Student Number:……

2011

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 21–34
- 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

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

Use the multiple choice answer sheet for questions 1-20

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1. For which one of the following molecular formulas is there only one possible structure?

(A) C_2HCl_3
(B) C_2H_4Cl
(C) $C_2H_2Cl_2$
(D) C_4H_9OH

2. The following are incomplete (not all reactants are included) and unbalanced equations representing three types of chemical reactions that involve glucose. In reactions 1 and 3, product A is the same compound. In reactions 2 and 3, product B is the same compound.

reaction 1 $C_6H_{12}O_6(aq) \rightarrow C_2H_5OH(aq)$ + product A
reaction 2 $C_6H_{12}O_6(aq) \rightarrow C_{12}H_{22}O_{11}(aq)$ + product B
reaction 3 $C_6H_{12}O_6(aq) \rightarrow$ product A + product B

Which one of the following correctly names reaction **3** and identifies product A and product **B?**

	Reaction 3	Product A	Product B
(A)	fermentation	water	carbon dioxide
(B)	fermentation	carbon dioxide	water
(C)	combustion	water	carbon dioxide
(D)	combustion	carbon dioxide	water

3. The following reaction systems are at equilibrium in separate sealed containers. If the volumes of the containers are halved at a constant temperature.
Which reaction will have the largest relative change in the concentration of reactants immediately after the volume change?

(A) $N_2O_{4(g)} \leftrightarrow 2NO_{2(g)}$
(B) $H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$
(C) $2CO_{2(g)} \leftrightarrow 2CO_{(g)} + O_{2(g)}$
(D) $CO_{(g)} + 2H_{2(g)} \leftrightarrow CH_3OH_{(g)}$

4. Barium hydroxide is soluble in water. The pH at 25°C of a 0.0050 $mol.L^{-1}$ solution of $Ba(OH)_2$ is

(A) 2.0
(B) 2.3
(C) 11.7
(D) 12.0

5. 0.132 g of a pure carboxylic (alkanoic) acid (R—COOH) was dissolved in 25.00 mL of water and titrated with 0.120 $mol.L^{-1}$ NaOH solution. A volume of 14.80 mL was required to reach the endpoint of the titration .

The carboxylic acid could be

(A) HCOOH
(B) CH_3COOH
(C) C_2H_5COOH
(D) C_3H_7COOH

6. A monoprotic acid solution has a concentration of $5.8 \times 10^{-5} mol.L^{-1}$. Assuming the acid is completely ionised, what is the pH of the solution?

(A) 4.2
(B) 5.8
(C) 6.6
(D) 8.3

7. The molar heat of combustion of ethanol is 1367 KJ $mol^{-1.}$

What quantity of ethanol must be combusted to raise the temperature of 1.0 kg water from 50°C to boiling point at sea level (assuming no loss of heat to the surroundings)?

(A) 6.5g
(B) 7.0g
(C) 209g
(D) 300g

8. The formula for carbonic acid is H_2CO_3, and the formula for hydrogen carbonate is HCO_3^-
Together they form a buffer that is found in blood.
Which of the following reactions represents what happens when excess base enters the bloodstream?

(A) $HCO_{3\,(aq)}^- + H_3O^+_{(aq)} \rightarrow H_2CO_{3(aq)} + H_2O_{(l)}$
(B) $H_2CO_{3(aq)} + OH^-_{(aq)} \rightarrow HCO_{3\,(aq)}^- + H_2O_{(l)}$
(C) $HCO_{3\,(aq)}^- + H_2O_{(l)} \rightarrow H_2CO_{3(aq)} + OH^-_{(aq)}$
(D) $H_2CO_{3(aq)} + H_2O_{(l)} \rightarrow HCO_{3\,(aq)}^- + H_3O^+_{(aq)}$

9. Select the row which matches the compounds with the correct boiling points.

	Propanoic acid (^0C)	*Propane (^0C)*	*Propan-1-ol (^0C)*
(A)	141	-42	97
(B)	99	-42	97
(C)	141	97	-42
(D)	141	139	-42

10. A patient with a suspected liver disorder is to be injected with a radioisotope. The radioisotope will enter the bloodstream and accumulate in the liver. The radiation it emits will be measured by an instrument outside the patient's body, and be used to assess the health of the liver.

