

THE WEST AFRICAN EXAMINATIONS COUNCIL
West African Senior School Certificate Examination

November 2011

CHEMISTRY 2

3 hours

Do not open this booklet until you are told to do so. While you are waiting, write your name and index number in the spaces provided at the top right-hand corner of this booklet and thereafter, read the following instructions carefully. This paper consists of two parts, A and B. Answer Part A on your Objective Test answer sheet and Part B in your answer booklet. Part A will last for 1 hour after which the answer sheet will be collected. Do not start Part B until you are told to do so. Part B will last for 2 hours.

PART A
OBJECTIVE TEST
[50 marks]

1 hour

- Use HB pencil throughout.
- If you have got a blank answer sheet, complete the top section as follows.
 - In the space marked *Name*, write in capital letters your **surname** followed by your **other names**.
 - In the spaces marked *Examination*, *Year*, *Subject* and *Paper*, write 'WASSCE', '2011 NOV.', 'CHEMISTRY' and '2' respectively.
 - In the box marked *Index Number*, write your **index number** vertically in the spaces on the left-hand side. There are numbered spaces in line with each digit. Shade carefully the space with the same number as each digit.
 - In the box marked *Paper Code*, write the digits **505213** in the spaces on the left-hand side. Shade the corresponding numbered spaces in the same way as for your index number.
 - In the box marked *Sex*, shade the space marked **M** if you are **male**, or **F** if you are **female**.
- If you have got a pre-printed answer sheet, check that the details are correctly printed, as described in 2 above. In the boxes marked *Index Number*, *Paper Code* and *Sex*, **reshade** each of the shaded spaces.
- An example is given below. This is for a male candidate, whose name is **Chukwuma Adekunle CIROMA**, whose **index number** is **5251102068** and who is offering **Chemistry 2**.

THE WEST AFRICAN EXAMINATIONS COUNCIL

PRINT IN BLOCK LETTERS

Name: **CIROMA CHUKWUMA ADEKUNLE** Examination: **WASSCE** Year: **2011 NOV.**
Surname Other Names
Subject: **CHEMISTRY** Paper: **2**

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SEX	
Indicate your sex by shading the space marked M (for Male) or F (for Female) in this box:	M F

INSTRUCTIONS TO CANDIDATES

- Use grade HB pencil throughout.
- Answer each question by choosing one letter and shading it like this: [A] [B] [C] [D]
- Erase completely any answers you wish to change.
- Leave extra spaces blank if the answer spaces provided are more than you need.
- Do not make any markings across the heavy black marks at the right-hand edge of your answer sheet.

For Supervisors only.

If candidate is absent shade this space: ☐

Answer all the questions.

Each question is followed by four options lettered A to D. Find out 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. Sodium
- D. Sulphur

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

[A]

[B]

☒ [C]

[D]

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

Do all rough work on this question paper.

Now answer the following questions.

- The smallest particle of a substance that can exist on its own and still retains the chemical properties of that substance is
 - A. a radical.
 - B. an ion.
 - C. a molecule.
 - D. a compound.
- Consider two atoms represented as $^{16}_8\text{X}$ and $^{17}_8\text{Y}$. The difference between the atoms is in the
 - A. number of protons.
 - B. number of neutrons.
 - C. number of protons and electrons.
 - D. electron structure.
- The number of electrons present in $^{31}_{15}\text{P}^{3-}$ ion is
 - A. 3.
 - B. 15.
 - C. 18.
 - D. 31.
- Which of the following ions is monoatomic?
 - A. Mg^{2+}
 - B. OH^-
 - C. CN^-
 - D. NH_4^+
- The correct electron configuration of an element $^{20}_{20}\text{W}$ is
 - A. $1s^2 2s^2 3s^2 2p^6 3p^6 4s^2$.
 - B. $1s^2 2s^2 3s^2 2p^6 4s^2 3p^6$.
 - C. $1s^2 2s^2 2p^6 3s^2 3p^8 4s^0$.
 - D. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$.

