

**PHYSICAL SCIENCE
EXAM PRACTISE**

GRADE 12

2020-2022

CHEMISTRY

GAPS ALLIGNED

EXAM QUESTIONS PER TOPIC COMPILED BY A.OLIVIER

BOOK 2



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A Section A Multiple Choice Questions and
A Section B Structured Questions

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Compiled by A. Olivier
Published by:



Tel: 014 592 6083

Cell: 079 092 0519 (no sms Voda.com)/063 133 6292 (no sms MTN)

Email: admin@amaniyah.co.za / www.amaniyah.co.za

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TABLE OF CONTENTS

	TERMS AND DEFINITIONS	I
CHAPTER 1	ORGANIC CHEMISTRY	1
CHAPTER 2	REACTION RATE AND ENERGY IN CHEMICAL REACTIONS	166
CHAPTER 3	CHEMICAL EQUILIBRIUM	256
CHAPTER 4	ACIDS AND BASES	330
CHAPTER 5	GALVANIC CELLS	378
CHAPTER 6	ELECTROLYTIC CELLS	438
CHAPTER 7	FERTILIZER	486

The final exam in Physical Sciences will cover the topics set out below for:

PAPER 2: CHEMISTRY

<p>Representing Chemical Change (Grade 10) (This section must be read in conjunction with the CAPS, p. 37.)</p>	<p>Balanced chemical equations</p> <ul style="list-style-type: none"> Write and balance chemical equations. Interpret balanced reaction equations in terms of: <ul style="list-style-type: none"> Conservation of atoms Conservation of mass (use relative atomic masses)
<p>Quantitative Aspects of Chemical Change (Grade 11) (This section must be read in conjunction with the CAPS, p. 82.)</p>	<p>Molar volume of gases</p> <ul style="list-style-type: none"> 1 mole of any gas occupies 22,4 dm³ at 0 °C (273 K) and 1 atmosphere (101,3 kPa). <p>Volume relationships in gaseous reactions</p> <ul style="list-style-type: none"> Interpret balanced equations in terms of volume relationships for gases, i.e. under the same conditions of temperature and pressure, equal number of moles of all gases occupy the same volume. <p>Concentration of solutions</p> <ul style="list-style-type: none"> Calculate the molar concentration of a solution. <p>More complex stoichiometric calculations</p> <ul style="list-style-type: none"> Determine the empirical formula and molecular formula of compounds. Determine the percentage yield of a chemical reaction. Determine percentage purity or percentage composition, e.g. the percentage CaCO₃ in an impure sample of seashells. Perform stoichiometric calculations based on balanced equations. Perform stoichiometric calculations based on balanced equations that may include limiting reagents.
<p>Intermolecular Forces (Grade 11) (This section must be read in conjunction with the CAPS, p. 71–73.)</p>	<p>Intermolecular and interatomic forces (chemical bonds)</p> <ul style="list-style-type: none"> Name and explain the different intermolecular forces (Van der Waal's forces): <ol style="list-style-type: none"> Dipole-dipole forces: <ul style="list-style-type: none"> Forces between two polar molecules Induced dipole forces or London forces: Forces between non-polar molecules Hydrogen bonding: <ul style="list-style-type: none"> Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen or fluorine – a special case of dipole-dipole forces Describe the difference between intermolecular forces and interatomic forces using a diagram of a group of small molecules; and in words. Example: <div style="text-align: center;"> </div> State the relationship between intermolecular forces and molecular size. For non-polar molecules, the strength of induced dipole forces increases with molecular size.

- Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.
Boiling point:
The temperature at which the vapour pressure equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.
Melting point:
The temperature at which the solid and liquid phases of a substance are at equilibrium. The stronger the intermolecular forces, the higher the melting point.
Vapour pressure:
The pressure exerted by a vapour at equilibrium with its liquid in a closed system. The stronger the intermolecular forces, the lower the vapour pressure.

Organic Molecules

(This section must be read in conjunction with the CAPS, p. 104–116.)

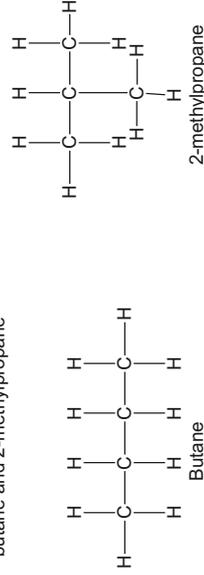
- Define organic molecules as molecules containing carbon atoms.
- Organic molecular structures – functional groups, saturated and unsaturated structures, isomers**
Write down condensed structural formulae, structural formulae and molecular formulae (up to 8 carbon atoms, one functional group per molecule) for:
 - Alkanes (no ring structures)
 - Alkenes (no ring structures)
 - Alkynes
 - Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)
 - Alcohols (primary, secondary and tertiary alcohols)
 - Carboxylic acids
 - Esters
 - Aldehydes
 - Ketones
- Know the following definitions/terms:
 - Molecular formula: A chemical formula that indicates the type of atoms and the correct number of each in a molecule.
Example: C₄H₈O
 - Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.
- Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.

$$\text{CH}_3\text{CH}_2\text{COCH}_3 \quad \text{OR} \quad \begin{array}{c} \text{O} \\ || \\ \text{CH}_3\text{CH}_2\text{CCH}_3 \end{array}$$
- Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.
Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH₂ group
Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains

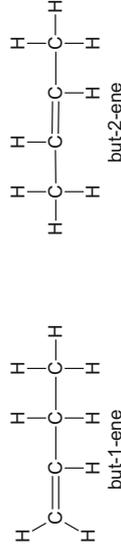
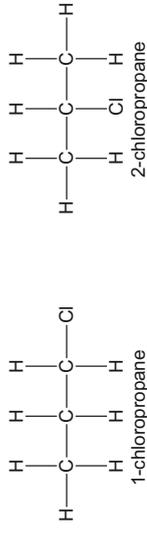
- Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains
- Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds

Homologous series	Structure of functional group	
	Structure	Name
Alkanes	$\begin{array}{c} \\ -C-C- \\ \end{array}$	Only C-H and C-C single bonds
Alkenes	$\begin{array}{c} \diagup \\ C=C \\ \diagdown \end{array}$	Carbon-carbon double bond
Alkynes	$-C\equiv C-$	Carbon-carbon triple bond
Haloalkanes	$\begin{array}{c} \\ -C-X \\ \end{array}$ (X = F, Cl, Br, I)	-
Alcohols	$\begin{array}{c} \\ -C-O-H \\ \end{array}$	Hydroxyl group
Aldehydes	$\begin{array}{c} O \\ \\ -C-H \end{array}$	Formyl group
Ketones	$\begin{array}{c} O \\ \\ -C-C- \\ \end{array}$	Carbonyl group
Carboxylic acids	$\begin{array}{c} O \\ \\ -C-O-H \end{array}$	Carboxyl group
Esters	$\begin{array}{c} O \\ \\ -C-O-C- \\ \end{array}$	-

- Structural isomer: Organic molecules with the same molecular formula, but different structural formulae
- Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.
- Restrict structural isomers to chain isomers, positional isomers and functional isomers.
- Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane



- Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-chloropropane and 2-chloropropane or but-2-ene and but-1-ene



- Functional isomers: Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid



IUPAC naming and formulae

- Write down the IUPAC name when given the structural formula or condensed structural formula for compounds from the homologous series above, restricted to one functional group per compound, except for haloalkanes. For haloalkanes, maximum two functional groups per molecule.
- Write down the structural formula when given the IUPAC name for the above homologous series.
- Identify alkyl substituents (methyl- and ethyl-) in a chain to a maximum of THREE alkyl substituents on the parent chain.
- When naming haloalkanes, the halogen atoms do not get preference over alkyl groups – numbering should start from the end nearest to the first substituent, either the alkyl group or the halogen. In haloalkanes, where e.g. a Br and a Cl have the same number when numbered from different ends of chain, Br gets alphabetical preference. When an alkyl group is a substituent in a molecule, it should be treated as a substituent.
- When writing IUPAC names, substituents appear as prefixes written alphabetically (bromo, chloro, ethyl, methyl), ignoring the prefixes di- and tri.

