

SC50525&1  
WASSCE 2023  
CHEMISTRY 2 &1  
Essay and Objective  
3 hours

**2&1**

Name.....

Index Number.....

**THE WEST AFRICAN EXAMINATIONS COUNCIL**

**West African Senior School Certificate Examination  
for School Candidates**

SC 2023

CHEMISTRY 2&1

3 hours

*Do not open this booklet until you are told to do so. While you are waiting, read and observe the following instructions carefully. Write your name and index number in the spaces provided above.*

*This booklet consists of two papers. Answer Paper 2, which comes first, in your answer booklet and Paper 1 on your Objective Test answer sheet. Paper 2 will last 2 hours after which the answer booklet will be collected. Do not start Paper 1 until you are told to do so. Paper 1 will last 1 hour.*

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Answer four questions in all: Question 1 in Section A and three questions from Section B.

All questions carry equal marks.

Credit will be given for clarity of expression and orderly presentation of material.

## SECTION A

Answer all the questions in this section.

1. (a) Define the term *polymerization*. [2 marks]
- (b) State **three** characteristics of an equilibrium reaction. [3 marks]
- (c) Explain **briefly** why the reaction of dilute  $\text{H}_2\text{SO}_4$  with solid  $\text{CaCO}_3$  stops after sometime. [2 marks]
- (d) (i) What is meant by the statement *matter is particulate*.  
(ii) Name **two** of the building blocks of matter. [3 marks]
- (e) Explain **briefly** why a mixture of sodium chloride and ammonium chloride can be separated by sublimation. [2 marks]
- (f) (i) State the property of a substance that makes it paramagnetic.  
(ii) State the difference between *a pure covalent bond* and *a co-ordinate bond*. [2 marks]
- (g) State **two** of the assumptions that are made in order to explain the behaviour of gases. [2 marks]
- (h) (i) Name the concept of acids and bases that deals with non-aqueous systems.  
(ii) Define an acid and a base under the concept named in (i). [3 marks]
- (i) A solid sample does **not** conduct electric current. Suggest **two** ways by which it can be made to conduct electric current. [2 marks]
- (j) Write balanced nuclear equations to represent **each** of the following states:  
(i)  ${}_{92}^{235}\text{U}$  undergoes  $\alpha$ -particle emission to produce element X.  
(ii) X also undergoes  $\beta$ -particle emission to produce element Y. [4 marks]

Answer three questions only from this section.

2. (a)  $\text{CO}_2$  and  $\text{SiO}_2$  are both covalent compounds. Explain **briefly** why  $\text{CO}_2$  is a gas whereas  $\text{SiO}_2$  is a solid under ordinary conditions. [2 marks]
- (b) An element X reacts with bromine to form an ionic compound  $\text{XBr}_2$ .  
 (i) State with reasons the physical state of  $\text{XBr}_2$  at room temperature.  
 (ii) State with reasons whether X is a metal or a non-metal.  
 (iii) Predict **two** properties of  $\text{XBr}_2$  other than its physical state.  
 (iv) State the charge of an ion of X. [7 marks]
- (c) (i) State the *law of definite proportions*.  
 (ii) What volume of stock HCl with percentage purity of 36% and relative density 1.18 would be required to prepare  $2.0 \text{ dm}^3$  of  $0.25 \text{ mol dm}^{-3}$  HCl.  
 [ $M(\text{HCl}) = 36.5 \text{ g mol}^{-1}$ ] [8 marks]
- (d) Iron was added to dilute tetraoxosulphate (VI) acid, the mixture was warmed gently and a gas was given off. The iron dissolved and a pale green solution was formed when more iron was added, the reaction eventually stopped and some iron was left.  
 (i) Write the formula of **two** ions present in dilute tetraoxosulphate (VI) acid.  
 (ii) State why the mixture had to be warmed gently.  
 (iii) What would be observed to indicate that a gas was being given off.  
 (iv) Name the gas.  
 (v) Explain why the reaction stopped.  
 (vi) What is the name of the salt that gives the solution its green colour?  
 (vii) State a method that could be used to separate the excess iron from the green solution. [8 marks]
3. (a) (i) State *Hess's law of constant Heat Summation*.  
 (ii) Sulphur (VI) oxide is formed according to the following reaction:  

$$2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)} \quad \Delta H^\theta = -1900 \text{ kJ mol}^{-1}$$
  
