

CHEMOLOGY EDUCATION SERVICES

Name: _____

2011 CHEMISTRY Unit 4 TRIAL EXAM

Time allowed: 1 hour 30 minutes
QUESTION AND ANSWER BOOKLET

Structure of booklet

<u>Section</u>	<u>Number of questions</u>	<u>Number of questions to be answered</u>
A	20 multiple choice questions	20 multiple choice questions
B	8	8

Directions to students

Materials

Question and answer booklet of 17 pages.
Answer sheet for multiple choice questions.
An approved calculator may be used.

Data Pages may be found at

http://www.vcaa.vic.edu.au/vce/studies/chemistry/chem1_sample_2008.pdf

The Task

Pleasure ensure that you write your name on the multiple choice answer sheet and this answer booklet.

Answer **all** items from Section A, which should be answered on the sheet provided.

Answer **all** questions from Section B, which should be answered in this booklet in the spaces provided.

There is a total of 73 marks available.

All answers should be written in English.

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SECTION A

Specific instructions for Section A

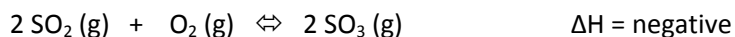
Question 1 consists of 20 multiple choice questions. Section A is worth approximately 27% of the marks available. You should spend about 30 minutes on this section.

Choose the response that is **correct** or **best answers the question**, and mark your choice on the multiple choice answer sheet provided.

No credit will be given for an item if two or more letters are marked for that question. Marks will not be deducted for incorrect answers and you should attempt every question.

Question 1

Which change will increase the equilibrium concentration of sulfur trioxide in this reaction?



- A. Decreasing the concentration of oxygen
- B. Increasing the pressure
- C. Using a catalyst
- D. Increasing the temperature

Question 2

The ionic product constant of water at 45°C is 4×10^{-14} . Which statement is correct about pure water at 45°C?

- A. $\text{pH} = 7$
- B. $[\text{H}^+] = [\text{OH}^-]$
- C. $[\text{OH}^-] > [\text{H}^+]$
- D. $[\text{H}^+] > [\text{OH}^-]$

Question 3

A student conducted an experiment to determine the heat content of a piece of white bread. When a 3.5 g sample was combusted in a bomb calorimeter the temperature of the water inside the calorimeter rose from 16.0°C to 28.7°C. The calibration factor of the calorimeter was $2.95 \text{ kJ } ^\circ\text{C}^{-1}$.

The heat content of the white bread, in kJ g^{-1} , is

- A. 37.5
- B. 24.2
- C. 13.5
- D. 10.7

Question 4

Consider the following information for the reaction $X + Y \rightarrow Z$.

Heat of Reaction = -120 kJ mol^{-1}

Activation energy = $+200 \text{ kJ mol}^{-1}$

The activation energy, in kJ mol^{-1} , for the reaction $Z \rightarrow X + Y$, is

- A. -320
- B. -80
- C. +80
- D. +320

Question 5

A student completed an experiment to determine the amount of energy absorbed by a volume of water.

The following data were recorded.

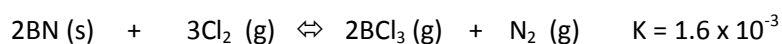
Mass of beaker	215.6 g
Mass of beaker plus water	336.1 g
Final temperature of water	71.0°C
Energy absorbed	21.2 kJ

What was the initial temperature of the water?

- A 15°C
- B 25°C
- C 29°C
- D 42°C

Question 6

Consider the following equilibrium:



At equilibrium, there were 0.30mol BN , 0.20mol BCl₃ and 0.10mol N₂ in a 2.0L container.
How many moles of Cl₂ were present?

- A. 0.31mol
- B. 1.4 mol
- C. 2.7 mol
- D. 4.8 mol

Question 7

Consider the following buffer equilibrium system:

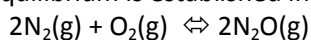


What is the net result of adding a small amount of HNO_3 ?

- A. The pH increases slightly.
- B. The pH decreases slightly.
- C. The $[\text{CN}^-]$ increases slightly.
- D. The $[\text{HCN}]$ decreases slightly.

Question 8

The following equilibrium is established in a 2.0 L vessel:

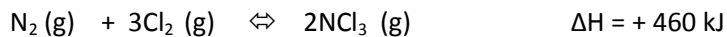


Which one of the following sets of conditions would be expected to push the equilibrium furthest to the right?

Addition of chemical	Volume of reaction vessel
A. nitrogen gas	increased
B. nitrogen gas	decreased
C. argon gas	increased
D. argon gas	decreased

Question 9

Consider the equilibrium system:

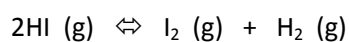


Which of the following describes what happens when some NCl_3 is added?

	Equilibrium Shift	Value of K_{eq}
A.	right	remains constant
B.	right	increases
C.	left	remains constant
D.	left	decreases

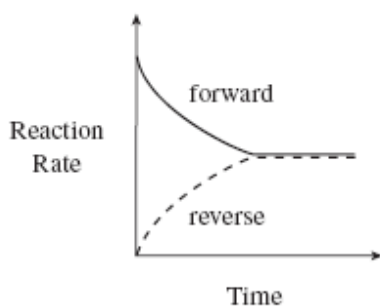
Question 10

A student places some HI (g) into a closed reaction container and the following equilibrium is established:

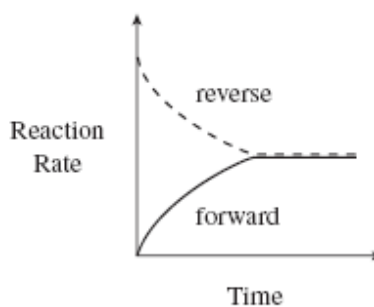


Which of the following describes the forward and reverse reaction rates?

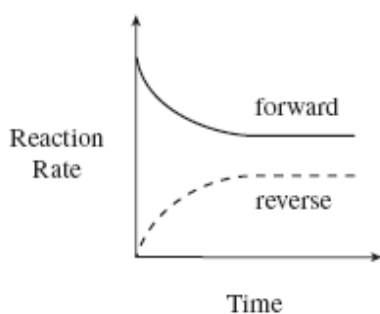
A.



