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2012 Trial Examination

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Unit 4 – Written examination 2

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

QUESTION & ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	8	8	61
			Total 81

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, VCAA data booklet and a scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 17 pages.

Instructions
- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions.
Choose the response that is **correct** or **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
No mark will be given if more than one answer is completed for any question.
Marks will **not** be deducted for incorrect answers.

Questions 1 and 2 refer to the following information

Ethyne gas, also known as acetylene, can be manufactured by a process of heating methane at very high temperatures. An excess of methane is used.

$$6CH_4(g) + 6O_2(g) \rightleftharpoons 2C_2H_2(g) + 10H_2O(g) + 2CO(g)$$

Question 1
The manufacturers use low pressure and high temperature for this process to ensure a high yield. These conditions are used because
A. they will minimise energy consumption of the process, ensuring that the process is viable
B. there are more product molecules than reactant molecules and the process is endothermic
C. there are more product molecules than reactant molecules and the process is exothermic
D. they are the standard conditions used for all reversible reactions

Question 2
The reaction mixture reaches equilibrium and then the temperature is increased further. After the system reaches equilibrium again, it is found that there are 12000 less oxygen molecules than before the temperature was changed. If the number of oxygen molecules changed by 12000, the net change in total molecules in the system will be
A. a decrease of 24000 molecules
B. unchanged because products are formed at the same rate reactants are consumed
C. an increase of 4000 molecules
D. anincrease of 28000 molecules

Question 3
The pH of a sample of pure water is found to be 6.8. This means that the
A. water cannot be pure because the pH should be 7
B. concentration of OH^- ions must be $10^{-7.2}$
C. value of K_w must be less than 10^{-14}
D. concentration of OH^- ions must be $10^{-6.8}$

Question 4
The pH of a solution is 1.1. The solution might be
A. 0.05 M H_2SO_4
B. 2.0 M HCl
C. 0.10M boricacid
D. 0.01M HCl

SECTION A - continued

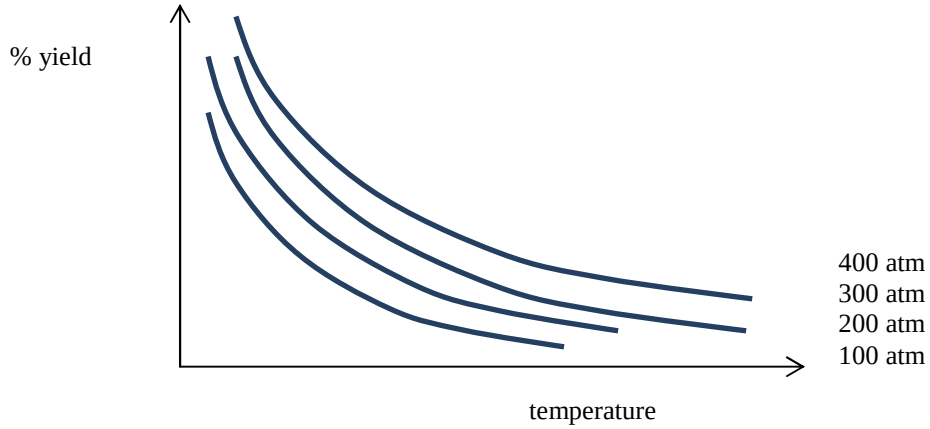
Question 5
Hydrogen iodide can decompose to form hydrogen gas and iodine gas. The equation is

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

When 0.034 mole of hydrogen iodide is added to an empty reactor, the amount of hydrogen gas at equilibrium is found to be 0.0080 mole. The numerical value of K will be
A. 0.0019
B. 0.0036
C. 0.024
D. 280

Questions 6 and 7 refer to the following information

The yield of a particular reversible reaction varies with changes to the temperature and pressure. The graph shows the trends in yield at a range of different conditions.