 State and explain the effect of increase in pressure on the:  
 (α) equilibrium position of the reaction;  
 (β) equilibrium constant of the reaction.  
 (iii) what would be the effect of an increase in temperature on the equilibrium position of the reaction? [10 marks]
- (b) (i) Explain why the production of aluminium may be considered as an environmentally friendly process but electrolysis of sodium chloride is **not**.  
 (ii) Name **two** major factors which would favour the siting of an aluminium smelter in a country. [6 marks]

- (c) Explain **briefly** why an aqueous solution of iron (III) ions when added to sodium trioxocarbonate (IV) produces carbon (IV) oxide.

[4 marks]

- (d) A mixture of 8 g of  $H_2$  and 32 g of  $O_2$  has a total pressure of 100 kPa at a specified temperature. Calculate the partial pressure of  $O_2$  at that temperature.

$$[H = 1.0, O = 16.0]$$

[5 marks]

4. (a) (i) Define the term *bond energy*.  
(ii) State **two** uses of bond energy values.

[4 marks]

- (b) (i) Complete combustion of 1.00 mol of  $C_3H_6O$  liberates 1790 kJ of heat. Given that heat of formation of carbon (IV) oxide is  $-393.5 \text{ kJ mol}^{-1}$  and that of water is  $-285.8 \text{ kJ mol}^{-1}$ . Calculate the standard enthalpy of formation of  $C_3H_6O$ .

The equation of the reaction is :



- (ii) In terms of Bronsted-Lowry acid-base reaction, state if the enthalpy of formation of one mole of water would be greater or less than that for the following reaction:



- (iii) Give reasons for the answer stated in (ii).

[10 marks]

- (c) Describe **briefly** what happens when a sample is analyzed using a mass spectrometer.

[5 marks]

- (d) (i) What is meant by the term *solubility product constant*.  
(ii) Deduce the solubility constant  $K_{sp}$  expression for  $Ca_3(PO_4)_2$ .  
(iii) Predict the molecular structure and type of hybrid orbital for  $ICl_2$ .

[6 marks]

5. (a) (i) Explain the term *radioactivity*.  
 (ii) Explain **briefly** the following observation:  
 ${}_{92}^{238}\text{U}$  and its corresponding + 2 ion behave the same way in nuclear reactions.  
 (iii) State with reasons whether the following statement is true or false:  
 ${}^{14}\text{C}$  has a half-life of 5,600 years hence half of a given quantity of  ${}^{14}\text{C}$  will disintegrate in 2,800 years.

[8 marks]

- (b) (i) Explain **briefly each** of the following terms:  
 ( $\alpha$ ) limiting reagent;  
 ( $\beta$ ) excess reagent.  
 (ii) If 6.37 g of ammonia ( $\text{NH}_3$ ) are allowed to react with 11.4 g of Carbon (IV) oxide, ( $\text{CO}_2$ ), determine which of the reactants would be the limiting reagent.

[10 marks]

- (c) (i) Describe **briefly** how gold could be extracted from its ore.  
 (ii) State **one** use of gold.  
 (iii) State **one** property of gold that makes it **suitable** for the use stated in (ii).

[7 marks]

**END OF ESSAY TEST**

Answer all the questions.

Each question is followed by four options lettered A to D. Find the correct option for each question and shade in pencil on your answer sheet, the answer space which bears the same letter as the option you have chosen. Give only one answer to each question. An example is given below.

Which of the following elements reacts with water?

- A. Carbon
- B. Iodine
- C. Sulphur
- D. Sodium

The correct answer is Sodium which is lettered D and therefore answer space D would be shaded.

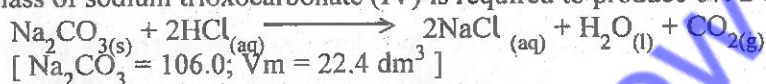
A  B  C  D

Think carefully before you shade the spaces; erase completely any answer you wish to change.

Do all rough work on this question paper.

Now answer the following questions.

