e-Learning

Chemistry Paper 2 (Practical), WASSCE (SC), 2022

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Question 1

(a) (i) Define an acid according to the Lewis concept.
(ii) Give one example of a Lewis acid. [3 marks]

(b) Explain *salting out* in soap preparation. [2 marks]

(c) State the reagent and condition necessary for the following conversion:

$$H\text{-}C\equiv C\text{-}H \rightarrow Ag - C \equiv C - Ag$$

[2 marks]

(d) What is the percentage abundance of an isotope? [2 marks]

(e)
(i) Why does the element with atomic number 18 **not** have an oxide?
(ii) Explain why chlorine(I) oxide has a low melting point.
[3 marks]

(f) Describe a test to distinguish between concentrated *HNO3* and concentrated H2SO4.
[3 marks]

(g) State two differences between an *electrochemical cell* and an *electrolytic cell*.
[2 marks]

(h) How does the trend in ionization energy affect the reactivity of group I element?
[3 marks]
Define the term *molecular formula*

. [2 marks]

(j) (i) State which of the gases H2 and NH3 would deviate more from ideal behaviour.
(ii) Give reasons for the answer stated in **1***(j)(i)*. [3 marks]

Observation

This question was popular among the candidates and majority of them responded to it.
In part (a), this question was deleted because it was not in Nigerian syllabus.

In part (b), majority of the candidates explained *salting out* in soap.

In part (c), majority of the candidates could not state the reagent and condition necessary for converting H-C.C -H Ag-C.C -Ag.

In part (d), few candidates were able to determine the percentage abundance of an isotope.

In part (e), majority of the candidates gave a reason why the element with atomic number 18 not have an oxide but majority of the candidates explained why chlorine(I) oxide has a low melting point.

In part (f), majority of the candidates could not describe a test to distinguish between concentrated HNO3 and concentrated H2SO4.

In part (g), majority of the candidates stated the differences between an *electrochemical cell* and *electrolytic cell*.

In part (h), majority of the candidates stated how the trend in ionization energy affects the reactivity of group I elements.

In part (i), majority of the candidates defined the term *molecular formula*.

In part (j), majority of the candidates could not state which of gases H2 and NH2 would deviate more from ideal behaviour.

The expected answers include:

(a) Question deleted

(b) Is the addition of NaCl to the reaction mixture in soap production to facilitate the precipitation of soap from the mixture

(c) reagent - AgNO3 in NH3(aq) / Ammoniacal silver trioxonitrate (V)
Condition - heat

(d) I**s** the fraction of a given isotope in a mixture of isotopes of the same element
OR
The % of an isotope with a specific atomic mass found in a naturally accruing sample of an element

(e) (i) because the element is /has
- unreactive
- stable

- inert
- a noble gas
- completely filled outermost shell

(ii) because of weak forces between the molecules hence not much heat is needed to break the forces

(f) - (Conc) HNO_3 produces brown fumes (of NO_2) when copper tunings are Added to it / copper (II) salt is added but H_2SO_4 will not react with the copper tuning / copper (II) salt.

- When Conc. H_2SO_4 is added to sugar it chars the sugar but Conc. HNO_3 will not
- Add $BaCl_2$ solution to each acid white precipitate indicates H_2SO_4
no precipitate indicates HNO_3

(g)

Electrochemical cell	Electrolytic cell
- the anode is negative / cathode is Positive	- anode is positive / cathode is negative
- chemical energy is converted to electrical energy	- electrical energy is converted to chemical energy
- the two half cells are in separate containers and connected by a salt bridge	- the two half cells are in the same container
- reaction is spontaneous	- non- spontaneous
- current is generated from within the cell	- current is generated from external source / battery

(h) group 1 elements reacts by forming positive ions, the higher the ionization energy, the more difficult it is to lose the electron hence the lower the reactivity of the elements

OR

Ionization energy decreases down group 1 elements, the lower the ionization energy, the easier to loose an electron

(b) Is the addition of NaCl to the reaction mixture in soap production to facilitate the precipitation of soap from the mixture

