| MARKER CODE |
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| Student Personal Identification Number |
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# Solomon Islands National Form Six School Certificate

# 2019

# CHEMISTRY
# QUESTION AND ANSWER BOOKLET

**TUESDAY 12th NOVEMBER 2:00 PM** **TIME: 3 Hours Plus 10 Minutes Reading Time.**

## INSTRUCTION

1. This Exam Paper consists of TWO (2) sections. **ATTEMPT ALL QUESTIONS.**

| | | MARKS | TIME |
|---|---|---|---|
| **SECTION A:** | Multiple Choice Questions | 40 | 36 minutes |
| **SECTION B:** | Q21: Atomic Structure and Bonding | 25 | 21 minutes |
| | Q22: Quantitative Chemistry | 31 | 23 minutes |
| | Q23: Organic Chemistry | 24 | 23 minutes |
| | Q24: More Organic Chemistry | 18 | 17 minutes |
| | Q25: Inorganic Chemistry | 19 | 18 minutes |
| | Q26: Oxidation and Reduction | 27 | 18 minutes |
| | Q27: Principle of Physical Chemistry | 16 | 24 minutes |
| | **TOTAL:** | **200** | **180 minutes** |

2. Write your **Student Personal Identification Number (SPIN)** on the top right hand corner of this page and at the top of the **back-flap** on the last page at the end of this booklet.

3. Write all answers to the Multiple Choice Questions on the answer sheet on the **back-flap** on the last page.

4. In SECTION B, write the answers to the questions in the spaces provided in this booklet.

   **NOTE:** A copy of the **Periodic Table of the Elements – Sheet** should be provided and it is at the back of this booklet.
   The symbol M is used for molar mass.
   For example, M (Mg) = 24 g/mol, M ($CO_2$) = 44 g/mol and M ($NH_3$) = 17 g/mol

5. Do NOT use correction fluid.

6. Mobile phones are NOT allowed in the Examination room.

7. Check that this booklet contains pages **2-39** in the correct order and none of these pages is blank. **Page 37** has been left blank deliberately.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**SECTION A:** **MULTIPLE CHOICE QUESTIONS** **(40 MARKS)**

**Answer all the questions in this section. Write the letter (A, B, C or D) of your best choice answer in the boxes on the back-flap provided at the back of this booklet. Each question is worth 2 marks.**

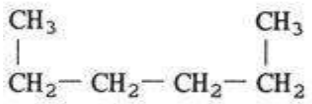
1. The simplest alkyne is;

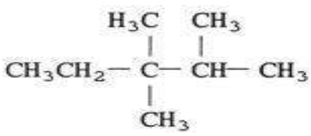
   A. ethyne.
   B. ethane.
   C. ethylene.
   D. propyne.

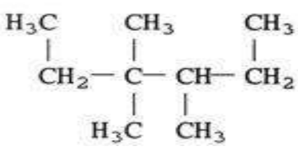
2. The melting and boiling points of hydrocarbons are determined by;

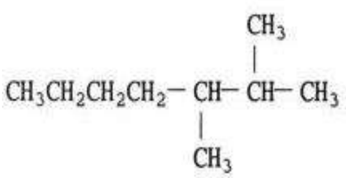
   A. London forces.
   B. hydrogen bonding.
   C. ion-dipole attraction.
   D. dipole-dipole attraction.

3. The structure of 2, 3-dimethylheptane is;

   A. 

   B. 

   C. 

   D. 

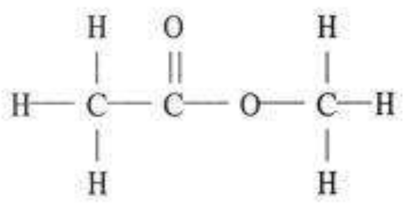
4. How many isomers are possible for $C_5H_{12}$ ?

A. 1
B. 2
C. 3
D. 4

5. What general class of compounds is also known as olefins?

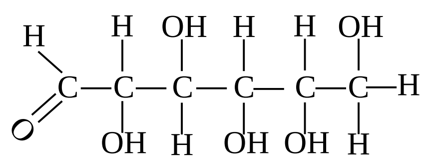
A. Alkanes
B. Alkenes
C. Alkynes
D. Aromatics

6. The compound below is;



A. an ester.
B. a ketone.
C. an aldehyde.
D. a carboxylic acid.

7. What **functional group** is MOSTLY present in the open-chain form of glucose?



A. Oxo
B. Ketone
C. Hydroxyl
D. Hydronium

8. The general formula of a **carboxylic acid** is;

A. R-O-R
B. R-CO-R
C. R-CO-OH
D. R-CO-OR

9. The Alkyl halide below can be classified as ________________ alkyl halide.

$$\begin{array}{c} \quad\quad\;\; H \\ \quad\quad\;\; | \\ CH_3-C-Cl \\ \quad\quad\;\; | \\ \quad\quad\;\; H \end{array}$$

A. a Tertiary
B. a Primary
C. a Secondary
D. an Intermediate

10. Oxides of active metals combine with acid to form;

A. oxygen gas.
B. hydrogen gas.
C. metal hydrides.
D. water and a salt.

11. What is the coefficient of $H_2O$ when the following equation is completed and balanced?

$Ba_{(s)}$ + ___$H_2O \rightarrow Ba(OH)_2 + H_2$

A. 1
B. 2
C. 3
D. 4

12. The ion with the SMALLEST diameter is;

A. $Br^-$
B. $Cl^-$
C. $I^-$
D. $F^-$

13. 2.86 grams of an oxide of copper is found to contain 2.54 grams of copper. Which of the following gives the formula of the copper oxide?