Question 6
From the graph it can be concluded that the reaction is a reversible one that is
A. exothermic with more product molecules than reactant molecules
B. endothermic with less product molecules than reactant molecules
C. exothermic with less product molecules than reactant molecules
D. endothermic with more product molecules than reactant molecules

Question 7
Some of the possible strategies available to the manufacturer to alter the rate include
I high temperature
II high pressure
III addition of an inert gas
IV use of a catalyst
Which of these factors above will lead to an increase in the rate of the reaction?
A. **II** only
B. **II**and **IV** only
C. **I**, **II** and **IV** only
D. all of the above

SECTION A - continued
TURN OVER

Question 8
Three weak acids of the same concentration are placed in separate beakers. The pH of the three beakers is measured and shown in the table below

Beaker	pH
A	4.1
B	2.9
C	4.8

From the values given in the table the acids could be, from beaker A to C,
A. hypochlorous, ethanoic and boric
B. benzoic, hypochlorous and boric
C. boric, ethanoic and hypochlorous
D. lactic, hydrocyanic and hydrofluoric

Question 9
A 0.1 M solution of a weak acid is found to have a 1% ionisation level. The pH of the acid will close to
A. 1
B. 1.1
C. 2
D. 3

Question 10
LPG gas is a mixture of propane and butane gases. The proportion varies with the source of the LPG. The mass of propane, in g, that releases the same amount of energy as 1.00 g of butane is close to
A. 0.90
B. 0.98
C. 1.00
D. 1.02

Question 11
Sulfur can be converted to sulfur trioxide, SO_3in a two step process. The overall equation for this process is

$$\mathbf{2S(g) + 3O_2(g) \rightarrow 2SO_3(g)}$$

The ΔH value for this reaction, given the following information, will be, in kJ mol^{-1},

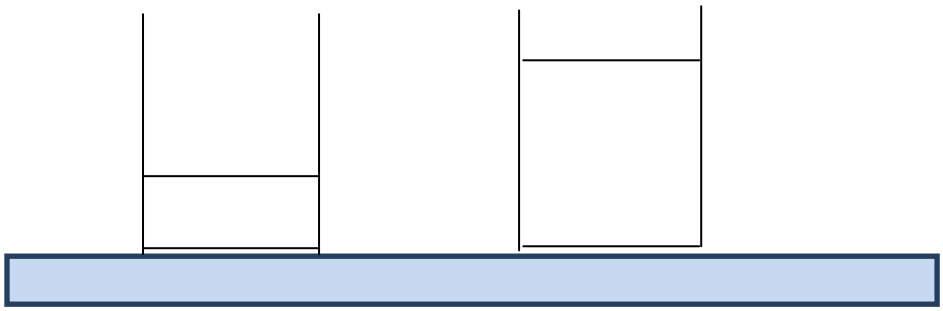
$$\mathbf{S(g) + O_2(g) \rightarrow SO_2(g) \quad \Delta H = -297\ kJ\ mol^{-1}}$$

$$\mathbf{2SO_3(g) \rightarrow 2SO_2(g) + O_2(g) \quad \Delta H = +198\ kJ\ mol^{-1}}$$

A. + 396
B. + 99
C. - 396
D. - 792

SECTION A - continued

Question 12
Two identical beakers are placed on a hot plate at the same time. The first beaker contains 12 g of water at 20 ^{0}C. The second beaker contains 30 g of water also at 20 ^{0}C. The beakers are heated until the first beaker reaches 35^{0}C. Assuming 100% efficiency of heat transfer to the water, what is the likely temperature, in ^{0}C, of the water in the second beaker?



A. 26
B. 30
C. 35
D. 57.5

Question 13
Four common sources of energy used in society are

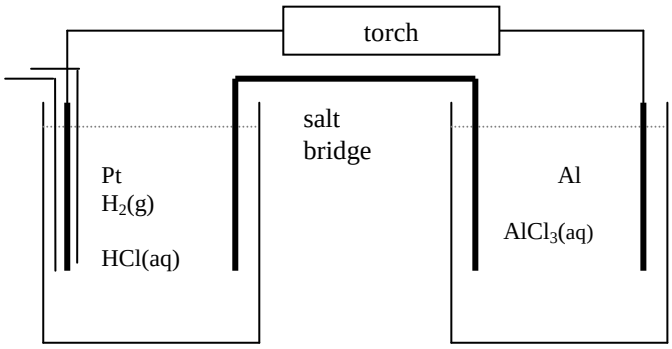
brown coal	galvanic cell	nuclear fission	photovoltaic cell
I	**II**	**III**	**IV**

The order of efficiency of these energy sources, from most efficient to least, is
A. **I, II, III** and **IV**
B. **II, III, I** and **IV**
C. **III, II, I**and **IV**
D. **IV, II, III** and **I**

