



# THE KING'S SCHOOL

---

2014  
Higher School Certificate  
Trial Examination

# Chemistry

**Disclaimer:**

This is a Trial HSC Examination only. It does not reflect the format and topics of the HSC Examination designed by the NSW Board of Studies for the respective sections.

## 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
- A Data Sheet and Periodic Table is provided

**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 – 39

Allow about 2 hour 30 minutes for this part

### Section II -

*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. Manganese is a transition metal which forms the following compounds:

Compound 1  $\text{MnO}_2$   
Compound 2  $\text{KMnO}_4$

The oxidation numbers of manganese in compounds 1 and 2 respectively are:

- A +4, +6  
B +2, +3  
C +4, +7  
D +2, -3
2. Which items of equipment would be most useful in an investigation to determine the total dissolved solids (TDS) in a water sample?
- A filter funnel and magnetic stirrer  
B pH probe and hotplate  
C burette and thermometer  
D evaporating dish and balance
3. A sample of rock was heated, crushed and then treated with acid, in preparation for testing for iron content, using atomic absorption spectroscopy. A weighed portion of the sample was used and the result of the test indicated that the rock contained 1.34% iron.
- Which of the following descriptions best describes this test?
- A qualitative and destructive  
B quantitative and destructive  
C qualitative and non-destructive  
D quantitative and non-destructive
-

4. The following results were obtained by a student performing titrations.

Titration	Initial burette reading (mL)	Final burette reading (mL)
1	0.00	23.40
2	24.00	46.75
3	0.00	22.70
4	0.00	22.75

Which value should the student use as the solution volume in the calculation?

- A 22.70 mL  
 B 22.73 mL  
 C 22.90 mL  
 D 23.40 mL
5. The element krypton-87 undergoes beta decay.

Which of the following equations correctly represents this reaction?

- A  ${}_{36}^{87}\text{Kr} \rightarrow {}_{34}^{83}\text{Se} + {}_2^4\alpha$   
 B  ${}_{36}^{87}\text{Kr} \rightarrow {}_{35}^{87}\text{Br} + {}_{+1}^0e$   
 C  ${}_{36}^{87}\text{Kr} \rightarrow {}_{37}^{87}\text{Rb} + {}_{-1}^0e$   
 D  ${}_{36}^{87}\text{Kr} \rightarrow {}_{+1}^0e + {}_{35}^{87}\text{Br}$
6. What mass of ethanol is obtained when 5.68 g of carbon dioxide is produced during fermentation of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ), at  $25^\circ\text{C}$ ?
- A 2.95 g  
 B 5.94 g  
 C 11.5 g  
 D 147.2 g

7. Which of the following is the best oxidising agent?

- A bromine
- B chloride ion
- C potassium ion
- D potassium

8. Acid-tolerant yeast is used in the fermentation of sugars.

What is the function of the yeast?

- A the yeast creates an anaerobic environment so the reaction can proceed
- B the yeast provides the enzymes necessary for the fermentation process to occur
- C the yeast creates a suitable reaction temperature
- D the yeast reduces the pH of the reaction to prevent pathogens growing

9. Which combination of metals, as electrodes, would produce the highest voltage in a galvanic cell?

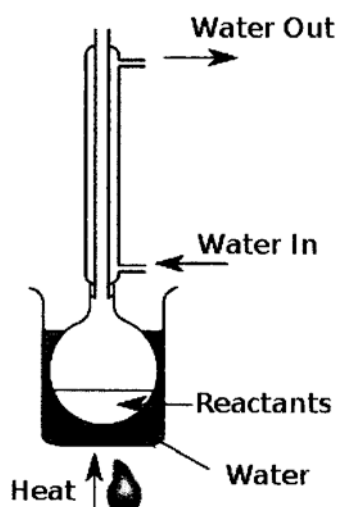
- A aluminium and silver
- B manganese and tin
- C lead and silver
- D zinc and copper

10. 20 mL of  $0.08 \text{ mol L}^{-1}$  HCl is mixed with 30 mL of  $0.05 \text{ mol L}^{-1}$  NaOH.

What is the pH of the resultant solution?

