Student Number:

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2010

Trial HSC Examination

HSC Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your student number at the top of each page where relevant
- A data sheet and Periodic Table are provided at the back of this paper

Total marks – 100

This examination has TWO SECTIONS, Section I and section II

SECTION I – Total marks 90
This section has two parts **Part A and Part B**

Part A – 20 marks- Multiple Choice
Attempt Questions 1–20

- Allow about 40 minutes for this part

Part B – 70 marks
Longer Answer Questions

- Attempt Questions 21–35
- Allow about 2 hours for this part

SECTION II – Total marks 10
Option Question

- Allow about 20 minutes for this part
- USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS

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Section 1 (90 marks)
Part A (20 marks)

Use the multiple choice answer sheet for questions 1-20

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1. A solution of bromine water is suitable to identify which group of compounds?

(A) Alkenes
(B) Alkanes
(C) Alkanols
(D) Esters

2. Ethanol is now widely used as a component of petrol. The molar heat of combustion of ethanol is 1370 kJ/mol and its density is 0.8 g/mL.
What is the heat produced when 1.0 L of ethanol undergoes complete combustion?

(A) 1.1×10^6 kJ
(B) 29.8 kJ
(C) 2.4×10^4 kJ
(D) 78.8 kJ

3. Which reagent oxidises copper metal to copper(II) ions?

(A) Silver nitrate solution
(B) Concentrated HCl
(C) Steam
(D) Zinc sulfate solution

4. For any working galvanic cell, which statement is correct concerning the anode?

(A) It is always a metal.
(B) The polarity is negative.
(C) Oxygen is required for the reaction.
(D) Electrons pass from the external circuit into this electrode.

5. Bromothymol blue is an indicator, changing from yellow to blue with a pH range of 6.0-7.0. Bromothymol blue is added to a variety of different solutions. The solutions were made by dissolving samples of the compounds shown in the table below.
Which alternative below matches the solutions shown with the correct indicator colour?

	NO_2	CaO	NaCl	Na_2O
(A)	yellow	blue	green	blue
(B)	blue	blue	green	yellow
(C)	green	yellow	blue	green
(D)	blue	green	blue	yellow

6. What volume of 0.080 mol/L, KOH solution is required to completely neutralise a 20.0 mL volume of 0.050 mol/L sulfuric acid?

(A) 6.3 mL
(B) 12.5 mL
(C) 20.0 mL

(D) 25.0 mL

7. Dilute solutions of citric and hydrochloric acid are both found to have a pH of 2.0.

Which combination of concentrations, in mol/L, could explain this observation.

	Citric acid	Hydrochloric acid
(A)	0.020	0.020
(B)	0.10	0.010
(C)	2.0	1.0
(D)	0.20	0.020

8. Which of the following correctly identifies a base and its conjugate acid in the equation below?

$$NH_2^- + HF \rightleftharpoons NH_3 + F^-$$

	Base	Conjugate acid
(A)	NH_2^-	NH_3
(B)	HF	F^-
(C)	NH_3	F^-
(D)	F^-	NH_2^-

9. A 0.1 mol/L solution of acetic (ethanoic) acid has a pH of 2.9. A buffer solution was prepared by adding a salt to this solution.

Which of the following alternatives correctly identifies the required salt, and the resulting pH of the buffer solution?

(A) Sodium chloride, pH < 2.9
(B) Sodium acetate, pH < 2.9
(C) Sodium acetate, pH > 2.9
(D) Sodium chloride, pH = 7

10. A 10.0 mL sample of 0.5 mol/L HCl solution is diluted to 1.0 L using distilled water.

Which of the following changes would be a result of this dilution?

(A) A decrease in pH by 1
(B) An increase in pH by 1
(C) A decrease in pH by 2
(D) An increase in pH by 2

11. Which of the following statements best describes chlorine free radicals?

(A) They react with CFCs causing them to release more chlorine gas.
(B) They react with ozone in the stratosphere and convert it to oxygen.
(C) They are mostly formed in the troposphere and filter through to the stratosphere.

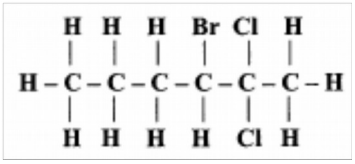
(D) They do not directly affect ozone but cause significant amounts of greenhouse gases to form.

12. A solution is known to contain either sodium sulfate or sodium chloride.

Which of the tests below would enable you to identify the substance present?