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- For a given example (from the above functional groups), explain the relationship between physical properties and:
 - Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces
 - Type of functional groups
 - Chain length
 - Branched chains

<p>Oxidation of alkanes</p> <ul style="list-style-type: none"> State the use of alkanes as fuels. Write down an equation for the combustion of an alkane in excess oxygen. <p>Esterification</p> <ul style="list-style-type: none"> Write down an equation, using structural formulae, for the formation of an ester. Name the alcohol and carboxylic acid used and the ester formed. Write down reaction conditions for esterification. <p>Substitution, addition and elimination reactions</p> <ul style="list-style-type: none"> Identify reactions as elimination, substitution or addition. Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes: <ul style="list-style-type: none"> Hydrohalogenation: The addition of a hydrogen halide to an alkene Halogenation: <ul style="list-style-type: none"> The reaction of a halogen (Br₂, Cl₂) with a compound Hydration: The addition of water to a compound Hydrogenation: <ul style="list-style-type: none"> The addition of hydrogen to an alkene <p>Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:</p> <ul style="list-style-type: none"> Dehydrohalogenation of haloalkanes: The elimination of hydrogen and a halogen from a haloalkane Dehydration of alcohols: Elimination of water from an alcohol Cracking of alkanes: <ul style="list-style-type: none"> The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules. <p>Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:</p> <ul style="list-style-type: none"> Hydrolysis of haloalkanes Reactions of HX (X = Cl, Br) with alcohols to produce haloalkanes Halogenation of alkanes <ul style="list-style-type: none"> The reaction of a halogen (Br₂, Cl₂) with a compound <p>Plastics and polymers (ONLY BASIC POLYMERISATION as application of organic chemistry)</p> <ul style="list-style-type: none"> Describe the following terms: <ul style="list-style-type: none"> Macromolecule: A molecule that consists of a large number of atoms Polymer: A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern Monomer: Small organic molecules that can be covalently bonded to each other in a repeating pattern Polymerisation: A chemical reaction in which monomer molecules join to form a polymer Distinguish between addition polymerisation and condensation polymerisation: <ul style="list-style-type: none"> Addition polymerisation: A reaction in which small molecules join to form very large molecules by adding on at double bonds Addition polymer: A polymer formed when monomers (usually containing a double bond) combine through an addition reaction Condensation polymerisation: Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water
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<p>Condensation polymer: A polymer formed by monomers with two functional groups that are linked together in a condensation reaction in which a small molecule, usually water, is lost</p> <ul style="list-style-type: none"> Identify monomers from given addition polymers. Write down an equation for the polymerisation of ethene to produce polythene. State the industrial uses of polythene.
<p>Energy and Change (This section must be read in conjunction with the CAPS, p. 90–91.)</p> <p>Energy changes in reactions related to bond energy changes</p> <ul style="list-style-type: none"> Define heat of reaction (ΔH) as the energy absorbed or released in a chemical reaction. Define exothermic reactions as reactions that release energy. Define endothermic reactions as reactions that absorb energy. Classify (with reason) reactions as exothermic or endothermic. <p>Exothermic and endothermic reactions</p> <ul style="list-style-type: none"> State that $\Delta H > 0$ for endothermic reactions, i.e. reactions in which energy is absorbed. State that $\Delta H < 0$ for exothermic reactions, i.e. reactions in which energy is released. <p>Activation energy</p> <ul style="list-style-type: none"> Define activation energy as the minimum energy needed for a reaction to take place. Define an activated complex as the unstable transition state from reactants to products. Draw or interpret fully labelled sketch graphs (potential energy vs. course of reaction) of catalysed and uncatalysed endothermic and exothermic reactions.
<p>Rate and Extent of Reaction (This section must be read in conjunction with the CAPS, p. 123–124.)</p> <p>Rates of reaction and factors affecting rate</p> <ul style="list-style-type: none"> Define reaction rate as the change in concentration of reactants or products per unit time. Calculate reaction rate from given data. Rate = $\frac{\Delta C}{\Delta t}$ (Unit: mol·dm⁻³·s⁻¹) Questions may also include calculations of rate in terms of change in mass/volume/ moles/per time. List the factors that affect the rate of chemical reactions, i.e. nature of reacting substances, surface area, concentration, pressure for gases, temperature and the presence of a catalyst. Explain in terms of the collision theory how the various factors affect the rate of chemical reactions. The collision theory is a model that explains reaction rate as the result of particles colliding with a certain minimum energy to form products. <p>Measuring rates of reaction</p> <ul style="list-style-type: none"> Answer questions and interpret data (tables or graphs) on different experimental techniques for measuring the rate of a given reaction. <p>Mechanism of reaction and of catalysis</p> <ul style="list-style-type: none"> Define the term (positive) catalyst as a substance that increases the rate of a chemical reaction without itself undergoing a permanent change.

- Interpret graphs of distribution of molecular energies (number of particles against their kinetic energy also known as Maxwell-Boltzmann curves) to explain how a catalyst, temperature and concentration affect rate.
- Explain that a catalyst increases the rate of a reaction by providing an alternative path of lower activation energy. It therefore decreases the net activation energy.
- Use a graph showing the distribution of molecular energies (number of particles against their kinetic energy) to explain why only some molecules have enough energy to react, and hence how adding a catalyst and heating the reactants affects the rate.

Chemical Equilibrium

(This section must be read in conjunction with the CAPS, p. 125–126.)

Chemical equilibrium and factors affecting equilibrium

- Explain what is meant by:
 - Open and closed systems: An open system continuously interacts with its environment, while a closed system is isolated from its surroundings.
 - A reversible reaction: A reaction is reversible when products can be converted back to reactants.
 - Chemical equilibrium: It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction.
- List the factors that influence the position of an equilibrium, i.e. pressure (gases only), concentration and temperature.

Equilibrium constant

- List the factors that influence the value of the equilibrium constant, K_c .
- Write down an expression for the equilibrium constant, having been given the equation for the reaction.
- Perform calculations based on K_c values.
- Explain the significance of high and low values of the equilibrium constant.

Application of equilibrium principles

- State Le Chatelier's principle: When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.
- Use Le Chatelier's principle to explain changes in equilibria qualitatively.
- Interpret graphs of equilibrium, e.g. concentration/rate/number of moles/mass/volume versus time.
- Explain the use of rate and equilibrium principles in the Haber process and the contact process.

Acids and Bases

(This section must be read in conjunction with the CAPS, p. 127–128.)

Acid-base reactions

- Define acids and bases according to Arrhenius and Lowry-Bronsted theories: Arrhenius theory: An acid is a substance that produces hydrogen ions (H^+) in water. A base produces hydroxide ions (OH^-) in water. Lowry-Bronsted theory: An acid is a proton (H^+ ion) donor. A base is a proton (H^+ ion) acceptor.
- Distinguish between strong acids/bases and weak acids/bases with examples. Strong acids ionise completely in water to form a high concentration of H_3O^+ ions. Examples of strong acids are hydrochloric acid, sulphuric acid and nitric acid. Weak acids ionise incompletely in water to form a low concentration of H_3O^+ ions. Examples of weak acids are ethanoic acid and oxalic acid. Strong bases dissociate completely in water. Examples of strong bases are sodium hydroxide and potassium hydroxide. Weak bases dissociate/ionise incompletely in water to form a low concentration of OH^- ions.

Examples of weak bases are ammonia, calcium carbonate, potassium carbonate, calcium carbonate and sodium hydrogen carbonate.

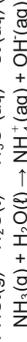
Distinguish between concentrated acids/bases and dilute acids/bases.

Concentrated acids/bases contain a large amount (number of moles) of acid/base in proportion to the volume of water.

Dilute acids/bases contain a small amount (number of moles) of acid/base in proportion to the volume of water.

