Student Number	
Mark / 100	

2009

TRIAL HSC EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Write your Student Number at the top of this page and pages 9, 10,12, 14, 16, 18, 20, 22
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper. This may be removed for your convenience.

Total Marks – 100

Section I

75 marks

This section has two parts: Part A and Part B

Part A – 15 marks
•Attempt Questions 1- 15
•Allow about 30 minutes for this part

Part B – 60 marks
•Attempt Questions 16 – 27
•Allow about 1 hour and 45 minutes for this part

Section II Pages 24 – 25

25 marks

•Attempt Question 28.
•Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

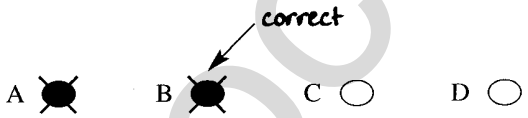
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



Mark your answers on the ANSWER sheet on page **9**

1. Which of the statements below describes a transuranic element?

(A) Elements transformed during nuclear reactions.

(B) Elements with atomic number more than 91.

(C) Elements with atomic number less than 92.

(D) Elements that undergo radioactive decay.

2. The table below shows information about a variety of indicators.

Indicator	*Colour in low pH*	*Colour in high pH*	*pH range*
Methyl orange	Red	Yellow	3.1 - 4.4
Bromophenol blue	Yellow	Blue	3.0 - 4.6
Methyl red	Pink	Yellow	4.4 - 6.0
Phenol red	yellow	red	6.8 - 8.4

Which two indicators could be best used to identify rain with a pH of approximately 6.2?

(A) methyl orange and bromophenol blue

(B) methyl red and phenol red

(C) methyl orange and methyl red

(D) methyl red and bromophenol blue

3. Which equation best represents catalytic cracking of a petroleum fraction?

(A) $C_{16}H_{34}(l) \xrightarrow{Al_2O_3} C_{16}H_{34}(g)$

(B) $nC_2H_4(g) \rightarrow (CH_2—CH_2)_n\ (s)$

(C) $C_{16}H_{34}(l) \xrightarrow{Al_2O_3} C_7H_{16}(l) \square\square + 3C_2H_4(g) + \square\square C_3H_6(g)$

(D) $C_7H_{16}(l) + 3\,C_2H_4(g) + \square\square C_3H_6(g) \xrightarrow{Al_2O_3} C_{16}H_{34}(l)$

4. Why is research into synthetic biopolymers attracting great interest?

(A) Synthetic biopolymers decompose more easily than traditional synthetic polymers**.**

(B) Synthetic biopolymers can be produced more cheaply than traditional synthetic polymers.

(C) Synthetic biopolymers have superior physical properties compared to traditional synthetic polymers.

(D) Synthetic biopolymers have superior chemical properties compared to traditional synthetic polymers.

5. Refer to the modified periodic table below to answer this question
The table provides information about the Groups to which each element *U, V, W, X, Y, Z* belong

I	**II**		**III**	**IV**	**V**	**VI**	**VII**	**Noble Gases**
Y			*V*					
							Z	
		U						
X								
							W	

What are the reactions of oxides of these elements with acid and with base?

	Oxides react with acids	*Oxides react with base*	*Oxide reacts with acid and with base*
(A)	*Z*	*X*	*V*
(B)	*Y*	*X*	*U*
(C)	*X*	*Z*	*V*
(D)	*V*	*W*	*Y*

6. Which condensed structural formula represents the ester formed from the reaction of propanoic acid with 1-heptanol?

(A) $CH_3CH_2COOCH_2CH_2CH_2CH_2CH_2CH_2CH_3$

(B) $CH_3CH_2CH_2CH_2CH_2CH_2COOCH_2CH_3$

(C) $CH_3CH_2CH_2CH_2COOCH_2CH_2CH_2CH_2CH_3$

(D) $CH_3CH_2CH_2CH_2CH_2CH_2OCH_2CH_2COOH$

The following information refers to questions 7 and 8

Calcium carbonate decomposes to form calcium oxide and carbon dioxide according to the following equilibrium reaction. This reaction is endothermic.