(c) reagent - $AgNO_3$ in $NH_3(aq)$ / Ammoniacal silver trioxonitrate
(V)
Condition - heat

(d) I**s** the fraction of a given isotope in a mixture of isotopes of the same element
OR
The % of an isotope with a specific atomic mass found in a naturally accruing sample of an element

(e) (i) because the element is /has
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OR

Ionization energy decreases down group 1 elements, the lower the ionization energy, the easier to lose an electron hence the higher the reactivity of the elements

(i) Molecular formula shows the actual number of atoms of each element in a molecule

(j) (i) NH_3 will deviate more

(ii) because it has a larger volume and also it has a stronger intermolecular force hence the higher the reactivity of the elements

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General Comments

Weakness/Remedies

Candidate's Strength

Question 2

1. (a) (i) Define the *first ionization energy of an element.*

(ii) Consider the following table and *use it to answer the questions that follow*.

Element	Li	Be	B	C	N	O	F	Ne
Atomic No.	3	4	5	6	7	8	9	10
1st I.E/kjmol^{-1}	520	900	801	1086	1402	1314	1681	2081

Explain **briefly** why the first ionization energy of **B** is less than that of **Be** despite the fact that the atomic number of **B** is greater than that of **Be**.

[8 marks]

(b) When Titanium chloride was electrolysed by passing 0.12 *A* current through the solution for 500 seconds, 0.015 g of titanium was deposited. What is the charge on titanium ion? [1F = 96500 C, Ti = 48.0] [6 marks]

(c) (i) Aluminium can be obtained by the application of electrolysis. State the electrolyte which yields aluminium or electrolysis.

(ii) Name two major factors which would favour the sitting of an aluminium smelter in a country.

[4 marks]

(d) (i) Define the term *paramagnetism*.

(ii) Consider the following ions:

$_{24}Cr^{2+}$, $_{24}Cr^{6+}$

I. Deduce the number of unpaired electrons in each of the ions.

II. State which of the ions will have a **greater** power of paramagnetism.

III. Give a reason for the answer stated in **2***(d)(ii)(II).*

[7 marks]

Observation

This question was popular among the candidates and their performance was average.

In part (a), majority of the candidates defined the *first ionization* of an element correctly.

In part (b), majority of the candidates could not calculate the charge on the titanium ion.

In part (c), majority of the candidates could not state the electrolyte which yields aluminium on electrolytes. However, they named two major factors which would favour the siting of an aluminium smelter in a country.

In part (d), few candidates defined paramagnetism correctly. However, they could not state which of the ions will have greater power of paramagnetism.

The expected answers include:

(a) (i) - Is the energy required to remove one electron from a mole of a gaseous atom

OR

- Is the minimum energy required to convert one mole of a gas of atom into one mole of a gaseous plus 1 ions

(ii) $_4Be : 1s^2\ 2s^2$

$_5B : 1s^2\ 2s^2\ 2p^1$

The electron to be removed from Be is in the 2s orbital which is closer to the Nucleus nuclear attraction is greater hence first ionization energy is greater but the electron to be removed from B is in the 2p orbital which is farther away from the nucleus, hence nuclear attraction is weaker hence first ionization energy is smaller.

OR

2p has less energy than 2s

So it is easier to remove an electron from 2p as the nuclear charge is weaker in 2p because 2p is further away from the nucleus**.** Hence, first ionization energy is small.

(b) $Q = It$

$Q = 0.12 \times 500$

$= 60\ C$

$96500 = 1\ F$

$= 60\ C$ liberates $0.015\ g$

$\therefore$ 96500 will liberate $\frac{96500}{60} \times 0.015$

$= 24\ g$

$n(T1) = \frac{m}{M}$

$= \frac{24}{48}$

$= 0.5\ mol$

$1\ F \equiv 0.5\ mol$

$\therefore 2F \equiv 1\ mol$

hence charge = + 2

Alternative A

Q = It
= 0.12 x 500
= 60 C
0.015 g of Ti is deposited by 60 C
∴48 g will be deposited by = $\frac{60}{0.015}$ x 48
= 192000 C
96500 C 1 mole of electron
∴192000 C = $\frac{1}{96500}$ x 192