1. What mass of sodium trioxocarbonate (IV) is required to produce 67.2 dm<sup>3</sup> of CO<sub>2</sub> at s.t.p?



- A. 428.0 g
  - B. 101.0 g
  - C. 318.0 g
  - D. 60.0 g
2. Which of the following statements is **not** applicable to organic compounds? They
- A. are generally soluble in non-polar solvents.
  - B. are ionic in nature.
  - C. form homologous series
  - D. have low melting and boiling points.
3. The lattice energy of NaCl is greater than that of NaBr because
- A. sodium is more electropositive than bromine.
  - B. bromine is more electropositive than chlorine.
  - C. the atomic size of chlorine is smaller than that of bromine.
  - D. the sodium introduced a covalent bond character into the NaCl.
4. A gas was collected over water at a pressure of 115 Kpa and 298 K, determine the partial pressure of the gas.  
(standard vapour pressure of water at 298 K = 37 Kpa)
- A. 152 Kpa
  - B. 58 Kpa
  - C. 64 Kpa
  - D. 78 Kpa
5. The gas that could be collected by **both** downward delivery and over water is
- A. hydrogen chloride.
  - B. hydrogen.
  - C. Sulphur (IV) oxide.
  - D. oxygen.

6. The volume occupied by 0.02 moles of a gas at s.t.p is  
[  $V_m = 22.4 \text{ dm}^3$  ]
- A.  $0.112 \text{ dm}^3$ .  
B.  $0.448 \text{ dm}^3$ .  
C.  $0.240 \text{ dm}^3$ .  
D.  $0.224 \text{ dm}^3$ .
7. When gases combine, they do so in volumes which bear a simple ratio to one another and to the volume of the product. Under which condition does this law hold?
- A. Volume measured at the same temperature and pressure.  
B. Homogeneous gaseous volumes measured at the same temperature only.  
C. Homogeneous gaseous volumes measured at the same temperature and pressure.  
D. Volume measured at the same pressure only.
8. Which of the following processes take(s) place during distillation?
- I Absorption;  
II Desorption;  
III Evaporation;  
IV Condensation.
- A. I only  
B. II and III only  
C. I and II only  
D. III and IV only
9. How many atoms of elements are there in the compound  $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$ ?
- A. 40  
B. 39  
C. 38  
D. 41
10. What would be observed when  $\text{CuSO}_4(\text{aq})$  is placed in an iron container and left to stand for several days?
- A.  $\text{CuSO}_4$  changes to black  $\text{CuO}$ .  
B. The colour of the solution changes from green to blue.  
C. Some iron particles are formed in the solution.  
D. Part of the container is coated with copper.
11. Chemical kinetics deals with the study of
- I. speed or rate of chemical reaction;  
II. the factors affecting the rates of chemical reactions;  
III. the mechanism by which the reactions proceed.
- A. I and II only  
B. II and III only  
C. I and III only  
D. I, II and III
12. If one mole of hydrogen chloride reacts with one mole of propene, what is the **major** product formed?
- A. 2-chloropropane  
B. 1-chloropropene  
C. 1-chloropropane  
D. 2-chloropropan