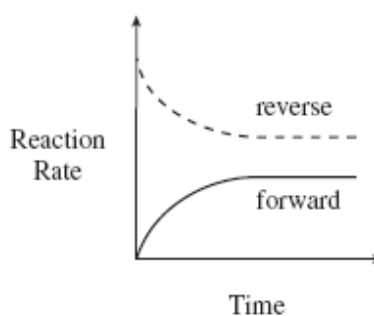
B.



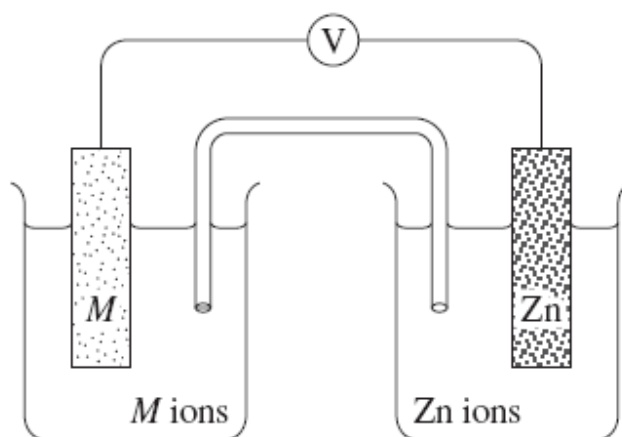
C.



D.

**Question 11**

The diagram shows a galvanic cell.



Which of the following metals (*M*) acting as an anode would produce the lowest theoretical potential for the cell?

- A. Calcium
- B. Copper
- C. Iron
- D. Manganese

Use the following diagram to answer questions 12, 13 and 14.

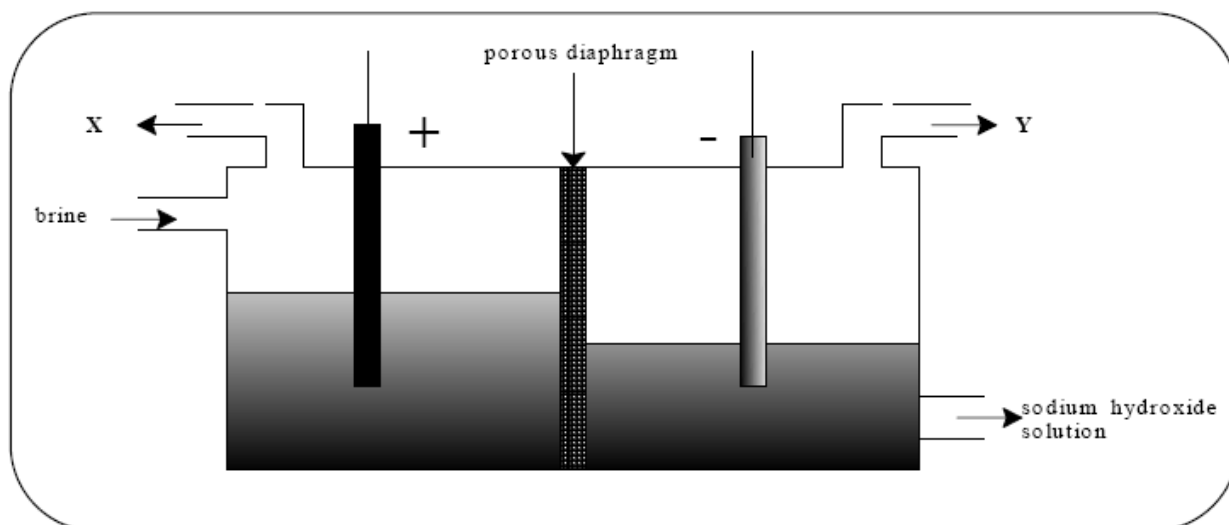


Figure 3: Down's Process

Question 12

The gases labelled X and Y are

	X	Y
A.	chlorine	oxygen
B.	oxygen	chlorine
C.	chlorine	hydrogen
D.	hydrogen	chlorine

Question 13

ONE of the functions of the porous diaphragm in the cell is to

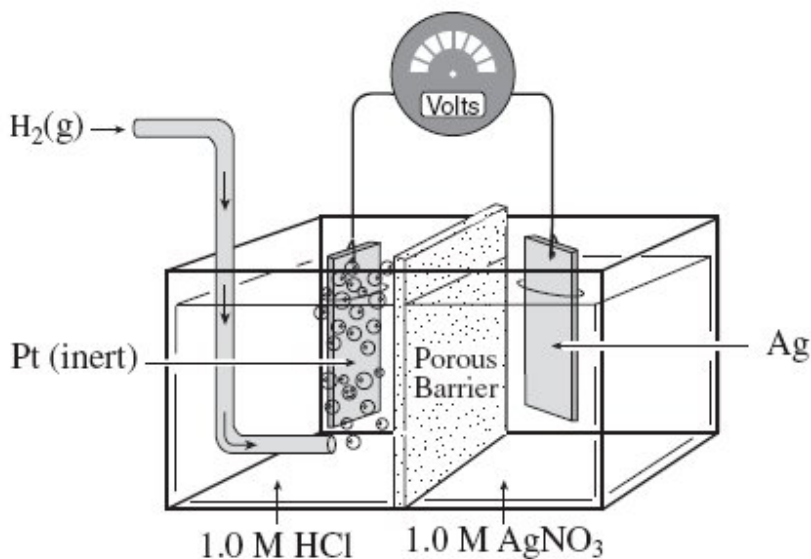
- A. act as a catalyst to increase the rate of reaction.
- B. allow movement of ions between the cell compartments.
- C. prevent sodium ions from entering the solution near the anode.
- D. prevent the electrolyte from making contact with the gases provided.

Question 14

The **main** reason for using a highly concentrated brine solution as the electrolyte in the cell is to

- A. allow an electric current to pass through the cell.
- B. produce chlorine gas, in preference to oxygen gas.
- C. allow sodium hydroxide to be separated from the salt by crystallization.
- D. create non-standard conditions that ensure hydrogen gas production.