(A) A yellow flame obtained when a platinum wire is dipped into each solution separately and heated, would indicate the presence of sulfate ions.
(B) Add barium nitrate solution. The formation of a white precipitate would indicate the presence of sulfate ions.
(C) Add barium nitrate solution. The formation of a white precipitate would indicate the presence of chloride ions.
(D) Add NaOH solution. The formation of a white precipitate would indicate the presence of sulfate ions.

13. What is the correct name of the following compound?



(A) 3-bromo-2,2- dichlorohexane
(B) 2-dichloro-3-bromohexane
(C) 3-bromo-2-dichlorohexane
(D) 4-bromo-5,5-dichlorohexane

14. Which of the following chemicals is currently used as a replacement for CFCs?

(A) Hydrofluorocarbons
(B) Halons
(C) Freons
(D) Esters

15. Which of the following ions causes water to be called 'hard'?

(A) Mg^{2+} and OH^-
(B) NH_4^+ and Ca^{2+}
(C) Mg^{2+} and Ca^{2+}
(D) Na^+ and Cl^-

16. Which of the following species is capable of forming a coordinate covalent bond with a water molecule?

(A) An ammonium ion
(B) A chloride ion
(C) A hydrogen molecule
(D) A hydrogen ion

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17. What is a typical use of a microscopic membrane filter?

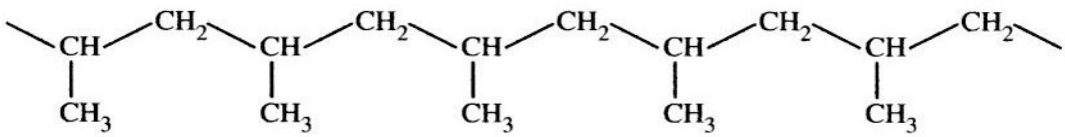
(A) To sanitise town water supplies by adding chlorine.
(B) To allow H^+ and OH^- ions to react to form pure water molecules
(C) To remove coagulated solids from waste water
(D) To remove some bacteria from contaminated water supplies.

18. The carbon-14 isotope is unstable and emits a form of radiation. Which of the following accounts for the instability of this isotope?

(A) It has too many neutrons compared to protons.
(B) It has an unequal number of protons and electrons.
(C) It has too many protons and neutrons.

(D) It has an incomplete outer shell of electrons.

19. 'X' is an unknown hydrocarbon which undergoes polymerisation to produce the polymer with a structure shown below.



Which of the following is the correct name of 'X'?

(A) Ethene
(B) Propene
(C) Propane
(D) 1-methylethene

20. Metallic copper can be produced from copper(II) oxide by reacting it with hydrogen gas, as shown in the following equation.

$$CuO_{(s)} + H_{2(g)} \longrightarrow Cu_{(s)} + H_2O_{(l)}$$

Which of the following statements regarding this reaction is correct?

(A) Hydrogen gas is acting as the oxidant.
(B) Copper undergoes an increase in oxidation state.
(C) Hydrogen atoms accept electrons from CuO.
(D) The oxidation state of oxygen remains unchanged.

Student Number:

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2010 Trial HSC Examination

Chemistry

OUTCOME	MARK
Knowledge and Understanding	/83
Planning & Conducting Investigations Q 24 & 26b	/9
Problem Solving Q 33 & 36c	/8
TOTAL	/100

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST alternative.

1	**A B C D**	**11**	**A B C D**
2	**A B C D**	**12**	**A B C D**
3	**A B C D**	**13**	**A B C D**
4	**A B C D**	**14**	**A B C D**
5	**A B C D**	**15**	**A B C D**
6	**A B C D**	**16**	**A B C D**
7	**A B C D**	**17**	**A B C D**
8	**A B C D**	**18**	**A B C D**
9	**A B C D**	**19**	**A B C D**
10	**A B C D**	**20**	**A B C D**

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Section I continued

Part B- 70 marks
Attempt Questions 21-35

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 21 (5 marks) **Marks**

Biofuels include biomass and other fuels derived by chemical processing of biomass.

(a) Ethanol is one such biofuel. Outline the process by which it is extracted from biomass. Include a relevant equation. **3**

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(b) Identify TWO advantages of this biofuel over the commonly used fuels petrol and diesel. **1**

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(c) Describe a potential problem associated with the increasing use of biofuels. **1**

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Question 22 (7 marks) **Marks**

A student is provided with a strip of zirconium metal and asked to measure its potential difference against samples of magnesium, nickel and zinc.

