**MARKING SCHEME:CHEMISTRY (S5)**

**End of Year Examination: (100 marks)**

**End of Year Examination: 2020**

**SECTION A: (70 marks)**

1.a) Organic chemistry is the study of the structure, properties, composition, reactions and preparation of **carbon-containing** compounds **with the exception of simple salts such as carbonates, hydrogen carbonates and carbides.(2 marks)**

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

b) Four differences between organic and inorganic compounds:**(2 marks)**

**-**All organic compounds contain carbon atoms while most inorganic compounds do not contain carbon atoms.

**-** Organic compounds are volatile and highly inflammable while inorganic compounds are not.

**-** Organic compounds are insoluble in water but soluble in organic solvents while inorganic compounds are insoluble in water but soluble in organic compounds.

**-**Most organic compounds exhibit isomerism while very few inorganic compounds do exhibit isomerism.

**(Give 0.5 mark for each correct statement)**

**(Accept other correct answers)**

c) The reasons why carbon forms a large number of compounds:**(2 marks)**

-Carbon can form four chemical bonds to other atoms.

-Carbon atoms are small and therefore very fit to form large molecules.

-Carbon atoms can join head to tail to form rings of carbon atoms.

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

**(Consider only two correct answers)**

2.a) Isomerism is the existence of two or more compounds having **the same molecular formula** but with **different arrangement of atoms** within the molecule. **(2 marks)**

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

b) Drawing of but-2-ene:

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Names of stereoisomers:

-Cis but-2-ene

-Trans but-2-ene **(2 marks)**

**(Give 1 mark for the drawing and 1 mark for the names)**

3. The molecular formula of the compound: **(3 marks)**

 C : H : N

$\frac{60}{12}$ : $\frac{12}{1}$ : $\frac{28}{14}$

 5 : 12 : 2

Empirical formula: C5H12N2

Molecular formula: (C5H12N2)n =300

((12X5)+(12)+(14X2))n = 300

100n = 300

n = 3

**Molecular formula = C15H36N6**

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

4. a) The molecular formula of the hydrocarbon A. **(2 marks)**

Formula of an alkyne is given by:

CnH(2n-2) = 82

12n +1(2n-2) = 82

14n=82

n= 6

**Molecular formula : C6H10**

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

b) The atomic mass of bromine. **(2 marks)**

Since 1 mole of the hydrocarbon reacts with 4 bromine atoms to be saturated:

0.25 →82

1→ 4 X atomic mass of bromine (AM)

AM=82

**The atomic mass of bromine = 82**

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

c) Name: **2,5-dimethyl hex-3-yne (1 mark)**

5. a) Branched chain alkanes have less boiling point as compared to straight chain isomers because:**(2 marks)**

-In the linear alkanes, the **inter-molecular surface of contact is larger** than in branched chain alkanes with the same molar mass.

-As the **inter-molecular surface of contact becomes larger**, the **forces of attraction between molecules increase** and therefore **the boiling point increase much more in linear chain alkanes**.

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

b) Some traces of chloroethane may be formed when methane is chlorinated in addition to the normal chloromethane product because:**(2 marks)**

-During the free radical halogenation of methane, a **methyl radical may react with another methyl radical** in the chain termination step **to form ethane**.

-The **formed ethane can therefore also react** with a **chlorine radical to form chloroethane**.

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

c) -It is liquid at room temperature and pressure. **(1 mark)**

**(Accept other correct answers)**

6. a) Two reasons why the addition of lead to petrol has been discontinued: **(2 marks)**

-Lead emitted by combustion of petrol results in the cause of central nervous system damage in humans.

-Lead emitted by combustion of petrol results in the cause of accelerated ageing in humans.

-Lead emitted by combustion of petrol results in the cause of high blood pressure in humans.

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

**(Accept other correct answers)**

b) The heat of combustion of cyclohexane:**(3 marks)**

The heat of combustion of cyclohexane = ∆Hf(6CO2) + ∆Hf(6H2O)- ∆Hf(C6H12)

 = (6 X -394) +(6 X -294) – (-156)

**= -3924 KJ mol-1**

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

7. a) Appropriate reaction equations.:

Reaction equations:**(2 marks)**

 C2H6(g) + $\frac{7}{2}$O2(g) → 2CO2(g) + 3H2O(l)

 2H2(g) + O2(g) → 2H2O(l)

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

b)The volume of ethane in the mixture:

Since 1 volume of ethane reacts to give 2 volumes of CO2 ;