- A 1.1
- B 2.7
- C 4.0
- D 7.0

11. The equipment shown was used to heat two reactants with a concentrated sulfuric acid catalyst.



Which of the following is a possible combination of reactants and product(s)?

	Reactants	Products
A	water and sulfuric acid	hydrogen, oxygen and sulfur
B	methanoic acid and ethanoic acid	methyl ethanoate
C	propanoic acid and butan-1-ol	butyl propanoate
D	butanoic acid and propan-1-ol	propyl butanoate and water

12. Red cabbage was used to make a natural indicator. The table below shows the colour of the indicator as pH changes.

<b>pH</b>	2	4	6	8	10
<b>colour</b>	red	purple	violet	blue	blue-green

A solution of  $0.010 \text{ mol L}^{-1}$  HCl was tested using the indicator. 10 mL of this solution was then diluted by adding 990 mL of water and this solution was also tested.

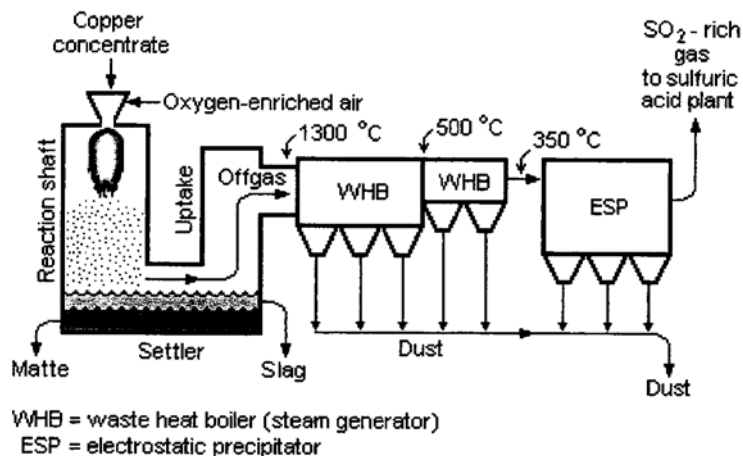
Which two colours would be observed?

- A red and blue-green
- B red and purple
- C purple and violet
- D violet and blue-green

13. Oxides of three elements were tested with both hydrochloric acid and sodium hydroxide. Oxide X reacted with sodium hydroxide only, oxide Y reacted with both solutions and oxide Z reaction with hydrochloric acid only.

If the elements that formed these oxides are all in the same period of the Periodic Table, in which order do they appear (from left to right)?

- A X, Y, Z  
 B X, Z, Y  
 C Z, Y, X  
 D Z, X, Y
14. Many scientists have furthered our understanding of acids.
- Which option correctly links a scientist to the main concept which they proposed?
- A Lavoisier – acids contain oxygen  
 B Davy – acids are proton donors  
 C Arrhenius – acids are sour and change litmus to red  
 D Bronsted and Lowry – acids are electron pair acceptors
15. Copper(I) sulfide can be rapidly roasted in air enriched with oxygen, to form copper in a flash smelter.

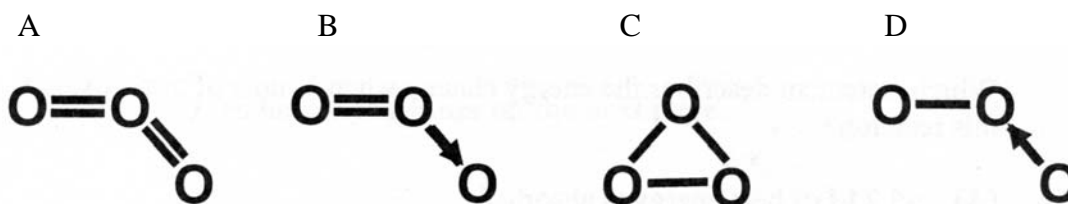


The sulfide ore reacts with oxygen to produce copper and sulfur dioxide gas.

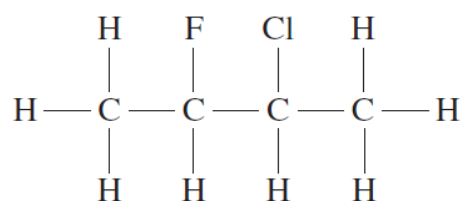
If 5.45 g of copper is produced, what volume of sulfur dioxide gas (measured at 25°C and 100 kPa) would be generated for use at the sulfuric acid plant?

