Student number: ……

Ascham School

2016

HIGHER SCHOOL CERTIFICATE

CHEMISTRY MIDCOURSE EXAM

General Instructions
Reading time - 5 minutes
Working time - 80 minutes

- Board approved calculators may be used
- Answer the multiple choice questions on the answer sheet provided
- Answer the extended answer questions in the spaces provided
- Use a black or a blue pen
- Draw diagrams using pencil
- A ***Data Sheet*** and ***Periodic Table*** are provided at the end of this paper
- Write your student number at the top of pages 1 and on the answer sheet.

Total Marks – 50

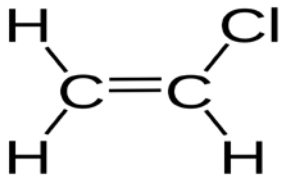
Part A – 10 marks Multiple-choice
- Attempt questions 1-10
- Allow about 16 minutes for this section
- Answer on the multiple choice answer grid provided

Part B – 40 marks Extended Answers
- Attempt all questions in this section
- Allow about 64 minutes

PART A – MULTIPLE CHOICE

Question 1

The important monomer shown below may be called by its common name or its systematic name.



What is the common name of this monomer?

a) Vinyl chloride

b) Styrene

c) Polyvinylchloride

d) Chloroethene

Question 2

Which of the following shows the correct property and structure of low-density polyethylene

	STRUCTURE	PROPERTY
a)	Highly branched	Flexible
b)	Very little branching	Rigid
c)	Highly branched	Rigid
d)	Very little branching	flexible

Question 3

Which of the following is a significant industrial source of ethylene?

a) Fermentation of sugar

b) Polymerization of poly(ethane)

c) Cracking of long chain hydrocarbons

d) Hydration of ethanol

Question 4

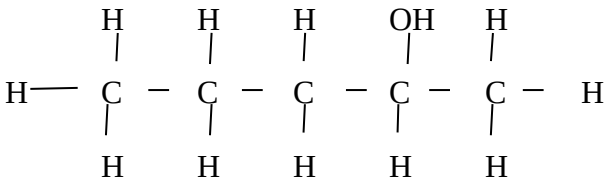
The heat of combustion of 1- butanol is 2676 kJ/mol

What is the value of heat of combustion in kJ/g

a) 30.41
b) 36.10
c) 44.60
d) 47.79

Question 5

The compound below is organic



The IUPAC name of this compound is:

a) pentanol
b) 2- propanol
c) 4- pentanol
d) 2- pentanol

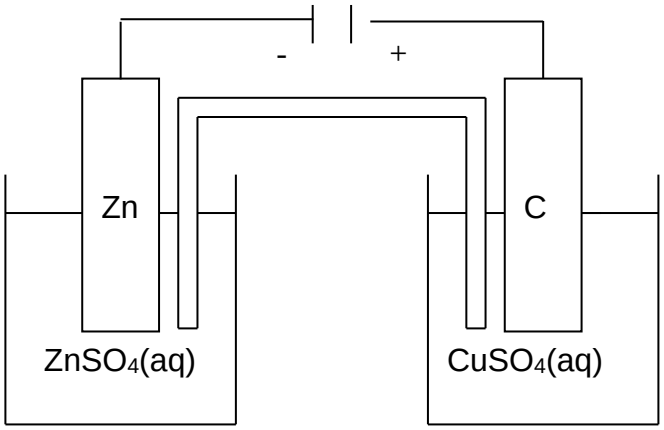
Question 6

Which of the following species **could not be** amphiprotic

a) H_2O
b) NH_3
c) HSO_4^-
d) CH_3COOH

Question 7

Consider the following electrochemical cell:



a) The electrons will move away from the zinc electrode and copper will be reduced at the carbon electrode
b) The electrons will move towards the zinc electrode and zinc will be reduced
c) The negative ions in the salt bridge will move towards the left hand half-cell and carbon will be oxidized
d) The positive ions in the salt bridge will move towards the left hand half cell and zinc will be reduced.