Use the following diagram to answer questions 15, 16 and 17.



Question 15

What is the cathode half-cell reaction?

- A. $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$
- B. $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$
- C. $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
- D. $2\text{Cl}^- + 2\text{e}^- \rightarrow \text{Cl}_2$

Question 16

Which of the following is correct as the cell operates?

	Direction of Ag^+ Migration	pH Near the Pt Electrode
A.	towards Pt	increases
B.	towards Pt	decreases
C.	towards Ag	increases
D.	towards Ag	decreases

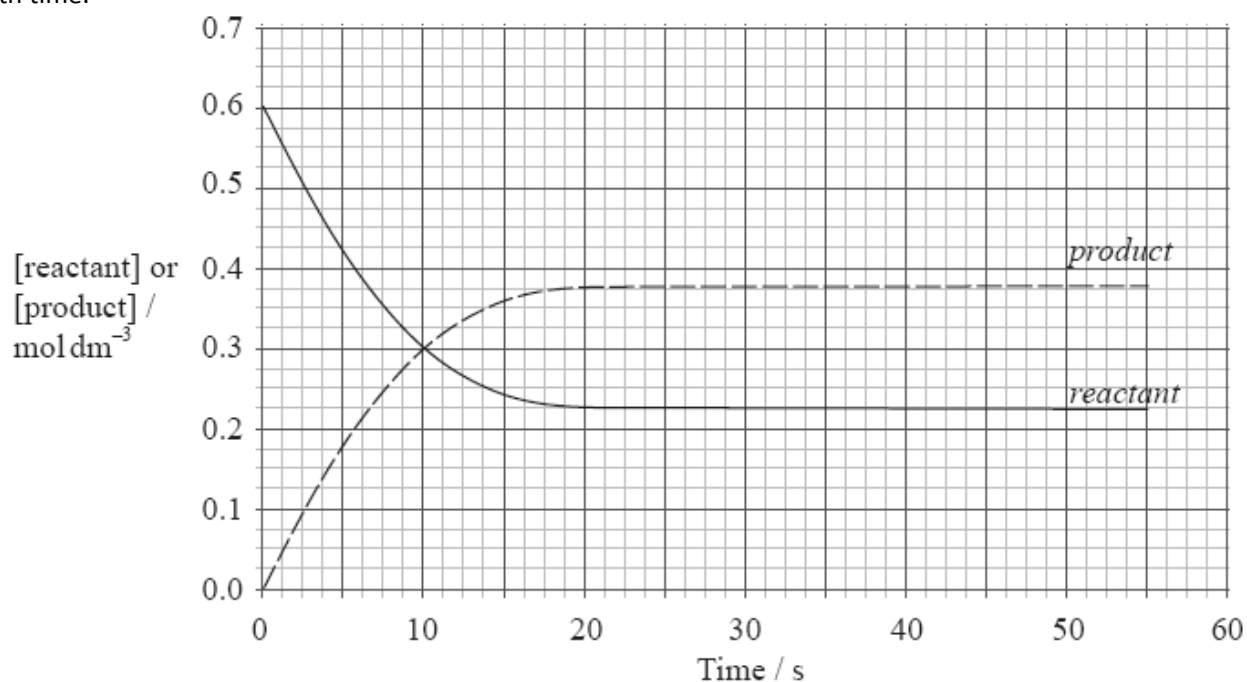
Question 17

Which of the following is correct as the cell operates?

	Direction of Electron Flow	Mass of Pt Electrode
A.	from Ag to Pt	increases
B.	from Ag to Pt	decreases
C.	from Pt to Ag	decreases
D.	from Pt to Ag	does not change

Question 18

The graph below shows how the concentrations of the reactant and product in a reversible reaction change with time.



- I. Time = 10 s
- II. Time = 20 s
- III. Time = 55 s

When is the reaction at equilibrium?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

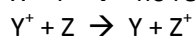
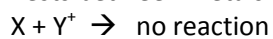
Question 19

What happens at the negative electrode in an electrochemical cell and in an electrolytic cell?

	Electrochemical Cell	Electrolytic Cells
A.	Oxidation	Reduction
B.	Reduction	Oxidation
C.	Oxidation	Oxidation
D.	Reduction	Reduction

Question 20

Tests between metals X, Y and Z and their ions produced the following results:



Which of the following describes the relative strengths of the oxidizing agents?

- A. $X > Y > Z$
- B. $Z > Y > X$
- C. $X^+ > Y^+ > Z^+$
- D. $Z^+ > Y^+ > X^+$

END OF SECTION A

SECTION B**Specific Instructions for Section B**

Section B consists of 7 short answer questions (question 1 to 7). You must answer all of these questions. The section is worth 53 marks or approximately 73% of the total. You should spend approximately 60 minutes on this section. The marks allocated and suggested times are at the end of each question.

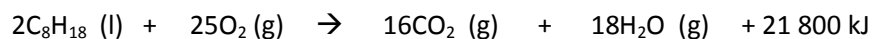
Questions should be answered in the spaces provided in this booklet.

You should

- * give simplified answers with the appropriate number of significant figures. Unsimplified answers will not receive full marks.
- * Show all working in your answers to numerical problems. No marks can be given unless accompanied by working.
- * make sure all chemical equations are balanced and that formulas for individual substances include an indication of state. Eg $\text{H}_2(\text{g})$, $\text{NaCl}(\text{s})$.

Question 1 (10 marks)

The combustion of octane, a major component of petrol, may be represented by the equation:



- (a) Rewrite this equation using the ΔH notation with the unit kJ mol^{-1} . (1 mark)

- (b) Explain why this reaction causes an increase in both the temperature and pressure within an automobile engine. (2 marks)

- (c) Calculate the mass of octane that would have to undergo combustion in order to release 109 MJ of energy. (2 marks)

- (d) Explain why octane does not react with oxygen at room temperature but it burns rapidly with a spark. (2 marks)

(e) On the axes below, construct an enthalpy/potential energy diagram for the combustion reaction.