- A 531 L  
 B 975 L  
 C 1060 L  
 D 2660 L

16. Which structure best represents bonding in an ozone molecule.



17. What is the correct IUPAC name for the following compound?



- A 2-chloro-3-fluorobutane  
 B 2-fluoro-3-chlorobutane  
 C 3-fluoro-2-chlorobutane  
 D 3-chloro-2-fluorobutane

18. What are the principal ions that cause hardness of water?

- A  $\text{Fe}^{2+}$  and  $\text{Cu}^{2+}$   
 B  $\text{Pb}^{2+}$  and  $\text{Ba}^{2+}$   
 C  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$   
 D  $\text{Hg}^{2+}$  and  $\text{Na}^+$

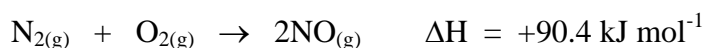
19. The production of high quality drinking water is summarised in the flow diagram below.

raw water → X → sedimentation → Y → Z → drinking water

What is the process and chemical used in steps X, Y and Z?

	Step X		Step Y		Step Z	
	Process	Chemical	Process	Chemical	Process	Chemical
A	filtration	charcoal	sterilisation	aluminium hydroxide	flocculation	chlorine
B	flocculation	aluminium hydroxide	filtration	charcoal	sterilisation	chlorine
C	flocculation	chlorine	filtration	charcoal	sterilisation	aluminium hydroxide
D	filtration	charcoal	sterilisation	chlorine	flocculation	aluminium hydroxide

20. Nitric oxide (NO) gas can be produced by direct combination of nitrogen and oxygen gases.



Which statement describes the energy change when 1 mole of nitric oxide is produced in this reaction?

- A 45.2 kJ of heat energy is absorbed
- B 45.2 of heat energy is released
- C 90.4 kJ of heat energy is absorbed
- D 90.4 kJ of heat energy is released

**End of Part A**



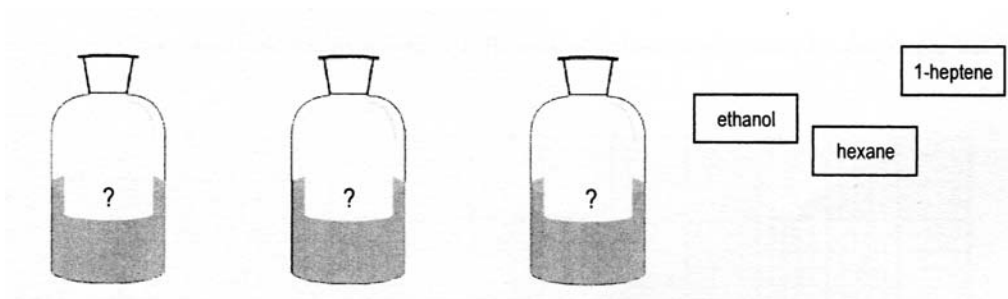
**Part B****Total marks (80)****Attempt ALL questions****Allow about 2 hours 30 minutes for this part**

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

**Question 21** (6 marks)**Marks**

Three chemical bottles are missing their labels. It is known that one is 1-heptene, another is hexane and the other is ethanol.



- (a) Using only water and bromine water as your reagents, design a first-hand investigation to correctly identify each of the THREE chemicals. Include the method and expected results.

**4**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Identify ONE hazard in this investigation AND suggest a safety measure that could be used to minimise risk.

**2**

.....

.....

.....