Question 8

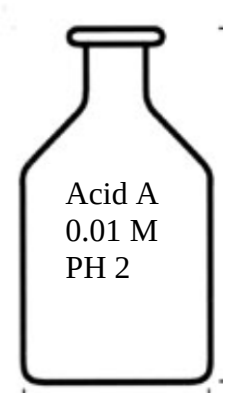
A buffer solution was prepared by adding a salt to a solution of acetic (ethanoic) acid

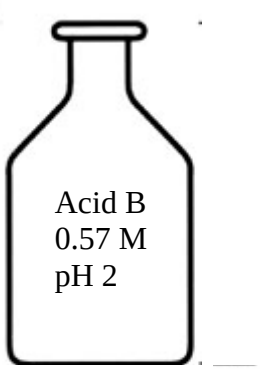
What is a suitable salt for this purpose?

a) Ammonium chloride
b) Potassium hydroxide
c) Sodium acetate
d) Sodium chloride

Question 9

Consider the following reagent bottles of acids:





In comparing these two solutions we can say that:

a) The $[H^+]$ is greater in the solution of acid A
b) The $[H^+]$ is greater in the solution of acid B
c) The acids are of equal strength
d) A is the stronger acid.

Question 10

Which of the following salts when dissolved in water will produce a solution with a pH of less than 7

a) NH_4Cl
b) NaCl
c) CH_3COONa
d) KNO_3

Student Number…….

SECTION B - EXTENDED ANSWERS

Question 11 **5 marks**

Ethanol is described as a “water-like” compound but also has properties of hydrocarbons

a) Referring to ethanol’s molecular structure, explain why it has similarities to both water and hydrocarbons. 3

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b) Construct chemical equations to demonstrate ONE renewable and ONE non-renewable method of ethanol production 2

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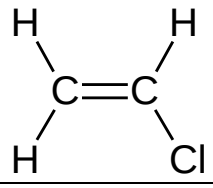
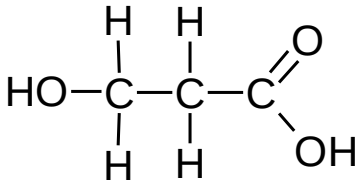
Student Number…….

Question 12 **4 marks**

The table below shows the structural formula of two monomers, labelled A and B.

Monomer	Structural formula
A	
B	

Using appropriate equations to support your answer, compare the polymerisation reactions of monomers A and B.

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Student Number…….

Question 13 **4 marks**

During this topic you gathered and presented information on the structure and function of an electricity producing cell.

Name the cell that you researched ……

Compare this cell to either a lead acid battery or a dry cell in terms of

- cost and practicality and
- effect on society

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Student Number…….

Question 13 **6 marks**

Assess the suitability of cellulose as a future source of energy and chemicals for industry.

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Student Number…….

Question 14 **4 marks**

During the Acidic Environment topic you were required to make and ester

Write a chemical equation for the esterification reaction you performed using structural or semi- structural formula 2

This experiment required a careful risk analysis. What were two significant risks in performing this experiment and what measures did you take to minimize the risks 2

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Question 15 **5 marks**

Both water and the hydrogen carbonate ion HCO_3^- are amphiprotic

a) Define amphiprotic 1

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b) Show, with an equation, the hydrogen carbonate ion behaving as an acid with hydroxide ion. 1

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c) Identify the conjugate acid/base pairs 1

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d) "The Lowry-Bronsted theory of acids and bases is more useful than the Arrenhius theory". Justify this statement. **2**

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Student Number…….

Question 23 **4 marks**

An experiment was performed to find the volume of carbon dioxide (at SLC) that is dissolved in a 2 litre bottle of Coca Cola.

The bottle was first weighed and then it was opened. It was left open with the lid removed for a period of time (3 days) and the mass was regularly recorded.

Data collected

Mass of bottle, cap and contents before opening	= 2,076.2 g
Mass 24 hrs after opening	= 2,067.9 g
Mass 48 hrs after opening	= 2,067.7 g
Mass 74 hrs after opening	= 2,067.5 g
Total mass lost	= 8.7g

a) Write an equation for the equilibrium that exists in this bottle between carbon dioxide and carbonic acid when it is closed tightly. 1

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b) Use this equation to explain why bubbles appear when the bottle cap is removed. 1

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c) From the data provided calculate the volume of gas that was released per litre of Coca Cola **2**

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Student Number…….