Which of the following properties of a radioisotope would make it suitable for such an application?

	Half-life	Type of emission
(A)	7.5 hours	alpha and gamma
(B)	3.2 minutes	gamma only
(C)	6 hours	gamma only
(D)	5 400 years	beta and gamma

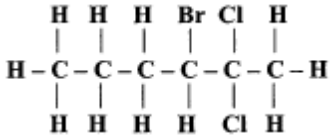
11. Which of the following statements best describes chlorine free radicals?

(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. A student uses a pH meter to obtain the pH for solutions of sodium hydroxide and sodium carbonate. The pH reading for each solution is 10.2.

The student can correctly conclude that:

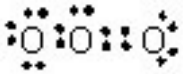
(A) both solutions are weak bases
(B) each solution has the same concentration
(C) only the sodium hydroxide contains OH^- ions
(D) both solutions have an $[H_3O^+]$ of $10^{-10.2}$

17. Which of the following is the correct electron dot structure for ozone?

(A)

(B)

(C)



(D)

18. The table gives the results of chemical tests for selected anions and cations.

Ion	Add 0.1 M Na_2CO_3	Add 0.1 M HCl	Add 0.1 M KSCN	Add 0.1 M $AgNO_3$
Ca^{2+}	white ppte	no change	no change	no change
Ba^{2+}	white ppte	no change	no change	no change
Pb^{2+}	white ppte	white ppte	no change	no change
Fe^{3+}	brown ppte	no change	red colour	no change
Cl^-	no change	no change	no change	white ppte

(ppte = precipitate)

When the above tests were performed on an unknown solution the following results were obtained.

Add 0.1 M Na_2CO_3	Add 0.1 M HCl	Add 0.1 M KSCN	Add 0.1 M $AgNO_3$
white ppte	no change	no change	white ppte

Which of the conclusions listed is consistent with the results?

(A) The solution contained Ca^{2+} only
(B) The solution contained $FeCl_3$ only
(C) The solution contained both $CaCl_2$ and $BaCl_2$
(D) The solution contained both $CaCl_2$ and $PbCl_2$

19. Which statement below best describes the function of iron oxide in the Haber process?

(A) It increases the reaction rate by increasing the enthalpy change of both the forward and reverse reactions.
(B) It increases the reaction rate by decreasing the activation energy of both the forward and reverse reactions.
(C) It increases the reaction rate by increasing the kinetic energy of the collisions that are occurring in the system.
(D) It increases the reaction rate by disturbing the equilibrium and favoring the forward reaction.

20. Consider each of the following equations:

(i) $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$
(ii) $HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq} + Cl^-_{(aq)}$
(iii) $NH_{3(aq)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-_{(aq)}$
(iv) $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

An acid can be defined as a proton donor. This can be seen in:

(A) equation (i) only
(B) equation (ii) only
(C) equation (ii) and (iii)
(D) all of the equations

Student Number:……

2011 Trial HSC Examination

Chemistry

OUTCOME	MARK
Knowledge and Understanding	/74
Planning & Conducting Investigations Q24(b)(c)(d) Q30(b)	/9
Problem Solving Q21, Q22(a)(b) Q23(b), Q31, Q34(b)	/17
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