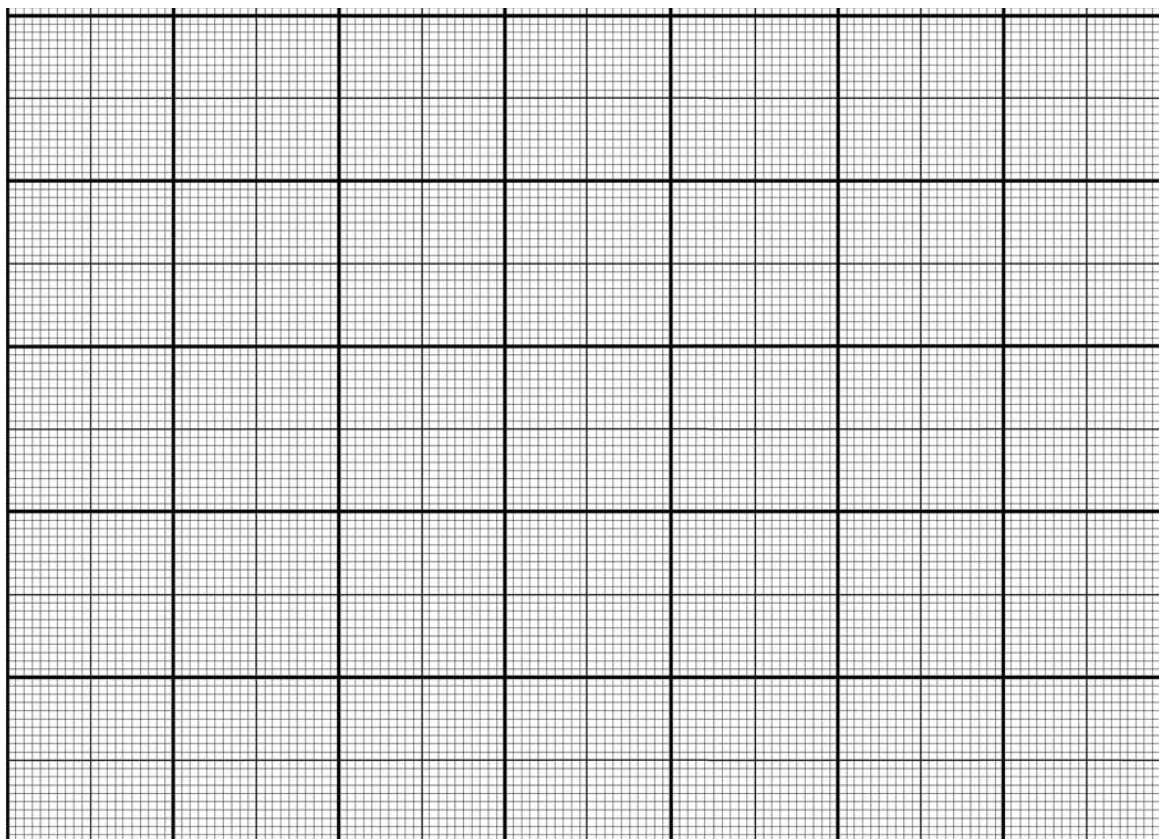
**Question 22** (4 marks)**Marks**

A water sample was prepared for testing using ammonium molybdate and ascorbic acid. It was then analysed to determine phosphate levels, using a colorimeter.

Standard solutions of known phosphate concentration were also prepared in the same way. The results for the standards are shown below.

<b>Solution</b>	<b>Concentration PO<sub>4</sub><sup>3-</sup> (ppm)</b>	<b>Absorbance</b>
Blank	0	0.000
1	1.0	0.105
2	2.5	0.255
3	5.0	0.520

- (a) Plot a graph of phosphate concentration against absorbance values.

**2**

**Question 22 continues on the next page**

*Question 22 continued ...*

**Marks**

(b) The absorbance reading for the sample was measured to be 0.360.

Determine the phosphate concentration using the calibration graph.

**1**

.....

(c) Suggest ONE way in which reliability of the results can be improved.

**1**

.....

.....

**Question 23** (4 marks)

Describe TWO different methods of production of transuranic elements.

**4**

.....

.....

.....

.....

.....

.....

.....

**Question 24** (2 marks)

**Marks**

Cellulose is a condensation polymer and a biopolymer. It is found in plant cell walls.

Define the terms *condensation polymer* and *biopolymer*.

**2**

.....

.....

.....

.....

.....

.....

**Question 25** (2 marks)

Describe the composition and properties of a solution which is suitable for use as an indicator.

**2**

.....

.....

.....

.....

.....

.....

**Question 26** (5 marks)**Marks**

The table below compares some properties of two fuels – octane and ethanol.