Question 24 **4 marks**

A chemist needed to determine whether a 0.001M solution of a diprotic acid was a weak acid rather than a strong acid.

(a) If the acid was strong what pH would you expect it to have? 1

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(b) Which indicator could she use to determine if the acid is strong or weak? 1

indicator	colour (low pH – high pH)	pH range
bromothymol blue	yellow-blue	6.0 – 7.6
litmus	red - blue	5.0 – 8.0
methyl orange	red - yellow	3.1 – 4.4
phenolphthalein	colourless - red	8.3 – 10.5

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(b) 50.00 mL of 0.250 M sulfuric acid was added to 25.00 mL of 0.300 M potassium hydroxide.

Calculate the pH of the resulting solution. 2

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Student Number……

Question 25 **4 marks**

Consider the following oxides:

Aluminium oxide	nitrogen dioxide	Carbon dioxide	Carbon monoxide	Magnesium oxide	Sulfur dioxide
Al_2O_3	NO_2	CO_2	CO	MgO	SO_2

(a) Write an equation for the reaction of sulfur dioxide with sodium hydroxide. 1

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(b) Identify one oxide that will react with HCl. 1

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(c) Outline a major concern associated with increasing concentrations of acidic oxides in the atmosphere.

Illustrate your answer by writing a reaction. 2

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END OF TASK

Student number: ……

2016

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MULTIPLE CHOICE ANSWER GRID

Place a cross through the correct alternative

Question 1	A	B	C	D
Question 2	A	B	C	D
Question 3	A	B	C	D
Question 4	A	B	C	D
Question 5	A	B	C	D
Question 6	A	B	C	D
Question 7	A	B	C	D
Question 8	A	B	C	D
Question 9	A	B	C	D
Question 10	A	B	C	D

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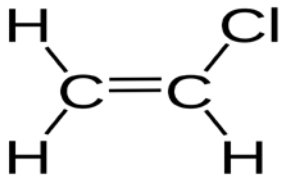

What is the common name of this monomer?

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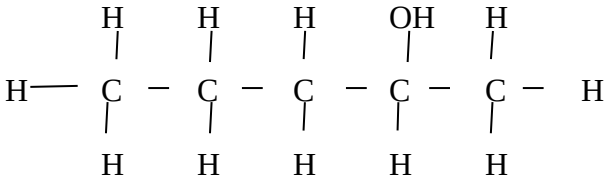

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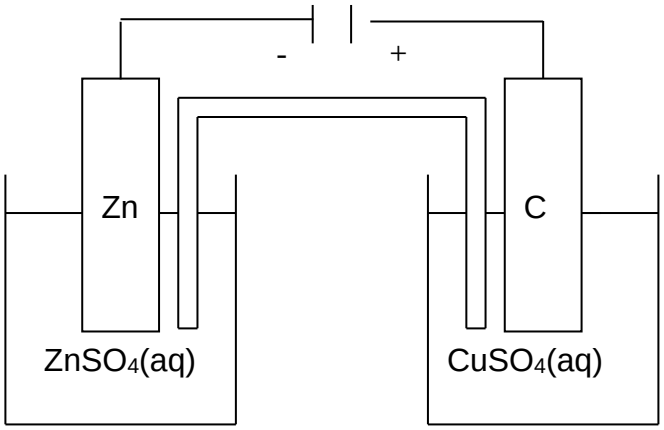

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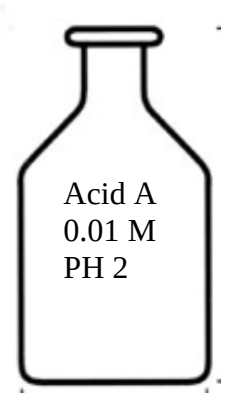

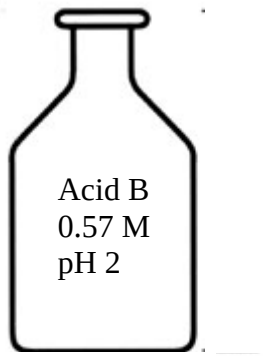

In comparing these two solutions we can say that:

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Question 10

Which of the following salts when dissolved in water will produce a solution with a pH of less than 7

a) NH_4Cl
b) NaCl
c) CH_3COONa
d) KNO_3

Student Number…….

