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

**S2, SECTION A: (70 marks)**

1. a) The ionic bond is formed when there is **electrostatic attraction** between one or more **positively charged ions and one or more negatively charged ions** to make one molecule.**(2 marks)**

**(Accept any other correct description)**

**(Consider the underlined statements when awarding marks)**

b) 2 properties of covalent bonds **(2 marks)**

-Covalent compounds have low melting and boiling points

-Covalent compounds are soluble in non-polar solvents.

**(Accept any other correct properties)**

**(Give 1 mark for each correct physical properties)**

c) -Graphite allotrope of carbon conducts electricity but diamond allotrope does not conduct electricity because in graphite, there are 3 electrons that participate in carbon to carbon bonding and **the fourth electron is free**, **mobile** and conducts electric charges.

-In diamond, **all four electrons of carbon atoms participate in covalent bonding** thus there is no possibility of conduction of electric charges.**(2 marks)**

**(Accept any other correct description)**

**(Consider the underlined statements when awarding marks)**

1. a) -The metallic character increases as you move down a group, it is because the **number of shells increase as you move dow**n the group and the **outermost shell electrons becomes more loosely attracted** to the nucleus.

-So it becomes much easier to lose the outermost shell electrons as you move down the group. **(2 marks)**

**(Accept any other correct description)**

**(Consider the underlined statements when awarding marks)**

b) -The metalloids are economically important since they are used to make **various devices such as transistors, diodes and resistors** needed in electronic gadgets like radios, television sets and computers. These **devices are sold in exchange of money** and therefore the economy of countries is raised.

-Metalloids such silicon is used also in glassware manufacture.**(2 marks)**

**(Accept any other correct and reasonable arguments)**

**(Consider the underlined statements when awarding marks)**

c) Names of 2 elements you can find free, uncombined in nature:**(2 marks)**

-Gold (Au)

-Diamond (carbon)

**(Accept any other correct and answers)**

3.a) 1 danger that can be caused by polluted water:**(1 mark)**

**-**Illnesses such as diarrhea and cholera

**(Accept any other correct and answers)**

b) 2 ways water pollution can be prevented. **(2 marks)**

 -Avoid spillage of garbage in rivers

 -Avoid over-use of manufactured fertilisers in fields

**(Accept any other correct and answers)**

4.a) -The problem of domestic wastes can solved by putting damping biodegradable wastes in composts to decay.

-The non-biodegradable wastes like plastics and glass can be taken to factories for recycling so that they are re-used later. **(2 marks)**

**(Accept any other correct and answers)**

b) Names of 2 non-biodegradable wastes **(2 marks)**

-Detergents used for cleaning

-Plastics

**(Accept any other correct and answers)**

5. a) Balance equation:**(2 marks)**

2KClO3(s)heat 2KCl(s) + 3O2(g)

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

b) The observable changes in the reaction mixtureafter four days:**(2 marks)**

-The blue colour of copper sulphate disappears and turns colourless

-There is deposition of a brown solid on the bottom of the container

-The zinc solid disappears.

**(Give 1 mark for any of the two answers given above)**

6.a) A saturated solution is that which contains **less than the maximum amount of solute** such that **if more of the solute is added, it does not dissolve**.**(2 marks)**

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

b) Solid compounds: NaCl, Pb(NO3)2, CaCl2, BaSO3.

i) Is easily decomposed to give a brown gas: **Pb(NO3)2(1 mark)**

iii) Reacts with warm dilute nitric acid to give off a colorless gas:**BaSO3(1 mark)**

iv) Burns when solid to give a yellow flame: **NaCl(1 mark)**

7. a) The chemical equation for the preparation of phosphorous pentoxide P2O5:**(2 marks)**

4P(s) + 5O2(g) → 2P2O5(s)

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

b) 2 important uses of phosphorous:**(2 marks)**

-Phosphorous is used to make match stick heads

- Phosphorous is used phosphates used in fertilisers

**(Accept other correct answers)**

8. a) The term strong electrolyte refers to **a solution** whose **solute molecules completely dissociate into ions**.**(2 marks)**

**(Consider the underlined statements when awarding marks)**

b) 2 useful applications of electrolytes **(2 marks)**

-Electrolytes (sulphuric acid) are used in vehicle batteries to generate current

-In the human stomach the solution of solute ions such as H+, Cl-, Na+, Mg2+ is needed so that they can enter the bloodstream in the intestines.