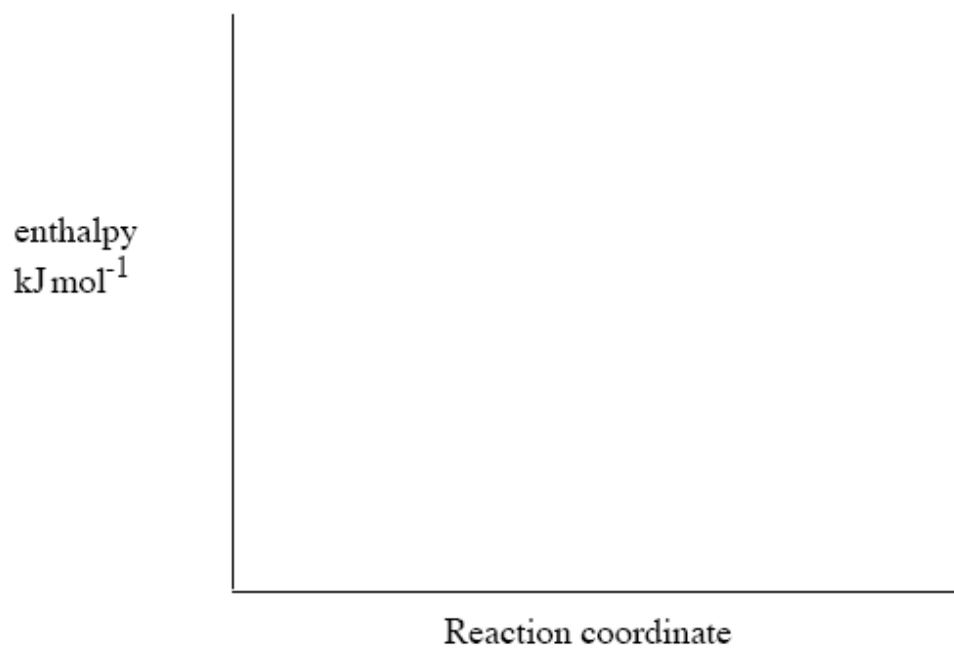
Clearly mark:

(3 marks)

(i) enthalpy of reactants and products

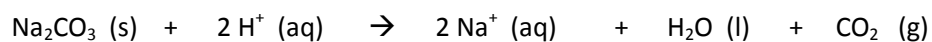
(ii) ΔH

(iii) E_{act}



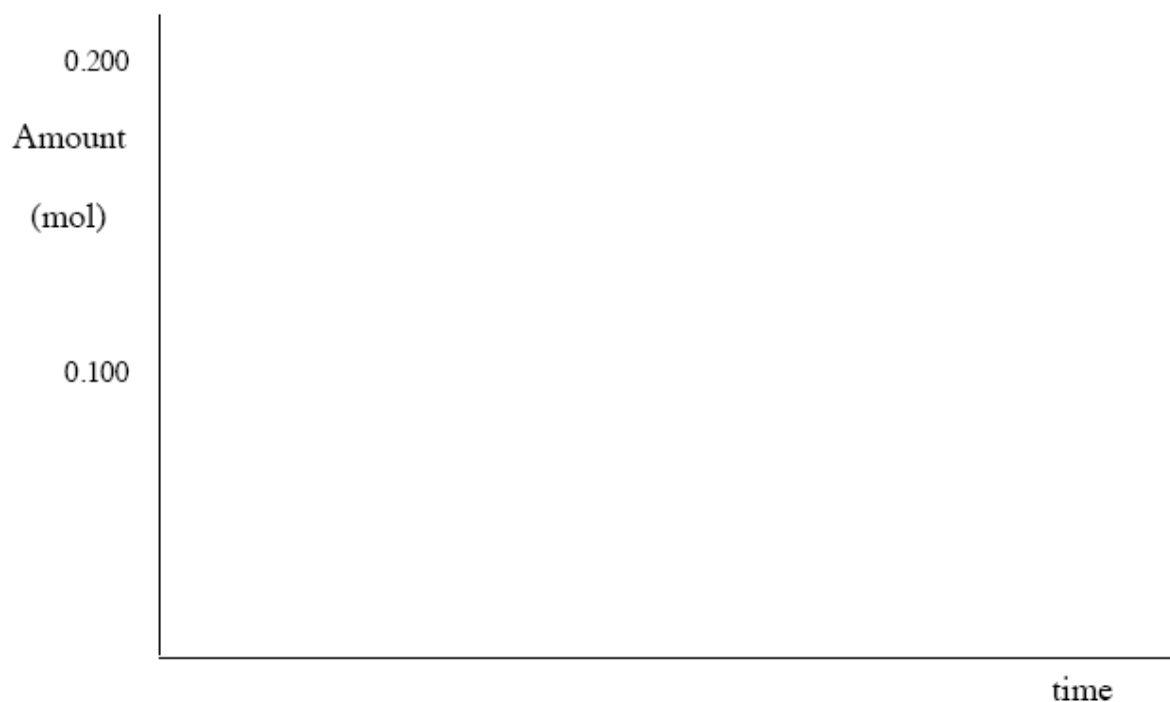
Question 2 (5 marks)

Consider the following reaction:



In an experiment 0.200 mole of sodium carbonate, Na_2CO_3 powder and 0.150 mole of hydrochloric acid, HCl were placed in an open beaker. The reaction was allowed to proceed to completion.