[Given M(Cu) = 64 $gmol^{-1}$,  M(O) = 16 $gmol^{-1}$ ]

A. $Cu_2O$
B. $CuO$
C. $CuO_2$
D. $Cu_2O_3$

14. In the manufacture of methanol, hydrogen is reacted with carbon monoxide over a catalyst of zinc and chromium oxides as represented in the equilibrium reaction below.

$$2H_{2(g)} + CO_{(g)} \rightleftharpoons CH_3OH_{(g)} \qquad \Delta H = -128.4\ kJmol^{-1}$$

Which of the following changes would favour a forward reaction?

A. Using a different catalyst.
B. Decreasing the total pressure.
C. Increasing the surface area of the catalyst.
D. Increasing the concentration of carbon monoxide.

15. When concentrated ammonia ($NH_3$) solution is added drop by drop to copper sulfate ($CuSO_4$) solution, a pale blue jelly-like precipitate forms. The chemical species that produces the pale blue precipitate is;

A. $CuOH$.

B. $Cu(OH)_2$.

C. $[Cu(NH_3)_2]^{2+}$.

D. $[Cu(NH_3)_4]^{2+}$.

16. In which of the following **pairs** does sulphur has the same oxidation number?

A. $H_2S$, $SO_2$
B. $SO_2$, $SO_3$
C. $SO_3$, $H_2SO_3$
D. $SO_3$, $SO_4^{2-}$

17. Aspirin (Mr. 180.159g/mol) reacts with sodium hydroxide solution according to the equation below:

$$CH_3COOC_6H_4COOH_{(s)} + NaOH_{(aq)} \longrightarrow CH_3COOC_6H_4COONa_{(aq)} + H_2O_{(l)}$$

A student took one aspirin tablet, dissolved it in 20 ml of warm methylated spirit, added phenolphthalein indicator, and titrated it against 0.09954 $molL^{-1}$ NaOH solution. 16.4 ml of NaOH was required to reach the end-point. What is the mass of aspirin in the tablet?

A. 5.94 grams
B. 0.97 grams
C. 0.594 grams
D. 0.297 grams

18. Which of the following equations below represents a **REDOX** reaction?

A. $NH_{3\,(l)} + HCl_{(g)} \longrightarrow NH_4Cl_{(l)}$
B. $SO_{3\,(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4\,(l)}$
C. $2Na_{(s)} + Cl_{2\,(g)} \longrightarrow 2NaCl_{(g)}$
D. $HCOOH_{(l)} + CH_3CH_2OH_{(l)} \longrightarrow HCOOCH_{2\,(l)}$

19. The molar mass ($M_r$) of the protein haemoglobin is about 65,000 grams/mole. A molecule of haemoglobin contains 0.35% Fe by mass. How many iron atoms, Fe, are in a haemoglobin molecule?

*[Given $A_r(Fe) = 56\ gmol^{-1}$]*

A. 1
B. 2
C. 3
D. 4

20. Which of the following trend below is TRUE about the relationship between **atomic radius** and **first ionization energy** across Period 3 of the Periodic Table?

| | **Atomic Radius** | **First Ionisation Energy** |
|---|---|---|
| A | Decreases | Decreases |
| B | Increases | Increases |
| C | Increases | Decreases |
| D | Decreases | Increases |

**Section A:** **40**

## SECTION B: SHORT ANSWER QUESTIONS (160 MARKS)

**Answer ALL Questions (21 – 27) in the spaces provided.**
**If you are unable to calculate a value in one question which you will need for your calculations in a later question, select an appropriate value and use it where needed.**

### QUESTION 21: ATOMIC STRUCTURE AND BONDING (25 MARKS)

A. Use the table below which shows the atomic number, mass number and number of neutrons of atoms C and D to answer questions (1 – 3) that follow.

| Symbol | Atomic number | Mass number | Number of neutrons |
|---|---|---|---|
| $^{20}_{10}C$ | ***(i)*________** | 20 | 10 |
| $^{40}_{20}D$ | 20 | 40 | ***(ii)*________** |

1. Complete the above table by filling in the two empty spaces labeled *(i)* and *(ii).*

   (i) __________________________ (ii) __________________________

   (2 marks)

2. Write the electron configuration (arrangement) of;

   (a) atom C: ______________________________

   (b) ion D: ______________________________ (2 marks)

3. Which one of the two atoms given in the table above (C or D) is chemically unreactive? Justify your answer.

   Atom: __________________________________ (1 mark)

   Justification: ________________________________________________

   (1 mark)

B. Both methane ($CH_4$) and oxygen ($O_2$) are covalent molecules.

1. Draw the electron dot diagram (Lewis structure) for;

(a) Methane, $CH_4$

(b) Oxygen, $O_2$

(2 marks)

2. Name the molecular shape of;

(a) methane, $CH_4$: ____________________________________

(b) oxygen, $O_2$: ____________________________________

(2 marks)

3. Methane and oxygen are non-polar molecules but the **bonding** within each molecule differs. Clearly explain this difference.