6. Which of the following sets of elements has the same outermost electron configuration?
- H, He, Be.
 - H, Li, Be.
 - H, Li, Na.
 - He, Ne, Ar.
- A. I
B. II
C. III
D. IV
7. What is the relative atomic mass of hydrogen which contains 99.30% of ^1_1H atoms and 0.70% ^2_1H atoms?
- A. 1.017
B. 1.99
C. 50.35
D. 199.70
8. Which of the following periodic properties decreases down the group?
- A. Atomic radius
B. Electron affinity
C. Electronegativity
D. Ionic radius
9. One of the **main** characteristic properties of transition metals is their ability to
- A. ionize readily by electron loss.
B. form basic oxides.
C. react with water.
D. exhibit variable oxidation states.
10. The high melting points of ionic compounds are due to
- A. the presence of electrostatic forces of attraction.
B. their ability to dissolve in water.
C. their ability to exist as solids.
D. their ability to conduct electricity in the molten state.
11. Which of the following molecules has the **strongest** covalent bond?
- A. H_2
B. Cl_2
C. O_2
D. N_2
12. Which of the following molecules is non-linear?
- A. CO_2
B. F_2
C. H_2O
D. HCl

13. Naphthalene crystals are held together by
 A. hydrogen bonds.
 B. van der Waal's forces.
 C. dispersion forces.
 D. electrovalent bonds.
14. A metal **Z** forms two chlorides, ZCl_2 and ZCl_3 . What type of bond exists between **Z** and chlorine?
 A. Covalent
 B. Dative
 C. Ionic
 D. Metallic
15. Which of the following bonds are broken when ethanol boils?
 I. Hydrogen bonds
 II. Ionic bonds
 III. Covalent bonds
 A. I only
 B. II only
 C. I and II only
 D. II and III only
16. Which of the following equations represents a reaction that is **not** feasible?
 A. $\text{Cl}_{2(g)} + 2\text{NaBr}_{(aq)} \longrightarrow 2\text{NaCl}_{(aq)} + \text{Br}_{2(g)}$
 B. $\text{Cl}_{2(g)} + 2\text{KI}_{(aq)} \longrightarrow 2\text{KCl}_{(aq)} + \text{I}_{2(g)}$
 C. $\text{Cl}_{2(g)} + 2\text{NaF}_{(aq)} \longrightarrow 2\text{NaCl}_{(aq)} + \text{F}_{2(g)}$
 D. $\text{Cl}_{2(g)} + 2\text{KBr}_{(aq)} \longrightarrow 2\text{KCl}_{(aq)} + \text{Br}_{2(g)}$
17. One mole of a compound $\text{M}(\text{OH})_2$ has a mass of 58 g. What is the relative atomic mass of **M**?
 [$\text{H} = 1.00$, $\text{O} = 16.0$]
 A. 24
 B. 58
 C. 92
 D. 94
18. Nitrogen combines with oxygen to form two different oxides in which 1.0 g nitrogen combines with 1.142 g of oxygen and 1.714 g of oxygen respectively. This observation illustrates the law of
 A. constant composition.
 B. conservation of mass.
 C. chemical combination.
 D. multiple proportion.
19. If 60 cm^3 of a gas is heated from 27°C to 77°C , what is the new volume of the gas at constant pressure?
 A. 21 cm^3
 B. 51 cm^3
 C. 70 cm^3
 D. 171 cm^3

20. The pressure of a gas is due to the
- absence of attractive forces between molecules.
 - constant random motion of molecules.
 - collisions between the molecules and the walls of the container.
 - collision between the molecules.
21. Liquids with strong intermolecular forces have
- small number of molecules escaping into gaseous state.
 - low boiling points.
 - large number of molecules escaping into gaseous state.
 - high vapour pressures.
22. The collision between gas molecules is perfectly elastic because
- cohesive forces between the molecules are negligible.
 - there is no loss of energy during collision.
 - they are highly compressible.
 - they move randomly in straight lines.
23. The similarity between combustion and neutralization reactions is that they are
- endothermic.
 - exothermic.
 - oxidation processes.
 - reduction processes.
24. When an ionic solid dissolves in water, the water molecules split the crystals into free ions. The energy required for this process is
- kinetic energy.
 - potential energy.
 - hydration energy.
 - lattice energy.
25. The reaction of ammonia with **excess** air in the presence of heated platinum catalyst would yield
- water and nitrogen (II) oxide.
 - water and nitrogen (IV) oxide.
 - water vapour and nitrogen.
 - water vapour and ammonium ion.
26. Which of the following chemical equations illustrates behaviour of an acid?
- $X_2O_{(s)} + H_2O_{(l)} \longrightarrow 2X^+_{(aq)} + 2OH^-_{(aq)}$
 - $HX_{(aq)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + X^-_{(aq)}$
 - $HX_{(s)} + H_2O_{(l)} \longrightarrow HX_{(aq)} + H_2O_{(l)}$
 - $X_{(s)} + 2H_2O_{(l)} \longrightarrow X^+_{(aq)} + 2OH^-_{(aq)} + H_2(g)$