 **(Accept other correct answers)**

9. Organic compound X contains carbon, hydrogen and oxygen atoms. A sample of compound X with 8.48 g by mass is completely burnt in oxygen. The products of combustion give 16.9 g of CO2 and 6.92 g of H2O.

a) The empirical formula of compound X: **(4 marks)**

 Number of moles of CO2 = $\frac{16.9}{44}$ = 0.384 mole

Number of moles of H2O = $\frac{6.92}{18}$ =0.384 mole

Number of moles of C = 0.384,

Number of moles of H=0.384 X 2= 0.768

Mass of C= 0.384X12=4.608 g

Mass of H =0.768X1= 0.768 g

Mass of O= 8.48-(4.608+0.768)

Mass of O= 3.104 g

Number of moles of O= $\frac{3.104}{16}$ =0.194 mole

Ratio: C : H : O

$\frac{0.384}{0.194}$ : $\frac{0.768}{0.194}$ : $\frac{0.194}{0.194}$

 2 : 4 : 1

 Empirical formula is (**C2H4O)n**

**(Give 3.5 marks and 0.5 mark for the final answer)**

b) The molecular formula of compound X if its molar mass is 88 g/mol. **(2 marks)**

(C2H4O)n = 88

((12x2)+4+16)n=88

44n =88

n=2

The molecular formula of compound X is **C4H8O2**

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

10. a) Graham”s law of diffusion of ideal gases states that the rate of diffusion of a gas is inversely proportional to the square root of its density. **(2 marks)**

b) A certain gaseous fluoride of phosphorous has a formula PFx . Under similar conditions, fluorine F2 diffuses 1.82 times faster than the gaseous PFx

i) The molecular mass of PFx :**(3 marks)**

$\frac{Rate F\_{2}}{Rate PF\_{x}}$ =$\frac{\sqrt{Molar mass of PF\_{x}}}{\sqrt{Molar mass of F\_{2}}}$

$1.82$ = $\frac{\sqrt{Molar mass of PF\_{x}}}{\sqrt{38}}$

$1.82X 6.164$ = $\sqrt{PF\_{x}}$

$11.218$ = $\sqrt{PF\_{x}}$

$Molecular mass of PF\_{x}$**= 125**

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

ii) The value of x in the formula PFx . **(3 marks)**

31+19x=125

19x=125-31 = 94

X = 4.947

**X = 5**

**(Also accept X=4.947 as the answer)**

11.a)Explanation on observation: HCl molecule is covalent but HCl dissolved in water produces a solution that conducts electricity. **(2 marks)**

**-**HCl molecule exists as a non-charged substance but when it is dissolved in water, it dissociates into ions H+ and Cl- which are charged and can conduct electricity.

 **(Accept other correct explanations)**

b) The chemical formula of 2 compounds which are ionic. **(2 marks)**

- Na2SO4

- KCl

**(Accept other correct answers)**

12.a) 2 uses of silicon dioxide. **(2 marks)**

-Silicon dioxide is used to make glass

-Silicon dioxide is used as a component in cement.

**(Accept other correct answers)**

b) Explanation of the formation of a metallic bond. **(2 marks)**

-A metallic bond is a type of chemical bonding that rises from **electrostatic attractive force** between **conduction electrons and positively charged metal ions**.

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

13.a) 3 properties of metals. **(3 marks)**

-Metals are malleable

-Metals conduct heat and electricity

-Metals are shiny.

**(Accept other correct answers)**

b) 2 chemical equations to show that ZnO is amphoteric. **(4 marks)**

As a base: ZnO + 2H+ → Zn2+ + H2O

As an acid: ZnO + H2O + 2OH- → Zn(OH)42-

**(Give 2 marks for each balanced chemical equation)**

14.a) Calculate the mass of sulphur present in 6.5 g of Na2SO4**(3 marks)**

(Atomic mass: Na=23, S=32 and O=16)

Molar mass of Na2SO4= (23x2)+32+(16x4) = 142 g/mole

 Mass of S in Na2SO4 = $\frac{32}{142}$ X6 = **1.352 g**

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

b)Balanced chemical equation of the reaction of decomposition for:

2Ca(NO3)2(s)heat 2CaO(s) + 4NO2(g) +O2(g)**(2 marks)**

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

**(Neglect state symbols while awarding marks)**

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

16. a) One example of rapid oxidation. **(1 mark)**

**-**Combustion of charcoal (carbon)

**(Accept other correct answers)**

b) i) The chemical equation of the reaction between magnesium and carbon dioxide. **(2 marks)**