Write down the reaction equations of aqueous solutions of acids and bases.

Examples: $HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$ (HCl is a monoprotic acid.)



Identify conjugate acid-base pairs for given compounds. When the acid, HA , loses a proton, its conjugate base, A^- , is formed. When the base, A^- , accepts a proton, its conjugate acid, HA , is formed. These two are a conjugate acid-base pair.

Describe a substance that can act as either acid or base as amphiprotic. Water is a good example of an amphiprotic substance. Write equations to show how an amphiprotic substance can act as acid or base.

Write down neutralisation reactions of common laboratory acids and bases.

Examples: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$



NOTE: The above are examples of equations that learners will be expected to write from given information. However, any other neutralisation reaction can be given in a question paper and used to assess, e.g. stoichiometry calculations. Determine the approximate pH (equal to, smaller than or larger than 7) of salts in salt hydrolysis. Define hydrolysis as the reaction of a salt with water.

- Hydrolysis of the salt of a weak acid and a strong base results in an alkaline solution, i.e. the $pH > 7$. Examples of such salts are sodium ethanoate, sodium oxalate and sodium carbonate.
- Hydrolysis of the salt of a strong acid and a weak base results in an acidic solution, i.e. the $pH < 7$. An example of such a salt is ammonium chloride.
- The salt of a strong acid and a strong base does not undergo hydrolysis and the solution of the salt will be neutral, i.e. $pH = 7$.
- Motivate the choice of a specific indicator in a titration. Choose from methyl orange, phenolphthalein and bromothymol blue. Define the equivalence point of a titration as the point at which the acid/base has completely reacted with the base/acid.
- Define the endpoint of a titration as the point where the indicator changes colour.
- Perform stoichiometric calculations based on titrations of a strong acid with a strong base, a strong acid with a weak base and a weak acid with a strong base. Calculations may include percentage purity.
- For a titration, e.g. the titration of oxalic acid with sodium hydroxide:
 - List the apparatus needed or identify the apparatus from a diagram.
 - Describe the procedure to prepare a standard oxalic acid solution.
 - Describe the procedure to conduct the titration.
 - Describe safety precautions.
 - Describe measures that need to be in place to ensure reliable results.
 - Interpret given results to determine the unknown concentration.
- Explain the pH scale as a scale of numbers from 0 to 14 used to express the hydrogen ion concentration.
- Calculate pH values of strong acids and strong bases.
- Define the concept of K_w as the equilibrium constant for the ionisation of water – the ionic product of water (ionisation constant of water).

- Explain the auto-ionisation of water, i.e. the reaction of water with itself to form H_3O^+ ions and OH^- ions.
- Interpret K_a values of acids to determine the relative strength of given acids. Interpret K_b values of bases to determine the relative strength of given bases.
- Compare strong and weak acids by looking at:
 - pH (monoprotic and diprotic acids)
 - Conductivity
 - Reaction rate

Electrochemical Reactions

(This section must be read in conjunction with the CAPS, p. 134–137.)

Electrolytic cells and galvanic cells

- Define the galvanic cell as a cell in which chemical energy is converted into electrical energy. A galvanic (voltaic) cell has self-sustaining electrode reactions.
- Define the electrolytic cell as a cell in which electrical energy is converted into chemical energy.
- Define oxidation and reduction in terms of electron (e^-) transfer: Oxidation is a loss of electrons. Reduction is a gain of electrons.
- Define oxidation and reduction in terms of oxidation numbers: Oxidation: An increase in oxidation number
Reduction: A decrease in oxidation number
- Define an oxidising agent and a reducing agent in terms of oxidation and reduction: Oxidising agent: A substance that is reduced/gains electrons.
Reducing agent: A substance that is oxidised/loses electrons.
- Define an anode and a cathode in terms of oxidation and reduction: Anode: the electrode where oxidation takes place
Cathode: the electrode where reduction takes place
- Define an electrolyte as a substance of which the aqueous solution contains ions OR a substance that dissolves in water to give a solution that conducts electricity.
- Electrolysis: The chemical process in which electrical energy is converted to chemical energy OR the use of electrical energy to produce a chemical change.

Relation of current and potential difference to rate and equilibrium

- Give and explain the relationship between current in an electrolytic cell and the rate of the reaction.
- State that the potential difference of a galvanic cell (V_{cell}) is related to the extent to which the spontaneous cell reaction has reached equilibrium.
- State and use the qualitative relationship between V_{cell} and the concentration of product ions and reactant ions for the spontaneous reaction, namely V_{cell} decreases as the concentration of product ions increases and the concentration of reactant ions decreases until equilibrium is reached at which the $V_{\text{cell}} = 0$ (the cell is 'flat'). (Qualitative only. Nernst equation is NOT required.)

Understanding of the processes and redox reactions taking place in galvanic cells

- Describe the movement of ions in the solutions.
- State the direction of electron flow in the external circuit.
- Write down the half-reactions that occur at the electrodes.
- State the function of the salt bridge.
 - Use cell notation or diagrams to represent a galvanic cell.
 - When writing cell notation, the following convention should be used:
 - The $\text{H}_2|\text{H}^+$ half-cell is treated just like any other half-cell.
 - Cell terminals (electrodes) are written on the outside of the cell notation.
 - Active electrodes:
 - reducing agent | oxidised species || oxidising agent | reduced species
 - Inert electrodes (usually Pt or C):
 - Pt | reducing agent | oxidised species || oxidising agent | reduced species | Pt
 - Example: $\text{Pt} | \text{Cr}(\text{aq}) | \text{Cr}_2(\text{g}) || \text{F}_2(\text{g}) | \text{F}(\text{aq}) | \text{Pt}$
- Predict the half-cell in which oxidation will take place when two half-cells are connected.
- Predict the half-cell in which reduction will take place when connected to another half-cell.
- Write down the overall cell reaction by combining two half-reactions.
- Use the Table of Standard Reduction Potentials to calculate the emf of a standard galvanic cell.
- Use a positive value of the standard emf as an indication that the reaction is spontaneous under standard conditions.

Standard electrode potentials

- Write down the standard conditions under which standard electrode potentials are determined.
- Describe the standard hydrogen electrode and explain its role as the reference electrode.
- Explain how standard electrode potentials can be determined using the reference electrode and state the convention regarding positive and negative values.

Understanding the processes and redox reactions taking place in electrolytic cells

- Describe the movement of ions in the solution.
- State the direction of electron flow in the external circuit.
- Write equations for the half-reactions taking place at the anode and cathode.
- Write down the overall cell reaction by combining two half-reactions.
- Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic processes:
 - The decomposition of copper(II) chloride
 - Electroplating, e.g. the electroplating of an iron spoon with silver/nickel
 - Refining copper
 - The electrolysis of a concentrated solution of sodium chloride and its use in the chlor-alkali industry
 - The recovery of aluminium metal from bauxite (South Africa uses bauxite from Australia.)
- Describe risks to the environment of the following electrolytic processes used industrially:
 - The production of chlorine (the chemical reactions of the chloro-alkali industry)
 - The recovery of aluminium metal from bauxite

Chemical Industry

(This section must be read in conjunction with the CAPS, p. 138–140.)

The fertiliser industry (N, P, K)

- List, for plants:
 - Three non-mineral nutrients C, H and O and their sources, i.e. the atmosphere (CO_2) and rain (H_2O)
 - Three primary nutrients N, P and K and their sources
- Explain why fertilisers are needed.
- Explain the function of N, P and K in plants.
- Interpret the N : P : K fertiliser ratio and perform calculations based on the ratio.
- Describe/Explain/Write balanced equations and interpret flow diagrams of the following processes in the industrial manufacture of fertilisers:
 - N_2 – fractional distillation of air
 - H_2 – at SASOL from coal and steam
 - NH_3 – Haber process
 - HNO_3 – Ostwald process
 - H_2SO_4 – Contact process
 - NH_4NO_3 ; $(\text{NH}_4)_2\text{SO}_4$
- Evaluate the use of inorganic fertilisers on humans and the environment.
- Define eutrophication as the process by which an ecosystem, e.g. a river or dam, becomes enriched with inorganic plant nutrients, especially phosphorus and nitrogen, resulting in excessive plant (algae) growth. As plant growth becomes excessive, the amount of dead and decaying plant material increases rapidly.
- Discuss alternatives to inorganic fertilisers as used by some communities.