The volume of ethane= 60/2

= **30 cm3(1 mark)**

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

c)The percentage composition of ethane by volume in the mixture:**(2 marks)**

$\frac{30}{75}$X 100%

**= 40%**

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

8. a) CFC abbreviation in full words. **(1 mark)**

CFC :Chlorofluoro carbons

b) One use of CFCs. **(1 mark)**

 -Blowing agents for packing materials

-Are used as refrigerants

- Are used as solvents

**(Give 1 mark for any of the correct answers)**

**(Accept other correct answers)**

c) -The environmental effects caused by CFC:**CFCs react with ozone layer of the atmosphere and destroy this layer. (1 mark)**

-The way these effects can be avoided:

People can avoid emitting the CFCs iin the atmosphere by using other chemicals that substitute CFCs during use.**(1 mark)**

d) i) The chemical formula for ozone molecule:**(1 mark)**

**O3**

 ii) One beneficial presence of the ozone layer:**(1 mark)**

Ozone layer protects humans from ultraviolet rays of the sun.

 9. a) i) The name of the mechanism involved in this reaction. **(1 mark)**

-Electrophilic addition reaction

 ii) The mechanism for the reaction to get 1,2-dibromoethane. **(3 marks)**

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**(Give 1 mark for each step of the mechanism)**

 b) The name of the reaction of ethane with bromine in the presence of sunlight to form bromoethane. **(1 mark)**

**-Free radical substitution reaction**

10.a)i) The compound that you would expect to be the least soluble in water: **A(1 mark)**

1. A reason for your answer in 11a)i) above: **(1 mark)**

-It is because there are **no partial positive charges** nor **partial negative charges** on the atoms in the molecule.

(b) i) The IUPAC names of compounds A and C.**(1 mark)**

A: Propene

C: Propanone

**(Give 0.5 mark for each answer)**

ii) Name of one isomer of compound C:**(1 mark)**

-**Propanal**

11.a) IUPAC name of the aldehyde with the molecular formula of C3H6O:  **(1 mark)**

**-**Name: Propanal

b) Structural formula and name: **(2 marks)**

**(Give 1 mark for the structural formula and 1 mark for the name)**

c) Chemical equation: **(2 marks)**

3CH3CH2CHO + Cr2O72-(aq) + 8H+ → 3CH3CH2COOH + 2Cr3+(aq) + 4H2O(l)

12. Compound A has the molecular formula C5H10O

a) Structural formula of the possible isomer of A: **(1 mark)**

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b) Chemical equation between compound A and iodine in aqueous NaOH:  **(2 marks)**

 CH3CH2CH2COCH3 +4OH- + 3I2 → CH3CH2CH2COO- + 3I- + 3H2O + CHI3

**(Give 1 mark for unbalanced equation)**

13. a) Chemical test to distinguish between methyl amine and dimethyl amine:  **(2 marks)**

**-Test: HNO2**

**-**Observation: A **yellow oily liquid** is formed **with dimethylamine** but **with methylamine**, it is a **colourless gas** that is given off.

**(Give 1 mark for the test reagent and 1 mark for the observations)**

b) Chemical test to distinguish between propanal and propanone:  **(3 marks)**

-Test: Tollens reagent

-Observation: A **silver mirror** is formed **with propanal** but **not with propanone** .

**(Give 1 mark for the test reagent and 2 marks for the observations)**

14. The pressure-temperature phase diagram for

 substance, X.

1. **** **(2 marks)**

b) The name of point A and its significance. **(2 marks)**

Point A: Triple point

Significance of point A: It is a point at which the **solid, liquid and gas** phases **coexist in equilibrium**.

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

1. Examples gadgets (instruments) which are used by man in daily life that function by applying the principle of phase change. **(2 marks)**

-Refrigerator

-Combustible gas cylinder

**(Accept other correct examples)**

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

15.a) The second law of thermodynamics states that the **total entropy of an isolated system can never decrease** over time and **is constant if all processes are reversible**. **(1 mark)**

**(Give 0.5 mark for each underlined statement)**

1. Spontaneous reaction is a reaction that favours the formation of products at the conditions under which the reaction is occurring.