27. Which of the following acids is a **weak** acid?

- A. H_3PO_4
- B. HClO_4
- C. H_2SO_4
- D. HNO_3

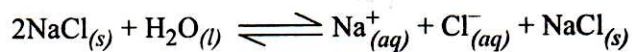
28. When an alkali is warmed with ammonium trioxonitrate (V), the gas liberated is

- A. NO .
- B. NO_2 .
- C. N_2O .
- D. NH_3 .

29. Which of the following compounds would **not** dissociate completely in water?

- A. H_2CO_3
- B. H_2SO_4
- C. HNO_3
- D. HCl

30. Consider the process represented by the following chemical equation.



The equation represents

- A. saturated solution.
- B. unsaturated solution.
- C. solute dissolving in a solvent.
- D. fully dissociated solute.

31. Which of the following salts would **not** be recovered from its solution by heating to dryness?

- A. Na_2CO_3
- B. NH_4NO_3
- C. K_2SO_4
- D. NaCl

32. The colour of methyl orange in a solution of potassium hydroxide is

- A. yellow.
- B. orange.
- C. pink.
- D. colourless.

33. Which of the following factors would **not** affect the rate of a chemical reaction?

- A. Addition of a catalyst
- B. Density of the reactants
- C. Change in temperature of the reaction system
- D. Physical states of reactants

34. Which of the following quantities represents 965C of electricity?
[$1F = 96500C$]
- 96500 moles of electrons
 - 965 moles of electrons
 - 1.0 mole of electrons
 - 0.01 mole of electrons
35. During the electrolysis of $CuSO_{4(aq)}$ using carbon electrodes, the substance produced at the anode is
- $Cu_{(s)}$
 - $SO_{4(g)}$
 - $O_{2(g)}$
 - $H_2O_{(l)}$
36. Which of the following processes does **not** involve redox reaction?
- Rusting of iron
 - Combustion of fuels
 - Decomposition of limestone
 - Bleaching action of dye
37. Which of the following substances is **not** a reducing agent?
- NH_3
 - KI
 - H_2O_2
 - CaI_2
38. When methane combines with **excess** chlorine gas in the presence of ultra-violet radiation, the product formed is
- tetrachloromethane.
 - trichloromethane.
 - dichloromethane.
 - chloromethane.
39. The IUPAC name of the compound $CH_3CH(OH)CH_2OH$ is
- propan-2-ol.
 - propan-1, 2-diol.
 - propan-2, 3-diol.
 - propan-3-ol.
40. Which of the following reactions would benzene **readily** undergo?
- Polymerization
 - Addition
 - Substitution
 - Hydrolysis

41. A hydrocarbon contains 25% hydrogen. Its empirical formula would be
[C = 12, H = 1.00]
- A. CH_4
 - B. CH_3
 - C. CH_2
 - D. CH
42. A hydrocarbon X was bubbled into an alkaline solution of KMnO_4 and the solution changed from purple to green. X would likely be an
- A. alkene.
 - B. alkane.
 - C. alkanol.
 - D. alkanone.
43. Which of the following formulae **cannot** be used to represent primary alkanols?
- A. $\text{C}_n\text{H}_{2n+1}\text{OH}$
 - B. $\text{C}_n\text{H}_{2n+2}\text{O}$
 - C. $\text{RR}'\text{CHOH}$
 - D. ROH
44. Which of the following pairs of metals constitute soft solder?
- A. Lead and copper
 - B. Sodium and lead
 - C. Sodium and copper
 - D. Lead and tin
45. The compound that could be used to remove impurities from haematite in the blast furnace is
- A. CaCO_3 .
 - B. CaSiO_3 .
 - C. NaOH .
 - D. H_2SO_4 .
46. Which of the following compounds is used in the manufacture of photographic films?
- A. Aluminium chloride
 - B. Silver chloride
 - C. Zinc chloride
 - D. Iron (II) chloride
47. A factor which is **not** usually considered when siting an industry is nearness to
- A. source of power.
 - B. source of raw materials.
 - C. market.
 - D. residential area.