TERMS AND DEFINITIONS

MATTER AND MATERIALS: ORGANIC MOLECULE	
Addition reaction	A reaction in which a double bond breaks into the starting material and elements are added to it.
Addition polymer	A polymer formed when monomers (which usually contain a double bond) bond through an addition reaction.
Addition polymerization	A reaction in which small molecules combine to form very large molecules by addition to double bonds.
Alcohol	An organic compound containing H atoms in alkanes has been replaced by hydroxyl groups (-OH groups). General formula: $C_nH_{2n+1}OH$
Aldehyde	An organic compound having the general structure RCHO where R = H or alkyl. General formula: RCHO (R = alkyl group)
Alkane	An organic compound containing only C-H and C-C single bonds. General formula: C_nH_{2n+2}
Alkene	An organic compound of carbon and hydrogen containing a carbon-carbon double bond. General formula: C_nH_{2n}
Alkyl group	A group that forms when one H atom is removed from an alkane.
Alkyne	An organic compound of carbon and hydrogen containing a carbon-carbon triple bond. General formula: C_nH_{2n-2}
Vapour pressure	The pressure exerted by a vapour in equilibrium with its liquid in a closed system.
Dehydration	Elimination of water from a compound e.g. an alcohol.
Dehydrohalogenation	The elimination of hydrogen and a halogen from a haloalkane.
Dipole-dipole forces	Intermolecular forces occurring between polar molecules i.e. molecule in which there is an uneven distribution of charge so that the molecule has a positive and a negative side.
Elimination response	A reaction in which elements of the starting material are lost and a double bond is formed.
Esterification	The preparation of an ester from the reaction of a carboxylic acid with an alcohol.
Functional group	A bond or an atom or a group of atoms that determines the physical and chemical properties of a group of organic compounds.

Functional isomers	Compounds with the same molecular formula but different functional groups.
Condensed structural formula	A formula that shows the way atoms in a molecule are bound, but does NOT show ALL bonding lines.
Haloalkane (Alkyl halides)	An organic compound in which one or more H atoms in an alkane have been replaced by halogen atoms. General formula: $C_nH_{2n+1}X$ (X = F, Cl, Br or I)
Halogenation / halogenation	The reaction of a halogen (Br_2 , Cl_2) with a compound.
Homologous series	A series of organic compounds that can be described by the same general formula. OF A series of organic compounds in which one member of the next differs with a CH_2 -group.
Hydration	The addition of water to a compound.
Hydrogenation	The addition of hydrogen to an alkene.
Hydrohalogenation	The addition of a hydrohalide to an alkene.
Hydrolysis	The reaction of a compound with water.
Intermolecular forces	Forces between molecules that determine physical properties of compounds.
IUPAC designation	A chemical nomenclature (set of rules) developed by the International Society of Pure and Applied Chemistry (IUPAC) to generate systematic names for chemical compounds.
Carbonyl group	Functional group of ketones ($>C=O$)
Carboxyl group	Functional group of carboxylic acids (-COOH)
Carboxylic acid	An organic compound containing a carboxyl group (-COOH group). General formula: $CC_nH_{2n+1}COOH$ (or RCOOH)
Chain isomers	Compounds with the same molecular formula, but different types of chains.
Condensation polymer	A polymer formed by two monomers with different functional groups linking together in a condensation reaction in which a small molecule, usually water, is lost.
Condensation polymerization	Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water.
Hydrocarbon	Organic compounds consisting only of hydrogen and carbon.
Boiling point	The temperature at which the vapour pressure of the substance is equal to atmospheric pressure.

Cracking	The chemical process in which longer chain hydrocarbon molecules are broken down into shorter, more useful, molecules.
London forces (forces of dispersion)	A weak intermolecular force between non-polar molecules.
Macromolecule	A molecule that consists of a large number of atoms.
Molecular formula	A chemical formula that indicates the type of atoms and the number of each in each molecule, e.g. CH ₄ .
Monomer	Small organic molecules that can be covalently bound to each other in a repeating pattern.
Unsaturated connections	Compounds in which one or more multiple bonds occur between C atoms in their hydrocarbon chains.
Organic chemistry	Chemistry of carbon compounds.
Polymer	A large molecule consisting of smaller monomer units covalently bound to each other in a repeating pattern.
Polymerization	A chemical reaction in which monomer molecules combine to form a polymer.
Position isomers	Compounds of the same molecular formula but different positions of the side chain, substituents or functional groups on the parent chain.
Primary alcohol	One C atom is bonded to the C atom bonded to the hydroxyl group. Example: $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
Primary haloalkane	One C atom is bonded to the C atom bonded to the halogen. Example: $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{Br} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
Secondary alcohol	Two C atoms are bonded to the C atom bonded to the hydroxyl group. Example: $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$

Secondary haloalkane	Two C atoms are bonded to the C atom bonded to the halogen. Example: $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{Br} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	Two C atoms are bonded to the C atom bound to the hydroxyl group. Example: $\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
Melting point	The temperature at which solid and liquid phases of a substance are in equilibrium.	
Structural formula	A structural formula of a compound shows which atoms are bound together in a molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold atoms together.	
Structural isomers	Organic molecules with the same molecular formula, but different structural formulas.	
Substituent (thank you)	A group or branch attached to the longest continuous chain of C atoms in an organic compound.	
Substitution reaction	A reaction in which an atom or group of atoms in a molecule is replaced by another atom or group of atoms.	
Organic chemistry	Chemistry of carbon compounds.	
Tertiary alcohol	Three C atoms are bonded to the C atom bonded to the hydroxyl group. Example: $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	Three C atoms are bonded to the C atom bound to the hydroxyl group. Example: $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$
Tertiary haloalkane	Three C atoms are bonded to the C atom bonded to the halogen. Example: $\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{Br} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	

Van der Waals forces	A combined name used for different types of intermolecular forces.
Saturated connections	Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains. OF
Hydrogen bonding	Compounds with only single bonds between C atoms. A strong intermolecular force occurring between molecules in which a H atom is covalently bonded to any one of an N, O or F atom.

CHEMICAL CHANGE: QUANTITATIVE ASPECTS OF CHEMICAL CHANGE	
Mol	One mole of a substance is the amount of dust that contains the same number of particles as there are atoms in 12 g of carbon-12.
Molar gas volume at STD	The volume of one mole of a gas. (1 mole of any gas is 22,4 dm ³ at 0 °C (273 K) in 1 atmosphere (101,3 kPa).
Molar mass	The mass of one mole of a substance. Symbol: M Unit: g·mol ⁻¹
Avogadro's Law	Under the same conditions of temperature and pressure, the same number of moles of all gases occupy the same volume.
Concentration	The amount of solute per liter / cubic decimeter of the solution. In symbols: $c = \frac{n}{V}$ OF $c = \frac{m}{MV}$ Unit: mol·mol ⁻³
Empirical formula	The simplest integer ratio of atoms present in a compound.
Percentage yield	Yield is the amount of product obtained from a reaction. Yield percentage = $\frac{\text{actual mass}}{\text{calculated mass}} \times 100$
Percentage of purity	Percentage purity = $\frac{\text{mass of pure chemicals}}{\text{total mass of monster}} \times 100$
Percentage composition	The percentage of each component in a substance. Percentage of component = $\frac{\text{mass contribution of component}}{\text{mass of all components}} \times 100$
Restrictive Reagent	The substance that is fully used up when the chemical reaction is complete.

