Name: CHRISTIAN GOLOGON

Index Number: 779002026

THE WEST AFRICAN EXAMINATIONS COUNCIL

Senior High School Certificate Examination

CHEMISTRY

May 2013   2½ **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* **identification number** *in the space provided above.*

This paper consists of **two** *parts: Papers* 1 *and* 2*. Answer Paper* 1 *on your Objective Test Answer Sheet and Paper* 2 *in your Answer Booklet. Paper* 1 *will last for* 1 *hour after which the answer sheet will be collected. Do* **not** *start Paper* 2 *until you are told to do so. Paper* 2 *will last for* 1½ *hours.*

PAPER 1
OBJECTIVE TEST
[40 marks]   **1 hour**

1.   Use **2B** pencil throughout.
2.   On the objective answer sheet supplied, provide the following details **correctly**:
   (a)   Supply the information required in the spaces marked *CENTER NAME, CENTER No, SCHOOL NAME* and *SCHOOL No.*
   (b)   In the space marked *STUDENT'S NAME,* write your **surname** followed by your **other names.** Write your *IDENTIFICATION NUMBER* in the space marked *STUDENT No.*
   (c)   In the spaces marked *SUBJECT and GRADE,* write CHEMISTRY AND 12TH in that order.
   (d)   In the box marked *IDENTIFICATION NUMBER,* provide your **identification number** vertically in the spaces on the left-hand side and shade each numbered space in line with each digit. This identification number must be the same as the one indicated on your Admission Slip. Repeat the process with the correct information for the box marked *YEAR OF FIRST ENTRY*.
   (e)   In the box marked *Subject Code,* write the digits 402 vertically in the spaces on the left-hand side. **Shade** the corresponding numbered spaces as you did for your identification number.
3.   An example is given below. This is for a **male** candidate whose name is Sagbeh Bondoe FANIA. His identification number is 101123456; his first entry is in 2013 and he is offering **Chemistry**.

THE WEST AFRICAN EXAMINATIONS COUNCIL-LIBERIA

PRINT IN BLOCK LETTERS

TOE-BROWNE ACADEMY	500104
CENTER NAME	CENTER No.
WYNNA GAYVOLOR HIGH SCHOOL	101123
SCHOOL NAME	SCHOOL No.
FANIA, Sagbeh Bondoe	456
STUDENT NAME	STUDENT No.
CHEMISTRY	12TH
SUBJECT	GRADE

IDENTIFICATION NUMBER

YEAR OF FIRST ENTRY

SUBJECT CODE

For Supervisors only.
If a candidate is absent shade this space.

Shade the space marked
M (for Male) or F (for Female)   M   F
In this box

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PAPER 1
OBJECTIVE
[40 marks]

*Answer **all** the questions.*   **1 hour**

*Paper 1 consists of **sixty** objective questions. Each question is followed by **four** options lettered **A** to **D**. Choose 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.*

   Liquids exhibit all these properties **except**
   A.   definite volume.
   B.   definite shape.
   C.   incompressibility.
   D.   slow diffusion.

*The correct answer is **definite shape** which is lettered **B** and therefore the answer space **B** would be shaded like this.*

   [A]   [■]   [C]   [D]

Think carefully before you shade the answer space on the answer sheet. Erase completely any answers you wish to change.

*Do all rough work on this question paper. Now answer **all** the following questions.*

1.   Which statement is **true** about a substance that is subjected to a lower external pressure at a constant temperature?
   A.   A liquid will boil at a lower temperature.
   B.   A liquid will exhibit at a lower vapor pressure.
   C.   A gas in an insulated container will change into a liquid.
   D.   A gas in a non-rigid container will exhibit a smaller volume.

2.   One liter is **exactly** equal to
   A.   1 quart.
   B.   1000 m^3.
   C.   1000 L.
   D.   1000 mL.

3.   As a rule, metals
   A.   gain electrons.
   B.   lose electrons.
   C.   gain and lose electrons.
   D.   neither gain nor lose electrons.