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

7. What mass of calcium carbonate is needed to form 5.00 L of carbon dioxide at 25^{o}C and 100 kPa?

(A) 1.238 g

(B) 10.51 g

(C) 20.19 g

(D) 22.04 g

8. What would happen if the reaction at equilibrium suddenly has its volume decreased?

(A) The reaction shifts to the right, favouring the formation of CaO.

(B) The reaction shifts to the right, favouring the formation of CO_2.

(C) The reaction shifts to the left, favouring the formation of $CaCO_3$**.**

(D) The reaction shifts to the left, favouring the formation of CO_2.

9. Which conditions would promote the greatest increase in the pH of an aqueous solution of carbon dioxide?

(A) Addition of CO_2 and cooling

(B) Addition of H_2O and heating

(C) Addition of carbonic acid

(D) Cooling the reaction

10. Which chemical would have the highest boiling point?

(A) butane

(B) propanoic acid

(C) 1-butanol

(D) butanoic acid

11 Given the following reaction:

$$HClO_4 + CH_3COOH \rightleftharpoons CH_3COOH_2^+ + ClO_4^-$$

Which species are acting as Bronsted-Lowry acids in this reaction?

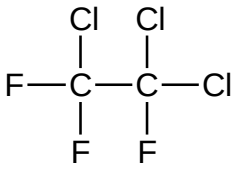
(A) $HClO_4$ and ClO_4^-

(B) CH_3COOH and $HClO_4$

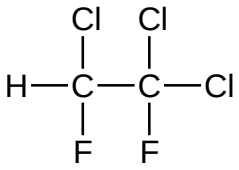
(C) $HClO_4$ and $CH_3COOH_2^+$

(D) CH_3COOH and ClO_4^-

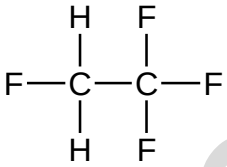
12. Consider the following compounds:



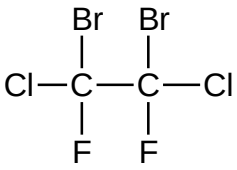
Z



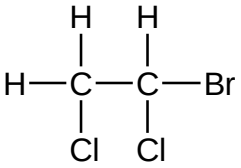
E



M



Q



G

Choose the set which classifies *Z, E, M, Q* and *G* correctly

	Z	***E***	***M***	***Q***	***G***
(A)	haloalkane	HFC	HCFC	halon	CFC
(B)	CFC	HFC	HCFC	haloalkane	halon
(C)	CFC	HCFC	HFC	halon	haloalkane
(D)	CFC	HCFC	halon	HFC	haloalkane

13. A water sample was found to have a pH of 1.2. Which ion is likely to be absent in the water sample?

(A) chloride

(B) carbonate

(C) sulfate

(D) nitrate

14. Which quality of water is being tested by determining the percentage of light that is transmitted or scattered, in the absence of added reagents, through a standard depth of water?

(A) NTU

(B) TDS

(C) BOD

(D) Turbidity

15. *Ginny, Hermione, Luna* and *Cho* were each given different unknown solutions containing only one cation. The unknown ions may be sodium, barium, iron and copper.

The students tested their solutions with sulfate, carbonate and chloride ions. Their results are given in the table. Cho had a blue coloured solution. The others had colourless solutions.

Analyst	*sulfate*	*carbonate*	*chloride*
Ginny	precipitate	precipitate	no precipitate
Hermione	no precipitate	no precipitate	no precipitate
Luna	no precipitate	precipitate	no precipitate
Cho	no precipitate	precipitate	no precipitate

What ion did they each have?

	Ginny	*Hermione*	*Luna*	*Cho*
(A)	barium	sodium	iron	copper
(B)	iron	sodium	barium	copper
(C)	sodium	barium	iron	copper
(D)	barium	iron	sodium	copper

Student Number …….