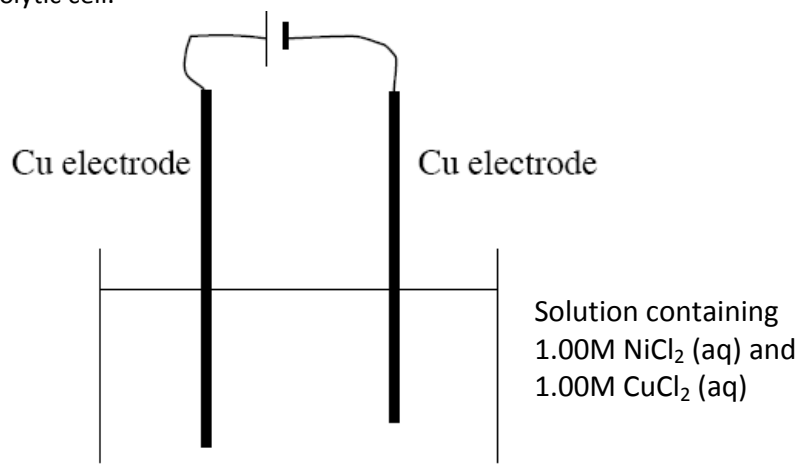
- (a) On the axes below sketch graphs to illustrate the rate of disappearance of the sodium carbonate powder and the hydrochloric acid. Also sketch the rate of appearance of the carbon dioxide. Clearly label **all three** graphs. (3 marks)



- (b) On the axes above add a new graph for $\text{Na}_2\text{CO}_3(\text{s})$ showing the effect of using large crystals of sodium carbonate instead of the powder. Explain in terms of the collision theory why the graph is the shape you have drawn. (2 marks)

Question 3 (5 marks)

A solution containing 1.00 M nickel(II) chloride, NiCl_2 , and 1.00M copper(II) chloride, CuCl_2 , is electrolysed in the following electrolytic cell.



The voltage applied to the cell can be varied and is gradually increased.

- (a) What are the possible products that could appear at the anode? Predict the product that will occur first. (2 marks)

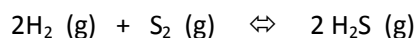
- (b) What are the possible products that could appear at the cathode? Predict the product that will occur first.

(2 marks)

- (c) What is the minimum voltage required to obtain the species predicted in parts (a) and (b)? (1 mark)

Question 4 (5 marks)

Consider the following equilibrium:



Initially, 9.0×10^{-4} mol S_2 and 1.1×10^{-2} mol H_2S are placed in a 1.0 L container.
At equilibrium, there is 8.6×10^{-3} mol H_2S present. Calculate a value for K .

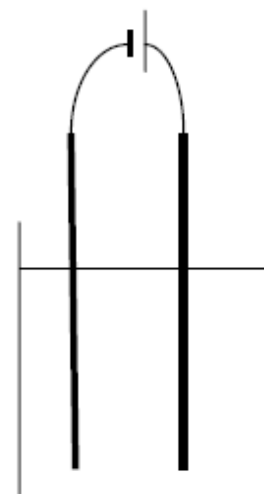
Question 5 (4 marks)

In an experiment to determine the molar mass of a sample of metal, two students assembled an electrolytic apparatus as shown.
A steady current of 1.20 A was passed through the cell for 38.0 minutes.
The students weighed the cathode before and after the experiment.

Their results were:

Mass of cathode before	12.320 g
Mass of cathode after	13.217 g

Use their experimental results to calculate the molar mass of this metal given that it exclusively forms $2+$ ions. (4 marks)



Excess 4.00 mol L^{-1}
metal sulfate solution

Question 6 (8 marks)

A half cell was used in conjunction with the $\text{Ni}^{2+}(\text{aq})/\text{Ni}(\text{s})$ half cell to produce an electrochemical cell that had a maximum E° of 0.53 volts.

(a) Complete the following:

(4 marks)

The expected anode reaction:

The expected cathode reaction:

Suitable chemical or chemicals for the salt bridge:

The E° calculation for the cell:

(b) Label the diagram below for this electrochemical cell, including:

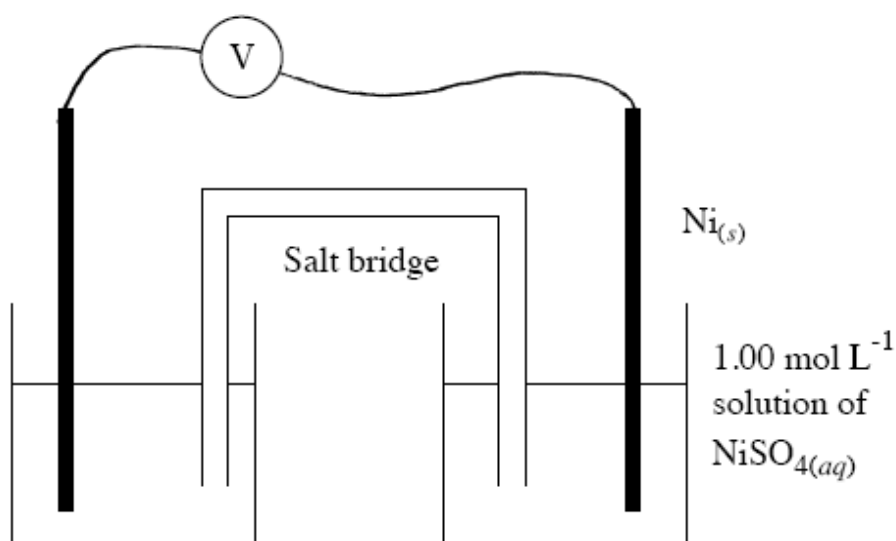
(4 marks)

(i) the materials in the second half cell

(ii) the **anode** and the **cathode**

(iii) the electron flow in the external circuit

(iv) the movement of ions through the salt bridge



Question 7 (7marks)

In VCE Chemistry Unit 4, you were required to investigate the industrial production of a chemical selected from ammonia, ethene, sulfuric acid or nitric acid. Choose one of these chemicals and circle it in the list below.

ammonia

ethene

sulfuric acid

nitric acid

a) Write a balanced equilibrium equation which is used in one of the steps in the production of your chosen chemical. Indicate whether the reaction is exothermic or endothermic. (3 marks)

b) Explain what conditions would lead to the maximum yield of the product in this reaction.