SECTION B - EXTENDED ANSWERS

Question 11 **5 marks**

Ethanol is described as a “water-like” compound but also has properties of hydrocarbons

a) Referring to ethanol’s molecular structure, explain why it has similarities to both water and hydrocarbons.
3

Mark	Criteria
3	**Identifies polar end and nonpolar chain using good description or diagram** **AND** **Explains how polar end can, like water, dissolve polar substances** **AND** **Explains how the nonpolar chain enables it to dissolve nonpolar hydrocarbons**
2	**Identifies polar end and nonpolar chain with poor or incomplete explanation** **OR** **Identifies polar end and explain how it enables it to dissolve polar substances** **OR** **Identifies nonpolar end and explains how it enables it to dissolve nonpolar substances**
1	**Identifies polar end and nonpolar chain with no explanation**

Sample answer

Ethanol has a polar OH group on the end of the molecule and a short nonpolar carbon chain. This enables ethanol, like water, to form dipole/dipole bonds with polar substances that are strong enough to drag the molecules or ions into solution by using the polar end group.

The nonpolar chain of the ethanol molecules behaves like hydrocarbons by providing a nonpolar section that can form dispersion forces with nonpolar substances to dissolve them.

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

2

Mark	Criteria
2	**Identifies renewable method of production and writes correct equation** **AND** **Identifies non-renewable method of production and writes correct equation**
1	**Identifies a renewable Or a non-renewable method of production with a correct equation** **OR** **Identifies a renewable and non-renewable method of production without equations or equations incorrect.**

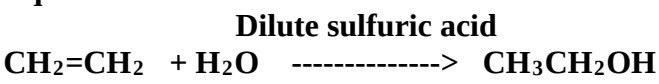
Sample answer

Ethanol can be produced from sugar or starch by fermentation with the aid of yeast . This is renewable because the source of sugar or starch can be regrown

Equation

Ethanol can be produced from ethene by hydration using dilute sulfuric acid as the catalyst. This is a nonrenewable source because ethene is derived from fossil fuels.

Equation



Student Number……

Question 12 **4 marks**

The table below shows the structural formula of two monomers, labelled A and B.

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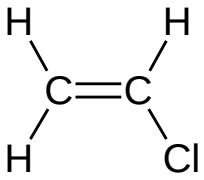
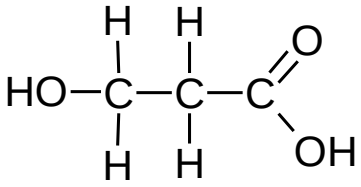
A	
B	

Using appropriate equations to support your answer, compare the polymerisation reactions of monomers A and B.

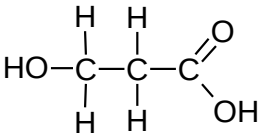
mark	criteria
4	**Identifies that A undergoes addition polymerization and writes correct equation** **AND** **Identifies B undergoes a condensation polymerisation and writes a correct equation**
3	**As above with one error or omission**
2	**Identifies A undergoes addition and B undergoes condensation polymerization** **OR** **Correctly writes two equations without identifying the type of polymerisation**
1	**Identifies type of polylmerisation for A or B or writes one correct equation**

Sample answer:

A is ethene and undergoes addition reaction to produce polyethane. In an addition reaction the double bond breaks and the monomer units join together to form a chain

Equation **n (CH_2=CH_2) ---> -(-CH2-CH2-)-$_n$**

B is a condensation reaction. The function groups at each end combine and eject a small molecule, often water, and a bond is made between the monomer units



-----> --(- O –CH_2-CH_2 C-O-CH_2-CH_2-C-O--)- +H_2O

Student Number……

Question 13 **4 marks**

During this topic you gathered and presented information on the structure and function of an electricity producing cell.