CHEMICAL CHANGE: ENERGY AND CHANGE	
Reaction heat (ΔH)	The energy absorbed or expended during a chemical reaction.
Exothermic reactions	Reactions that release energy. (ΔH < 0)
Endothermic reactions	Reactions that absorb energy. (ΔH > 0)
Activation energy	The minimum energy required for a reaction to take place.
Activated complex	The unstable transition state from reactants to products.

CHEMICAL CHANGE: REACTION RATE	
Response rate	The change in concentration of reactants or products per unit time. Unit: mol·mol ⁻³ ·s ⁻¹ Rate = $\frac{\Delta C}{\Delta t}$
Collision theory	A model that explains reaction rate as a result of particles colliding with a certain minimum energy.
Catalyst	A substance that increases the rate of a chemical reaction without undergoing a permanent change. (A catalyst increases the rate of a reaction by providing an alternative route of lower activation energy. It therefore lowers the net / total activation energy.)
Factors that response rate influence	<ul style="list-style-type: none"> • Nature of reacting substances • Reaction surface • Concentration (pressure for gases) • Temperature • Presence of a catalyst

CHEMICAL CHANGE: CHEMICAL BALANCE	
Open system	A system that has constant interaction with its environment - it exchanges matter and energy with its environment.
Closed system	A system that exchanges only energy, not matter, with its environment.
Reversible response	This is a dynamic equilibrium when the rate of the forward reaction is equal to the rate of the reverse reaction.
Chemical equilibrium	This is a dynamic equilibrium when the rate of the forward reaction is equal to the rate of the reverse reaction.
Factors affecting the equilibrium position influence	<ul style="list-style-type: none"> • Pressure (for gases only) • Concentration • Temperature

Le Chatelier se principle	When the equilibrium is disturbed in a closed system, the system establishes a new equilibrium by favouring the reaction that counteracts the disturbance.
CHEMICAL CHANGE: ACIDS AND BASES	
Amphiprotic substance /ampholite	A substance that can act as either an acid or a base in a reaction.
Arrhenius theory	An acid is a substance that forms hydrogen ions (H ⁺) / hydronium ions (H ₃ O ⁺) when it dissolves in water. A base is a substance that forms hydroxide ions (OH ⁻) when it dissolves in water.
Self-ionization of water	A reaction in which water reacts with itself to form ions (hydronium ions and hydroxide ions).
Concentrated acid / base	Contains a large quantity (number of moles) of acid / base in relation to the volume of water.
Conjugated acid-base pair	Two compounds or ions that differ from each other in the presence of a single H ⁺ -ion. Example: CO ₃ ²⁻ and HCO ₃ ⁻ OR HCl and Cl ⁻
Conjugated acid and basic	A conjugate acid has one H + ion more than its conjugate base. Example: HCO ₃ ⁻ is the conjugate acid of basis CO ₃ ²⁻ . CO ₃ ²⁻ is the conjugate base of acid HCO ₃ ⁻ .
Diluted acids / bases	Contains a small amount (number of moles) of acid / base in relation to the volume of water.
Diprotic acid	An acid that can donate two protons. Example: H ₂ SO ₄
Dissociation	The process by which ionic compounds break down into ions.
End point	The point in a titration where an indicator changes colour.
Equivalent point	The point in reaction where equivalent amounts of acid and base react completely.
Hydrolysis	The reaction of a salt with water. OR the reaction of an ion with water to form the conjugate acid and a hydroxide ion, or to form the conjugate base and a hydronium ion.
Ionization	The process in which ions are formed during a chemical reaction.
Ion product for water	The product of the ions that form during self-ionization of water. [H ₃ O ⁺][OH ⁻]

Ionization constant for water (K _w)	The equilibrium value of the ion product of water. K _w = [H ₃ O ⁺][OH ⁻] = 10 ⁻¹⁴ by 25 °C
K _a -value	Ionization constant for an acid.
K _b -value	Dissociation or ionization constant for a base.
Lowry-Bronsted theory	An acid is a proton donor (H ⁺ -ion-donor). A Basis is a proton receiver (H ⁺ -ion-receiver).
Monoprotic acid	An acid that can donate one proton Example: HCl
Neutralization	The reaction of an acid with a base to form a salt (ionic compound) and water.
pH	The negative of the logarithm of the hydronium ion concentration in mol · mol ⁻³ . In symbols: pH = -log[H ₃ O ⁺] Unit: none
pH-scale	A scale of 0 - 14 used as a measure of the acidity or alkalinity of solutions where pH = 7 is neutral, pH > 7 is basic and pH < 7 is acidic.
Salt	The ionic compound that is the product of a neutralization reaction.
Standard solution	A solution whose concentration is exactly known.
Strong bases	Dissociate completely in water to form a high concentration of OH ⁻ -ions. Examples: sodium hydroxide (NaOH) and potassium hydroxide (KOH)
Strongly acidic	Ionize completely in water to form a high concentration of H ₃ O ⁺ -ions. Examples: hydrochloric acid (HCl), sulfuric acid (H ₂ SO ₄) and nitric acid (HNO ₃)
Acid base indicator	A dye used to mix between acidic and basic solutions distinguish by means of the colour change it undergoes in this solutions.
Poor acids	Ionize incompletely in water to form a low concentration of H ₃ O ⁺ -ions. Examples: ethanoic acid CH ₃ COOH and oxalic acid (COOH) ₂
Weak bases	Dissociate / ionize incompletely in water to form a low concentration of OH ⁻ -ions. Examples: ammonia (NH ₃), Sodium Bicarbonate (NaHCO ₃), Sodium Carbonate (Na ₂ CO ₃), Potassium carbonate (K ₂ CO ₃), Calcium Carbonate (CaCO ₃).
Titration	The procedure for determining the amount of acid (base) in a solution by determining the volume base (or acid) of known concentration that will fully react with it.

CHEMICAL CHANGE: ELECTROCHEMICAL REACTIONS	
Galvanic cell	A cell in which chemical energy is converted to electrical energy. A galvanic (voltaic) cell has self-sustaining electrode reactions.
Electrolytic cell	A cell in which electrical energy is converted to chemical energy.
Redox reaction	An reaction in which an electron transfer takes place.
Oxidation	A loss of electrons. An increase in oxidation number.
Reduction	A Profit from electrons. A decrease in oxidation number.
Oxidizing agent	A substance that is reduced / absorbs electrons / of which the oxidation rate decreases.
Reducing agent	A substance that is oxidized / loses electrons / whose oxidation rate increases.
Anode	The electrode where oxidation occurs.
Cathode	The electrode where reduction occurs.
The electrolyte	A solution that conducts electricity through the movement of ions.
Electrolysis	The chemical process that converts electrical energy to chemical energy. OF The use of electrical energy to bring about chemical change.
Hydrolysis	The reaction of a salt with water. OR the reaction of an ion with water to form the conjugate acid and a hydroxide ion, or to form the conjugate base and a hydronium ion.
Salt bridge	The process in which ions are formed during a chemical reaction.
Cell notation	A short way to represent a galvanic cell. When a cell notation is written, the following convention must be used: <ul style="list-style-type: none"> The $H_2 H^+$-half cell is treated just like any other half cell. Cell terminals (electrodes) are written on the outside of the cell notation. Active electrodes: <ul style="list-style-type: none"> reducing agent oxidized species oxidizing agent del reduced species Inactive electrodes (usually Pt or C): <ul style="list-style-type: none"> Pt reducing agent oxidized species oxidative means reduced species Pt Example: $Pt Cl^-(aq) Cl_2(g) F_2(g) F^-(aq) Pt$

Overall cell response	The reaction obtained by combining two half reactions.
Positive value of the standard emf	The reaction is spontaneous under standard conditions
Standard conditions for a galvanic cell	<ul style="list-style-type: none"> Temperature: 25 °C / 298 K Concentration: 1 mol·mol⁻³ Pressure (gases only): 101,3 kPa / 1 atmosphere
By default hydrogen electrode	The reference electrode used to compile the Table of Standard Reduction Potentials. The hydrogen half-cell has an assigned standard reduction potential of 0 V. Half-cell notation: $Pt H_2(g) H^+(aq)$ Half reaction: $2H^+ + 2e^- \rightleftharpoons H_2$
Electroplating	Covering an object with a metal by making it the cathode in an electrolytic cell.
Bauxite	The ore from which aluminium is extracted.
The cryolite	An aluminium compound which dissolves aluminium oxide to reduce the cost of extracting aluminium. Chiolite has a lower melting point than aluminium oxide and the process can be carried out at a lower temperature.