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

(2 marks)

C. Complete the table below by filling in the five empty spaces labeled *(i)* to *(iv).* A description of sodium chloride is given as an example.

| Substance | Type of solid | A property | Reason for that property |
|---|---|---|---|
| Sodium chloride | Ionic solid | Conducts electricity in the molten state | Ions are free to move and can migrate to the appropriate electrode. |
| Aluminium | *(i)* | *(ii)* | Can be hammered or rolled into thin sheets due to the presence of delocalized electrons in the metallic lattice/structure. |
| Carbon dioxide | *(iii)* | Low melting point and boiling point | *(iv)* |

(4 marks)

D. The table **below** gives the first ionization energies for some of group 1 and group 8 elements.

| Group | Element | Atomic number | First ionization energy ($kJ\ mol^{-1}$) |
|---|---|---|---|
| 1 | Lithium<br>Sodium<br>Potassium | 3<br>11<br>19 | 526<br>502<br>425 |
| 8 | Helium<br>Argon | 2<br>18 | 2379<br>1527 |

1. Clearly state the difference in the **first ionization energies** of the two groups of elements.

______________________________________________________________

______________________________________________________________

(1 mark)

2. Explain why the FIRST ionization energy for the elements decreases down the group.

______________________________________________________________

______________________________________________________________

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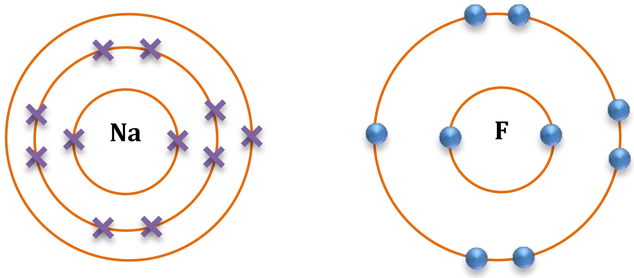
(2 marks)

E. The electronic structures of sodium (proton number 11) and fluorine (proton number 9) are shown in figure below.




These two elements react together to form an ionic compound, **Sodium Fluoride**.

1. What is the formula of Sodium Fluoride?

_______________________________________________ (1 mark)

2. Look carefully at the structures of the Sodium and Fluoride ions.

 a. What is similar between these ions?

 ____________________________________________________________

 ____________________________________________________________

 (1 mark)

 b. List TWO (2) differences between these ions.

 (i) _____________________________________________________

 (ii) _____________________________________________________

 (2 marks)

3. Would you expect Sodium Fluoride to conduct electricity? Explain.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

(2 marks)

**Q21** 25

**<u>QUESTION 22</u>: <u>QUANTITATIVE CHEMISTRY</u> (31 MARKS)**

A. During the preparation of a standard solution of Sodium carbonate ($Na_2CO_3$), a student obtains the following results:

Mass of beaker = 128.45 g

Mass of beaker and anhydrous sodium carbonate = 131.10 g

She dissolves this Sodium carbonate in enough water to make exactly 100ml of standard solution. *(NB: Ar of Na = 23 g/mol; Ar of C = 12 g/mol; and Ar of = 16 g/mol)*

1. Calculate the concentration of the solution she prepared in:

a. grams per litre (g $L^{-1}$)

(2 marks)

b. Moles per litre (mol $L^{-1}$)

(2 marks)

2. She titrated this standard solution against a solution of hydrochloric acid and found that 20ml of the sodium carbonate solution was exactly neutralised by 5ml of the acid.

**Use the above information to answer questions (a – d) that follow.**

a. What piece of **apparatus** would she have used to measure the amount of acid necessary to neutralise the standard solution?

______________________________________________________________

(1 mark)

b. Describe how she would have known when the two solutions were neutralised.

______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________

(2 marks)

c. Write an equation for the reaction, which occurred between hydrochloric acid and sodium carbonate.

______________________________________________________________
______________________________________________________________
______________________________________________________________
______________________________________________________________

(2 marks)

d. Calculate the **concentration** of the hydrochloric acid solution in mol $L^{-1}$.

(3 marks)

## MOLE & MOLAR MASS

B. Methane burns in air according to the incomplete equation below:

$$\square\ CH_{4\,(g)} + \square\ O_{2\,(g)} \longrightarrow \square\ CO_{2\,(g)} + \square\ H_2O_{\,(l)}$$

1. Write the *balanced equation* for the reaction.

_______________________________________________________________

_______________________________________________________________

(1 mark)

2. What *mass of Carbon dioxide* is obtained from 80g of Methane?

(2 marks)

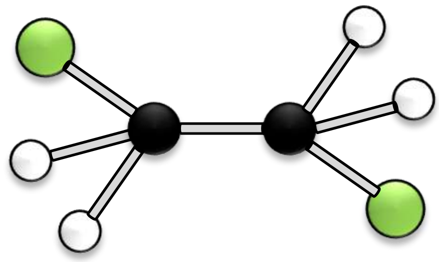
3. What *mass of Oxygen* reacts with 80g of Methane?

(2 marks)

4. What *mass of Water* is obtained from 200g of Methane?

(2 marks)

The figure below shows a model of a molecule of a solvent used in the dry-cleaning of clothes.





1. What is the *molecular formula* of the solvent?

_______________________________________________________________

_______________________________________________________________

(1 mark)

2. What is the *relative molecular mass* of the solvent?

(2 marks)

3. A component of petrol was analysed as follows:

84.2% Carbon; 15.8% Hydrogen

a. Calculate the *empirical formula* of this component.

(2 marks)

b. If the molar mass of this component of petrol is 114 g $mol^{-1}$, calculate its *molecular formula.*

(2 marks)

c. **Use the information below to answer questions (1 – 3) that follow.**

The reaction between potassium hydroxide and sulphuric acid is represented by the equation:

$$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$$

20ml of a 0.3 mol $l^{-1}$ potassium hydroxide solution is neutralised by 15ml of sulphuric acid.