4.   Of the **first** 18 elements in the Periodic Table, how many are gases at 25 °C and 100 kpa?
   A.   Less than seven
   B.   Seven
   C.   Eight
   D.   Nine

5.   What is the coefficient of O_2 when the following equation is balanced?
   $$wC_{10}H_8(s) + xO_2(g) \rightarrow yCO_2(g) + zH_2O(l)$$
   A.   1
   B.   6
   C.   7
   D.   12

6.   Which of the following radiations has the **longest** wavelength?
   A.   Infrared
   B.   X-ray
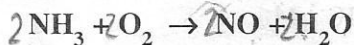   C.   Microwave
   D.   Ultraviolet

7. A lightstick is a plastic tube containing two chemicals that mix when the tube is bent to create a glow. The chemicals in the lightstick give off light as they react. When the lightstick is placed in warm water the glow increases. This is because the
   A. activation energy for the process is lowered.
   B. average kinetic energy of the ractants increases.
   C. higher temperature catalyzes the reaction.
   D. higher temperature changes the wavelength of light emitted.

8. What is the conjugate base of HSO_4^-?
   A. H^+
   B. H_2SO_4
   C. OH^-
   D. SO_4^{2-}

9. Sulphur has variable oxidation states. Which range includes the average oxidation state of S in $Na_2S_4O_6$?
   A. Less than 0
   B. 0 to +2
   C. +2 to +4
   D. greater than +4

10. A substance which, at its melting point, will liberate oxygen is
    A. $Ca(ClO_3)_2$.
    B. $C_6H_{12}O_6$.
    C. NaOH.
    D. H_2O.

11. The element which is liquid at ordinary temperature is called
    A. lithium.
    B. caesium.
    C. francium.
    D. radium.

12. The reaction between a metallic oxide and an acid produces
    A. another acid.
    B. a base.
    C. a salt.
    D. a hydrogen.

13. Which of the properties of pure liquid changes with the amount of matter?
    A. Boiling point
    B. Melting point
    C. Density
    D. Volume

14. Sodium peroxide reacts with water to form oxygen gas and
    A. sodium oxide.
    B. sodium hydroxide.
    C. sodium hydride.
    D. sodium.

15. What is the **maximum** number of electrons that can have a principal quantum number of 4 within one atom?
    A. Two
    B. Four
    C. Sixteen
    D. Thirty-two

16. Which of the following Chemists defined acid as substance that accepts a pair of electrons and a base as a substance that donates a pair of electrons?
    A. G.N. Lewis (1875 - 1956)
    B. Svante Arrhenius (1859 - 1927)
    C. T.M. Lowry (1879 - 1947)
    D. J.N. Bronsted (1879 - 1947)

17. How many unpaired electrons are there in an Mn^{2+} ion in the ground electronic state?
    [**Mn = 25**]
    A. 0
    B. 2
    C. 3
    D. 5

18. What is the number of significant digits in **0.00200300**?
    A. 4
    B. 6
    C. 8
    D. 9

Turn over

19. What is the Keq expression for the reaction;
C(s) + CO$_2$(g) ⇌ 2CO(g)?

A. Keq = $\frac{2[CO]}{[CO_2]}$

B. Keq = $\frac{2[C][CO]}{[CO_2]}$

C. Keq = $\frac{[CO]^2}{[CO_2]}$

D. Keq = $\frac{[C][CO]^2}{[CO_2]}$

20. The mass of one atom of an element
is **1.71 x 10^{-22}** g. What is the atomic mass of
this element in g mol^{-1}?
[N$_A$ = **6.022 x 10^{23} mol^{-1}**]
A. 101
B. 103
C. 105
D. 107

21. Which functional group is **not** commonly
found in proteins?
A. Alcohol
B. Amine
C. Amide
D. Aldehyde

22. Which properties of electromagnetic radiation
are **inversely** related?
A. Amplitude and frequency
B. Energy and wavelength
C. Energy and frequency
D. Wavelength and amplitude

23. How many valence electrons are in one ion of
thiosulphate, S$_2$O$_3$$^{2-}$?
A. 26
B. 28
C. 30
D. 32

24. Which element is the **major** component in
solar cell?
A. As
B. Ge
C. P
D. Si

25. When the equation below is balanced, what
would be the Sn^{2+}(aq)/IO$_3$$^-$(aq) mole ratio?
Sn^{2+}(aq) + IO$_3$$^-$(aq) + H$^+$(aq) → Sn^{4+}(aq) +
I$_2$(aq) + H$_2$O(l)