= 1.989
≈2.0 moles of electron
∴charge on Ti ion is + 2

Alternative B
$\frac{m}{M} = \frac{1t}{nF}$
$n = \frac{M1t}{mF}$
$= \frac{48 \times 0.12 \times 500}{0.015 \times 96500}$
= 1.989 ≈ 2
∴ Change on Ti ion is +2

(c) (i) Alumina (Al_2O_3) mixed with molten cryolite (Na_3AlF_6)
(ii) - abundant deposits of bauxite
- cheap source of electricity

(d) (i) Is the ability of a substance to be attracted strongly into a magnetic field

(ii) I. $24Cr^{2+}$ - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6 3d^4$
unpaired electrons = 4

$24Cr^{6+}$ - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
unpaired electrons = 0

II. $24Cr^{2+}$

III. the greater the number of unpaired electrons in the 3d – orbital, the greater the paramagnetism.

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Question 3

1. (a) (i) Define the term *Avogadro's number*.
2. If 2.30 g of an oxide of nitrogen, contains 3.01 x 1022 molecules, calculate the molar mass of .

(iii) Deduce the formula of

[NA= 16.02 x 10^{23}, N = 14.0, O = 16.0]

[9 marks]

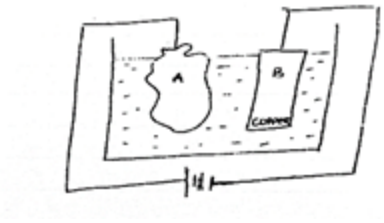
(b) (i) Describe briefly what happens when each of the following substances are added to water:

1. CCl4;
2. SiCl4.

(ii) Explain briefly why the reactions in **3***(b)*(i)(I) and 3*(b)*(i)(II) are different.

[6 marks]

(c) Study the diagram below and answer the questions that follow.



i. What is the set-up used for?
ii. Mention **two** compound that could be used as electrolytes in the cell.
iii. Write a half-cell equation for the reaction at the anode.
iv. Calculate the electrochemical equivalent of copper if the cathode gained mass of 3.2 *g* when 50 *amperes* of current was passed for 5 *mins* 13 *seconds.*

[10 marks]

Observation

A fair attempt was made on the question and the performance of candidates was below average.

In part (a), majority of the candidates defined the term *Avogadro's number*. However, they could not calculate the molar mass of x from the given values.

In part (b), few candidates could describe what happens when CCl4 and SiCL4 are added to water.

In part (c), majority of the candidates could not state what the set-up is used for. However, they mentioned two compounds that could be used as electrolytes in the cell. Also, they could not calculate the electrochemical equivalent of copper if the cathode gained mass of 3.2 *g* when 50 *amperes* of current was passed for 3 *mins* and 13 *seconds*.

The expected answers include:

(a) (i) Number of particles (atoms, molecules, ions etc) present in one mole of a substance.

OR

Number of particles present in 12.0 g of carbon – 12

(ii) $n = \frac{N}{L}$

moles of X = $\frac{3.01 \times 1022}{6.02 \times 1023}$

= 0.05

but no. of moles = $\frac{2.30\ g}{\text{Molar mass}}$

or Molar mass = $\frac{2.30\ g}{\text{No. of moles}}$

$= \frac{2.30}{0.05}$

= 46 g

Alternative

3.0 x 1022 molecules has a mass of 2.30 g

1 mole of a substance contain = 6.02 x 1023 molecules

6.02 x 1023 has a mass of $\frac{2.30 \times 6.02 \times 1023}{3.0 \times 1022}$

= 46 g mol-1

(iii) let N*x* Oy be the formula of the oxide

or 14 *x* + 16 y = 46

x = 1, y = 2

ie. 14 (1) + 16(2) = 46

formula of x = NO2

(b) (i) I. Two layers are formed / no reaction / immiscible

II. there is a reaction / hydrolysis with steamy fumes / white fumes

(ii) The reaction occurs by interaction of the lone pair of electrons of water binding to

the central atom (silicon or carbon) / attaching to the central atom

In silicon, the 3d – orbital is available to accept the pairs of electrons but in carbon there is no vacant orbitals for bonding

