**MARKING SCHEME,CHEMISTRY (2019) (100 marks)**

**S5, SECTION A: 70 marks**

1.a) Number of moles

 C H O

$\frac{57.82}{12}$ : $\frac{3.6}{1}$ : $\frac{38.58}{16}$

$\frac{4.81}{2.41}$ : $\frac{3.6}{2.41}$ : $\frac{2.41}{2.41}$

 2 : 1.5 : 1

 The empirical formula is : **(C4H3O2)n**

**(Give 1.5 marks for the working method and 0.5 mark for the final answer)**

b)The molecular formula of the compound if its molecular mass is 166 g/mol **(2 marks)**

(C4H3O2)n =166

(12X4)+(3)+(16X2) =166

83n =166

n=2

The molecular formula is : **C8H6O4**

**(Give 1.5 marks for the working method and 0.5 mark for the final answer)**

2. “Homologous series” **(2 marks)**

-Homologous series is a group of organic compounds that have the **same functional group** but **differ from each other by(CH2)** one methylene group.

**(Give 1mark for each statement highlighted in bold)**

**(Accept other correct descriptions)**

3. a) 3 structural formula of isomers of C5H11OH. **(3 marks)**



b) The structural formula of C5H11OH isomer that presents optical stereoisomerism. **(1 mark)**

**-Y**

c) The structural formula of C5H11OH isomer that reacts with ZnCl2 in HCl acid (Lucas test) to produce turbidity in less than 20 seconds.**(1 mark)**

**-Z**

d) The structural formula of C5H11OH isomer that reacts with K2Cr2O7 in H2SO4 solution to produce an aldehyde. **(1 mark)**

**-X**

4.a)1 physical properties of alkanes:**(1 mark)**

 -The first four members of alkanes are gases

-Alkanes are insoluble in polar solvents like water but are soluble in non-polar solvents like ether.

**(Give 1mark for any correct statement)**

**(Accept other correct answers)**

b) The mechanism of reaction for the following reaction:**(3 marks)**

 CH4 + Cl2 → CH3Cl + HCl



**(Give 1 mark each step)**

c) The social-economic importance of alkanes in biogas that is produced by decay of cowdung in domestic composts in our Rwandan society. **(2 marks)**

-The alkane in biogas is used for domestic combustion in kitchens and this results in preservation of the environment because charcoal and wood are not used.

-The alkane biogas helps the people to save money that would be used to buy charcoal

- The alkane biogas burns without sooty flames so the products of combustion do not pollute the atmosphere.

**(Give 1mark for each correct statement)**

**(Accept other correct answers)**

5.a) The organic compound produced by the elimination reaction between 1,2-dichloropropane and NaOH **(1 mark)**

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b) A test reagent you can use to distinguish between ethane and ethyne and the observable changes for the test. **(2 marks)**

-Reagent: Use bromine water

-Observation: The red colour of bromine becomes colourless (discharges)

**(Give 1mark for each correct statement)**

**(Accept other correct answers)**

6.a) The products of the following chemical reaction: **(2 marks)**

 + PCl5 → CH3COCl+ POCl3+HCl

c) 1 important use and 1 problem caused by alkyl halides to man. **(2 marks)**

**-**Important use: Alkyl halides are used to make hard polymers

**-**Problem: Alkyl halides in form of chlorofluorocarbons destroy the ozone layer

**(Give 1mark for each correct statement)**

**(Accept other correct answers)**

7.a) The products of the following reaction: **(2 marks)**

2CH3CH2CH2OH + 2Na → 2CH3CH2CH2O-Na+ +H2

**(Give 1 mark each product)**

b) A chemical test that can be used to distinguish between propan-1-ol and propan-2-ol and the observable change. **(2 marks)**

-Chemical test: Iodine and NaOH

-Observable change: The mixture of Iodine and NaOH react when heated with propan-2-ol to give a yellow precipitate but propan-1-ol does not.

8.a) 1 chemical properties of aldehydes that is differs from those ofketones. **(1 mark)**

-Aldehydes react with hot Fehling solution to give a brick-red precipitate whereas ketones do not.

**(Accept other correct answers)**

b) The products of reaction of the following equation: **(2 marks)**

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9.a) Increasing acid strength of carboxylic acids in order starting with the least strong. **(2 marks)**

CH3COOH < CH2ClCOOH <CH2FCOOH

c) The names of 2 components that are required to make soap. **(2 marks)**

-Sodium hydroxide

-Palm oil or oil or fats

**(Give 1mark for each correct statement)**

**(Accept other correct answers)**

10.a) In terms of physical and chemical properties, 2 differences between soap and detergents. **(2 marks)**

-Detergents are non-biodegradable while soap is biodegradable

-Detergents are made byartificial synthesis while soap is made from natural substances.