A. 1/1
B. 2/1
C. 1/2
D. 5/2

26. The raction between metals and ozone
produces
A. an oxide.
B. an ozonide.
C. a carbonate.
D. hydroxide.

27. In the reaction between zinc and hydrochloric
acid, hydrochloric acid acts as
A. a reducing agent.
B. an oxidizing agent.
C. neither oxidizing nor reducing agent.
D. a catalyst.

28. Of the following, the element that reacts
readily with water is
A. lithium.
B. fluorine.
C. potassium.
D. chlorine.

29. The pH of a weak acid is
A. 1.
B. 2.
C. 6.
D. 8.

30. Which of the following named compounds is
incorrect?
A. CaSO$_3$: Calcium sulphite
B. N$_2$O$_5$: di-nitrogen pentoxide
C. Al(NO$_3$)$_3$: Aluminium trinitrate
D. Cu(ClO$_4$)$_2$: Copper II perchlorate

31. The halogen which loses electrons less readily
is
A. fluorine.
B. chlorine.
C. bromine.
D. iodine.

32. When PF_5 accepts one electron pair, it acts as
    A.   a Lewis base.
    B.   a Lewis acid.
    C.   an Arrhenius acid.
    D.   an Arrhenius base.

33. What is the pH of 300 mL of 0.0040 mol L^{-1} $HCl_{(aq)}$?
    A.   2.60
    B.   2.40
    C.   3.40
    D.   3.60

34. The reaction between hydronium ions and hydroxide ions to form water is called
    A.   neutralization reaction.
    B.   hydrolysis reaction.
    C.   hydrogenation reaction.
    D.   combination reaction.

35. The energy of a photon is **greatest** in the case of
    A.   infrared radiation.
    B.   visible light.
    C.   X-ray.
    D.   radio waves.

36. How many valence electrons are there in one carbonate ion, CO_3^{2-}?
    A.   20
    B.   22
    C.   24
    D.   26

37. For the equilibrium system,
    $A(a) \rightleftharpoons B(b)$, the Kp expression for the system can be given as
    A. $Kp = P_A/P_B$.
    B. $Kp = P_B^b/P_A^a$.
    C. $Kp = P_A^a/P_B^b$.
    D. $Kp = P_B^B/P_A$.

38. Which pair of aqueous 1.0 M solutions should be chosen to prepare a buffer?
    A.   HCl and NaCl
    B. NH_4Cl and HCl
    C. CH_3COOH and CH_3COONa
    D. NH_3 and NaOH

39. What concentration of ethanoate (acetate) ions is expected in 0.18 M solution of ethanoic (acetic) acid? [Ka = 1.76 x 10^{-5} at 25 °C]
    A.   1.8 x 10^{-3} M
    B.   1.8 M
    C.   3.2 x 10^{-6} M
    D.   4.2 x 10^{-3} M

40. When a lead storage battery is put into operation, both electrodes build a layer of
    A.   Pb metal.
    B. PbO_2.
    C. Pb_3O_4.
    D. $PbSO_4$.

41. What $[OH^-]$ would lower the solubility of $Mg(OH)_2$ to **1.5 x 10^{-5} mol/L?**
    [Ksp is 1.5 x 10^{-11} for $Mg(OH)_2$]
    A.   1.0 x 10^{-3} mol/L
    B.   3.9 x 10^{-4} mol/L
    C.   6.2 x 10^{-5} mol/L
    D.   3.9 x 10^{-6} mol/L

42. Three liters of 0.20 mol/L $Na_2SO_4(aq)$ and one liter 0.40 mol/L $NaNO_3(aq)$ are mixed. The resulting concentrations of Na^+, NO_3^{3-} and SO_4^{2-} are respectively,
    A.   0.20 mol/L, 0.40 mol/L and 0.20 mol/L
    B.   0.40 mol/L, 0.10 mol/L and 0.15 mol/L
    C.   0.40 mol/L, 0.15 mol/L and 0.10 mol/L
    D.   0.30 mol/L, 0.10 mol/L and 0.15 mol/L

43. Fractional distillation of liquid air serves as a commercial source of
    A.   ammonia.
    B.   pure water.
    C.   oxygen.
    D.   hydrogen.