48. Which of the following methods can be used to separate a mixture of petrol and liquid paraffin?
- A. Fractional distillation
 - B. Filtration
 - C. Chromatography
 - D. Evaporation
49. Pollution of rivers by domestic waste causes
- A. an increased level of sediments.
 - B. increased presence of heavy metals.
 - C. reduced level of dissolved oxygen.
 - D. scarcity of nutrients in water.
50. Which of the following polymers is thermoplastic?
- A. Perspex
 - B. Cellulose
 - C. Bakelite
 - D. Proteins

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

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

PART B

ESSAY

2 hours

[100 marks]

Answer **four** questions in all: **three** questions from Section I and **one** question from either Section II or Section III.

All questions carry equal marks.

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

SECTION I

FOR ALL CANDIDATES

Answer **three** questions from this section.

1. (a) What is a *transition element*? [2 marks]
- (b) Iron can be represented as ${}_{26}\text{Fe}$.
 - (i) Write the electron configuration for iron.
 - (ii) Explain **briefly** why iron exhibits:
 - I. paramagnetism;
 - II. variable oxidation.
 - (iii) Mention **two** by-products in the extraction of iron in the blast furnace.
 - (iv) Write an equation to illustrate the formation of **each** of the by-products in 1(b)(iii). [10 marks]
- (c) List the elements present in **each** of the following alloys:
 - (i) steel;
 - (ii) bronze;
 - (iii) brass;
 - (iv) soft solder. [4 marks]
- (d) Outline how a pure dry sample of silver chloride could be obtained from aqueous solutions of sodium chloride and silver trioxonitrate (V). [5 marks]
- (e) If 2.40 g of carbon is burnt completely in air, calculate the volume of carbon (IV) oxide produced at s.t.p. [4 marks]

[$C = 12.0$. Molar volume, $V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$]
2. (a) Consider the following list of elements:
nitrogen, fluorine, aluminium and potassium.
Which of the elements
 - (i) forms diatomic molecule with a triple bond?
 - (ii) is the most reactive electropositive element?
 - (iii) forms amphoteric oxide?
 - (iv) is the **most** reactive non-metal? [4 marks]

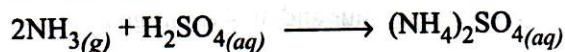
- (b) (i) State what would be observed if chlorine gas is passed into an aqueous solution of:
 I. iron (II) chloride;
 II. potassium bromide.
- (ii) Give the names of the products in 2(b)(i)I and 2(b)(i)II.
- (iii) Write an ionic equation to represent **each** of 2(b)(i)I and 2(b)(i)II.
- (iv) Suggest the type of reaction in **each** of 2(b)(i)I and 2(b)(i)II.

[13 marks]

- (c) State **two** differences between *conductors* and *electrolytes*.

[2 marks]

- (d) Consider the reaction represented by the following chemical equation:



Determine the mass of ammonium tetraoxosulphate (VI) that would be produced from 85 g of ammonia.

$$[\text{H} = 1.00, \text{N} = 14.0, \text{O} = 16.0, \text{S} = 32.0]$$

[6 marks]

3. (a) (i) What is the shape of
 I. *s-orbital*;
 II. *p-orbital*?
- (ii) Which ion has the following composition?
 0 – electron, 2 – protons and 2 – neutrons.

[3 marks]

- (b) The following table shows the melting and boiling points of oxides of the elements X, Y and Z.

Oxides	Melting point/K	Boiling point/K
X_2O	1403	2223
Y_2O	273	373
Z_2O	49	128

- (i) What type of bond binds X, Y and Z respectively to oxygen in their oxides?
- (ii) Explain briefly how the bond in Z_2O is formed?
- (iii) What type of forces hold the molecules of
 I. Y_2O ,
 II. Z_2O respectively?