1. Calculate the amount of potassium hydroxide in the 20ml sample.

(2 marks)

2. What amount of sulphuric acid is required to completely neutralise the potassium hydroxide?

(1 mark)

3. Calculate the *concentration* of the sulphuric acid solution.

(2 marks)

**Q22** 31

**<u>QUESTION 23</u>:** **<u>ORGANIC CHEMISTRY</u>** **(24 MARKS)**

A. Write the **structural formulae** of the products that form when ethylene reacts with each of the following substances by an addition reaction. (Assume that needed catalysts or other conditions are provided.)

1. $Br_2$ (2 marks)

2. HBr (2 marks)

3. $H_2O$ (in acid) (2 marks)

4. The hydrogenation of Aldehydes will produce an alcohol. In the presence of hydrogen molecule, with the right conditions of heat, pressure and catalyst, an alcohol is produced. Complete the following reactions and name the alcohol that is produced.

$$CH_3\overset{\overset{\displaystyle O}{\|}}{C}H \; + \; H-H \xrightarrow[\textit{catalyst}]{\textit{heat, pressure}} \; ?$$

a. Product Formulae/Structure: - (1 mark)

b. Name of Product: - ____________________ (1 mark)

5. Write the **IUPAC names** of the following compounds.

a. $CH_3CH_2\overset{CH_3}{\overset{|}{C}}HCH_2\underset{CH_3}{\underset{|}{C}}HCH_3$ ________________________(1 mark)

b. $CH_3CH \quad CHCH_2CH_3$ ________________________(1 mark)

c. $CH_3CH\overset{CH_3}{\overset{|}{C}}H \quad CHCH_3$ ________________________(1 mark)

6. Calculate the percentage composition by mass of each element in a potassium ferricyanide, $K_3\,[Fe\,(CN)_6]$ molecule.
(NB: *Ar of K = 39.0 g/mol; Ar of Fe = 56.0 g/mol; Ar of C = 12.0 g/mol and Ar of N = 14.0 g/mol*)

(4 marks)

B. Alkanes are saturated hydrocarbons which can be obtained from crude oil. Pentane is an example of an alkane. A molecule of pentane contains five carbon atoms.

1. (a) State the meaning of the following terms below;

(i) *saturated:*

______________________________________________________

______________________________________________________

(ii) *hydrocarbon:*

______________________________________________________

______________________________________________________

(2 marks)

(b) Give the **general formula** for the alkanes.

___________________________________________________

(1 mark)

2. Pentane burns completely in oxygen.

(a) Write an *equation* for this reaction.

___________________________________________________

(1 mark)

(b) State how carbon dioxide may affect the environment.

___________________________________________________

___________________________________________________

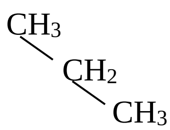
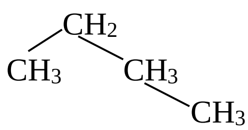
(1 mark)

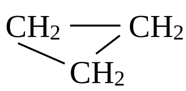
(c) Give the name of the **gas**, which forms when carbon dioxide burns incompletely in air.

___________________________________________________

(1 mark)

C. Decide whether the members of each pair are *identical*, are *isomers*, or are *unrelated*.

1.  and  (1 mark)

2. $CH_3CH{=}CH_2$ and  (1 mark)

3. $H-\overset{\overset{\large O}{\|}}{C}-CH_3$ and $CH_3-\overset{\overset{\large O}{\|}}{C}-H$ (1 mark)

Q23 24

## **QUESTION 24**: **MORE ORGANIC CHEMISTRY** **(18 MARKS)**

A. From the table below answer questions (1 – 3) that follow.

1. In the table below complete the spaces (a, b, c and d) by working out the **molecular formula and relative molecular mass ($M_r$)** for each alcohol.

| ALCOHOL | MOLECULAR FORMULA | $M_r$ | BOILING POINT ($^oC$) |
|---|---|---|---|
| methanol | $CH_3OH$ | 32g/mol | 65 |
| ethanol | $CH_3CH_2OH$ | **(a)** __________ | 78 |
| propan-1-ol | $CH_3CH_2$ $CH_2OH$ | **(b)** _____________ | 97 |
| butan-1-ol | $CH_2OHCH_2CH_2CH_3$ | 74g/mol | **?** |
| pentan-1-ol | **(c)** __________________________ | 88g/mol | 138 |
| hexan-1-ol | **(d)** __________________________ | 102g/mol | 158 |

(4 marks)

2. Plot a graph of *boiling point (vertical axis)* against *the molecular mass* (horizontal axis) of each alcohol using the grid provided on the next page. Use your graph to find the boiling point of butan-1-ol in the table above. *(You can use a scale of 5 for both axes).*

(3 marks)

3. Suggest a reason why the boiling point of propan-2-ol is only 82$^{o}$C compared to that of propan-1-ol.

______________________________________________________________

______________________________________________________________

(1 mark)

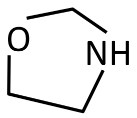
4. Classify the alcohol below as either *1$^{o}$, 2$^{o}$,* or *3$^{o}$:*

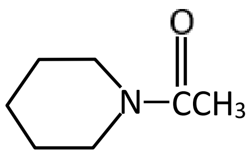
   a. 3,3-dimethylpentan-2-ol

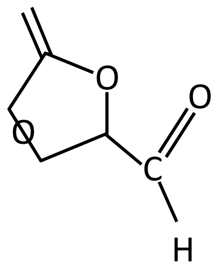
______________________________________________________________