Section I **MARKS -----/15**

Part A

Multiple Choice Answer Sheet

1.	A ○	B ○	C ○	D ○
2.	A ○	B ○	C ○	D ○
3.	A ○	B ○	C ○	D ○
4.	A ○	B ○	C ○	D ○
5.	A ○	B ○	C ○	D ○
6.	A ○	B ○	C ○	D ○
7.	A ○	B ○	C ○	D ○
8.	A ○	B ○	C ○	D ○
9.	A ○	B ○	C ○	D ○
10.	A ○	B ○	C ○	D ○
11.	A ○	B ○	C ○	D ○
12.	A ○	B ○	C ○	D ○
13	A ○	B ○	C ○	D ○
14.	A ○	B ○	C ○	D ○
15.	A ○	B ○	C ○	D ○

Student No. ……..

Part B. 60 marks
Attempt questions 16 to 27
Allow about 1 hour and 45 minutes for this part
▸ *Show all relevant working in questions involving calculations*

MARKS

Question 16 (5 marks)

The table shows properties of some fuels.

FUEL	*MAIN SOURCE*	*Heat of Combustion* ($kJ\ g^{-1}$)	*Boiling Point* (^0C)
Methane	Petrochemical industry	55.6	-161.5
Propane	Petrochemical industry Natural Gas	50.3	-42.1
Octane	Refined from crude oil	47.9	125.7
Ethanol	Hydration of ethane Fermentation	29.7	78.3

Assess the potential of ethanol as an alternative fuel. **5**

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MARKS

Question 17 (4 marks)

You have studied one of the cells: (i) The Dry Cell Battery (ii) The Lead Acid Battery
Answer the questions using one of the cells.

(a) State ONE environmental impact associated with the cell you have chosen. **1**

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(b) Describe the chemistry of the cell you have chosen. **3**

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Student Number ……..

MARKS

Question 18 (7marks)

(a) Draw, in the space below, a scientifically labeled diagram of the following galvanic cell in operation : . **3**

Ni / Ni^{2+} and Ag^{+} / Ag

(b) Write the anode half-equation for the above galvanic cell **1**

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(c) Write the cathode half-equation for the above galvanic cell **1**

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(d) Use the standard reduction potential table to calculate the E^0 potential of the above galvanic cell. Show all working **2**

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Test continues next page

MARKS

Question 19 (5 marks)

A student carried out a first-hand investigation to determine the heat of combustion of ethanol using a spirit-burner. The student heated 200 mL of water in a beaker for 3 minutes and recorded results of the investigation in the table below :

Initial mass of burner	213.27 g
Final mass of burner	212.58 g
Mass of fuel used	0.69 g
Mass of water heated	200.00 g
Initial temperature of water	18.00 ^{o}C
Final temperature of water	40.00 ^{o}C

(a) Write a balanced equation for the combustion of ethanol including states. **1**

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(b) Calculate the molar heat of combustion of ethanol. **3**

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(c) Suggest a reason why the experimental value is less than the theoretical ΔH value of -1364 kJmol^{-1} **1**

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MARKS

Question 20 (3 marks)

Explain why alkanes and their corresponding alkenes have similar physical properties, but very different chemical properties. **3**

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Question 21 (3 marks)

Explain the differences in pH values that would be observed for 0.05 $molL^{-1}$ solutions of acetic, citric and hydrochloric acids. **3**

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Test continues next page

MARKS

Question 22 (5 marks)

(a) State one industrial source of oxides of sulfur. **1**

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(b) Write a chemical equation to show the formation of one type of oxide of nitrogen. **1**

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(c) Explain the concern about the release of oxides of nitrogen into the environment. **2**

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(d) Describe how you would assess the validity of the information gathered about the atmospheric concentrations of oxides of sulfur and nitrogen. **1**

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Test continues next page

Student Number …….

MARKS

Question 23 (2 marks)

(a) Calculate the pH of a 0.25 $molL^{-1}$ solution of nitric acid. **1**

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(b) Describe the effect on the pH if the nitric acid is diluted with demineralised water. **1**

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Test continues next page

Question 24 (8 marks)

Anna Lizt is a technology-oriented student of Esur Semaj High School. Anna wanted to analyse the acid content of a certain diprotic food acid (H_2A) using two titration techniques for endpoint determination: the *indicator* method and the *pH probe* method.

Table 1 outlines the steps of the analysis Anna followed. Table 2 gives the results of the analysis.