[8 marks]

- (c) The following equation illustrates homogeneous equilibrium established when hydrogen and carbon (IV) oxide react:



- (i) Why is this reaction regarded as homogeneous?
 - (ii) Explain **briefly** the effect of an increase in pressure on the:
 - I. equilibrium position;
 - II. reaction rate.
 - (iii) State **three** features of an equilibrium reaction. [8 marks]
- (d) A compound Q contains 29.1% sodium, 40.5% sulphur and 30.4% oxygen. Determine the:
- (i) empirical formula;
 - (ii) molecular formula of Q if its relative molar mass is 158. [6 marks]
[O = 16.0, Na = 23.0, S = 32.0]

4. (a) (i) What is meant by *saponification*?
- (ii) List the raw materials needed for the manufacture of soap.
- (iii) Name the **main** by-product obtained from the manufacture of soap. [5 marks]
- (b) What type of reaction is represented by **each** of the following equations?
- (i) $\text{C}_3\text{H}_8 + \text{Cl}_2 \longrightarrow \text{C}_3\text{H}_7\text{Cl} + \text{HCl}$
 - (ii) $n(\text{CH}_2=\text{CH}_2) \longrightarrow -(\text{CH}_2-\text{CH}_2)_n$
 - (iii) $\text{C}_{16}\text{H}_{34} \longrightarrow 3\text{C}_2\text{H}_4 + \text{C}_{10}\text{H}_{22}$
 - (iv) $\text{C}_2\text{H}_4 + \text{H}_2 \longrightarrow \text{C}_2\text{H}_6$
 - (v) $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{SO}_4 \longrightarrow \text{C}_2\text{H}_5\text{HSO}_4 + \text{H}_2\text{O}$
- [5 marks]

- (c) An organic compound U produces effervescence when reacted with sodium metal liberating gas V.
- U produces a sweet fruity smelling liquid when warmed with colourless liquid W in the presence of a catalyst.
- W reacts with sodium hydrogen trioxocarbonate (IV) solution to produce gas G.
- (i) Write the functional group present in U and W.
 - (ii) Identify gases V and G.
 - (iii) Name the type of reaction between:
 - I. U and sodium metal;
 - II. U and W.
 - (iv) Name the catalyst used in the reaction between U and W.

(v) If the molar mass of **W** is 74 g mol^{-1} , deduce the:

- I. molecular formula;
 - II. structural formula of the compound.
- [H = 1.00; C = 12.0, O = 16.0]

[12 marks]

(d) Explain briefly why the reaction between magnesium and 1.0 mol dm^{-3} ethanoic acid would be slower than the reaction between magnesium and 1.0 mol dm^{-3} hydrochloric acid.

[3 marks]

SECTION II

FOR CANDIDATES IN GHANA ONLY

Answer one question from this section.

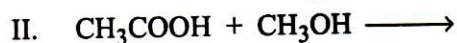
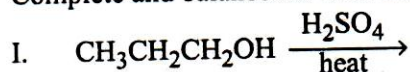
No marks will be awarded for answering questions not peculiar to your own country.

5. (a) (i) What is *fermentation*?

(ii) Write an equation for the fermentation of glucose.

(iii) What substance must be added to glucose solution to make it ferment?

(iv) Complete and balance the following chemical equations:



[9 marks]

(b) Explain why ethanol is completely miscible with water?

[3 marks]

(c) (i) What is *biotechnology*?

(ii) Distinguish between *fine chemicals* and *heavy chemicals*.

(iii) Mention the major raw material used in the large scale production of each of the following products:

I. cement;

II. tyre.

[6 marks]

(d) (i) List **three** chemical properties of acids.

(ii) Give **two** large scale uses of H_2SO_4 .

(iii) Write a chemical equation for the action of heat on **each** of the following compounds:

I. AgNO_3 ;

II. $\text{Pb}(\text{NO}_3)_2$.

[7 marks]

6. (a) (i) Define *hybridization*.

(ii) Explain briefly how sp^3 hybrid orbitals are formed.

[5 marks]

(b) Consider the equilibrium reaction represented by the following equation:



(i) Write an expression for the equilibrium constant K_p .

(ii) Sketch the energy profile diagram for the forward reaction indicating the position of

I. reactants and products;

II. activated complex;

III. enthalpy change;

IV. activation energy.

[7 marks]