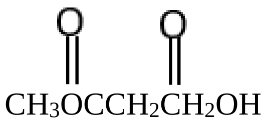
(1 mark)

5. Name the **functional group** present in each of the following structures.

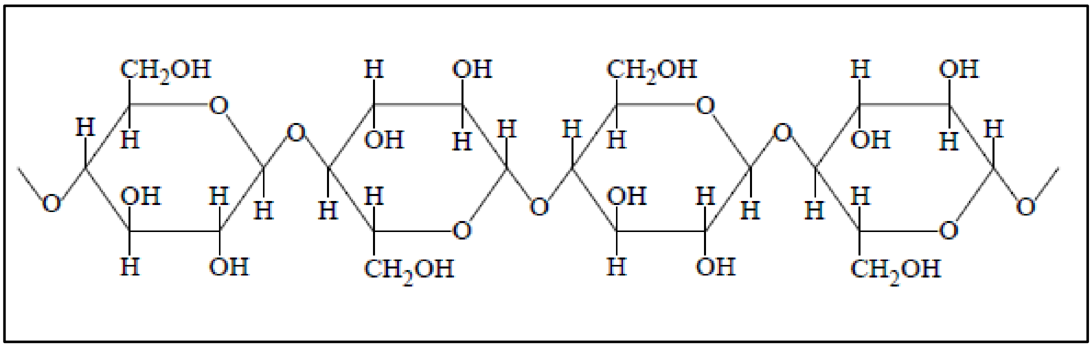
   a.  ___________________________(1 mark)

   b.  ______________________ (1 mark)

   c.  ______________________ (1 mark)

   d.  _______________________ (1 mark)

B. The cellulose that is present in plant matter cannot be directly fermented to produce bioethanol. The cellulose polymer must first be broken down into its constituent monomers. A section of cellulose polymer is shown below.



1. What is the name of the **monomer** from which cellulose is formed?

_______________________________________________

(1 mark)

2. Complete the *chemical equation* to show the formation of ethanol by fermentation.

$C_6H_{12}O_{6\ (aq)}$ ⟶ ______________ + ______________

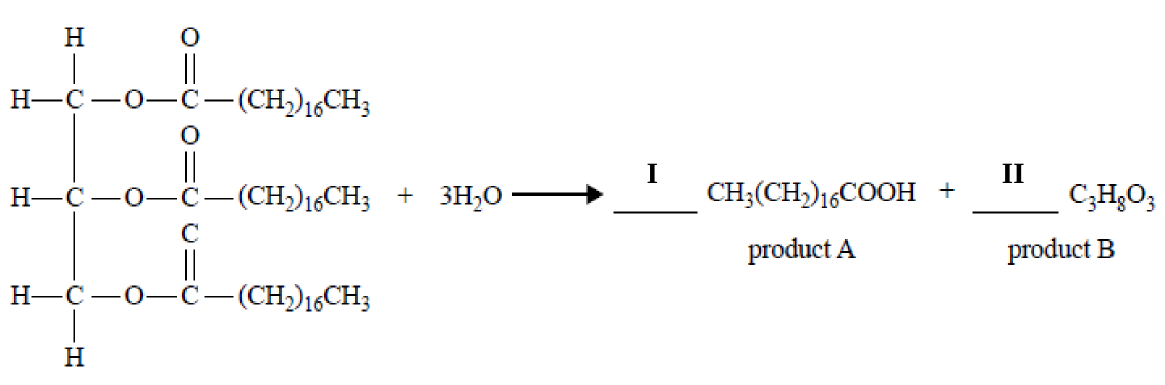
(2 marks)

3. Ethanol can be manufactured directly from ethene gas in the presence of a catalyst. Write the *equation* for this reaction.

_______________________________________________

(1 mark)

C. An incomplete chemical equation with two unknown coefficients **I** and **II** shows the hydrolysis of a triglyceride is shown below.




The fatty acid produced in the above reaction is completely oxidized to produce carbon dioxide and water.

Write the *equation* for the oxidation reaction.

________________________________________________________

(1 mark)

**Q24** **18**

**<u>QUESTION 25</u>:** **<u>INORGANIC CHEMISTRY</u>** **(19 MARKS)**

Periodic trends of oxides and chlorides of group 3 elements can be classified according to its type – *basic, amphoteric* and *acidic*.

A. 1. Complete the **electron configuration** of the $Al^+$ ion.

$1s^2$______________________________________________________

(1 mark)

2. State the meaning of the term **amphoteric**.

___________________________________________________________

___________________________________________________________

(1 mark)

3. State and explain the general **basicity and acidity** trend of the Period 3 Oxides of sodium to chlorine.

Trend______________________________________________________

___________________________________________________________

(1 mark)

Explanation

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

(3 marks)

B. Ammonium sulfate reacts with sodium hydroxide to form ammonia, sodium sulfate and water as shown in the equation below.

$$\mathbf{(NH_4)_2SO_4(s) + 2NaOH\ (aq) \longrightarrow 2NH_3\ (g) + Na_2SO_4\ (aq) + 2H_2O\ (l)}$$

1. A 3.14 g sample of ammonium sulfate reacted completely with 39.30cm$^3$ of a sodium hydroxide solution.

   (i) Calculate the amount*, in moles*, of $(NH_4)_2SO_4$ in 3.14 g of ammonium sulfate.