TABLE 1

Step	*Indicator method*	*pH probe method*
1	5.214 g of a solid monoprotic primary standard acid (MW = 204.22 g mol^{-1}) weighed, dissolved and diluted to 250.00 mL in a 250-mL volumetric flask.	
2	25.00 mL aliquot of the acid is pipetted into a 250-mL conical flask	25.00 mL aliquot of the acid is pipetted into a 250-mL beaker
3	two drops of phenolphthalein added to the flask	a magnetic stirring bar and a pH probe (connected to a data logger) are inserted into the beaker.
4	burette is filled with NaOH solution	burette is filled with NaOH solution, the magnetic stirrer turned on and the data logger activated
5	NaOH solution added dropwise until the colourless solution turns light pink	NaOH solution added incrementally and the pH monitored after each addition. A graph of pH against volume of added NaOH solution exhibits an S shaped curve
6	25.00 mL of food acid is diluted to 250.00 mL in a volumetric flask	
7	Steps 1-5 repeated 3 times	
8	Steps 1-5 done 4 times substituting food acid (H_2A) solution instead of the standard acid solution An average titre of 38.45 mL was obtained for the *pH probe* technique	

Question 24 contnues next page

MARKS

TABLE 2

Standardisation NaOH

Trial	*Titre (mL)*	
	Indicator method	*pH probe*
1	22.51	22.48
2	22.31	22.28
3	22.37	22.30
4	22.28	22.32

(a) What rinsing protocol is required for step 2 in the indicator method given in Table 1? **1**

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(b) Explain the need to standardise the NaOH with a primary standard solution instead of just preparing a standard solution of NaOH by weighing. solid NaOH. **1**

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(c) Calculate the concentration of the standard acid solution in mol L^{-1} **1**

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(d) Calculate the concentration of the NaOH solution.using the pH probe method. **1**

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Question 24 contnues next page

MARKS

(e) Calculate the concentration (in mol L^{-1}) of the diprotic food acid (H_2A) using the pH probe technique. **2**

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(f) Which of the techniques gave more reliable results for the standardisation of the NaOH? Explain a possible reason for this. **2**

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Question 25 (3 marks**)**

Justify the need for monitoring combustion reactions. Use balanced formula equations to support your answer. **3**

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Test continues next page

Student Number ……..

MARKS

Question 26 (5 marks)

Mercurio Krum is a very inquisitive high school student. Mercurio suspected that his home's water supply has an unusually high level of copper ions from the household's copper water pipes as the water tasted awful. He therefore asked his university friend to help him do an AAS analysis of the water samples from his home.