Name the cell that you researched ……**various cells – no mark awarded**……

Compare this cell to either a lead acid battery or a dry cell in terms of

- cost and practicality and
- effect on society

Mark	Criteria
4	**Makes valid comparison between the two cells of cost and practicality AND Makes a valid comparison between the two cells on effect on society AND Comparisons are explicit not implied**
3	**Describes the cost and practicality of each AND describes effect on society of each without an explicit comparison**
2	**Compares cost and practicality of each OR effect on society of each but not both**
1	**Describes cost and practicality of each OR effect on society of each but not both OR Describes cost and practicality and effect on society of one cell only.**

Sample Answer.
(comparison of lead acid and Vanadium redox cell)

Both the lead acid and vanadium cells are expensive. The lead acid because of the expensive chemicals it requires and the vanadium because it is still in the development stage so in future its cost should decrease. Both cells are large and bulky with and contain a liquid so they are only useful in applications where they can be kept upright and size is not an issue. They are both rechargeable and both be can used to store renewable energy such as solar energy although the vanadium cell is much more efficient. They can both be used to power electric vehicles although the potential to replace the electrolyte rather than recharge is a major advantage for the vanadium cell. Also the amount of energy stored by the vanadium cell can easily be increased by increasing the size of the electrolyte tank.
The lead acid cell enabled the motor vehicle to be started by an electric starter motor rather than a hand crank which was great development and made motoring accessible to more people. The vanadium cell has the potential to have an even larger impact on society by accelerating the push to renewable energy by providing superior storage and providing a better energy source for electric cars reducing societies dependence on fossil fuels.

This question could be answered in table form but you must ensure that each column is not just a list of features. Each feature for one cell needs a corresponding feature to the other cell right next to it in the table
Eg cell 1 rechargeable Cell 2 not rechargeable
If you say
Cell 1 rechargeable Cell 2 large and bulky you are not making a comparison.

Student Number…….

Question 14 **6 marks**

Assess the suitability of cellulose as a future source of energy and chemicals for industry.

Mark	Criteria
6	1. identifies that cellulose is a potential source of glucose and is renewable 2. identify that glucose can be used to make ethanol by fermentation 3. identifies that ethanol is an alternative fuel 4. identify that ethanol can be used to make ethene by dehydration and that ethene is an important chemical in making polymers 5. identifies the current problems in breaking cellulose into its monomer units 6. Gives an assessment And includes at an equation with either 2 or 3
5	One of the above is omitted or there is one serious factual error
4	4 of the criteria are adequately met
3	3 criteria are adequately met
2	2 criteria are adequately met
1	1 criteria is met

Sample answer

Cellulose is abundant form of biomass and can be sourced from wastes produced by other industries (eg the timber industry or sugar production). Unlike fossil fuels cellulose is a renewable resource

Cellulose is a polymer made of glucose monomer units. It is possible to break down the cellulose to glucose which could then be used as the starting point for the production of ethanol (an alternative fuel) and ethene (an important chemical needed in industry particularly in the production of polymers).

Ethanol can be produced from glucose by fermentation, using yeast.

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2CH_3CH_2OH + 2CO_2$$

Ethene can then be produced from the ethanol by dehydration using concentrated sulfuric acid as the catalsyt

$$CH_3CH_2OH \xrightarrow{\text{conc.H2SO4}} CH_2{=}CH_2 + H_2O$$

Unfortunately at present the process for breaking cellulose into its monomer units is very expensive and produces toxic wastes making it uneconomical and detrimental to the environment.

While at present fuel and chemicals for industry can be produced more cheaply from fossil fuels the finite supply of these means alternatives will be needed. Cellulose due to its renewability, abundance and potential to provide glucose monomers has the makings of an excellent alternative but better methods of breaking the cellulose down will be needed before it can fulfil its potential.

Student Number…….