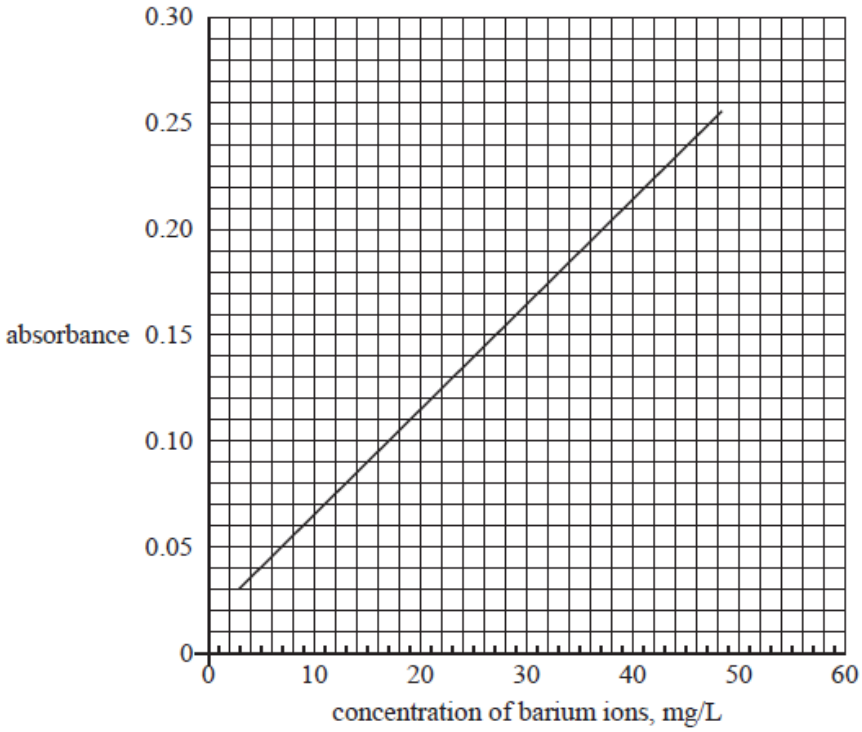
Section I continued

Part B- 70 marks
Attempt Questions 21-34
Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 21 (6 marks)

Elemental sulfur can be used to control outbreaks of powdery mildew on grapes. However, sulfur remaining on the grapes after harvest can be converted to a number of undesirable compounds during fermentation in wine production.
A wine chemist uses atomic absorption spectroscopy to determine the amount of sulfur remaining on grapes. In a particular analysis, 100.0 g of grapes are treated with 100.0 mL of surfactant solution to remove the sulfur remaining on the grapes when they were harvested.
This surfactant solution is treated to convert all of the sulfur to sulfate ions and then dried to produce an ash containing the sulfate ions
This ash is transferred to a 10.00 mL volumetric flask containing 2.00 mL of 200 mg/L solution of barium Ba^{2+} ions.
The volume of solution in the volumetric flask is then made up to the calibration line. A precipitate of $BaSO_4$ forms and settles to the bottom of the volumetric flask.
A small amount of the solution containing the unreacted Ba^{2+} ions is removed from the volumetric flask and analysed using atomic absorption spectroscopy. This solution gave an absorbance of 0.11.
A calibration curve was prepared using standard solutions of 10, 20, 30 and 40 mg/L Ba^{2+} (aq).



(a) Determine the concentration of barium ions remaining in the 10.00 mL sample solution and hence determine the mass of barium ions, in mg, remaining in the 10.00 mL sample solution. **2**

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(b) Determine the amount of barium ions, in moles, that reacted to produce the barium sulfate precipitate.

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(c) Determine the mass of sulfur in mg, remaining on the 100 g of harvested grapes. **2**

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(d) The amount of sulfur could also be determined using gravimetric analysis.
Give one reason why atomic absorption spectroscopy is a better way to determine the residual sulfur on the grapes compared to gravimetric analysis. **1**

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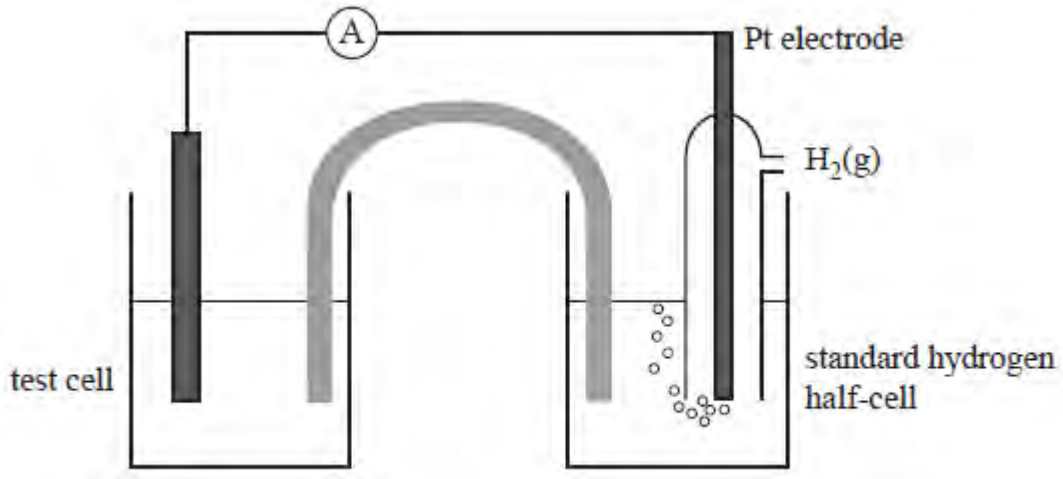
Question 22 (5 marks)