44. Which aqueous solution at 25 °C has a pH greater than 8?
    A.   Saturated carbon dioxide solution
    B.   0.01 M ammonium acetate
    C.   0.10 M sulphuric acid
    D.   10 – 9 M hydrochloric acid

Turn over

45. What is the coefficient of O_2 when the given equation is balanced with the **smallest** whole number coefficient?

$$2NH_3 + 2O_2 \rightarrow 2NO + 2H_2O$$

   A. 2
   B. 3
   C. 4
   D. 5

46. Which equation represents the **first** ionization of calcium?

   A. $Ca(s) \rightarrow Ca^+(g) + e^-$
   B. $Ca(g) \rightarrow Ca^+(g) + e^-$
   C. $Ca^+(g) \rightarrow Ca^+(g) + e^-$
   D. $Ca^{2+}(g) + e^- \rightarrow Ca^+(g)$

47. An oxide of manganese contains 2.29 g of manganese per gram of oxygen. What is the empirical formula of this compound?

   A. MnO
   B. MnO_2
   C. Mn_2O_3
   D. MnO_3

48. Which substance contains individual molecules in the solid state?

   A. Graphite
   B. Iodine
   C. Mercury
   D. Silicon carbide

49. For which substance is the oxidation number of vanadium the same as that in the VO_3^- ion?

   A. VN
   B. VCl_3
   C. $VOSO_4$
   D. VF_5

50. What bonds are present in

$$H - C \equiv C - H ?$$

   A. 5 sigma
   B. 4 sigma
   C. 2 sigma and 3 pi
   D. 3 sigma and 2 pi

51. Which class of compounds does **not** contain $C = O$ double bonds in its molecules?

   A. Esters
   B. Amides
   C. Alcohols
   D. Acids

52. A sample of gas in a small test tube produces a pop when a burning splint is inserted. Which gas could it be?

   A. H_2
   B. O_2
   C. Cl_2
   D. NO

53. Electrolysis is used commercially to isolate which metal(s)?
   I. Al
   II. Fe

   A. I only
   B. II only
   C. I and II
   D. None of the above

54. Five pallets of a metal have a total mass of 1.25 grams and a volume of 0.278 mL. What is the density of the metal in g mL^{-1}?

   A. 0.348 g mL^{-1}
   B. 0.900 g mL^{-1}
   C. 4.500 g mL^{-1}
   D. 22.50 g mL^{-1}

55. What is the color of the flame test for sodium?

   A. Green
   B. Red
   C. Violet
   D. Yellow

56. How many significant digits should be reported in the answer to the calculation below?

$$\frac{12.501 \times 3.52}{0.0042} + 6.044$$

   (*Assume all numbers are experimentally determined.*)

   A. 5
   B. 4
   C. 3
   D. 2

57. Which piece of apparatus can measure a volume of 25.0 mL precisely?

   A. 25 mL beaker
   B. 25 mL conical flask
   C. 25 mL graduated cylinder
   D. 25 mL pipette

58. Which of the pair of species below have similar molecular geometries?

    A. NO_3^- and ClO_3^-
    B. NH_4^+ and PF_4^-
    C. BF_3 and NF_3
    D. H_3O and PH_3

59. Which of the following compounds is an amine and a carboxylic acid?

    A. $HOOC — CH_2 — CH_2 — NH_2$
    B. $H_2N — CH_2 — CH_2 — CO — NH_2$
    C. $H_2N — CH_2 — CH_2 — OH$
    D. $H_3C — CH_2 — COO — NH_4^+$

60. Given the pair of molecules below, two isomeric molecules are

    A. 1-propanol and 1-butanol.
    B. cyclobutane and 2-butene.
    C. propane and propene.
    D. pentanal and pentanoic acid.

END OF OBJECTIVE TEST

DO NOT TURN OVER THIS PAGE
UNTIL YOU ARE TOLD TO DO SO.