Question 15 **4 marks**

During the Acidic Environment topic you were required to make and ester

Write a chemical equation for the esterification reaction you performed using structural or semi- structural formula 2

Mark	Criteria
2	**Correctly writes an equation with structural or semi structural formula including all reactants, products, catalyst and equilibrium arrows (states not necessary**
1	**Equation has one or two errors**
0	**Equation has more than 2 errors**

Various answers

This experiment required a careful risk analysis. What were two significant risks in performing this experiment and what measures did you take to minimize the risks 2

Mark	criteria
2	**Identifies two risks relevant to this experiment and gives risk minimisation strategy**
1	**Identifies one risk with suitable risk minimisation strategy** **OR** **Identifies two risks without suitable risk minimisation strategy**

Sample answer

What	Why is it a risk	Control measure
Volatile reactants and products	**The fumes are toxic (or chemicals are flammable)**	**Ensure good ventilation (fume cupboard) or store in fume cupboard** **(or Use water bath for heating)**
Concentrated acid	**Highly corrosive or toxic fumes**	**Wear protective clothing (googles and rubber gloves)** **Or only the teacher will handle the acid** **Or keep and pour acid in the fume cupboard**

Question 16 **5 marks**

Both water and the hydrogen carbonate ion HCO^{3-} are amphiprotic

a) Define amphiprotic 1

Gives correct definition

Eg. A species which can donate or accept a proton

b) Show with an equations the hydrogen carbonate ion behaving as an acid with hydroxide ion. 1

Writes correct equation

Eg. $HCO_3^- + OH^- \rightarrow H_2O + CO_3^{2-}$

c) Identify the conjugate acid/base pairs 1

Identifies one acid/base conjugate pair from the equation above

Eg. **HCO_3^- / CO_3^{2-} OR H_2O/ OH^-**

d) "The Lowry-Bronsted theory of acids and bases is more useful than the Arrenhius theory". Justify this statement.

2

Mark	**criteria**
2	**Justifies statement with two valid reasons**
1	**Justifies statement with one valid reason**

Specimen answer

The Arrenhius theory that acids produce hydrogen ions in solution only applies to aqueous solutions and excludes acids and bases which are not soluble or where water is not the solvent whereas the L-B theory that acids are proton donors can apply to systems which have a solvent other than water.

The Arrenhius theory gives no recognition of the role of the solvent (water). The L-B theory includes water in the reaction as a donor or receiver of a proton and is therefore able to act as an acidor base. an acid or a base in the The L-B theory can explain why some substances are able to react as a base in some situations or an acid depending on the other reactant. The Arrenhius theory cannot account for amphoteric (amphiprotic) substances.

The L-B theory can explain why some salts formed in neutralisation reactions are not neutral. The Arrenhius theory cannot

Other correct reasons are possible

Student Number……

Question 17 **4 marks**

An experiment was performed to find the volume of carbon dioxide (at SLC) that is dissolved in a 2 litre bottle of Coca Cola.

The bottle was first weighed and then it was opened. It was left open with the lid removed for a period of time (3 days) and the mass was regularly recorded.

Data collected

Mass of bottle, cap and contents
before opening = 2,076.2 g
Mass 24 hrs after opening = 2,067.9 g
Mass 48 hrs after opening = 2,067.7 g
Mass 74 hrs after opening = 2,067.5 g

Total mass lost = 8.7g

a) Write an equation for the equilibrium that exists in this bottle between carbon dioxide and carbonic acid when it is closed tightly. 1

Mark	Criteria
1	**Writes correct equation including states**
0	**Error in equation or states not included**

b) Use this equation to explain why bubbles appear when the bottle cap is removed. 1

Correctly applies le Chatellier's law to explain appearance of bubbles (le Chatellier need not be mentioned)

Eg.

c) From the data provided calculate the volume of gas that was released per litre of Coca Cola **2**

Mark	Criteria
2	**Calculates volume correctly to be 2.5 litres with two significant figures**
1	**Calculates volume correctly but has wrong number of significant figures** **OR** **Correctly calculates moles of carbon dioxide produced with correct number of significant figures**

Calculation
Mass $_{(CO2)}$ **= 8.7 g**
Mol $_{(CO2)}$ **= 8.7/44**
Vol $_{(CO2)}$ **= 8.7/44 x 24.79 per 2 litres**
= 2.5 L per litre to 2 sig fig.