An example of such a reaction: Reaction between sodium and water. **(2 marks)**

**(Give 1 mark for the description and 1 mark for the example)**

**SECTION B: Attempt three questions in this section (30 marks)**

16. a) **-** Suitable indicator: Phenolphthalein **(0.5 mark)**

**-**Colour change observed: The pink colour changes to colourless at the end-point . **(0.5 mark)**

b) The number of moles of HCl used in 26.05 cm3. **(2 marks)**

$\frac{0.11}{1000}$ X 26.05

=**0.0028655 mole**

c)The number of moles of Na2CO3 in 25 cm3 of solution. **(2 marks)**

$\frac{0.0028655}{2}$ = **0.00143275 mole**

d) The number of moles of Na2CO3 in 500 cm3 of solution in the volumetric flask. **(1 mark)**

$\frac{0.00143275}{25}$ X 500

**= 0.028655 mole**

1. The molarity of Na2CO3 solution. **(2 marks)**

$\frac{0.00143275}{25}$ X 1000

$=$ **0.05731 mole/litre**

f) The number of moles of crystallization **X** inNa2CO3.xH2O **(2 marks)**

Mass of Na2CO3 in the sample = 0.05731 X 106/2 = 3.03743g

Mass of H2O = 8.2 -3.03743 = 5.16257 g

Number of moles of H2O in 500 ml= 0.2868 mole

X= $\frac{0.2868}{0.028655}$

**X= 10**

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

**(Accept other correct working methods)**

17.

a)Two reasons why steel objects are plated (covered) with chromium. **(2 marks)**

-Chromium does not rust

- Chromium makes objects look attractive.

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

b) i) The ionic half-equation for the reaction at the negative electrode (cathode). **(2 marks)**

 Cr3+(aq) + 3e → Cr(s)

 ii) Name of this gas: Oxygen **(1 mark)**

iii) Explanation:

Chromium anode does not dissolve properly into the solution. **(2 marks)**

c) 3 examples of applications of electrolysis on a large scale. **(3 marks)**

-Electroplating of coins

-Production of aluminium

-Production of chemicals.

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

18.a)Enthalpy change of neutralization is that which occurs when one mole of H+ ions react with one mole of OH- ions to form one mole of H2O. **(2 marks)**

b)i) The plastic coffee cup container does not let much heat to escape from the container to the surroundings. **(1 mark)**

 ii) The mass of the solution is: 75+ 75 = 150 cm3 **(1 mark)**

iii) The quantity of heat liberated (heat change) in this experiment. **(2 marks)**

Quantity of heat liberated= m.c.Өt

Quantity of heat liberated= 150 X 4.18 X (48.5-21)

Quantity of heat liberated= 150X4.18X 27.5

Quantity of heat liberated= 17242.5 J =**17.2425 KJ**

iii) The number of moles of H2O which were $H\_{2}O$formed during this experiment. **(2 marks)**

= $\frac{4}{1000}$ X75 = **0.3 mole**

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

v) The standard enthalpy change of neutralization to form 1 mole of water H2O, in KJmol-1. **(2 marks)**

$\frac{17.2425}{0.3}$ **= 57.4775 KJ mol-1**

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

19.*a*) i) The structural formula of methyl propanoate. **(1 mark)**

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ii) The chemical equation for the reaction between methyl propanoate and sodium hydroxide. **(2 marks)**

CH3CH2COOCH3 + NaOH → CH3CH2COO- Na+ + CH3OH

b) Appropriate equations for the synthesis of amino ethane, CH3CH2NH2 from methyl propanoate indicating the reactants and conditions required. **(4 marks)**

 

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

**(Accept other correct methods)**

c) Chemical test: I2 in NaOH**(1 mark)**

Observable changes for a positive test: A yellow precipitate is formed with ethanol but not with amino ethane. **(1 mark)**

**(Accept other correct answers)**

d)The zwitterion form of cysteine amino acid. **(1 mark)**

 

20.a) i) The term hydrocarbon:

A hydrocarbon is a compound consisting entirely of hydrogen and carbon.  **(2 marks)**

 ii) The molecular formula of compound A. **(2 marks)**

C : H

 $\frac{85.63}{12}$ : $\frac{14.37}{1}$

$\frac{ 7.135}{ 7.135}$ : $\frac{14.37}{7.135}$

 1 : 2

Empirical formula is: CH2

Molecular formula is: (CH2)n = 86

(12+2)n = 86

 n = 6

**Molecular formula: C6H12**

 b)

 **(3 marks)**

 c) The reaction between B and hot NaOH to give C. **(2 marks)**

CH3CHBrCH2CH2CH2CH3 + OH- → CH3CHOHCH2CH2CH2CH3 (Alcohol C)

d ) Balanced chemical equation to obtain D. **(1 mark)** CH3COOH**+** CH3CHOHCH2CH2CH2CH3 H+ H3COOCH(CH3)CH2CH2CH2CH3 (Compound D)

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