-Soap don’t produce lather with hard water but detergents do.

-Detergents are acidic and cannot be used to wash the human body but soap can be used to wash the human body.

**(Give 1mark for each of the 4 correct statements)**

**(Accept only two statements)**

b) The products of the reaction given below: **(2 marks)**

 CH3CH2CONH2 + NaOH + Br2 → CH3CH2NH2+NaBr +Na2CO3 + H2O

11.a) i) and ii) The structural formula of a dipeptide formed by an amide bond between 2 methionine amino acids. **(2 marks)**

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**(Give 1.5 marks the structure and 0.5 mark the position of the bond)**

b)2 important functions of polypeptides in the human body. **(2 marks)**

-Polypeptides form enzymes in the human body

-Polypeptides form the structural muscles and bones

**(Accept other correct answers)**

12.a) 2 important applications of solid, liquid and gas phase equilibria by man. **(2 marks)**

-Used in refrigerators

-Used in flammable gases which are kept in gas cylinders

**(Accept other correct answers)**

b) 10.6 g of Na2CO3 was dissolved in 1 litre of solution. 25 ml of the resultant solution was put in a beaker and phenolphthalein indicator added. 18.5 ml of HCl was required to neutralize the Na2CO3 solution.

i) The number of moles of Na2CO3 in 25 ml of solutionii) Calculate the number of moles of HCl that reacted with Na2CO3. **(2 marks)**

Molar mass of Na2CO3 =106 g/mole,

Number of moles of Na2CO3in 1 litre = 0.1 mole

Number of moles of Na2CO3 in 25 ml=$\frac{0.1}{1000}$ X 25 = **0.0025 mole**

iii) The molarity of HCl. **(2 marks)**

Number of moles of HCl used=0.0025 X 2 **=0.005 mole**

Molarity of HCl = $\frac{0.005}{18.5}$ X 1000 = **0.27 mole/litre**

13. a) Conductivity varies with increase in concentration of a solution of a strong electrolyte such as NaCl. **(2 marks)**

-As the number of ions carrying the current per unit volume increases, so the conductivity increases.

-But at a very high concentration the increase in concentration is not proportional to the increase in conductivity, this is due to the fact that at a very high concentration, the distance between oppositely charged ions decrease and this results into attraction of ions hence the speed of mobility of ions reduce(**ionic interference**).

c) The economic importance of conductivity in solutions in our Rwandan society. **(2 marks)**

-Conductivity may help to measure the salinity of water

-To detect leakages in industries

**(Accept other correct answers)**

14.a) The equation of the reaction at the cathode and anode during the electrolysis of CuSO4 aqueous solution using carbon electrodes. **(2 marks)**

Anode: 4OH- → 2H2O(l) + O2(g) + 4e

Cathode: Cu2+(aq) +2e → Cu(s)

b) An electric current of 2.5 amperes was passed in an aqueous solution of Al3+ ions for 20 minutes. **(3 marks)**

The mass of Al deposited at the cathode:

Number of charges used= 2.5 X 20 X 60 = 3000 coulombs

Number of moles of Al deposited = $\frac{3000}{96500X3}$ = **0.01036 mole**

Mass of Al deposited = 0.01036 X 27 = **0.27972 g**

**(Give 2 marks for the working method and 1 mark for the final answer)**

15. a) ∆H4 = X . **(3 marks)**

-487 +∆H4 =2∆H2 + 2∆H3

∆H4 = (2∆H2 + 2∆H3) -(-487)

∆H4 = (2X-393) + (2X-285.6) + 487

**∆H4 = -870.2 KJ/mole**

**(Give 2 marks for the method and 1 mark for the final answer)**

b) Using firewood is better than using charcoal in domestic kitchens while cooking food.

-Because a lot of energy is lost while burning firewood to get charcoal

-It also wastes energy of people who prepare charcoal. **(2 marks)**

**(Accept any other correct explanation)**

**SECTION B: Each questions in this section is 10 marks**

16.a)

**(2 marks)**

**(Give 1 mark if the only written formula is that of the product)**

b)

**(2 marks)**

**(Give 1 mark if the only written formula is that of the product)**

17.a) The mass of the metal, M that was deposited at the cathode:

Number of charges= 0.65X35X60= **1365 Coulombs (1 mark)**

Number of moles of M deposited = $\frac{1365}{96500X2}$**(1 mark)**

Number of moles of M deposited =**0.007 mole (1 mark)**

Mass of M deposited = 63.5X 0.007 = **0.4445 g (1 mark)**

b) Number of moles of copper deposited = $\frac{15.24}{63.5}$ = **0.24 mole (1 mark)**

The quantity of charges used **= 96500 X 2 X 0.24 = 46320 coulombs (1 mark)**

The quantity of charges used = Current X time =46320 C

Current X 3600 =46320 C **(1 mark)**

**Current =** $\frac{46320}{3600}$ **=12.86 Amperes (1 mark)**

c) 2 characteristics of a homologous series. **(2 marks)**

-Members of the same homologous series have similar chemical properties

-The physical properties of members of a homologous series either gradually decrease or increase with increase in molecular mass.