In a problem-solving activity a student is given the following information regarding three half-equations. However, although the three numerical values of E^0 are correct, they have been incorrectly assigned to the three half-equations.

Half-equation	E^0
$AgCl(s) + e \rightleftharpoons Ag(s) + Cl^-(aq)$	–0.40 V
$Cd^{2+}(aq) + 2e \rightleftharpoons Cd(s)$	–0.36 V
$PbSO_4(s) + 2e \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$	+0.22 V

The objective of this task is to correctly assign the E° values to the corresponding half-equation. To do this, the student constructs standard half-cells for each of the above half-reactions. These half-cells are connected, one at a time, to a standard hydrogen half-cell as indicated in the diagram below.



The following observations were made either during or after the electrochemical cell discharged electricity for several minutes.

Experiment	Half-cell reaction being investigated	Experimental notes
1	$AgCl(s) + e \rightleftharpoons Ag(s) + Cl^-(aq)$	Electron flow was detected passing from the standard hydrogen half-cell to the half-cell containing the silver electrode.
2	$Cd^{2+}(aq) + 2e \rightleftharpoons Cd(s)$	The mass of the cadmium electrode decreased.
3	$PbSO_4(s) + 2e \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$	The pH of the solution in the standard hydrogen half-cell increased.

(a) The above information can only be used to assign one of the E^0 values to its corresponding half-equation. Identify this half-equation by placing the correct E^0 value next to its corresponding half-equation in the table below. **1**

Half-equation	E^0
$AgCl(s) + e \rightleftharpoons Ag(s) + Cl^-(aq)$	
$Cd^{2+}(aq) + 2e \rightleftharpoons Cd(s)$	
$PbSO_4(s) + 2e \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$	

(b) Explain why the other two E^o values cannot be correctly assigned to their half-equations. **2**

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(c)Using an equation, explain why the pH of the solution in the standard hydrogen half-cell increased in experiment 3. **2**

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Question 23 (5 marks)

A student *is* to accurately determine the concentration of a solution of sodium hydrogen carbonate in a titration against a standard solution of hydrochloric acid, HCl.
The first step in this experiment is to accurately dilute 100.0 mL of a 1.00 M HC1 stock solution to a 0.100 M solution using a 100 L volumetric flask
However, instead of using distilled water in the dilution, the student mistakenly adds 900.0 mL of 0.0222 M sodium hydroxide, NaOH, solution.

(a) Write an equation for the reaction that occurs in the 1.00L volumetric flask. **1**

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(b) Calculate the concentration of the hydrochloric acid in the 1.00 L volumetric flask after the student added the sodium hydroxide solution. Give your answer to correct significant figures. **2**

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Question 23 continued

(c) The student then uses this contaminated hydrochloric acid solution to determine the accurate concentration of the unknown sodium hydrogen carbonate solution. Will the calculated concentration of sodium hydrogen carbonate solution be greater or smaller than the true value? Justify your answer

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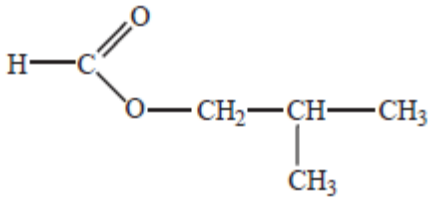
Question 24 (7 marks)

Many esters are used as flavoring agents in food. The structure of the ester used in raspberry flavoring is provided below