(a) Construct a labelled diagram of the apparatus you would use to measure the potential difference of zirconium against nickel. **2**

(b) The table below shows the measurements obtained by the student for this investigation.

Metals	Potential Difference (V)	Polarity of Zr
Mg,Zr	0.7	+
Ni, Zr	1.2	-
Zn,Zr	0.7	-

(i) Construct a half equation for the magnesium electrode in the first cell above. **1**

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(ii) Rank these 4 metals in order of increasing reactivity. Explain your reasoning. **2**

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(c) Predict the polarity of the zirconium in a similar cell, using copper and zirconium electrodes and estimate the voltage of this cell. **2**

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Question 23 (3 marks) **Marks**

There is concern over the emission of CFCs into the atmosphere. Account for these concerns using relevant equations. **3**

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Question 24 (4 marks)

During your study of chemistry you performed an analysis of a selected acid by titration.

Describe AND justify at least four steps you took in performing your analysis, to reduce experimental errors and thus ensure your titration results were valid and reliable. **4**

Steps taken	Justification

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Question 25 (6 marks) **Marks**

(a) Calculate the volume of CO_2 gas produced (measured at 25ºC and 100 kPa), when 5.00 g of $CaCO_3$ is dissolved in excess hydrochloric acid. **2**

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(b) Identify an amphiprotic ion formed when compressed carbon dioxide is dissolved in water, and construct an ionic equation for the reaction of this ion with dilute KOH solution. **2**

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(c) Outline an experiment to determine the mass of carbon dioxide in a can of soft drink, and the volume of this gas at 25ºC and 100 kPa. **2**

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Question 26 (7 marks) **Marks**

(a) Using structural formulae, write a balanced equation for the production of an ester using acetic (ethanoic) acid and propan-1-ol. Name the ester produced. **2**

(b) Justify the procedure that would be used in the production of this ester. Include a diagram of the apparatus in your answer. **5**

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Question 27 (3 marks)

The production of ammonia from gaseous elements is commonly known as the Haber process.

Write a complete equation for the process and explain the impact of a decrease in pressure on the system. **3**

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Question 28 (3 marks) **Marks**

The table below shows the boiling points of some organic compounds.

Name	Molar mass (g/mol)	Boiling point (°C)
Acetic acid	60.1	117.9
Propan-1-ol	60.1	97.2
Ethyl methanoate	60.1	54.2

Explain the difference in the boiling points between these three compounds. **3**

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Question 29 (3 marks)

Compound **Z** is formed from elements **X** and **Y** in an equilibrium reaction according to the following.

$$\mathbf{X + Y \rightleftharpoons Z}$$

The following table gives data on the percentage yield of **Z**, for various temperatures at constant pressure.

Temperature (°C)	Percentage yield of **Z**
200	20
300	39
350	51
400	64
500	90

Using this information, predict whether the production of Z is an endothermic or exothermic process. Explain your answer. **3**

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Question 30 (2 marks) **Marks**

The trace element cobalt, as the cobalt(II) ion, is vital to human health with a required level of around 0.3 µg/L in blood serum. A solution of cobalt ions can be prepared by dissolving cobalt (II) nitrate in water.

A standard solution of cobalt ions, at 1.0 g/L concentration, was prepared. Given the glassware below, describe how you would convert this into a 0.1 µg/L solution. (1 µg = $1x10^{-6}$ g). **2**