**(Give 1mark for each characteristics)**

18. a) IUPAC name of organic compound

**T: 2-bromobutane (1mark)**

b) i)

**(2marks)**



ii) Laevo and that is dextro:

**(2marks)**



c)

**(2marks)**



d) Test reagent used to determine whether Z is a primary, secondary or a tertiary alcohol:

**ZnCl2 in HCl acid (1mark)**

Observable changes:

White precipitate (turbidity) form in few **seconds for tertiary alcohols**, **(1mark)**

Turbidity forms in **5 minutes for secondary alcohols**. **(0.5mark)**

Turbidity forms after **many hours for primary alcohols. (0.5mark)**

19. a)The value of the number of water of crystallization (x) in hydrated zinc sulphate.

Mass of ZnSO4(s) = 7.4 g

Mass of xH2O(g) = 13.2-7.4= 5.8g

Molar mass of ZnSO4(s) = 65.5+32+(16x4) = 161.5g/mol **(1 mark)**

Molar mass of H2O = 18 g/mol **(0.5 mark)**

Number of moles of H2O = $\frac{5.8}{18}$ = 0.322 mole **(0.5 mark)**

Number of moles of ZnSO4 = $\frac{7.4}{161.5}$ = 0.0458 mole **(0.5 mark)**

RatioZnSO4 : H2O

$\frac{0.0458}{0.0458}$ = $\frac{0.322}{0.0458}$**(0.5 mark)**

 1 : 7

**Therefore X is : 7 (1 mark)**

b) Enthalpy change ∆H1 for the following reaction:

 C2H4(g) + H2(g) C2H6(g)∆H1 = ?

Given that:

 C2H4(g) +3O2(g) 2CO2(g) + 2H2O(l)∆H2 = -1410.9 KJ

 2C2H6(g) +7O2(g) 4CO2(g) + 6H2O(l)∆H3 = -3119.4 KJ

 2H2(g) + O2(g) 2H2O(l)∆H4 = -571.6 KJ

**Solution:**

∆H2 = ∆H1 + $\frac{1}{2}$∆H3 **(1 mark)**

∆H1 = ∆H2 - $\frac{1}{2}$∆H3 **(1 mark)**

∆H1 = -1410.9-(-1559.7) **(1 mark)**

**∆ H1 = +148.8 KJ (1 mark)**

**(Accept any other correct method)**

**c**) 2 factors that affect the magnitude of molar conductivity of solutions. **(2 marks)**

-Concentration of ions

-Temperature

-The nature of electrolyte that dissolves in water

**(Accept any 2 factors)**

20. Equations: Ag+(aq) + e → Ag(s) EӨ = +0.80 V

 Zn2+(aq) + 2e → Zn(s) EӨ = -0.76 V

 Fe2+(aq) + 2e → Fe(s) EӨ = -0.44 V

1. The e.m.f of the cell between the zinc electrode and silver electrode. **(2 marks)**

EӨ = EӨ cathode- EӨanode **(1 mark)**

EӨ = +0.80 –(-0.76) **(0.5 mark)**

EӨ = +1.56 V **(0.5 mark)**

**(Give 1.5 marks for the method and 0.5 mark for the final answer)**

1. State 2 observable changes seen: **(2 marks)**

-The zinc metal will have reduced in size partially or completely.

-There is a silver mirror on the sides of the boiling tube.

**(Accept other correct answers)**

1. To galvanise iron (Fe) metal and why. **(2 marks)**

-Zn can be used

-Reason: Zinc is capable of losing electrons to iron but silver cannot release electrons to iron.

**(Give 1 mark for the preferred metal and 1 mark for the reason)**

d) Heat energy released in KJ when 0.5 cm3 of ethanol is completely burned:

C2H5OH(l) + 3O2(g) → 2CO2(g) + 3H2O(l)

Mass of C2H5OH in 0.5 cm3 = $\frac{0.789}{2}$ =0.3945 g (**1 mark)**

Molar mass of C2H5OH = (12X2)+6+16=46 g/mol (**1 mark)**

Number of moles of C2H5OH in 0.5 cm3 = $\frac{0.3945}{46}$ = 0.008576 mole (**1 mark)**

Heat released when 0.5 cm3 = -1371 X 0.008576 = **-11.7576 KJ** (**1 mark)**

**(Give 3 marks for the method and 1 mark for the final answer)**

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