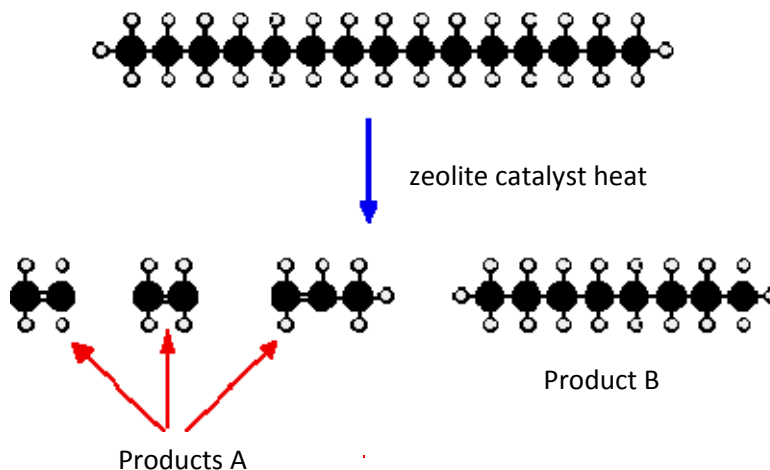
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- (c) Describe a chemical test for the phosphate ion in solid residue S₂. Include an equation. **2**

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Question 33 (6 marks)**Marks**

The diagram shows an industrial process which is significant in the production of materials for the petrochemical industry.



- (a) Identify the process. 1

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- (b) For ONE of the compounds indicated by arrows in the diagram (labelled Products A), write an equation to show the conversion of this compound into ethanol. Specify the conditions needed to produce a high yield of ethanol. 2

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- (c) Identify a significant use of Product B. 1

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Question 33 continues on the next page

*Question 33 continued ...***Marks**

- (d) For ONE of the compounds indicated by arrows in the diagram, explain how it is converted into a named polymer used in industry. Use equation(s) or diagrams in your response.

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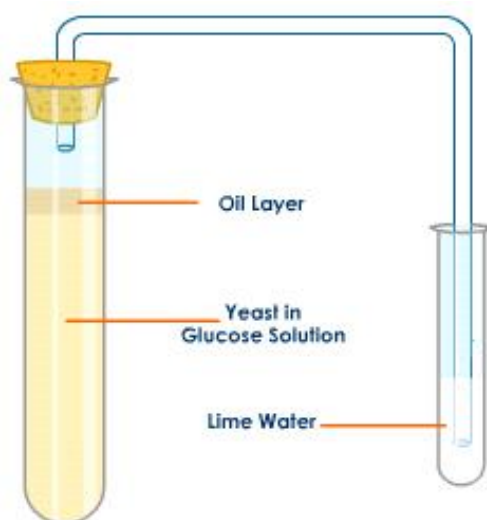
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Question 34 (4 marks)**Marks**

A student set up an experiment as shown in the diagram.



- (a) Write an equation for the reaction which occurs in the test tube containing glucose solution.

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- (b) Explain the purpose of the oil layer in this experiment.

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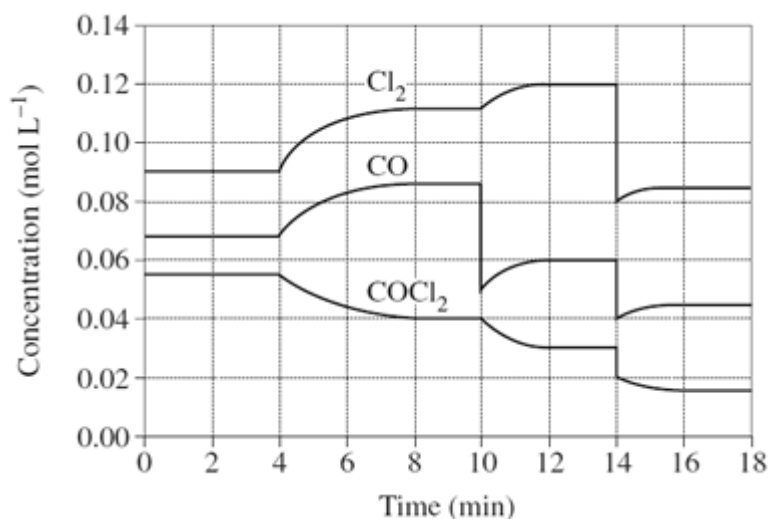
- (c) Explain how the progress of the reaction could be been monitored by the student.

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Question 35 (4 marks)**Marks**

The graphs show changes in the concentration of the three gases over time.



- (a) Identify the reason for the changes in the equilibrium system at:

2

Time (minutes)	Reason for change
10	
14	

- (b) Using Le Chatelier's Principle and relating your answer to the equation for the equilibrium reactions, explain why the concentrations of the three gases have changed between 4 and 9 minutes.

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Question 36 (2 marks)

Marks

Calculate the pH of a solution made by mixing 80 mL of 0.125 mol L⁻¹ hydrochloric acid with 20 mL of 0.285 mol L⁻¹ sodium hydroxide.

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Question 37 (5 marks)

Marks

"Monitoring of levels of heavy metals and of trace elements is essential for human health".

Assess this statement.

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Question 38 (4 marks)

Marks

Incomplete combustion is considered a problem for society.

- (a) Write an equation to show incomplete combustion of methane. **1**

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- (b) Outline how a student could set up an experiment using a Bunsen burner in the school laboratory to demonstrate TWO problems associated with incomplete combustion of natural gas (methane). **3**

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End of Section I

End of Paper

Section II**Total marks (25)****Attempt ONE question from Questions****Allow about 45 minutes for this section**

Answer the question on the writing booklet provided. You may ask for extra booklets if required.

	Pages
Question	Industrial Chemistry
Question	Shipwrecks, Corrosion and Conservation
Question	The Biochemistry of Movement
Question	The Chemistry of Art
Question	Forensic Chemistry