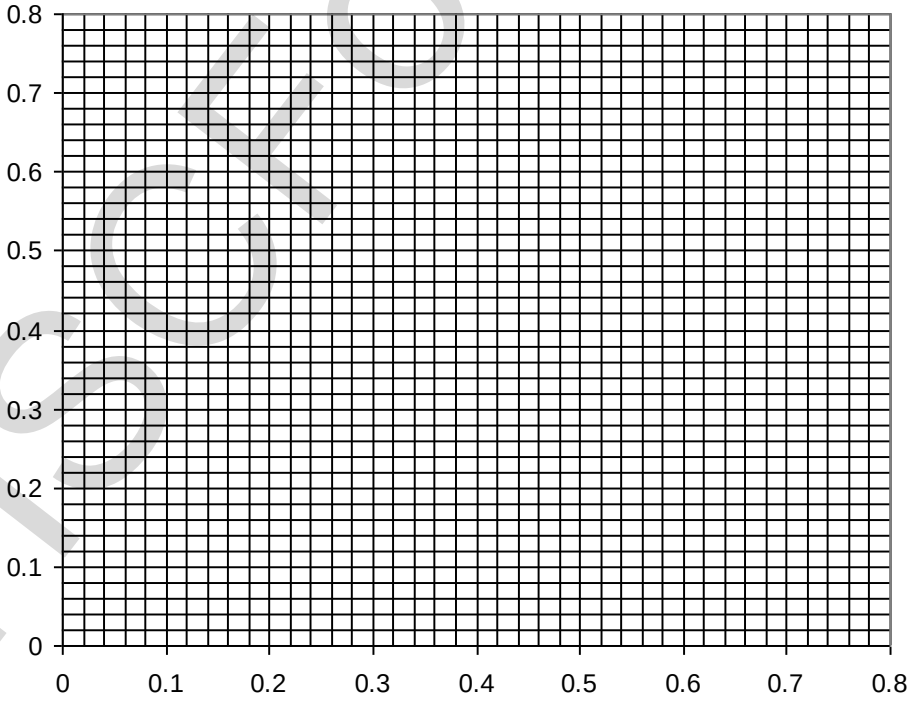
To do this,

- He took early morning water samples for five consecutive days.
- He pipetted 50.00 mL of his water sample into a 100.00 mL volumetric flask and then diluted it to the mark. He did this for all his samples
- He also prepared six standard copper solutions

The complete result of the analysis are tabulated in the table:

Sample	*ppm* Cu^{2+}	*Absorbance*
Standard 1	0.21	0.102
Standard 2	0.32	0.203
Standard 3	0.42	0.300
Standard 4	0.52	0.401
Standard 5	0.61	0.502
Standard 6	0.71	0.601
water sample	unknown	Ave 0.557

(a) Use the grid below to prepare a labeled calibration curve of the results. **2**



Question 26 contnues next page

MARKS

(b) Use your graph to determine the concentration of the water sample in ppm as obtained from the experiment. **1**

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(c) Calculate the Cu^{2+} concentration of the undiluted water sample in $molL^{-1}$ **1**

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(d) Mercurio consulted the internet and found that the Cu^{2+} concentration in drinking water to be safe for drinking must not exceed 1300 μg L^{-1} (10^{-6}g = 1 microgram (μg)). Should Mercurio recommend to his parents to replace the old water pipes with new ones? Justify your answer. **1**

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Test continues next page

Student Number ……..

MARKS

Question 27 (4 marks)

Explain the following characteristics of ozone and oxygen in terms of structure and/or bonding.

(a) Ozone is more reactive than oxygen. **2**

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(b) Ozone has a higher boiling point than oxygen. **2**

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Test continues next page

MARKS

Question 28 (6 marks)

Describe and assess the effectiveness of methods used to sanitise mass water supply. **6**

Test continues next page

2009 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY

Section II

Question 29: Industrial Chemistry

25 marks
Allow about 45 minutes for this section

Answer the questions in a writing booklet. Extra writing booklets are available.
Show all relevant working in questions involving calculations.

MARKS

(a) The table shows the effect of temperature on the equilibrium constant (*K*) for the Contact Process.

$$2SO_2\,(g) + O_2\,(g) \rightleftharpoons 2SO_3\,(g)$$

Temperature ^0C	*K*
700	2.63
800	0.915
900	0.384
1000	0.184
1100	0.098

(i) Is the reaction endothermic or exothermic? Use the values in the table to explain your answer. **2**

(ii) Give the equilibrium expression for the reaction in the Contact Process at 700^0C **1**

(iii) Sulfur trioxide is easily converted to sulfuric acid by adding it to water. However, in the Contact Process, an intermediate step is taken for safety reasons.

Identify the intermediate step and give an explanation for the necessity of this step in the process. **3**

Question 29 continues next page

MARKS

(b) In your practical work you performed a first hand investigation to demonstrate the effect of soap as an emulsifier.

(i) Describe your procedure. **2**

(ii) Explain the effect of soap as an emulsifier in your investigation. **3**

(c) Analyse the changes that have occurred in the use of electrolysis for the industrial production of sodium hydroxide **6**

(d) The Solvay process has been in use since the 1860s.

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(i) Identify the raw materials used in the Solvay Process. **1**

(ii) Write a chemical equation to show how ammonia is recovered for reuse in the Solvay Process. **1**

(iii) Calculate the volume of ammonia recovered from 500 kg of ammonium chloride at 25 ^{o}C and 100 kPa. **2**

(iv) Discuss two criteria that need to be considered when determining the location of a Solvay plant. **4**

End of Test