13. Ammonia gas could be produced when solid ammonium chloride is heated with
- $\text{Mg}(\text{NO}_3)_2$
  - $\text{Ca}(\text{OH})_2$
  - $\text{CaSO}_4$
  - $\text{HCl}$
14. Which of the following conditions is necessary for the formation of hydrogen bond?
- There should be the presence of a lone pair of electrons.
  - The bond involves sharing of electrons.
  - The atom bonded to hydrogen should have high electronegativity.
  - The atom bonded to hydrogen should have low electronegativity.
15. The factors that enhances the polarizability of an anion are
- high charge and large size.
  - small charge and large size.
  - high charge and small size.
  - low ionization energy.
16. Acid hydrolysis of methylpropanoate yields
- $\text{C}_2\text{H}_5\text{OH}$  and  $\text{C}_2\text{H}_5\text{COOH}$ .
  - $\text{CH}_3\text{OH}$  and  $\text{C}_2\text{H}_5\text{COOH}$ .
  - $\text{C}_4\text{H}_9\text{OH}$  and  $\text{C}_3\text{H}_7\text{COOH}$ .
  - $\text{CH}_3\text{COOH}$  and  $\text{C}_3\text{H}_7\text{OH}$ .
17. Which of the following changes of state would result in release of energy?
- $\text{H}_2\text{O}_{(l)} \longrightarrow \text{H}_2\text{O}_{(g)}$
  - $\text{H}_2\text{O}_{(g)} \longrightarrow \text{H}_2\text{O}_{(l)}$
  - $\text{H}_2\text{O}_{(s)} \longrightarrow \text{H}_2\text{O}_{(l)}$
  - $\text{H}_2\text{O}_{(s)} \longrightarrow \text{H}_2\text{O}_{(g)}$
18. Isomers have different
- empirical formulae.
  - molar mass.
  - structural formulae.
  - molecular formulae.
19. The hydrogen ion concentration of a solution whose pH is 3.7 would be
- $2 \times 10^{-1} \text{ mol dm}^{-3}$ .
  - $2 \times 10^{-3} \text{ mol dm}^{-3}$ .
  - $2 \times 10^{-2} \text{ mol dm}^{-3}$ .
  - $2 \times 10^{-4} \text{ mol dm}^{-3}$ .
20. The particle/rays that is most ionizing is
- alpha.
  - gamma.
  - beta.
  - protons.
21. Which of the following ions has the largest radius?
- $\text{F}^-$
  - $\text{Cl}^-$
  - $\text{Br}^-$
  - $\text{K}^+$



22. If the electron configuration of elements X and Y are 2:8:2 and 2:8:7 respectively; which of the following statements would be correct about the bond that would be formed by the elements?
- A covalent compound is formed.
  - Each atom of Y accepts one electron.
  - Each atom of X accepts two electrons.
  - Each atom of Y combines with 2 atoms of X to form a compound.
23. In a nuclear fusion reactor, usually
- one proton and one electron join.
  - two electrons join.
  - one nucleus and one electron join.
  - two nuclei join.
24. Scientists whose experiments gave evidence about the nature and structure of the atom include
- Robert Boyle.
  - Lord Rutherford.
  - Le chatelier.
  - M. Faraday.
25. Metal atoms combine with non-metal atoms to form ionic compounds, but molten lithium iodide does **not** conduct electricity, this shows that LiI is not ionic because
- $\text{Li}^+$  ion is small and has a low polarizing power.
  - $\text{I}^-$  ion is large and has a high polarizability.
  - $\text{Li}^+$  ion is small and has a high polarizing power.
  - $\text{I}^-$  ion is large and has a low polarizability.
- I and IV only
  - II and III only
  - I and II only
  - III and IV only
26. The equilibrium constant  $K_c$  for the reaction  $2\text{A}_{(g)} + \text{B}_{2(g)} \rightleftharpoons 2\text{AB}_{(g)}$  can be expressed as
- $K_c = \frac{[\text{AB}]^2}{[\text{B}_2]}$
  - $K_c = \frac{[\text{A}]^2[\text{B}_2]}{[\text{AB}]^2}$
  - $K_c = \frac{[\text{AB}]^2}{[\text{B}_2][\text{A}]^2}$
  - $K_c = \frac{[\text{A}][\text{B}_2]}{[\text{AB}]}$
27. If 10 g of a radioactive element P decays to 0.625 g in  $4.5 \times 10^2$  years, what is the half-life of P?
- $0.5625 \times 10^2$  years
  - $2.25 \times 10^2$  years
  - $1.125 \times 10^2$  years
  - $4.5 \times 10^2$  years

28. Consecutive members of alkyne homologous series differ by
- CH.
  - $C_nH_{2n-2}$ .
  - $CH_2$ .
  - $C_nH_{2n+1}$ .
29. A reaction had its rate law to be  $k[X]Y^2$ . Which of the following statements is /are correct?
- The overall order of the reaction is 2.
  - The order of the reaction with respect to Y is 2.
  - The rate is doubled when concentration of Y is doubled.
  - The rate is doubled when concentration of X is doubled.
- II, III and IV only
  - II and III only
  - I only
  - I, III and IV only
30. Iodine can be separated from a mixture of iodine and potassium chloride by
- sublimation.
  - distillation.
  - sedimentation.
  - filtration.
31. The following gases are heavier than air **except**
- $CO_2$ .
  - $NH_3$ .
  - HCl.
  - $SO_2$ .
32. Which of the following properties of atoms generally **increases** down the group in the periodic table?
- Ionization energy
  - Electron affinity
  - Electronegativity
  - Atomic radius
33. Greenhouse effect is as a result of
- water pollution.
  - soil pollution.
  - air pollution.
  - industrial pollution.
34. If  $200\text{ dm}^3$  of oxygen diffuses through a porous pot in 50 seconds. How long will it take  $80\text{ dm}^3$  of methane to diffuse through the same porous pot under the same condition?
- [ $MwO_2 = 32$ ;  $MwCH_4 = 16$ ]
- 7 seconds.
  - 14 seconds.
  - 20 seconds.
  - 40 seconds.