Question 14
Methane gas is used as a fuel in an acidic fuel cell. The half equation occurring at the anode will be
A. $O_2(g) + 4H^+(aq) + 4e \rightarrow 2H_2O(g)$
B. $CH_4(g) + 2H_2O(g) \rightarrow CO_2(g) + 8H^+(aq) + 8e^-$
C. $CH_4(g) + 4H^+(g) \rightarrow CO_2(g) + 4H_2O(l) + 4e^-$
D. $CO_2(g) + 8H^+(aq) + 8e^- \rightarrow CH_4(g) + 2H_2O(g)$

Questions 15and 16 refer to the following information

A galvanic cell is established to power a torch, as shown below



Question 15
For this cell, the
A. electrons will flow from the aluminium to thehydrogen half cell
B. aluminium electrode will be the positive anode
C. concentration of aluminium ions in solution will be falling
D. hydrogen half-cell will be the negative cathode

Question 16
For this cell, the overall equation will be
A. $2Al(s) + 3H_2(g) \rightarrow 2Al^{3+}(aq) + 6H^+(aq)$
B. $3Cl^-(aq) + Al(s) \rightarrow AlCl_3(aq)$
C. $2Al^{3+}(aq) + 3H_2(g) \rightarrow 2Al(s) + 6H^+(aq)$
D. $2Al(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2(g)$

Questions 17 and 18 refer to the following information

Alkaline cells get their name from the fact that the electrolyte they use is a strong alkaline solution like potassium hydroxide. The high conductivity of the solution and the powdered zinc electrodes give the alkaline cell performance advantages over the standard zinc-carbon cells. The alkaline cells have a higher energy density, longer shelf life and lower internal resistance.

A typical alkaline cell utilises the following half-reactions.

$2MnO_2(aq) + H_2O(l) + 2e^- \rightarrow Mn_2O_3(s) + 2OH^-(aq)$ +0.76 V

$ZnO(s) + H_2O(l) + 2e^- \rightarrow Zn(s) + 2OH^-(aq)$ -0.71 V

Question 17
The overall equation occurring in this cell during discharge will be
A. $2MnO_2(aq) + Zn(s) \rightarrow Mn_2O_3(s) + ZnO(s)$
B. $2MnO_2(aq) + H_2O(l) + Zn(s) \rightarrow Mn_2O_3(s) + ZnO(s) + 2OH^-(aq)$
C. $2MnO_2(aq) + ZnO(s) \rightarrow Mn_2O_3(s) + Zn(s)$
D. $Mn_2O_3(s) + ZnO(s) \rightarrow 2MnO_2(aq) + Zn(s)$

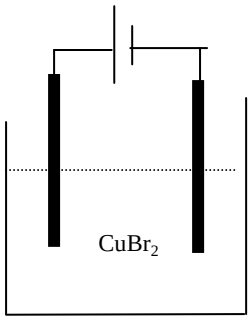
SECTION A - continued

Question 18
When this cell is discharging, the pH will
A. not be changing because all products and reactants are neutral
B. not be changing as the alkaline level is not changing
C. be increasing because OH^- ions are being consumed
D. be decreasing because OH- ions are being consumed

Question 19
In an electrolysis experiment, measurements reveal that 0.88 mole of material is formed at the anode and 1.76 mole of material is formed at the cathode. The electrolyte could be
A. 0.1 M $CuBr_2$
B. molten $MgCl_2$
C. 0.1 M NaCl
D. 5.0 M NaCl

Question 20
Electrodes are placed in an aqueous solution of copper bromide and the power supply switched on. A current of 2.0 amp flows for 48250secs.

The number of mole of copper that will be deposited at the anode in this cell will be
A. 0
B. 0.5
C. 1.0
D. 2.0



END OF SECTION A
TURN OVER

SECTION B – Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
To obtain full marks for your responses you should

- Give simplified answers with an appropriate number of significant figures to all numerical questions; simplified answers will not be given full marks.
- Show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s)

Question 1

The pH of a 0.010 M solution of a particular weak acid is found experimentally by a student to be 5.8. The expression for the acidity constant of the acid is

$$K_a = \frac{[H_3O^+][CN^-]}{[HCN]}$$

a.

i. Write a balanced equation for the reaction of the weak acid in water.