OR

Water is polar hence the reaction with SiCl4. But CCl4 is non polar hence there is no

reaction

(c) (i) - Purification of metals / copper
- Electroplating
- Extraction of copper

(ii) - $CuSO_4$
- $Cu(NO_3)_2$
- $CuCl_2(aq)$

(iii) $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-(aq)$

(iv) $m = ZIt$

t = 3 mins 13 sec

= 193 sec

$Z = \frac{m}{It}$

$= \frac{3.2}{50 \times 193}$

$= 3.32 \times 10^{-4}$ g / C

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Question 4

1. (a) (i) State **two** conditions used in the Haber process.

(ii) Explain **briefly** the effect of increasing the pressure on the rate of reaction in the Haber process.

[5 marks]

(b) (i) A mixture of nitrogen (IV) oxide and oxygen is bubbled into warm water tp produce trioxonitrate(V) oxide, write a balanced chemical equation for the reaction.

(ii) Using a balanced chemical equation only, explain what would happen if nitrogen (IV) oxide is bubbled into warm water.

Compare the gases evolved when trioxonitrate (V) acid decomposes under each of the following properties:

I. pH;
II. solubility in water;
III. reaction with carbon (II) oxide.

[10 marks]

(c) (i) Name **two** oxides of sulphur.

(ii) Write a balanced equation for the reaction between each of the named oxides in **4***(c)(i)* and water.

[6 marks]

Observation

In part (a), majority of the candidates stated two conditions used in the Haber process but could not explain the effect of increasing the pressure on the rate of reaction in the Haber process.

In part (b), majority of the candidates could not write a balanced chemical equation for the reaction.

In part (c), majority of the candidates named two oxides of sulphur.

In part (d), few candidates correctly named one calcium compound used to dry ammonia gas and in the manufacture of cement.

The expected answers include:

(a) (i) Temperature : 350 – 500oC / high temperature
Pressure : 150 – 1000 atm / high pressure
Catalyst : (Finely divided) Iron

(ii) Rate of the reaction increases as particles are closer together / more particles per unit volume**.** There are more collisions per second / collisions are more often

(b) (i) $4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3$

(ii) $2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

A mixture of two acids will be produced

(iii) $4HNO_3(aq) \rightarrow 4NO_2(g) + O_2(g) + 2H_2O(l)$

I. Oxygen is neutral while NO_2 is acidic / The pH of O_2 is 7 while the pH of NO_2 is less than 7.
II. NO_2 is soluble while O_2 is sparingly soluble in water
III. O_2 reacts with CO to form CO_2 while NO_2 reacts with CO to form a mixture of N_2 and CO_2

(c) (i) - Sulphur (IV) oxide
- Sulphur (VI) oxide

(ii) $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$
$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

(d) (i) - calcium oxide
- quick lime

(ii) - calcium trioxocarbonate (IV)
- limestone
- calcium oxide
- quick lime

(iii) - calcium tetraoxosulphate (VI)
- calcium hydrogen trioxocarbonate (IV)
- calcium chloride

(iv) Calcium tetraoxosulphate (VI) (dihydrate)
(v) Calcium tetraoxosulphate (VI) (dihydrate)

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Question 5

(a) (i) With the aid of an equation, explain briefly why aluminum metal is not affected by air.

(ii) In the extraction of aluminum from bauxite, state the:

I. Substance used for purifying the ore;

II. Composition of the mixture electrolyzed.

[8 marks]

(b) ZnO is an amphoteric oxide. Write equations to illustrate this statement.

[4 marks]

(c) (i) List three uses of sodium trioxocarbonate(IV).

(ii) Explain briefly why a solution of trioxnitrate(V) acid turns yellowish on storage for sometime.

(i) Describe **briefly** how trioxonitrate(V) ions could be tested for in the laboratory.

[8 marks]

(d) (i) Write balanced chemical equations for the preparation of hydrogen chloride;

I. using concentrated H_2SO_4

II. by direct combination of its constituent elements.

(ii) State **one** use of hydrogen chloride.