CHEMICAL SYSTEMS: FERTILIZER	
Non-minerals nutrients for plants	C, H and O Obtain from the atmosphere (CO ₂) and rain (H ₂ O)
Primary nutrients for plants	Nitrogen (N), phosphorus (P) and potassium (K) Function: N: essential for plant growth; green leaves P: development of roots, stems and seeds K: disease resistance and flower production / fruit
NPK fertilizer	Fertilizers containing three primary nutrients for plants. They contain ammonium nitrate (NH ₄ NO ₃), ammonium phosphate [(NH ₄) ₃ PO ₄] and potassium chloride (KCl)
N : P : K-relationship	The percentage of nitrogen, phosphorus and potassium in fertilizers.
Fractional distillation of liquid air	Industrial preparation of nitrogen from air.
Steam conversion	Hydrogen production from natural gas (methane) Reaction: $CH_4 + H_2O \rightarrow 3H_2 + CO$
Creation process	Industrial preparation of ammonia Reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (Iron catalyst)

Ostwald process	<p>Industrial preparation of nitric acid</p> <p>Responses:</p> <p>Catalytic oxidation of ammonia, Pt as catalyst:</p> <ul style="list-style-type: none"> $4\text{NH}_3 + 5\text{O}_2 \rightleftharpoons 4\text{NO} + 6\text{H}_2\text{O}$ $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$ $3\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 + \text{NO}$ <p>OR</p> $4\text{NO}_2 + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{HNO}_3$
Contact process	<p>Industrial preparation of sulfuric acid</p> <p>Responses:</p> <ul style="list-style-type: none"> $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ contact catalogs: vanadium pentoxide (V_2O_5) $\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S}_2\text{O}_7$ ($\text{H}_2\text{S}_2\text{O}_7$: smoking sulfuric acid OR pyruvic acid OR oleum) $\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4$ <p>ammonia + sulfuric acid \rightarrow ammonium sulphate</p> $2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ <p>ammonia + nitric acid \rightarrow ammonium nitrate</p> $\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$
Preparation of ammonium sulfate	
Preparation of ammonium nitrate	
Eutrophication	<p>The process in which an ecosystem, e.g. a river or pond, enriched with inorganic plant nutrients, especially phosphorus and nitrogen, which results in excessive plant growth. As plant growth becomes excessive, the dead and decaying plant material increases rapidly.</p>

ORGANIC CHEMISTRY

SECTION 1 : MULTIPLE CHOICE QUESTIONS

- Which ONE of the following is the general formula of alkynes? (2)
 - C_nH_{2n}
 - $\text{C}_{2n}\text{H}_{2n}$
 - $\text{C}_n\text{H}_{2n-2}$
 - $\text{C}_n\text{H}_{2n+2}$
- The type of reaction that takes place when a carboxylic acid and an alcohol react in the presence of an acid: (2)
 - Addition
 - Hydrolysis
 - Substitution
 - Esterification
- Which ONE of the following isomers has the LOWEST boiling point? (2)
 - $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 - $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{CH}_3$
 - $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}_3$
 - $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- The IUPAC name of an organic compound with molecular formula $\text{C}_7\text{H}_{14}\text{O}_2$: (2)
 - Heptanal
 - Heptan-1-ol
 - Heptan-2-one
 - Heptanoic acid
- Which ONE of the following structures is the functional group of aldehydes? (2)
 - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{H} \end{array}$
 - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$
 - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{C}- \\ | \quad | \end{array}$
 - $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{C}- \\ | \quad | \end{array}$
- Which ONE of the following equations represents a cracking process? (2)
 - $5\text{CH}_2=\text{CH}_2 \rightarrow -(\text{CH}_2\text{CH}_2)_5-$
 - $\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3(\text{CH}_2)_6\text{CH}_3$
 - $\text{CH}_3(\text{CH}_2)_6\text{CH}_3 \rightarrow \text{CH}_3(\text{CH}_2)_4\text{CH}_3 + \text{CH}_2=\text{CH}_2$
 - $\text{CH}_3(\text{CH}_2)_7\text{OH} \rightarrow \text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}_2 + \text{H}_2\text{O}$
- A boiling point of a compound is the ... (2)
 - minimum temperature at which it boils.
 - average temperature at which it boils across all possible atmospheric pressures.
 - maximum temperature at which it boils.
 - temperature at which its vapour pressure equals atmospheric pressure

8. Which ONE of the following organic reactions will take place only when exposed to light?

- A. $\text{CH}_2\text{CH}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_3$
 B. $\text{CH}_3\text{CH}_3 \rightarrow \text{CH}_2\text{CH}_2 + \text{H}_2$
 C. $\text{CH}_2\text{CH}_2 + \text{Cl}_2 \rightarrow \text{CH}_2\text{ClCH}_2\text{Cl}$
 D. $\text{CH}_3\text{CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{CH}_2\text{Cl} + \text{HCl}$

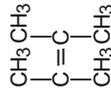
(2)

9. A carbonyl group is the functional group of ...

- A. alcohols
 B. ketones
 C. haloalkanes
 D. carboxylic acids

(2)

10. Consider the structure of an organic compound below.

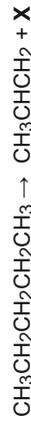


The IUPAC name of this compound is ...

- A. 2,3-dimethylbut-2-ene
 B. 2,2-dimethylbut-2-ene
 C. 1,1,2-trimethylprop-1-ene
 D. 1,1,2,2-tetramethylethene

(2)

11. Consider the reaction represented below.



Which ONE of the following CORRECTLY gives the type of reaction that takes place and the IUPAC name of product X?

Type of reaction	Product X
A. Elimination	Ethane
B. Elimination	Ethene
C. Addition	Ethane
D. Addition	Ethene

(2)

12. What product will be formed when an alkene reacts with water vapour (H_2O) in the presence of an acid catalyst?

- A. Ester
 B. Alkane
 C. Alcohol
 D. Aldehyde

(2)

13. Which ONE of the following represents a SUBSTITUTION REACTION?

- A. $\text{CH}_2=\text{CH}_2 + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br}$
 B. $\text{CH}_2=\text{CH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
 C. $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_2=\text{CH}_2 + \text{H}_2\text{O}$
 D. $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

(2)

14. Consider the two organic molecules I and II below.

I	II
$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{O} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$

Which ONE of the following represents the homologous series to which compound I and compound II belong?