(2 marks)

   (ii) Calculate the amount**, in moles,** of sodium hydroxide, which reacted.

(2 marks)

   (iii) Calculate the *concentration, in mol/L*, of the sodium hydroxide solution used.

(2 marks)

2. $SO_2$ and $SO_3$ dissolve in water to give weak *sulphurous acid*, and the very strong *sulphuric acid* respectively.

In the space below write the **chemical equations** for the two reactions.

(i) Equation 1: $SO_2$ + Water

________________________________________________________

________________________________________________________

(1 mark)

(ii) Equation 2: $SO_3$ + Water

________________________________________________________

________________________________________________________

(1 mark)

3. Glauber's salt is a form of hydrated sodium sulfate that contains 44.1% by mass of sodium sulfate. Hydrated sodium sulfate can be represented by the formula $Na_2SO_4 . xH_2O$ where ***x*** is an integer. Calculate the *value of x*.

*(NB: Ar of Na = 23.0 g/mol; Ar of S = 32.0 g/mol; Ar of O = 16.0 g/mol and Ar of H = 1.0 g/mol).*

(2 marks)

C. Aluminum Chloride reacts rapidly when moistened with water (see below).

$$AlCl_{3\,(s)} + H_2O_{(l)} \longrightarrow Al_2O_{3\,(s)} + HCl_{(aq)}$$

1. Balance the equation above by filling in the coefficients in front of respective formulae.

___________________________________________________________

___________________________________________________________

(1 mark)

2. Explain why **ionic chlorides** react differently from **covalent chlorides.**

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______________________________________________________________

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______________________________________________________________

(2 marks)

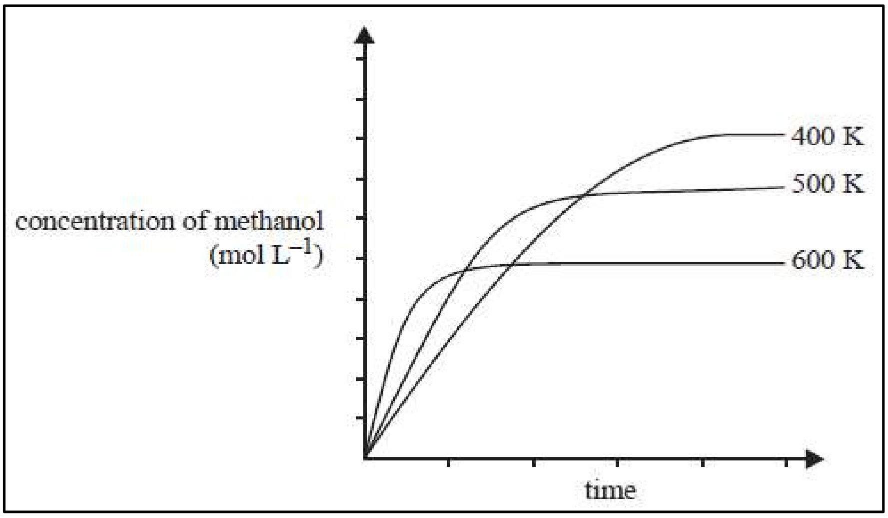
**Q25**

**19**

**QUESTION 26**: **PRINCIPLES OF PHYSICAL CHEMISTRY** **(27 MARKS)**

A. Methanol is produced by the catalytic conversion of a mixture of hydrogen and carbon monoxide gases at 520 K and a pressure of 50 to 100 atmospheres.

1. The graph below shows how the concentration of methanol changes with time at three different temperatures. *(The pressure is the same at each temperature).*




a) Is this reaction *exothermic* or *endothermic*? *Justify your answer.*

(i) Name of the reaction:

________________________________________________

(ii) Justify:

________________________________________________

(2 marks)

b) State why a moderately high temperature of 520 K is used although the equilibrium concentration of methanol is greater at a lower temperature.

________________________________________________

________________________________________________

________________________________________________

(2 marks)

c) Explain why, at a given temperature, the use of high pressure results in a **greater equilibrium** concentration of methanol.

______________________________________________________________

______________________________________________________________

______________________________________________________________

(2 marks)

d) Define **Dynamic equilibrium**.

______________________________________________________________

______________________________________________________________

(1 mark)

2. A catalyst consisting of a mixture of copper, zinc and aluminium is used to increase the rate of this reaction. *Explain how a catalyst can increase reaction rate.*

______________________________________________________________

______________________________________________________________

______________________________________________________________

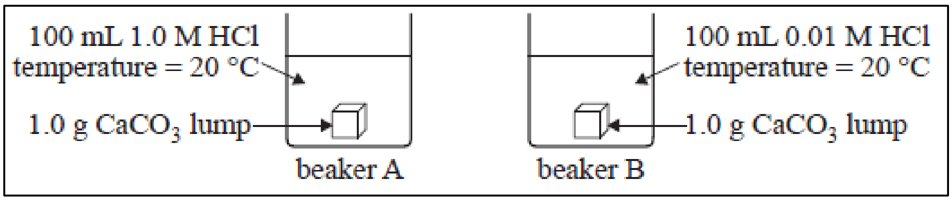
(2 marks)

B. Two experiments were conducted to investigate various factors that affect the rate of reaction between calcium carbonate and dilute hydrochloric acid.