2Mg(s) + CO2(g) → 2MgO(s) + C(s)

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

ii) Reducing agent is a substance that **donates a hydrogen atom** or **accepts an oxygen atom** or **donates electrons**.**(1 mark)**

**(Give 1 mark for any one of the three underlined statements)**

c) A simple experiment that can be carried out to show that rusting of iron requires both oxygen and water. **(3 marks)**

-I can put iron nail in a test tube half-filled with water

-In another test tube I put an ion nail in water such that the whole nail is covered with water and I pour oil on top of the water

-In another test tube I put an iron nail without water and I place wool on top of the nail and put calcium oxide powder on top of the wool to absorb any incoming water vapour.

-I leave the test tubes for 4 days and then check which iron nail has rusted.

I will find that the iron nail in which water is present and air present is the one that has rusted.

**(Accept other correct procedures)**

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

d) 3 ways that can be used to prevent rusting of iron. **(3 marks)**

-Painting

-Galvanisation

-Alloy formation

**(Accept other correct answers)**

17. a) The type of bond formed between E and F is: **(1 mark)**

**-**Ionic bond or electrovalent bond

b) The formula of the compound formed between B and D **(1 mark)**

BD4

c) The elements reacts most vigorously with: **(2 marks)**

i) Cold water: E ii) Heated zinc: D

d) The formula or charge of the ion formed by C **(1 mark)**

Formula:C2+ , Charge: 2+

**(Give 1 mark for either the formula or charge)**

e)The chemical equation for the reaction between ethene and bromine. **(2 marks)**

C2H4 + Br2 → C2H2Br2

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

f)Equation:

 C2H4(g) + 3O2(g) → 2CO2(g) + 2 H2O(l)

The mass of CO2 produced when 8 g of ethene completely burns in oxygen. **(3 marks)**

Molar massof ethane=(12x2) + 4=28 g/mole

Number of moles of ethene = $\frac{8}{28}$ =0.285 mole

Number of moles of CO2 formed= 0.285x2 = 0.57 mole

Mass of CO2 formed = 0.57 x 44 = 25.08 g

(Atomic mass: C=12, H=1)

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

18. A mixture of iron and iron oxide were reacted with excess sulphuric acid. 500 cm3 of hydrogen gas was produced (measured at room temperature and pressure). If the mixture had a mass of 3 g and only iron (Fe) reacted with the acid to produce H2 gas.

Determine:

a)The number of moles of H2 gas produced= $\frac{500}{24000}$= **0.0208 mole(2 marks)**

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

b) The number of moles of iron, Fe that reacted with the acid= **0.0208 mole(1 mark)**

c) The mass of iron, Fe in the mixture = 0.0208 x 56 = **1.1648 g(2 marks)**

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

d) The mass of Fe2O3 present in the mixture =3-1.1648 =**1.8352 g(2 marks)**

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

e) The percentage composition of Fe2O3 by mass in the mixture: **(3 marks)**

 % =(Mass of Fe2O3/ Total mass)X 100%

% Fe2O3 =$\frac{1.8352}{3}$X 100%

% of = **61.17 %**

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

19.a) 3 differences between organic compounds ad inorganic compounds. **(3 marks)**

**-**Organic compounds usually contain carbon, hydrogen, and oxygen**.**

**-**Organic compounds always contain carbon-hydrogen bonds.

-Inorganic compounds may contain carbon but do not contain carbon-hydrogen bonds.

-Organic compounds are generally insoluble in water but soluble in organic solvents.

-Inorganic compounds are generally soluble in water and non-soluble in organic solvents.

-Organic compounds are highly inflammable.

-Inorganic compounds are generally non-inflammable

**(Give 3 marks for any 3 answers given)**

b) The laboratory preparation of methane 

i) The importance of water in the trough is **to trap any mixed substance** in methane gas.**(1 mark)**

ii) The names of reactants A and B. **(2 marks)**

A:Sodium ethanoate

B: Sodium hydroxide

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

iii) The type of method of collection that is used to collect methane gas is **upward delivery** or **downward displacement of air**.**(1 mark)**

c) Balance combustion reaction equation: **(2 marks)**

C7H16(l) + 11O2(g) → 7CO2(g) + 8H2O(l)

**(Give 1 mark if only the number of products is correct)**

d) One important use of akanes in Rwandan society: Combustion as fuel**(1 mark)**

**(Accept any other correct answer)**