35. The atoms  ${}^{64}_{29}\text{Cu}$  and  ${}^{65}_{30}\text{Zn}$  have the same number of
- electrons.
  - neutrons.
  - nucleons.
  - protons.
36. The toughness of rubber is increased by the addition of
- ethene.
  - silicon.
  - carbon.
  - sulphur.
37. Which of the following particles is the **smallest**?
- $\text{S}^{2-}$
  - Ar
  - $\text{Cl}^{-}$
  - $\text{K}^{+}$
38. The mass spectrometer can be used to measure the
- mass of an electron.
  - mass of a proton in an atom.
  - mass of a neutron in an atom.
  - relative atomic mass of an atom.
39. What type of polymer is formed by reacting amino acids?
- Polyester
  - Addition polymer
  - Polyamide
  - Carbohydrate
40. If a maximum of 144 g of KCl dissolves in  $1 \text{ dm}^3$  of water at  $90^\circ\text{C}$ , determine the solubility of KCl at that temperature. [Cl = 35.5, K = 39.0]
- $19.3 \text{ mol dm}^{-3}$
  - $0.193 \text{ mol dm}^{-3}$
  - $0.0193 \text{ mol dm}^{-3}$
  - $1.93 \text{ mol dm}^{-3}$
41. The difference between molar mass and relative molecular mass is that, relative molecular mass
- is measured in  $\text{mol dm}^{-3}$  while molar mass is measured in  $\text{g mol}^{-1}$ .
  - measures the mass of an atom while molar mass measures the mass of molecules and compounds.
  - is calculated from mass of isotopes while molar mass is determined by spectrometry.
  - has no units while molar mass is measured in  $\text{g mol}^{-1}$ .
42. Generally environmental pollution is serious in big cities because they have
- great land mass.
  - high birth rate.
  - less dense population.
  - many industries.

43. One of the limitations of the mass spectrometer is that it
- easily breakdown during operation.
  - is a very expensive machine.
  - is very difficult to operate.
  - cannot be used to analyze substances which decomposes on heating.
44. Which of the following elements within any given period of the periodic table would always have the lowest first ionization energy? The
- noble gas.
  - halogen.
  - alkali metal.
  - alkaline earth metal.
45. The planar shape of  $\text{BCl}_3$  molecule can be explained in terms of the
- $\text{sp}^3$  hybridization of B.
  - $\text{sp}^2$  hybridization of B.
  - $\text{sp}$  hybridization of B.
  - $\text{sp}$  hybridization of Cl.
46. Which of the following compounds is the least reactive when added to aqueous sodium hydroxide?
- $\text{NaHSO}_4$
  - $\text{H}_3\text{PO}_4$
  - $\text{H}_2\text{SO}_4$
  - $\text{HCl}$
47. Which of the following observations would accompany the passing of  $\text{SO}_2$  into acidified  $\text{KMnO}_4$ ?
- Effervescence and yellow solution turns green.
  - Black deposit and purple solution turns green.
  - Decolourization of solution.
  - Yellow deposit and decolourization of solution.
48. The factors that influence the discharge of an ion during electrolysis are
- the concentration of ions in solution;
  - the position of the ion on the activity series;
  - the nature of the electrode.
- I and II only
  - II and III only
  - I and III only
  - I, II and III.
49. Fats and oils are
- esters.
  - amines.
  - alkenes.
  - alkanols.

50. The compound with octane number of zero is
- A. 3-methyloctane.
  - B. 2-methyloctane.
  - C. iso-octane.
  - D. n-heptane.

**END OF PAPER**

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