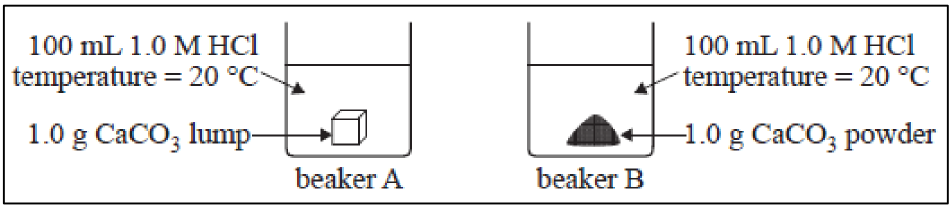
$$CaCO_3(s) + 2HCl(aq) \rightleftharpoons CO_2(g) + CaCl_2(aq) + H_2O(l)$$

The two experiments are summarized in the diagrams below.

**Experiment 1**




**Experiment 2**



1. Describe how the **reaction rate** can be measured in the experiments on page 30.

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

(2 marks)

2. Identify TWO (2) **rate-determining factors** that are investigated in experiment 1 on page 30.

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

(2 marks)

3. In experiment 2, will the rate of reaction be faster in beaker A or beaker B on page 30?

________________________________________________________________

________________________________________________________________

________________________________________________________________

________________________________________________________________

(2 marks)

4. Why is this statement **incorrect**?
'Collision theory states that all collisions between reactant particles will result in a chemical reaction.'

________________________________________________________________

________________________________________________________________

________________________________________________________________

(2 marks)

**C.** 0.415 g of a pure acid, $H_2X_{(s)}$, is added to exactly 100ml of 0.105 M $NaOH_{(aq)}$.
A reaction occurs according to the equation:

$$\mathbf{H_2X_{(s)} + 2NaOH_{(aq)} \rightarrow Na_2X_{(aq)} + 2H_2O_{(l)}}$$

NaOH is in excess. This excess NaOH requires 25.21ml of 0.197 M $HCl_{(aq)}$ for neutralisation.

i. Calculate the amount, in mol, of NaOH that reacts with the acid $H_2X$.

(3 marks)

ii. Calculate the *molar mass*, in g mol $^{-1}$, of the acid $H_2X$.

(2 marks)

**D.** The equation below represents an equilibrium process between dinitrogen tetrafluoride (N2F4) and nitrogen difluoride (NF2) in a closed system.

$$N\ F\ g \Leftrightarrow NF\ g \qquad \Delta rH^\circ = 38.5\ \text{kJ}$$

1. Define what a **closed system** is.

(1 mark)

2. Predict the changes in the following equilibrium reactions:

(i) The reaction mixture is heated at constant volume.

(2 marks)

(ii) The pressure on the reacting mixture is decreased at constant temperature.

(2 marks)

**Q26** 27

**<u>QUESTION 27</u>:** **<u>OXIDATION AND REDUCTION</u>** **(16 MARKS)**

1. The **lithium button cell**, used to power watches and calculators, is a primary cell containing lithium metal. The **lithium ion cell** is a secondary cell that is used to power laptop computers.

   a. State ONE (1) difference between a primary and secondary cell.

   ____________________________________________________________

   ____________________________________________________________

   (1 mark)

   b. By referring to information provided above, give ONE (1) reason why **lithium** is used as a reactant in these galvanic cells.

   ____________________________________________________________

   ____________________________________________________________

   (1 mark)

2. Determine the **oxidation state** of each atom in the $NO_2^-$ compound ion.

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

   (2 marks)

3. Identify the species being oxidized and reduced in the reaction below:

   $$\mathbf{Cr^{+} + Sn^{4+} \rightarrow Cr^{3+} + Sn^{2+}}$$

   *Oxidized Species*: ______________________

   *Reduced Species*: ______________________ (2 marks)

4. Write the balanced half reactions of the following chemical reactions:

a. $CO_2 + 2\ NH_2OH \rightarrow CO + N_2 + 3\ H_2O$ in basic solution

*(i) Oxidation half Equation:*

______________________________________________________________

(2 marks)

*(ii) Reduction half Equation:*

______________________________________________________________

(2 marks)

b. Using the above half equations, balance the overall REDOX equation.

______________________________________________________________

(2 marks)

5. This question requires you to refer to the information in the table below.

| | **Standard electrode potential $E^0$ in volts** |
|---|---|
| $HOBr_{(aq)} + H^+ + 2e^- \longrightarrow Br^-_{(aq)} + H_2O_{(l)}$ | +1.33 |
| $2HOBr_{(aq)} + 2H^+_{(aq)} + 2e^- \longrightarrow Br_{2\,(l)} + 2H_2O_{(l)}$ | +1.60 |

a. Explain why the reaction between chlorine gas and bromide ions is NOT predicted to occur to any significant extent under standard conditions.

$$Cl_{2\,(g)} + Br^-_{(aq)} + H_2O_{(l)} \longrightarrow 2Cl^-_{(aq)} + H^+ + HOBr_{(aq)}$$

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

(2 marks)

b. Differentiate between *Oxidation* and *Reduction*.