Student Number…….

Question 18 **4 marks**

A chemist needed to determine whether a 0.0010M solution of a diprotic acid was a weak acid rather than a strong acid.

(a) If the acid was strong what pH would you expect it to have? 1

1 mark	**Correctly calculates expected pH**

Calculation
0.001M solution of H_2SO_4
[H+] = 0.002
pH = 2.7 to 2 sig fig
mark only awarded if diprotic nature of acid is identified

(b) Which indicator could she use to determine if the acid is strong or weak? 1

indicator	colour (low pH – high pH)	pH range
bromothymol blue	yellow-blue	6.0 – 7.6
litmus	red - blue	5.0 – 8.0
methyl orange	red - yellow	3.1 – 4.4
phenolphthalein	colourless - red	8.3 – 10.5

1 mark	**Correctly identifies methyl orange**

Reasoning (not required in answer)
If the acid is strong the pH will be less that 3 so the methyl orange will be red
If the acid is weak the pH will be more than 4.4 so the methyl orange will be yellow

(b) 50.00 mL of 0.250 M sulfuric acid was added to 25.00 mL of 0.300 M potassium hydroxide.

Calculate the pH of the resulting solution. 2

mark	criteria
2	**Correctly writes equation for reaction , calculates moles of acid and moles of base, determines excess and calculates pH**
1	**Correctly writes equation for reaction and calculates either the number of moles of acid or base** **OR** **Calculates the number of moles of acid and base**

Sample answer
Equation: H_2SO_4 + 2KOH → K_2SO_4 + $2H_2O$
$n_{(H_2SO_4)}$ = 0.05000 x 0.250 = 0.0125 **$n_{(KOH)}$ = 0.025 x 0.300 = 0.0075**
$n_{(H+)}$ = 0.0250 **$n_{(OH-)}$ = 0.00750**
excess H+ = 0.0250 – 0.00750
= 0.0175
[H+] = 0.0175/ 0.075 = 0.2333
pH = 0.632 to 3 sig fig

END OF TASK

Student Number……

Question 19 **4 marks**

Consider the following oxides:

Aluminium oxide	nitrogen dioxide	Carbon dioxide	Carbon monoxide	Magnesium oxide	Sulfur dioxide
Al_2O_3	NO_2	CO_2	CO	MgO	SO_2

(a) Write an equation for the reaction of sulfur dioxide with sodium hydroxide.
1

1 mark	**Writes correct equation (no states required)**

Equation: $SO_2 + 2NaOH \rightarrow Na_2SO_4 + H_2O$

(b) Identify one oxide that will react with HCl.
1

1 mark	**Identifies MgO as basic oxide or (Al_2O_3 is amphoteric)**

(c) Outline a major concern associated with increasing concentrations of acidic oxides in the atmosphere.

Illustrate your answer by writing a reaction.
2

marks	criteria
2	**Outlines a concern associated with acid rain and uses an equation to show how acidic oxides contribute to acid rain**
1	**Outlines concerns** **OR** **Uses equation to show how acidic oxides contribute to acid rain**

Sample answer

Acid rain is of great concern because it has been linked to deforestation (or acidifies waterways to upset the ecology or causes damage to limestone/marble building and monuments)

Oxides of carbon, nitrogen and sulfur contribute to acid rain. These oxides dissolve in water in the clouds to form weak acids
$SO_2 + H_2O \rightarrow H_2SO_3$

Student number: ……

2016

HIGHER SCHOOL CERTIFICATE

CHEMISTRY MIDCOURSE EXAM

MULTIPLE CHOICE ANSWER GRID

Place a cross through the correct alternative

Question 1	A	B	C	D
Question 2	A	B	C	D
Question 3	A	B	C	D
Question 4	A	B	C	D
Question 5	A	B	C	D
Question 6	A	B	C	D
Question 7	A	B	C	D
Question 8	A	B	C	D
Question 9	A	B	C	D
Question 10	A	B	C	D