_____

ii. Use your Data Book to calculate the expected pH of a 0.010 M solution of this acid.

_____

_____

_____

iii. Suggest a possible reason for the difference between the pH value found by the student and the theoretical value obtained in part **ii**.

_____

_____

1 + 3 + 1 = 5 marks

SECTION B – Question 1 - continued

b. 20 mL of a 0.010 M HCN solution is compared to 10 mL of 0.001 M HCl.

Circle the correct answer in each of the following

i. The solution with the highest pH will be the HCN HCl

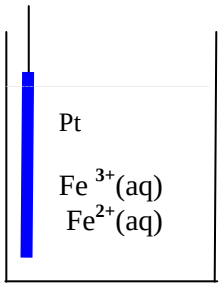
ii. The solution with the highest $[H_3O^+]$ will be the HCN HCl

iii. Which solution would require the largest volume of 0.01 M NaOH to neutralize the acid? HCN HCl

1 + 1 + 1 = 3 marks

Total 8 marks

Question 2



a. The half cell drawn above represents one of the half reactions shown on the electrochemical series.

i. Select the equation that this half cell is representing and write it out exactly as shown on the electrochemical series.

_____

ii. Which species is the reductant? _____

iii. You are asked to set this half cell up in a 250 mL beaker at standard conditions for an experiment. List all materials that you would use.

_____

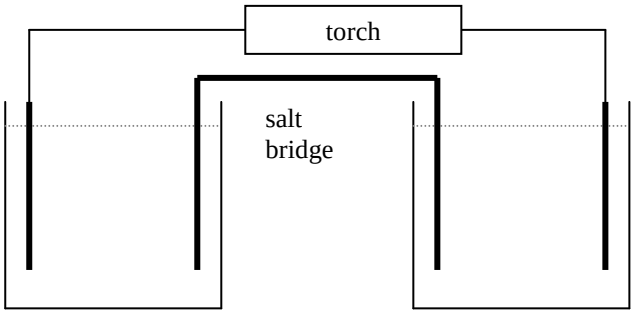
_____

1 + 1 + 2 = 4 marks

b. The half cell above is connected to a silver, silver ion half cell to power a torch

Use the outline below to show each of the following
- -the polarity of each electrode
- -direction of electron flow
- - half equations and overall equation

SECTION B – Question 2 - continued
TURN OVER



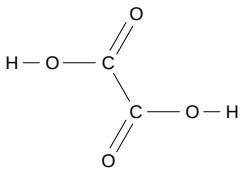
Half equation: _____ Half equation: _____

Overall equation: _____

4 marks
Total 8 marks

Question 3

Rhubarb is a plant grown in some parts of Victoria that has a stem like celery. The stem is edible and can be made into a pie, often mixed with apple. It has a very tart taste due to the presence of oxalic acid.
A molecule of oxalic acid is shown in the diagram.



When rhubarb is added to purple coloured potassium permanganate solution, $KMnO_4$, the solution slowly goes clear. This is a redox reaction between the oxalic acid and the MnO_4^- ions.

oxalic acid + MnO_4^- → colourless solution
purple

a. What is the molecular formula of the oxalic acid? _____

1 mark

b. When the oxalic acid reacts, it is oxidised to carbon dioxide.

i. Write a balanced half equation for the oxidation of the oxalic acid.

_____

ii. If a galvanic cell is formed between the oxalic acid and the MnO_4^-, what will the polarity of the oxalic acid electrode be?

_____

1 + 1 = 2 marks

SECTION B – Question 3 - continued

c. Three beakers are prepared that contain equal volumes of 0.10 M $KMnO_4$ solution. Three equal sized pieces of rhubarb are to be added to each beaker and the time it takes for the solution to become colourless is recorded.

beaker A
rhubarb added as one piece

beaker B
rhubarb sliced across middle

beaker C
rhubarb sliced as shown

i. List, in order of shortest time to longest, the times taken for each beaker to go colourless.

_____

ii. List, in order of slowest to fastest, the reaction rates of each beaker.