*(i) Oxidation*:

______________________________________________________________

______________________________________________________________

(1 mark)

*(ii) Reduction:*

______________________________________________________________

______________________________________________________________

(1 mark)

**Q27** **16**

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| Student Personal Identification Number |
| --- |
| |

**SINF6 - CHEMISTRY 2019**

## SECTION A:
## Multiple Choice

| | | | |
| --- | --- | --- | --- |
| 1. | | 11. | |
| 2. | | 12. | |
| 3. | | 13. | |
| 4. | | 14. | |
| 5. | | 15. | |
| 6. | | 16. | |
| 7. | | 17. | |
| 8. | | 18. | |
| 9. | | 19. | |
| 10. | | 20. | |

| SECTION | MARK | MARKER | CHECKER |
| --- | --- | --- | --- |
| **A** | 40 | | |
| **B.21** | 25 | | |
| **B.22** | 31 | | |
| **B.23.** | 24 | | |
| **B.24** | 18 | | |
| **B.25** | 19 | | |
| **B.26** | 27 | | |
| **B.27** | 16 | | |
| TOTAL MARK | **200** | | |
| **Marker/Checker Initials** | | | |

# Periodic Table of the Elements

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H Hydrogen 1.01 | | | | | | | | | | | | | | | | | 2 He Helium 4.00 |
| 3 Li Lithium 6.94 | 4 Be Beryllium 9.01 | | | | | | | | | | | 5 B Boron 10.81 | 6 C Carbon 12.01 | 7 N Nitrogen 14.01 | 8 O Oxygen 16.00 | 9 F Fluorine 19.00 | 10 Ne Neon 20.18 |
| 11 Na Sodium 22.99 | 12 Mg Magnesium 24.31 | | | | | | | | | | | 13 Al Aluminum 26.98 | 14 Si Silicon 28.09 | 15 P Phosphorus 30.97 | 16 S Sulfur 32.06 | 17 Cl Chlorine 35.45 | 18 Ar Argon 39.95 |
| 19 K Potassium 39.10 | 20 Ca Calcium 40.08 | 21 Sc Scandium 44.96 | 22 Ti Titanium 47.88 | 23 V Vanadium 50.94 | 24 Cr Chromium 51.99 | 25 Mn Manganese 54.94 | 26 Fe Iron 55.85 | 27 Co Cobalt 58.93 | 28 Ni Nickel 58.69 | 29 Cu Copper 63.55 | 30 Zn Zinc 65.38 | 31 Ga Gallium 69.72 | 32 Ge Germanium 72.63 | 33 As Arsenic 74.92 | 34 Se Selenium 78.97 | 35 Br Bromine 79.90 | 36 Kr Krypton 84.80 |
| 37 Rb Rubidium 85.47 | 38 Sr Strontium 87.62 | 39 Y Yttrium 88.91 | 40 Zr Zirconium 91.22 | 41 Nb Niobium 92.91 | 42 Mo Molybdenum 95.95 | 43 Tc Technetium 98.91 | 44 Ru Ruthenium 101.07 | 45 Rh Rhodium 102.91 | 46 Pd Palladium 106.42 | 47 Ag Silver 107.87 | 48 Cd Cadmium 112.41 | 49 In Indium 114.82 | 50 Sn Tin 118.71 | 51 Sb Antimony 121.76 | 52 Te Tellurium 127.6 | 53 I Iodine 126.90 | 54 Xe Xenon 131.29 |
| 55 Cs Cesium 132.91 | 56 Ba Barium 137.33 | 57-71 Lanthanides | 72 Hf Hafnium 178.49 | 73 Ta Tantalum 180.95 | 74 W Tungsten 183.85 | 75 Re Rhenium 186.21 | 76 Os Osmium 190.23 | 77 Ir Iridium 192.22 | 78 Pt Platinum 195.08 | 79 Au Gold 196.97 | 80 Hg Mercury 200.59 | 81 Tl Thallium 204.38 | 82 Pb Lead 207.20 | 83 Bi Bismuth 208.98 | 84 Po Polonium [208.98] | 85 At Astatine 209.98 | 86 Rn Radon 222.02 |
| 87 Fr Francium 223.02 | 88 Ra Radium 226.03 | 89-103 Actinides | 104 Rf Rutherfordium [261] | 105 Db Dubnium [262] | 106 Sg Seaborgium [266] | 107 Bh Bohrium [264] | 108 Hs Hassium [269] | 109 Mt Meitnerium [278] | 110 Ds Darmstadtium [281] | 111 Rg Roentgenium [280] | 112 Cn Copernicium [285] | 113 Nh Nihonium [286] | 114 Fl Flerovium [289] | 115 Mc Moscovium [289] | 116 Lv Livermorium [293] | 117 Ts Tennessine [294] | 118 Og Oganesson [294] |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 La Lanthanum 138.91 | 58 Ce Cerium 140.12 | 59 Pr Praseodymium 140.91 | 60 Nd Neodymium 144.24 | 61 Pm Promethium 144.91 | 62 Sm Samarium 150.36 | 63 Eu Europium 151.96 | 64 Gd Gadolinium 157.25 | 65 Tb Terbium 158.93 | 66 Dy Dysprosium 162.50 | 67 Ho Holmium 164.93 | 68 Er Erbium 167.26 | 69 Tm Thulium 168.93 | 70 Yb Ytterbium 173.06 | 71 Lu Lutetium 174.97 |
| 89 Ac Actinium 227.03 | 90 Th Thorium 232.04 | 91 Pa Protactinium 231.04 | 92 U Uranium 238.03 | 93 Np Neptunium 237.05 | 94 Pu Plutonium 244.06 | 95 Am Americium 243.06 | 96 Cm Curium 247.07 | 97 Bk Berkelium 247.07 | 98 Cf Californium 251.08 | 99 Es Einsteinium [254] | 100 Fm Fermium 257.10 | 101 Md Mendelevium 258.10 | 102 No Nobelium 259.10 | 103 Lr Lawrencium [262] |

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Metalloid | Nonmetal | Halogen | Noble Gas | Lanthanide | Actinide