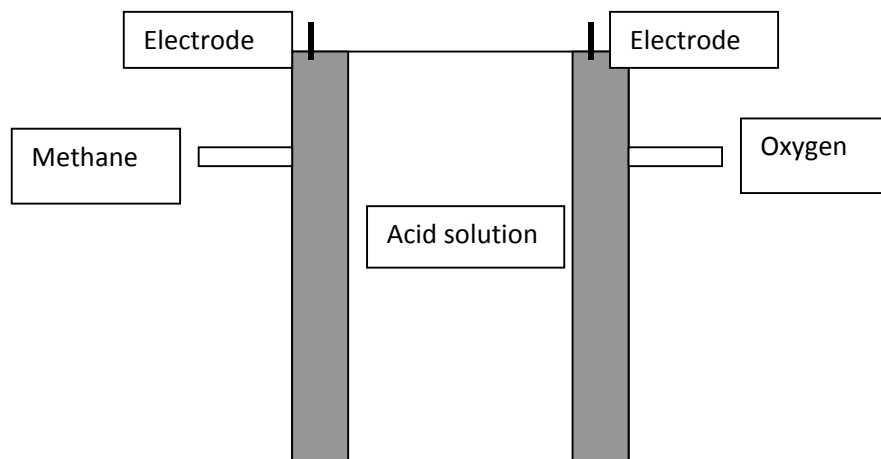
(2 marks)

c) Write the chemical formula of **one** useful product formed from the chemical you have chosen. (1 mark)

d) Give the name or formula of **one** waste chemical formed during the production of the chemical you have chosen. (1 mark)

Question 8 (9 marks)

A biogas generator can produce methane CH_4 from animal wastes or other organic material in the absence of oxygen. Biogas may contain up to 65 % methane. The biogas produced can be used in a fuel cell to generate electricity as shown below:



One of the products when methane reacts is carbon dioxide.

a) i) Write the half equation for the reaction at the anode. (1 mark)

ii) Write the half equation for the reaction at the cathode: (1 mark)

b) Write the overall equation for this fuel cell when it delivers electricity. (2 marks)

c) Label which electrode is the anode and the cathode of the cell and the polarity on the diagram. (2 marks)

d) Indicate the direction of electron flow on the diagram. (1 mark)

e) What would the advantages of this fuel cell be over a lead acid battery as a small scale energy source. (2 marks)

END OF EXAM

Physical constants

$$F = 96\,500 \text{ C mol}^{-1}$$

$$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$1 \text{ atm} = 101\,325 \text{ Pa} = 760 \text{ mmHg}$$

$$0^\circ\text{C} = 273 \text{ K}$$

$$\text{Molar volume at STP} = 22.4 \text{ L mol}^{-1}$$

$$\text{Avogadro constant} = 6.02 \times 10^{23} \text{ mol}^{-1}$$

Ideal gas equation

$$pV = nRT$$

The electrochemical series

	E° in volt
$\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$	+2.87
$\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$	+1.77
$\text{Au}^+(\text{aq}) + \text{e}^- \rightarrow \text{Au}(\text{s})$	+1.68
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \rightarrow 2\text{H}_2\text{O}(\text{l})$	+1.23
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$	+1.09
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag}(\text{s})$	+0.80
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightarrow \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$	+0.54
$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$	+0.40
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$\text{S}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{S}(\text{g})$	+0.14
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.00
$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s})$	-0.13
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Sn}(\text{s})$	-0.14
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ni}(\text{s})$	-0.23
$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Co}(\text{s})$	-0.28
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76
$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.83
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mn}(\text{s})$	-1.03
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Al}(\text{s})$	-1.67
$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s})$	-2.34
$\text{Na}^+(\text{aq}) + \text{e}^- \rightarrow \text{Na}(\text{s})$	-2.71
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Ca}(\text{s})$	-2.87
$\text{K}^+(\text{aq}) + \text{e}^- \rightarrow \text{K}(\text{s})$	-2.93
$\text{Li}^+(\text{aq}) + \text{e}^- \rightarrow \text{Li}(\text{s})$	-3.02

Periodic table of the elements

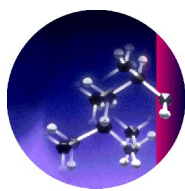
1 H 1.0																	2 He 4.0	
3 Li 6.9	4 Be 9.0																9 F 19.0	10 Ne 20.1
11 Na 23.0	12 Mg 24.3																17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 44.9	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.6	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8	
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.1	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3	
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 197.0	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)	
87 Fr (223)	88 Ra (226)	89 Ac (227)																

Lanthanides

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.3	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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Actinides

90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (255)	103 Lr (256)
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CHEMOLOGY EDUCATION SERVICES

Name: _____

CHEMISTRY EXAM 2 MULTIPLE CHOICE ANSWER SHEET

Colour the box after the letter corresponding to your answer.

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**☐

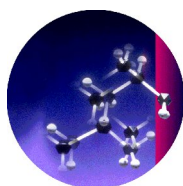
16. **A**☐ **B**☐ **C**☐ **D**☐

17. **A**☐ **B**☐ **C**☐ **D**☐

18. **A**☐ **B**☐ **C**☐ **D**☐

19. **A**☐ **B**☐ **C**☐ **D**☐

20. **A**☐ **B**☐ **C**☐ **D**☐



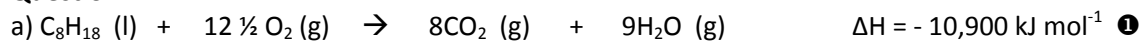
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SUGGESTED SOLUTIONS TO 2011 CHEMISTRY TRIAL EXAM 2