_____

iii. Suggest a reason for the different reaction rates obtained between beaker B and beaker C

_____

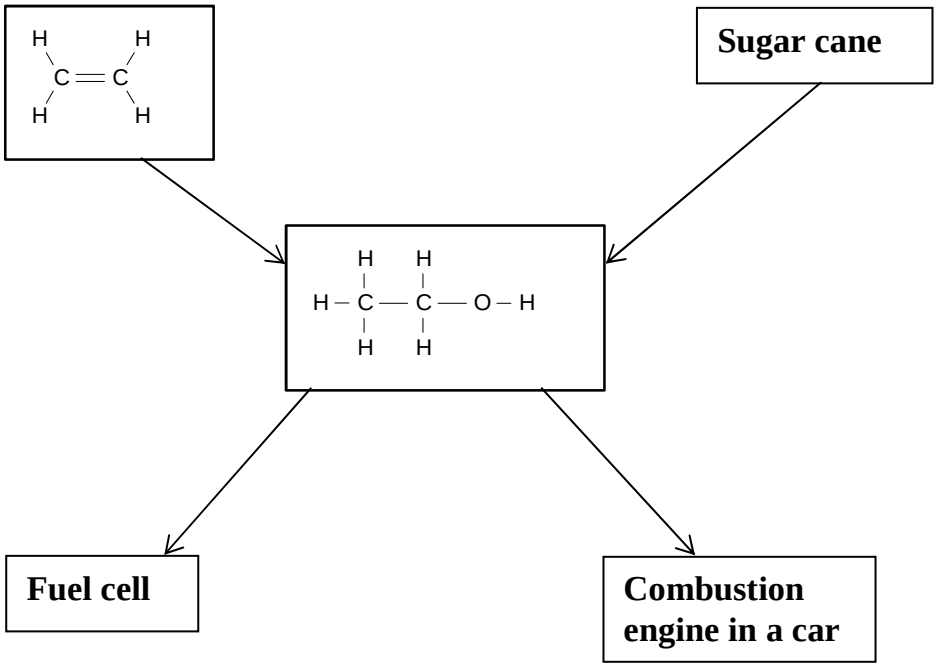
_____

1 + 1 + 1 = 3 marks
Total 6 marks

SECTION B – continued
TURN OVER

Question 4

Ethanol, C_2H_5OH, can be used as a fuel. Two sources of ethanol are shown in the flowchart below. Once the ethanol is produced it can be used in many ways. Two examples are in a fuel cell or blended with petrol in a conventional car engine.



a.

i. Which process for the manufacture of ethanol is considered to be the more sustainable? Explain your answer.

_____

_____

ii. List one disadvantage or limitation of the production of ethanol from sugar cane.

_____

1 + 1 = 2 marks

b.

i. Write a balanced overall equation for the combustion of ethanol in a car engine.

_____

SECTION B – Question 4 - continued

ii. Calculate the amount of energy released from the combustion of 10 litres of ethanol. The density of ethanol is 0.78 g mL^{-1} at the temperature used.

_____

_____

_____

_____

1 + 3 = 4 marks

c. Give the half equation for the reactions occurring at each electrode in an ethanol fuel cell if acid conditions are used.

anode: _____

cathode: _____

2 marks

d. Several energy conversions are required in the process of ethanol fuel causing a car to move. Outline what these energy conversions are in a conventional combustion engine car

_____

1 mark

Total 9 marks

Question 5

During the semester you have studied the production, properties and uses of one of the following industrial chemicals. Circle the chemical you have studied this semester.

ammonia ethane nitric acid sulfuric acid

a.

i. Write an equation for a reversible reaction occurring during the production of this chemical.

_____

ii. Explain the impact on this reaction of an increase in temperature.

_____

_____

SECTION B – Question 5 - continued

TURN OVER

iii. Explain the impact on this reaction of an increase in pressure.

_____

_____

iv. List one other strategy used to improve the yield in this reversible reaction.

_____

_____

1 + 1 + 1 + 1 = 4 marks

b. Write a balanced equation to show the formation of one of the reactants used in the reaction you chose in **part a. i**.

_____

1 mark

c. Explain one strategy used to minimize energy consumption during the production of your chosen chemical.

_____

1 mark
Total 6 marks

Question 6

Freon-12 is a CFC, a chlorofluorocarbon with a formula CCl_2F_2. Its use is now limited as a refrigerant because of links between it and the damage to the Earth's ozone layer. Freon-12 is manufactured in a reversible reaction between carbon tetrachloride and hydrogen fluoride;

$CCl_4(g) + 2HF(g) \rightleftharpoons CCl_2F_2(g) + 2HCl(g)$

a. As the temperature of this reaction is increased, the yield of Freon-12 increases.

i. What conclusion can you draw from this information?