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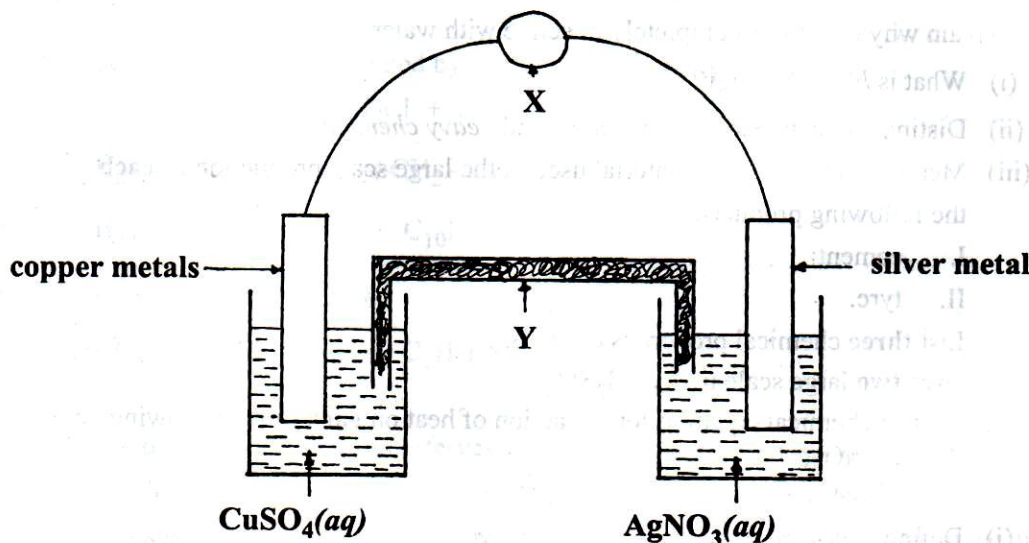
- (c) (i) Calculate the pH of a solution containing $4.0 \times 10^{-5} \text{ mol dm}^{-3}$ hydrogen ion.
 (ii) Indicate whether the solution is acidic or basic. Give a reason for your answer. [5 marks]
- (d) Give **three** differences between the solubilities of solids in liquids and gases in liquids. [3 marks]
- (e) Calculate the volume occupied by 0.125 moles of oxygen at 27°C and pressure of $2.02 \times 10^5 \text{ Nm}^{-2}$.
 [standard pressure = $1.01 \times 10^5 \text{ Nm}^{-2}$; 1 mole of gas occupies 22.4 dm^3 at s.t.p.] [5 marks]

SECTION III

FOR CANDIDATES IN NIGERIA, SIERRA LEONE AND THE GAMBIA.

*Answer one question only from this section.***No marks will be awarded for answering questions not peculiar to your own country.**

7. (a) (i) Distinguish between a *primary cell* and a *secondary cell*.
 (ii) Give **one** example of **each** cell in 7(a)(i). [4.marks]
- (b) Consider the following set-up.



The standard electrode potential for copper and silver are:

$$E^\ominus \text{Cu}^{2+}/\text{Cu} = +0.34 \text{ V}$$

$$E^\ominus \text{Ag}^+/\text{Ag} = +0.80 \text{ V}$$

- (i) Name the reference against which other electrode potentials are measured.
 (ii) Which instrument should be at position X?
 (iii) What is Y? State its function.
 (iv) Calculate the e.m.f. of the cell.

[7 marks]

- (c) Explain **briefly** why electrolysis of an aqueous solution of sodium chloride does not produce sodium at the cathode.

[3 marks]

- (d) (i) What is meant by *nuclear fission*?

- (ii) How could electrical energy be generated by nuclear fission?

[5 marks]

- (e) Turpentine was burnt in chlorine gas resulting in the formation of the products as illustrated below:



Calculate the mass of turpentine that would completely burn in 21.3 g of chlorine.

[H = 1.00; C = 12.0; Cl = 35.5]

[6 marks]

8. (a) Describe **briefly** how **each** of the following aqueous solutions could be identified in the laboratory:

- (i) ammonium trioxocarbonate (IV);
(ii) ammonium chloride.

[6 marks]

- (b) Arrange the following compounds in order of increasing boiling point and give reasons for your answer:

CS_2 , NaF and CO_2 .

[5 marks]

- (c) List **two** gases **each** that are:

- (i) acidic;
(ii) highly soluble in water;
(iii) oxidized by acidified $\text{KMnO}_{4(aq)}$.

[6 marks]

- (d) In a tabular form, compare the elements silicon and sulphur under the following properties:

- (i) metallic character;
(ii) physical state;
(iii) conduction of electricity.

[3 marks]

- (e) A cuboid piece of sodium metal measures $3\text{ cm} \times 4\text{ cm} \times 10\text{ cm}$. If the density of sodium is 0.971 g cm^{-3} , calculate the number of atoms in the sodium metal.

[Na = 23; Avogadro constant = $6.02 \times 10^{23}\text{ mol}^{-1}$].

[5 marks]