I	II
A. Ketones	Alcohols
B. Aldehydes	Ketones
C. Aldehydes	Alcohols
D. Ketones	Aldehydes

(2)

15. A compound with a general formula $\text{C}_n\text{H}_{2n+2}$ is a ...

- A. alkane
 B. alkene
 C. alkyne
 D. alcohol

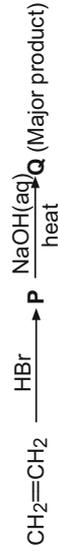
(2)

16. Which ONE of the following is a functional isomer of butanoic acid?

A	$\begin{array}{c} \text{O} \\ \\ \text{H}-\text{O}-\text{C}-\text{CH}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$	B	$\text{CH}_3-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3$
C	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	D	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{CH}_2-\text{CH}_3 \\ \\ \text{H} \quad \text{O} \end{array}$

(2)

17. In the flow diagram P and Q represent two organic compounds.



Compound Q is:

- A. CH_2CH_2
 B. CH_3CH_3
 C. $\text{CH}_3\text{CH}_2\text{Br}$
 D. $\text{CH}_3\text{CH}_2\text{OH}$

(2)

18. Which ONE of the following compounds is an aldehyde?

- A. CH_3COCH_3
 B. $\text{CH}_3\text{CH}_2\text{CHO}$
 C. $\text{CH}_3\text{CH}_2\text{COOH}$
 D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

(2)

19. Which ONE of the following compounds has dipole-dipole-forces between its molecules?
 A. Ethanal
 B. Ethane
 C. Ethene
 D. Ethyne (2)
20. Which ONE of the following is a product formed during the hydrolysis of bromoethane?
 A. Water
 B. Ethene
 C. Ethanol
 D. Bromine (2)
21. Which ONE of the following is the EMPIRICAL FORMULA of 1,2-dichloroethane?
 A. CHCl
 B. CH_2Cl_2
 C. CHCl_2
 D. $\text{C}_2\text{H}_4\text{Cl}_2$ (2)
22. Which ONE of the following compounds is an aldehyde?
 A. Pentanal
 B. Pentan-2-ol
 C. Pentan-2-one
 D. Ethyl propanoate (2)
23. Consider the reaction represented by the equation below:

$$\text{CH}_3\text{CHCH}_2 + \text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_3$$
 This reaction is an example of ...
 A. hydration
 B. dehydration
 C. substitution
 D. hydrogenation (2)
24. Consider the structural formula of a compound below.

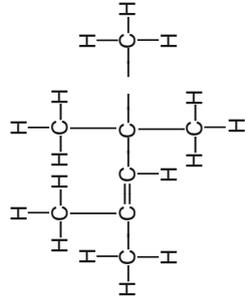
$$\begin{array}{ccccccc} & \text{H} & \text{H} & & \text{O} & \text{H} & \\ & | & | & & || & | & \\ \text{H} & - \text{C} & - \text{C} & - & \text{C} & - \text{C} & - \text{H} \\ & | & | & & | & | & \\ & \text{H} & \text{H} & & \text{H} & \text{H} & \end{array}$$
 Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?
 A. Propanoic acid and ethanol
 B. Propanoic acid and methanol
 C. Ethanoic acid and propan-1-ol
 D. Methanoic acid and propan-1-ol (2)
25. Which ONE of the following statements is CORRECT?
 Alkenes ...
 A. have the general formula $\text{C}_n\text{H}_{2n} + 2$.
 B. are unsaturated hydrocarbons.
 C. readily undergo substitution reactions.
 D. have one triple bond between two carbon atoms. (2)

26. The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$\text{C}_{11}\text{H}_{24} \rightarrow 2\text{C}_2\text{H}_4 + \text{Y} + \text{C}_4\text{H}_{10}$$
 Which ONE of the following is the IUPAC name of product Y?
 A. Prop-1-ene
 B. Propan
 C. Ethene
 D. Ethane (2)
27. When 2-chlorobutane is strongly heated in the presence of concentrated sodium hydroxide, the major product formed ...
 A. but-1-ene
 B. but-2-ene
 C. butan-1-ol
 D. butan-2-ol (2)
28. Which ONE of the following compounds is a ketone?
 A. $\text{CH}_3\text{COCH}_2\text{CH}_3$
 B. $\text{CH}_3\text{COOCH}_2\text{CH}_3$
 C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
 D. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$ (2)
29. Which ONE of the following compounds is SATURATED?
 A. $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$
 B. $\text{CH}_3\text{CH}_2\text{CHCH}_2$
 C. $\text{CH}_3\text{CHCHCH}_3$
 D. $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CHCH}_2$ (2)
30. A scientist investigates a factor which influences the boiling points of alkanes. He determines the boiling points of the first six straight chain alkanes. Which ONE of the following is the independent variable in this investigation?
 A. Boiling point
 B. Functional group
 C. Branching
 D. Chain length (2)
31. Which ONE of the following compounds below is an aldehyde?
 A. CH_3CHO
 B. CH_3COCH_3
 C. CH_3COOH
 D. CH_3OH (2)
32. The reaction represented by the equation below takes place in the presence of a catalyst.

$$\text{C}_{13}\text{H}_{28}(\ell) \rightarrow \text{C}_2\text{H}_4(\text{g}) + \text{C}_3\text{H}_6(\text{g}) + \text{C}_8\text{H}_{18}(\ell)$$
 This reaction is an example of ...
 A. addition
 B. cracking
 C. substitution
 D. polymerization (2)
33. Which ONE of the following is the functional group of aldehydes?
 A. $-\text{COO}-$
 B. $-\text{COOH}$
 C. $-\text{CHO}$
 D. $-\text{OH}$ (2)

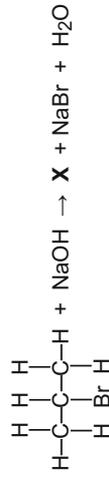
34. Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

- A. 2,2,4-trimethylpent-2-ene
 B. 2,2,4-trimethylpent-3-ene
 C. 2,4,4-trimethylpent-2-ene
 D. 2,4,4-trimethylpent-3-ene (2)

35. The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated. X represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound X?

- A. Prop-1-ene
 B. Prop-2-ene
 C. Propan-1-ol
 D. Propan-2-ol (2)

36. Which ONE of the following compounds has the highest melting point?

- A. CH_3CH_3
 B. $\text{CH}_3\text{CH}_2\text{CH}_3$
 C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
 D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ (2)

37. Consider the organic compounds (I to IV) shown below.

I	$\text{CH}\equiv\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	II	$\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_3$
III	$\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_3$	IV	$\text{CH}_3-\text{C}\equiv\text{CH}$

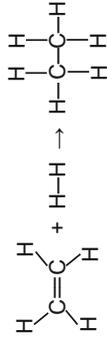
Which of the compounds above are structural isomers?

- A. I and II
 B. I and III
 C. I and IV
 D. II and III (2)

38. A structural isomer of butane is ...

- A. propane
 B. 2-methylbutane
 C. 2-methylpropane
 D. 2,2-dimethylpropane (2)

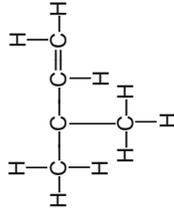
39. Consider the reaction represented below.



This reaction is an example of ...

- 0
 D. substitution (2)

40. Consider the organic compound represented below.



The compound is ...

- A. saturated and branched.
 B. unsaturated and branched.
 C. saturated and straight-chained.
 D. unsaturated and straight-chained. (2)

41. The alcohols form a homologous series. This means that alcohols have ...

- A. similar chemical properties.
 B. similar physical properties.
 C. the same molecular formula.
 D. the same structural formula. (2)

42. Which ONE of the following compounds CANNOT be an alkene?

- A. C_2H_4
 B. C_3H_6
 C. C_3H_8
 D. C_4H_8 (2)

43. Which ONE of the following compounds represented below is an UNSATURATED hydrocarbon?

- A.

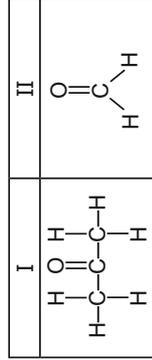
 B.

 C.

 D.

 (2)

44. Consider the two organic compounds represented by I and II, as shown below.



Which ONE of the following correctly represents the homologous series to which each belongs?

I	II
A. Aldehyde	Alcohol
B. Ketone	Alcohol
C. Ketone	Aldehyde
D. Aldehyde	Ketone

45. Which ONE of the following general formulae represents alkynes?

- A. C_nH_{2n+2}
 B. C_nH_{2n-2}
 C. C_nH_{2n}
 D. C_nH_{2n-1}

46. Which ONE of the following homologous series does NOT contain a CARBONYL group ($C=O$)?

- A. Aldehydes
 B. Alcohols
 C. Carboxylic acids
 D. Esters

47. The structures of four organic compounds are shown below.

I	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$	II	$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{OH} \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$
III	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\ \quad \\ \text{OH} \quad \text{CH}_3 \end{array}$	IV	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_3 \\ \quad \\ \text{CH}_2 \\ \\ \text{OH} \end{array}$

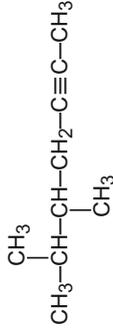
Which of the above compounds have the same IUPAC name?