_____

ii. Even though high temperatures increase the yield, the reaction is conducted at a relatively low temperature of 250 ^oC. Give two possible reasons for the temperature being limited to 250 ^oC

_____

_____

1 + 2 = 3 marks

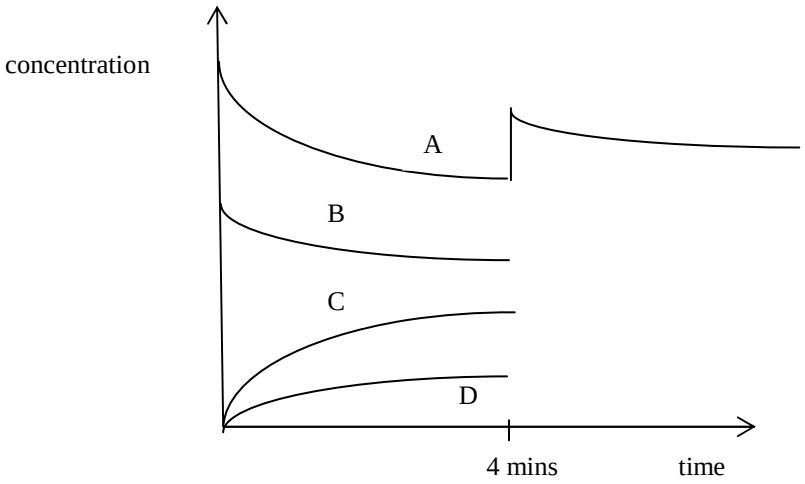
b. High pressures are not used in this reaction. Explain why.

_____

1 mark

SECTION B – Question 6 - continued

c. Reactants for this reaction are added to an empty reactor at 250 ^{0}C. The concentrations of each substance present are shown on the graph below.



i. Identify which graph represents each substance.

A _____ B _____

C _____ D _____

ii. What change was made to the system at the 4 minute mark?

_____

iii. The system will respond to partially oppose the change made at the 4 minute mark. Draw on the graph provided the concentrations of the other three substances present.

iv. How will the value of the equilibrium constant, K, compare after equilibrium is re-established? Explain your answer.

_____

_____

2 + 1 + 2 + 1 = 6 marks

SECTION B – continued
TURN OVER

Question 7
400 mL of 0.10 M $CuSO_4$ solution is added to a beaker. Inert electrodes are placed in the solution and a current of 0.23 amps is run through the circuit for 6.0 minutes.

a.

i. List the possible species present that might react.

_____

ii. List, in order of voltage, the half equations of each species present.

_____

_____

_____

iii. Write a balanced overall equation for the reaction that occurs.

_____

1 + 3 + 1 = 5 marks

b. Calculate the expected mass change at the negative electrode.

_____

_____

_____

3 marks

c. A gas is collected at the positive electrode. Calculate the volume of gas obtained if the gas is at SLC.

_____

_____

2 marks

d. Calculate the concentration of the copper ions in the solution after the 6 minutes has elapsed.

_____

_____

2 marks
Total 12 marks

SECTION B – continued

Question 8

a. A bottle of pure water is tested for pH. Two independent laboratories take two samples each. The pH is tested at 9 am by both laboratories and found to be 7.0. When the water is tested later in the day at 1 pm, both laboratories find the pH to be 6.8. Give a plausible explanation for the change in pH.

_____

_____

2 marks

b. A student burns a sample of ethanol under a beaker containing 80.0 mL of cooking oil.

The temperature of the oil changes from 12.3 ^{0}C to 31.4 ^{0}C.

To calculate the energy absorbed by the oil, the student performs the calculation below;

E = 4.18 x m x ΔT

= 4.18 x 80 x 19.1

= 6387 J

Give two problems with the working of the student.

_____

_____

2 marks

c. After careful examination of the electrochemical series, a student decides to connect a half cell containing fluorine gas with a half cell containing lithium metal.

i. Suggest one reason for the student to be interested in researching this cell.

_____

_____

ii. List one problem likely to arise with this cell.

_____

_____

1 + 1 = 2 marks

Total 6 marks

END OF QUESTION AND ANSWER BOOK