[5 marks]

Observation

This question was popular among the candidates as most of them responded to it.

In part (a), majority of the candidates described the observation that would be made when sulphur is heated from room temperature till 119 ºC.

In part (b), majority of the candidates stated two gaseous pollutants that can be generated by burning coal but could not state the gas responsible for most of the explosions in coal mines.

In part (c), majority of the candidates were able to describe a chemical test for water and were able to state the effect of boiling on a temporary hard water.

In part (d), majority of the candidates could not describe the laboratory preparation of oxygen gas with the aid of a labelled diagram.

The expected answers include:

(a) (i) Its colour darkens from pale yellow to amber colour while its crystals become needle-like and at 119ºC it begins to melt

(ii) the solution turns green, bubbles of colourless gas rise from the bottom of the mixture, but brown fumes of NO_2 are produced and the solution later turns blue

(b) (i) - SO_2
- NO_2
- CO
- CO_2
- H_2S

(ii) methane (CH_4)

(iii) - contamination of soil
- contamination of ground water
- soil erosion
- loss of biodiversity
- formation of sink holes

(iv) Because of the large surface area and the higher the area the faster the rate of reaction

1. Coke

(c) (i) the sample is added to anhydrous copper (II) tetraoxosulphate (VI) when it
turns from white to blue confirms the presence of water / sample is added to anhydrous cobalt chloride / cobalt chloride paper when it turns from blue to pink indicates the presence of water.

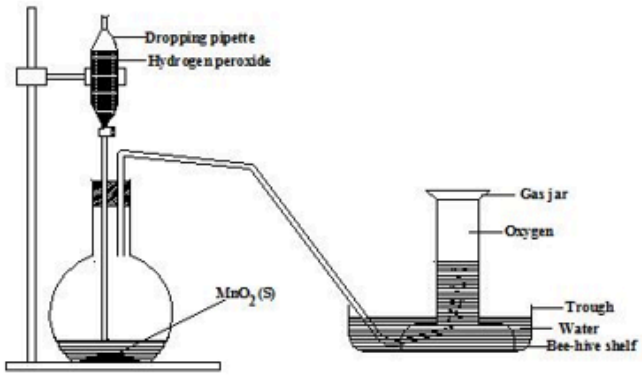
(ii) I. it softens temporary hard water

II. to remove permanent hardness / soften hard water

(iii) - $Ca(HCO_3)_2 \xrightarrow{heat} CaCO_3 + CO_2 + H_2O$

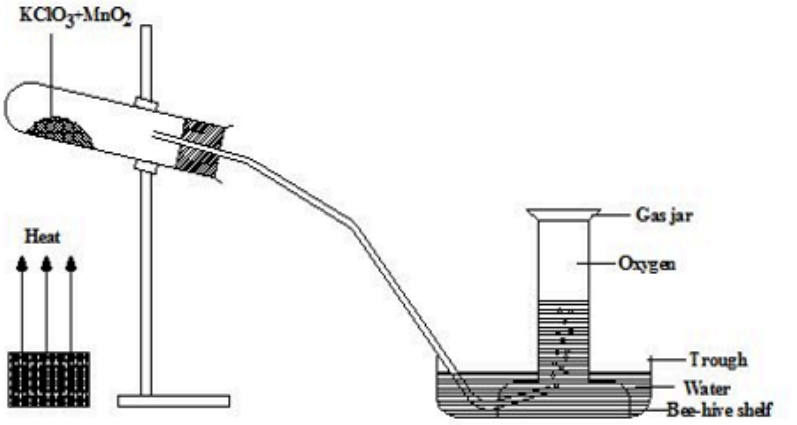
- $Mg(HCO_3)_2 \xrightarrow{heat} MgCO_3 + CO_2 + H_2O$

(d)



- Pour hydrogen peroxide into a conical flask containing some manganese (IV) Oxide the gas produced is collected in an upside – down gas jar filtered with water

OR



Powdered $KClO_3$ and MnO_2 are placed in a conical flask. Mixture is heated gently. Collect gas produced over water in a gas jar

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