Section A

1 B	As Pressure increases it will favour side with smaller number of mole. The right.	11 C	The closer the two metals on the E^0 table the lower the EMF. Calcium will not be suitable as it reacts with water.
2 B	In pur water the $[H^+] = [OH^-]$. The value of the K_w will change with temperature.	12 C	Chlorine is produced as the electrolyte is concentrated brine.
3 D	Energy = Cal. Factor x ΔT $= 2.95 \times 12.7$ $= 37.47\text{kJ for } 3.5\text{g of bread}$ $37.47/5 = 10.7\text{kJ/g}$	13 B	
4 D	The activation energy for the reverse reaction will be $\Delta H +$ activation energy for forward reaction.	14 B	
5 C	Energy = $m \times C \times \Delta T$ $21,200 = 120.5 \times 4.18 \times \Delta T$ $\Delta T = 42.1$ $\Delta T = T_{\text{final}} - T_{\text{initial}}$ $42.1 = 71 - T_{\text{initial}}$ $T_{\text{initial}} = 28.9^\circ\text{C}$	15 B	
6 D	$K = \frac{[BCl_3]^2 \times [N_2]}{[BN]^2 \times [Cl_2]^3}$ $1.6 \times 10^{-3} = \frac{(0.2/2)^2 (0.1/2)}{(0.3/2)^2 [Cl_2]^3}$ $[Cl_2] = 4.8\text{M}$	16 D	
7 A	Adding H^+ will cause the reaction to move to the left, the $[H^+]$ will decrease and the pH will increase.(less acidic)	17 D	
8 A	Adding nitrogen will cause a forward reaction, also Pressure increase as the product side has the smaller number of mole.	18 C	
9 C	Adding product causes reaction to move backwards. K remains same as only temperature affects value of K.	19 A	
10 A		20 C	If a reaction occurs the oxidant must be higher on the E^0 table than the reductant. $X^+ \rightarrow X$ $Y^+ \rightarrow Y$ $Z^+ \rightarrow Z$ In the table strongest oxidants are at top left, with strongest reductants at bottom right.

Section B ① = 1 mark**Question 1**

b) Reaction is highly exothermic. ① $n(\text{reactants}) < n(\text{products})$ thus a greater pressure results, Pressure is proportional to mol. ①

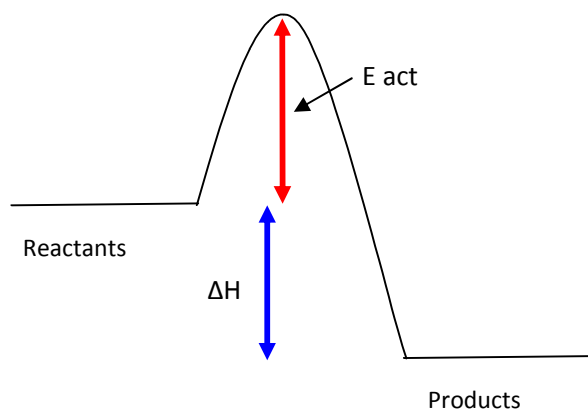
c) 1 mol octane releases 10,900 kJ

x mol releases 109,000 kJ ①

x = 10 mol of octane $m(\text{octane}) = 10 \times 114 = 1140\text{g}$ ①

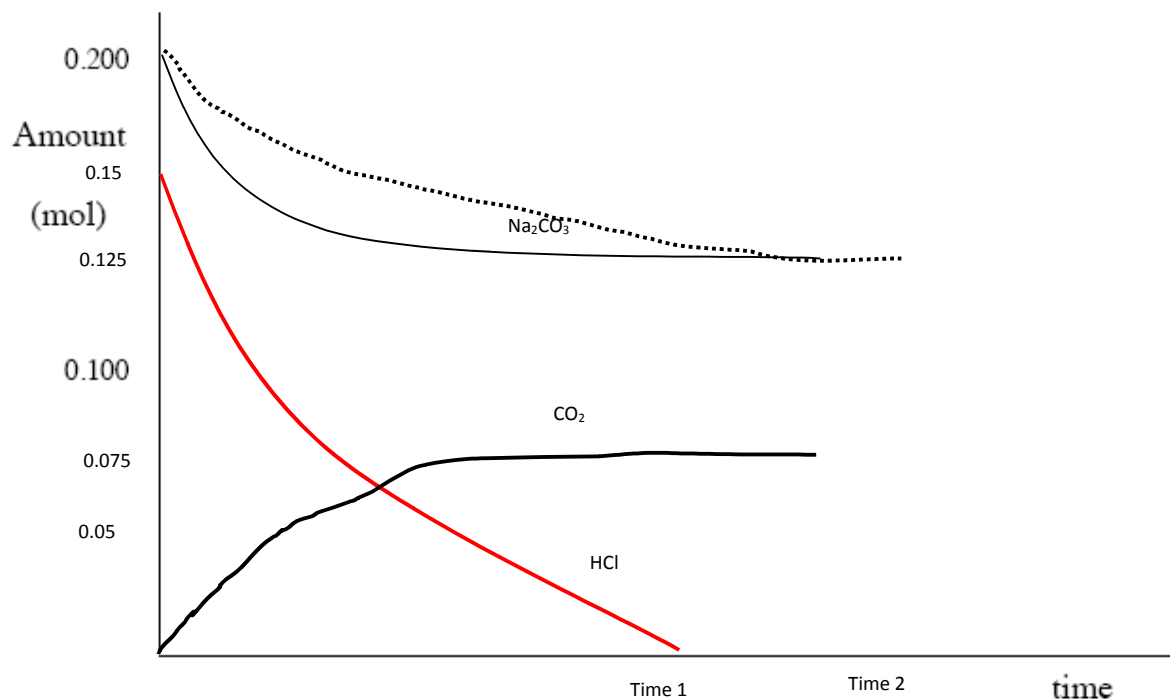
d) Need to overcome activation energy barrier. ① The energy is provided by the spark. ①

e)



Question 2

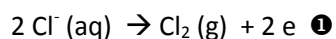
a)



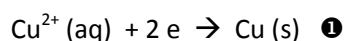
(b) Rate slower (dotted black line) due to much smaller surface area. ❶ There is less chance of fruitful collisions, thus the rate is much slower. There are fewer collisions per second between H^+ and Na_2CO_3 . ❷ A longer time to reach completion.