2 x 10 mL and 2 x 25 mL pipettes, 2 x 250 mL and 2 x 1000 mL volumetric flasks

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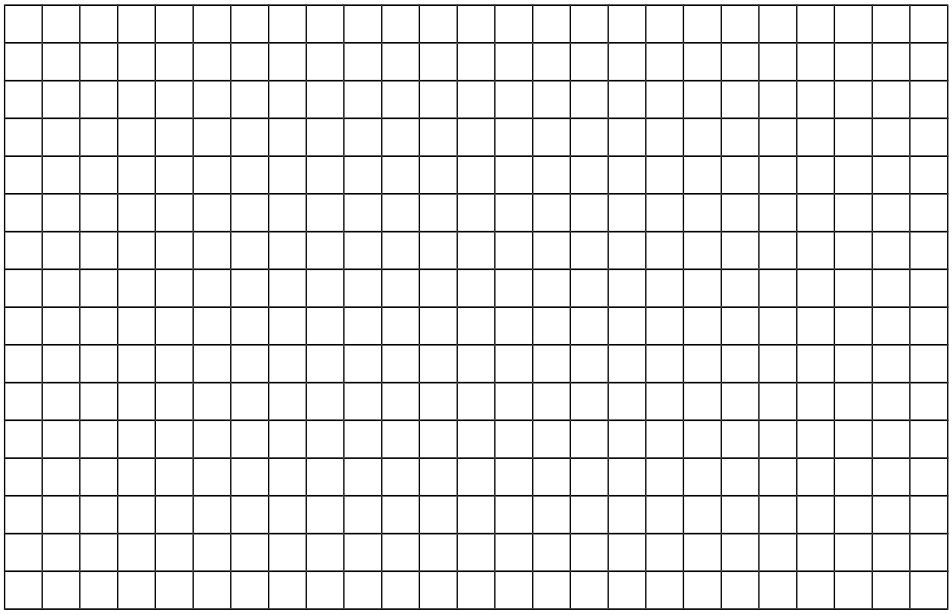
Question 31 (8 marks)

(a) The table below contains measurements of dissolved oxygen and biochemical oxygen demand (BOD), for a river into which sewage has been discharged.

Distance downstream (km)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Dissolved oxygen (ppm)	110	111	110	84	62	33	2	29	56
BOD (ppm)	2.0	2.1	2.0	108	78	49	31	18	2.0

Graph both dissolved oxygen and BOD versus the distance downstream on the grid below. **3**



Question 31 (continued) **Marks**

(b) Estimate the distance downstream at which the sewage was discharged. **1**

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(c) Explain the relationship between dissolved oxygen and biochemical oxygen demand in this 4 km stretch of the river. **2**

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(d) Describe how the biochemical oxygen demand could have been measured. **2**

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Question 32 (3 marks)

A student carried out an investigation to determine the sulfate content of lawn fertiliser. She weighed out 1.06g of fertiliser and completely dissolved this in 100 mL of water. She then added 50.0 mL of 0.10 mol/L barium nitrate solution and a white precipitate formed. The precipitate was filtered, dried and weighed. The mass of the precipitate was found to be 1.11 g.

Using the information above calculate the percentage (by mass) of sulfate in the fertiliser. **3**

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Question 33 (8 marks) **Marks**

You have studied one type of cell, other than the lead acid or the dry cell.

(a) Identify this cell. **1**

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(b) For this cell identify the anode and cathode and write equations for the reactions that occur at each. **3**

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(c) Evaluate this cell in comparison to the lead acid or the dry cell in terms of its cost and practicality and its impact on society. **4**

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Question 34 (4 marks) **Marks**

Radioisotopes are used extensively in industry and medicine.

Identify a radioisotope used in industry and account for its use in terms of its properties. **4**

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Question 35 (4 marks)

Evaluate the effectiveness of AAS in pollution control. **4**

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Section II

Question 36 - Industrial Chemistry (10 marks) **Marks**

Answer this question in a separate writing booklet.

(a) Outline TWO industrial uses of sulfuric acid. **2**

(b) The Contact Process is the name given to the reaction in which sulfur dioxide and oxygen are combined to form sulfur trioxide.

Outline a change in reaction conditions for the Contact Process that would achieve each of the effects below.

(i) Accelerates the reaction without affecting the yield. **1**
(ii) Increases yield without changing the equilibrium constant. **1**
(iii) Increases the equilibrium constant. **1**

(c) Dinitrogen tetroxide (N_2O_4) is an almost colourless liquid which boils at 21°C. In the gaseous state it exists in equilibrium with nitrogen dioxide (NO_2) which is an intensely brown coloured gas.

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)} \qquad \Delta H = 58 \text{ kJ mol}^{-1}$$

To study this equilibrium a chemist injects 0.024 mol of liquid N_2O_4 into a 1L evacuated flask. Using a colorimeter, it is observed that when the flask is heated to 50°C, 50% of the N_2O_4 has decomposed to NO_2.

(i) Determine the equilibrium constant for this reaction at 50°C. **3**
(ii) An unknown amount of N_2O_4 was injected into another flask and allowed to come to equilibrium at 50°C. The concentration of NO_2 at equilibrium was found to be 0.010 mol/L. Calculate the concentration of the N_2O_4 at equilibrium. **2**