YOU WILL BE SEVERELY PENALIZED IF YOU ARE FOUND LOOKING AT THE NEXT PAGE BEFORE YOU ARE TOLD TO DO SO.

PAPER 2
ESSAY
[60 marks]

1½ hours

Paper **2** *consists of* **nine** *essay questions divided into* **three** *sections:* **I, II** *and* **III.** *You are required to answer* **seven** *questions in all:* **four** *questions from Section* **I,** *two questions from Section* **II** *and* **one** *question from Section* **III.**

Write your answers in ink (**blue** *or* **black**).

SECTION I
[Compulsory]
[36 marks]

Answer **all four** *questions in this section.*

1. What is the equilibrium concentration of SO_3 in the following reaction if the concentration of SO_2 and O_2 are each 0.0500 M and Keq is 85.0. The equation for the reaction is $2SO_2 + O_2 \rightleftharpoons 2SO_3$.

2. If you start with 2.97×10^{22} atoms $^{91}_{42}Mo$, how many atoms will remain after 62.0 minutes? The half-life of $^{91}_{42}Mo$ is 15.49 minutes.

3. A gas is collected in a 242 cm^3 container. The pressure of the gas in the container is measured and determined to be 87.6 kpa. What is the volume of this gas at standard atmospheric pressure? (*Assume that temperature remains constant.*)

4. Draw structural formulas for **each** of the following hydrocarbons:
   (*a*) cyclononyne;
   (*b*) cyclobutene;
   (*c*) octyne;
   (*d*) ethyne;
   (*e*) cyclopentene.

SECTION II
[16 marks]

There are **three** *questions in this section. You are required to answer only* **two.**

5. Discuss in detail, using mathematical models where necessary, the contributions in science made by the following Scientists/Chemists:
   (*a*) De Broglie;
   (*b*) Schrφdinger;
   (*c*) Heisenburg;
   (*d*) Max Planck;
   (*e*) Einstein;
   (*f*) Mendeleyev.

6. What is the average atomic mass of the element molybdenum if it has the following isotopic composition?

Isotope	Mass	Abundance
92	91.906 808 amu	15.84%
94	93.905 090 amu	9.04%
95	94.905 837 amu	15.72%
96	95.904 674 amu	16.53%
97	96.906 023 amu	9.46%
98	97.905 409 amu	23.78%
100	99.907 478 amu	9.63%

7. What volume of gas should be corrected to correspond to the volume it would occupy at SPT, if that volume was measured at 75.6 kpa pressure and 60.0 °C. Given that volume to be 10.0 cm^3.
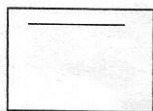
SECTION III
[8 marks]

*There are **two** questions in this section. You are required to answer only **one**.*

8. Name the following compounds:

(a)

(b)

(c)

$$\text{CH}_3 \quad\quad \text{CH}_3$$
$$\underset{\text{CH}_3}{\overset{}{\text{C}}} = \underset{\text{CH}_3}{\overset{}{\text{C}}}$$

(d) $CH_3 - C \equiv C - CH_3$

(e) $H - C \equiv C - CH_2 - CH_3$

Turn over
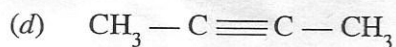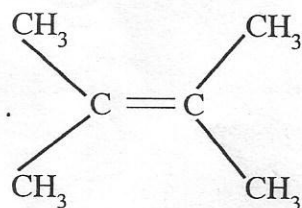
9. (a) Explain the following terms and give **one** example **each**:
   (i) oxidizing agent;
   (ii) reducing agent.

   (b) Consider the following equations:
   (i) $Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$
   (ii) $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
   (iii) $Cu(s) + Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + Ag(s)$
   State with reasons, which one is the
   (α) **strongest** oxidizing agent,
   (β) **strongest** reducing agent.

   (c) (i) Define *enthalpy of neutralization*.
   (ii) Describe **briefly** how enthalpy of neutralization of HCl(aq) and NaOH(aq) can be determined.
   (iii) Account for the observation, H_2SO_4 is a stronger acid than H_2SO_3.

END OF PAGER