Question 3

a) Possible products Cl_2 , O_2 , Cu^{2+} . ❶ At the anode it is the strongest reductant present that will react first.



b) Possible products: Cu , Ni , H_2 . ❶ At the cathode it is the strongest oxidant present that will react first.



c) 1.32 volts

Question 4

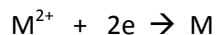
	$2\text{H}_2 (\text{g}) +$	$\text{S}_2 (\text{g}) \rightleftharpoons$	$2 \text{H}_2\text{S} (\text{g})$
Initially present	0	9×10^{-4}	1.1×10^{-2}
Reacts/produced	0.0024	$0.0024/2$ $= 0.0012$	$(1.1 \times 10^{-2}) - (8.6 \times 10^{-3})$ $= 0.0024 \text{ mol}$
Equilibrium	0.0024 mol	$(9 \times 10^{-4}) +$ 0.0012 mol $= 0.0021 \text{ mol}$	$8.6 \times 10^{-3} \text{ mol}$

$$K = \frac{(8.6 \times 10^{-3})^2}{(0.0024)^2 \times 0.0021} = 6114 \text{ M}^{-1}$$

Question 5

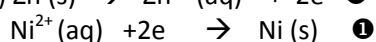
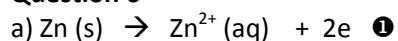
$$Q = It = 1.20 \times (38.0 \times 60) = 2736\text{C} \quad \text{①}$$

$$n(e) = Q/F = 2736/96500 = 0.0284 \text{ mol of electrons} \quad \text{①}$$



$$n(\text{Metal}) = \frac{1}{2} n(e) = \frac{1}{2} \times 0.0284 = 0.0142 \text{ mol} \quad \text{①}$$

$$M(\text{Metal}) = m/n = 0.897/0.0142 = 63.2 \text{ Thus the metal is Cu.} \quad \text{①}$$

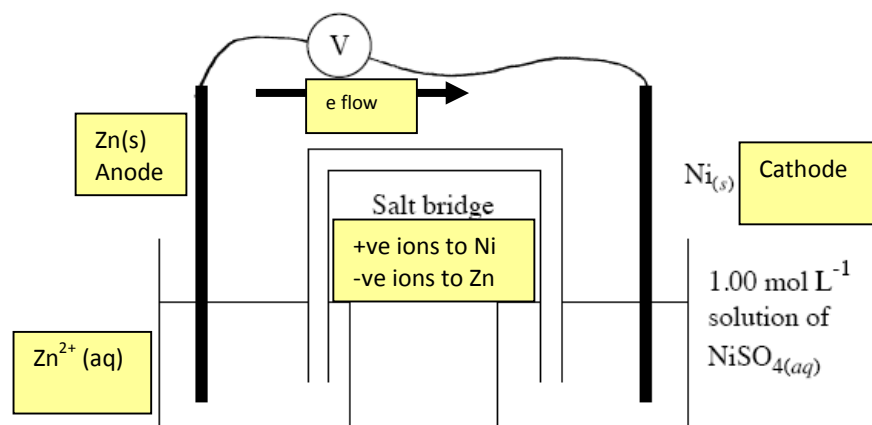
Question 6

Salt Bridge $\text{KNO}_3(\text{aq}) \quad \text{①}$

$$\text{EMF} = E^0(\text{oxidant}) - E^0(\text{reductant})$$

$$= -0.23 - (-0.76)$$

$$= 0.53 \text{ volts}$$

**Question 7**

a) One of the following: ①①① marks

Ammonia – $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ exothermic

Ethene – Several cracking reactions will be appropriate

e.g. $\text{C}_2\text{H}_6(\text{g}) \rightleftharpoons \text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$ endothermic

Sulfuric acid – $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ exothermic

Nitric acid – $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ exothermic

b) For reactions above

Chemical	Pressure	Temperature
Ammonia	High	Low
Ethene	Low	High
Sulfuric	High	Low
Nitric	High	Low

c) One of the following:

Ammonia – NH_4NO_3 , $(\text{NH}_4)_2\text{SO}_4$, $(\text{NH}_4)_3\text{PO}_4$, HNO_3

Ethene – $\text{C}_2\text{H}_5\text{OH}$, $-(\text{C}_2\text{H}_4)_n-$

Sulfuric acid – $\text{H}_2\text{S}_2\text{O}_7$, $(\text{NH}_4)_2\text{SO}_4$, ZnSO_4 , and other metal sulfates

Nitric acid – NH_4NO_3 , N_2O , metal nitrates

①

d)

One of the following:

Ammonia – CO_2 , aqueous ammonia

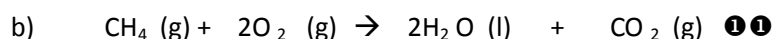
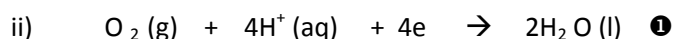
Ethene – unreacted feedstock, ethyne, CO_2 , H_2S , H_2 , CH_4

Sulfuric acid – SO_2 , spent catalyst

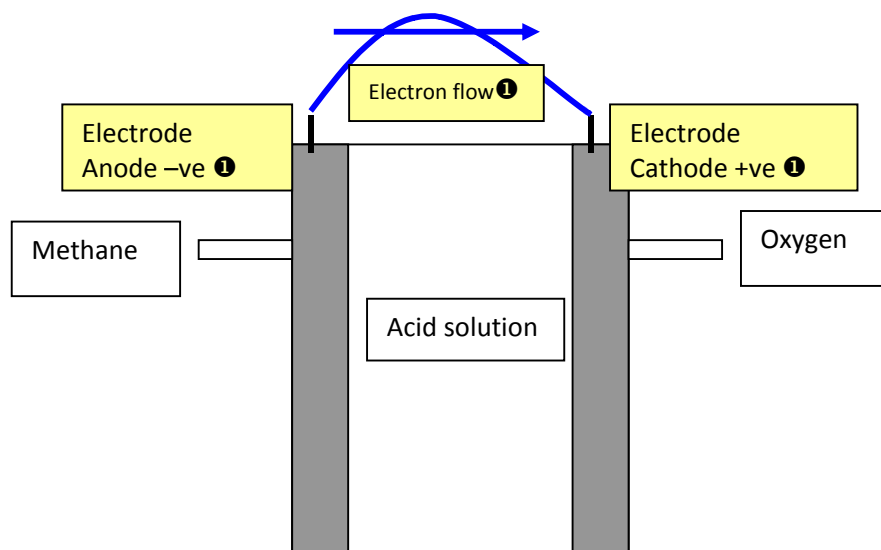
Nitric acid – NO , NO_2

①

Question 8



c)



e) Fuel cell is constant supply of energy while lead acid is storage cell. Fuel cell will be lighter in weight. No pollutants. No dangerous acids. Uses a renewable resource. ① ①