Property	Octane	Ethanol
Molar mass (g)	114.224	46.068
Boiling point (°C)	126	78
Density (g L <sup>-1</sup> )	700	790
Heat of combustion (kJ mol <sup>-1</sup> )	5500	1371

- (a) Suggest a reason why ethanol has a lower boiling point BUT is denser than octane. **1**

.....  
 .....

- (b) Calculate the heat of combustion in kJ g<sup>-1</sup> of each of these fuels. **2**

- (i) Octane:

.....  
 .....

- (ii) Ethanol:

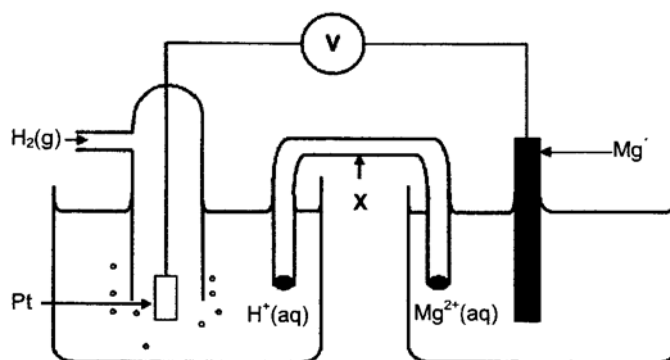
.....  
 .....

- (c) Outline ONE advantage and ONE disadvantage in using ethanol as an alternative fuel to octane. **2**

.....  
 .....

**Question 27** (5 marks)**Marks**

Examine the galvanic cell in the diagram below.



- (a) Identify the cathode in this cell AND write the half-equation for the cathode reaction. **2**

.....  
 .....

- (b) Identify TWO conditions for this to be a standard cell. **2**

.....  
 .....

- (c) Identify a significant function of the structure labelled **X** in the diagram. **1**

.....  
 .....

**Question 28** (4 marks)**Marks**

A student aims to determine the % calcium carbonate in an eggshell.



After washing and drying the eggshell, a 0.534 g sample is placed into a conical flask. 20.0 mL of 0.512 mol L<sup>-1</sup> hydrochloric acid is added and the mixture is gently warmed until all evidence of reaction has ceased.

The unreacted acid is then titrated against a standardised solution of 0.100 mol L<sup>-1</sup> sodium hydroxide.

The volume of sodium hydroxide required is 29.7 mL

- (a) Calculate the total moles of hydrochloric acid added to the sample of eggshell. **1**

.....  
.....  
.....  
.....

- (b) Calculate the moles of unreacted hydrochloric acid. **1**

.....  
.....  
.....  
.....

- (c) Calculate the % (w/w) calcium carbonate in the eggshell sample. **2**

.....  
.....  
.....  
.....  
.....

**Question 29** (4 marks)

**Marks**

Describe the use of acids as food additives AND esters as flavourings and perfumes.

**4**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

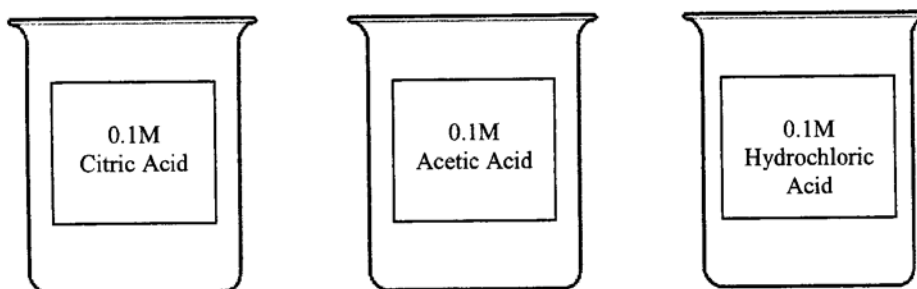
.....

.....



**Question 30** (5 marks)**Marks**

A first-hand investigation is used to compare the pH of  $0.10 \text{ mol L}^{-1}$  concentrations of citric, acetic (ethanoic) and hydrochloric acids.



- (a) Outline an appropriate method for the investigation that would increase validity and reliability.

**2**

.....

.....

.....

.....

.....

.....

.....

- (b) Some of the results of the investigation are shown in the table below.