(a) Give the names of two carbon compounds that can be used to synthesize this ester and the systematic name for this ester. **2**

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(b) In class, you prepared and extracted an ester. Account for the use of refluxing when making an ester. **2**

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(c) Describe the purpose of using sulfuric acid during esterification. **2**

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(d) Account for one major safety precaution (other than safe handling of the acid) you took when preparing your ester. **1**

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Question 25 (4 marks)

Elements with an atomic number greater than 92 do not occur naturally on earth, but small amounts of the elements have been synthesized by scientists.
Neptunium was first synthesized and isolated by American scientists in 1940.
The incomplete nuclear equation describing the reaction that produced a sample of Neptunium is shown below.

U-238 + X →

(a) Identify particle X in the above question. **1**

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(b) Outline the process by which a more recently discovered element has been synthesized and account for the fact that large samples of the element have generally been unable to be isolated. Include any relevant equation(s) in your answer. **3**

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Question 26 (3 marks)

Certain salts dissolve in water to lower its pH.

(a) Identify such a salt. **1**

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(b) With the help of an equation, explain how the pH is lowered. **2**

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Question 27 (3 marks)

Construct chemical equations to demonstrate ONE renewable and ONE non- renewable method of ethanol production. **3**

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Question 28 (7 marks)

The Haber process is an important industrial process for the production of ammonia.
Discuss the monitoring of the reaction vessel required to ensure optimum yield. **7**

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Question 29 (7 marks)

A student was researching the chemistry of ozone in the stratosphere and the depletion of levels of ozone by chlorofluorocarbons (CFCs). He made the following notes.

– ultraviolet light from the sun splits oxygen molecules into oxygen free radicals
– the oxygen free radicals react with oxygen to form ozone
– free radical chlorine atoms (from CFCs) react with ozone to form oxygen

(a) Write balanced equations for each of the three reactions described. **3**

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(b) Identify alternative chemicals used to replace CFCs and evaluate the effectiveness of their use as a replacement for CFCs **4**

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Question 30 (5 marks)

(a) Outline the process of eutrophication **1**

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(b) Describe and justify two water quality tests you could carry out to identify possible eutrophication. **4**

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Question 31 (3 marks)

A student carried out an investigation to determine the sulfate content of lawn fertiliser. She weighed out 1.16g of fertiliser and completely dissolved this in 100 mL of water. She then added 50.0 mL of 0.11mol/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 1.05 g. Using the information above calculate the percentage (by mass) of sulfate in the fertiliser. **3**

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Question 32 (8 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 33 (4 marks)

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

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Question 34 (3 marks)

(a) Write a balanced equation for the complete combustion of butanol. **1**

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(b) A mass of 86.0 g of butanol was burnt completely in air. Calculate the volume of carbon dioxide produced at 25°C and 100 kPa. **2**

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Section II

Question 35 - Industrial Chemistry (10 marks)

Answer this question in a separate writing booklet.

(a) The most common method for the industrial production of hydrogen is the steam reforming process, which requires high temperature, high pressure and a Ni catalyst
The equation for this reaction is

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +207 \text{ kJ mol}^{-1}$$

(i) Write an equilibrium expression for K for the steam reforming reaction. **1**

(ii) Le Chatelier's principle indicates that increased equilibrium yield *for* the reaction above is favoured by **low** pressure. Suggest one reason why high pressure is used in the industrial process described above. **1**

(iii) At 1500°C the concentrations of the gases in a particular equilibrium mixture were found to be $[CH_4] = 0.400$ mol.L^{-1}. $[CO] = 0.300$mol.L^{-1}. $[H_2O] = 0.068$ mol.L^{-1}
K = 5.67 at 1500°C for the reaction.

Calculate the molar concentration of H_2 in the equilibrium mixture. **2**

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

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} \qquad \Delta H = -196 \text{ kJ mol}^{-1}$$

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) The following equilibrium between the gases methane, hydrogen sulfide, carbon disulfide and hydrogen exists at high temperature.

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$

(i) Write the equilibrium expression for the reaction. **1**

(ii) This reaction is endothermic. Explain how the equilibrium constant will change if the temperature of the reaction were increased? **2**