Acid solution	pH
Citric	2.1
Acetic (ethanoic)	2.9
Hydrochloric	1.0

Explain why pH values are different for each of these acids.

**3**

.....

.....

.....

.....

.....

.....

.....

**Question 31** (5 marks)**Marks**

A sample of industrial wastewater was analysed and found to contain lead ions ( $\text{Pb}^{2+}$ ) at a concentration of  $5.00 \times 10^{-5} \text{ mol L}^{-1}$ .

- (a) Calculate the concentration of lead in this wastewater in parts per million (ppm) by mass.

**1**

.....  
.....

- (b) An excess of a  $0.10 \text{ mol L}^{-1}$  solution of sodium sulfide ( $\text{Na}_2\text{S}$ ) was added to 2.00 L of this industrial wastewater.

Calculate the maximum mass of lead sulfide precipitate that could be formed.

**2**

.....  
.....  
.....  
.....

- (c) Compare the use of atomic absorption spectroscopy (AAS) to the gravimetric method used above, in the analysis of this wastewater for lead.

**2**

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

**Question 32** (5 marks)

**Marks**

- (a) Describe the effects of temperature, pressure and the presence of a catalyst on the industrial production of ammonia using the Haber Process.

**3**

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

- (b) Outline the significance of Fritz Haber's development of this reaction at that time in world history.

**2**

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

**Question 33** (4 marks)

**Marks**

- (a) Describe TWO ways in which farm animals might cause an increase in biochemical oxygen demand (BOD) in a waterway.

**2**

.....  
.....  
.....  
.....  
.....  
.....

- (b) Explain why BOD is a more valid indicator of water quality than measuring dissolved oxygen (DO).

**2**

.....  
.....  
.....  
.....  
.....  
.....



**Question 35** (3 marks)**Marks**

(a) What is a coordinate covalent bond?

**1**

.....

.....

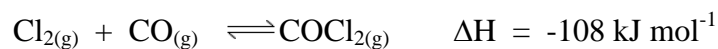
.....

(b) Use electron-dot formulae to draw a diagram to show the formation of a coordinate covalent bond during the reaction of ammonia gas and hydrogen chloride gas.

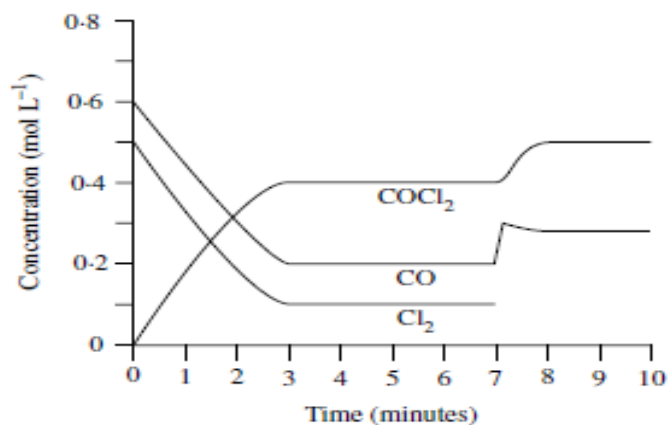
**2**

**Question 36** (5 marks)**Marks**

Phosgene,  $\text{COCl}_2(\text{g})$ , is produced from chlorine and carbon monoxide according to the equation:



When chlorine and carbon monoxide are mixed in the presence of a catalyst, the concentrations of each gas change as shown on the graphs below.



- (a) Explain qualitatively the changes in the 3 graphs over the 10-minute period. **3**

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) The change in the chlorine concentration after 7 minutes is not shown on the graph. Qualitatively predict the change in the chlorine level and explain your prediction. **2**

.....

.....

.....

.....





**Question 38** (2 marks)**Marks**

- (a) During an experiment in the school laboratory, ethanol burnt with a yellow flame, releasing less than the documented heat of combustion of ethanol.

Explain why this type of combustion has occurred during this experiment.

**1**

.....

.....

.....

.....

.....

.....

.....

- (b) Write an equation for a combustion reaction which may have occurred in this experiment.

**1**

.....



**Section II****Total marks (25)****Attempt ONE question from Questions ... to ...****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