- A. I and II only
 B. III and IV only
 C. I and III only
 D. II and IV only

48. Which ONE of the following pairs of reactants can be used to prepare the ester ethyl methanoate in the laboratory?

- A. Ethane and methanoic acid
 B. Methanol and ethanoic acid
 C. Ethanol and methanoic acid
 D. Ethene and methanol

49. The structural formula of an organic compound is given below.



The IUPAC name of this compound is ...

- A. 2,3-dimethylhept-5-yne
 B. 5,6-dimethylhept-2-yne
 C. 2,3-methylhept-2-yne
 D. 5,6-dimethylhept-3-yne

50. The type of compound formed when but-1-ene reacts with water in the presence of a suitable catalyst is a/an ...

- A. alcohol
 B. alkane
 C. haloalkane
 D. ester

51. Which ONE of the following compounds represents a ketone?



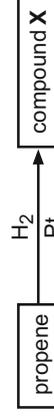
52. Consider the compound with molecular formula C_4H_{10} . How many structural isomers does this compound have?

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

53. Which ONE of the following pairs of reactants can be used to prepare the ester ethyl butanoate in the laboratory?

- A. Ethanal and butanol
 B. Ethanoic acid and butanol
 C. Ethanol and butanoic acid
 D. Ethanal and butanoic acid

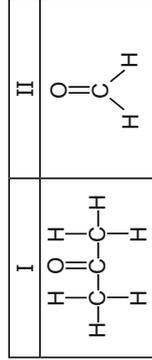
54. Consider the flow diagram below:



The IUPAC name for compound X is:

- A. propyne
 B. propan-1-ol
 C. propane
 D. propan-2-ol

44. Consider the two organic compounds represented by I and II, as shown below.



Which ONE of the following correctly represents the homologous series to which each belongs?

I	II
A. Aldehyde	Alcohol
B. Ketone	Alcohol
C. Ketone	Aldehyde
D. Aldehyde	Ketone

45. Which ONE of the following general formulae represents alkynes?

- A. C_nH_{2n+2}
 B. C_nH_{2n-2}
 C. C_nH_{2n}
 D. C_nH_{2n-1}

46. Which ONE of the following homologous series does NOT contain a CARBONYL group ($C=O$)?

- A. Aldehydes
 B. Alcohols
 C. Carboxylic acids
 D. Esters

47. The structures of four organic compounds are shown below.

I	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$	II	$\begin{array}{c} \text{CH}_3-\text{CH}_2-\text{CH}-\text{OH} \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$
III	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_3 \\ \quad \\ \text{OH} \quad \text{CH}_3 \end{array}$	IV	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_3 \\ \quad \\ \text{CH}_2 \\ \\ \text{OH} \end{array}$

Which of the above compounds have the same IUPAC name?

- A. I and II only
 B. III and IV only
 C. I and III only
 D. II and IV only

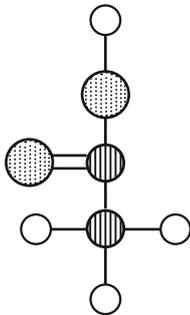
48. Which ONE of the following pairs of reactants can be used to prepare the ester ethyl methanoate in the laboratory?

- A. Ethane and methanoic acid
 B. Methanol and ethanoic acid
 C. Ethanol and methanoic acid
 D. Ethene and methanol

64. Which ONE of the following compounds will have the highest boiling point?
 A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OCH}_3$
 C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
 D. $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(=\text{O})\text{CH}_3$

(2)

65. The diagram below represents an organic compound consisting of three different elements.

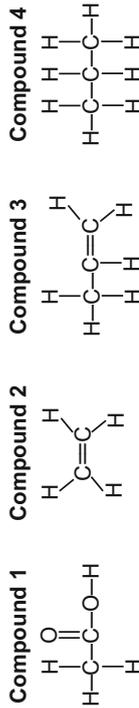


The IUPAC name of this compound is ...

- A. ethanol
 B. propanal
 C. ethanoic acid
 D. propan-2-one

(2)

66. The structures of four organic compounds are shown below.



Which of the above compounds will decolourise bromine water in a darkened room?

- A. 2 and 3
 B. 1 and 2
 C. 3 and 4
 D. 2, 3 and 4

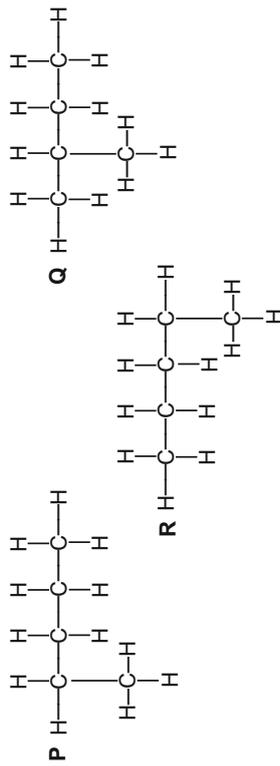
(2)

67. Which ONE of the following is a positional isomer of butan-1-ol?

A	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	B	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
C	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	D	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$

(2)

68. Consider the structural formulae of THREE organic compounds given below:

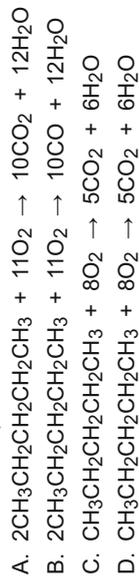


Which ONE of the following statements about the above compounds is CORRECT?

- A. **P** and **R** are the same compound.
 B. **Q** and **R** are the same compound.
 C. All three are different compounds.
 D. All three compounds are branched alkanes.

(2)

69. Which ONE of the following equations represents the incomplete combustion of pentane?



(2)

70. A Polymer formed as a result of addition polymerization is most likely to be derived from a monomer that is ...

- A. An ester
 B. An alcohol
 C. A hydrocarbon
 D. A carboxylic acid

(2)

71. The IUPAC name of an organic compound with the molecular formula $\text{C}_5\text{H}_{10}\text{O}$ can be:

- A. pentan-1-ol
 B. pentanoic acid
 C. 3-methylbutanal
 D. 3-methylbutan-1-one

(2)

72. Which one of the following pairs of compounds contain members of the same homologous series?

- A. C_2H_4 and C_3H_4
 B. C_3H_6 and C_4H_6
 C. CH_4O and $\text{C}_2\text{H}_4\text{O}_2$
 D. $\text{C}_2\text{H}_4\text{O}_2$ and $\text{C}_3\text{H}_6\text{O}_2$

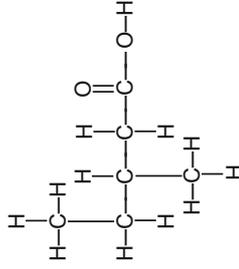
(2)

73. When 2-chloro butane is strongly heated in the presence of concentrated sodium hydroxide. The major product that forms is:

- A. But-1-ene
 B. But-2-ene
 C. Butan-1-ol
 D. Butan-2-ol

(2)

74. Consider the organic compound below:



The IUPAC name of this compound is:

- A. 1,2-dimethylbutanoic acid
 B. 3-methylpentanoic acid
 C. hexanoic acid
 D. 1-ethyl-1-methylpropanoic acid

(2)

75. The complete combustion of propane is represented by the balanced equation below:

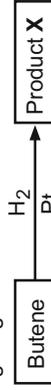


30 cm³ propane is mixed with 200 cm³ of oxygen and the mixture is ignited. What is the volume, in cm³, of the CO₂ in the resulting gas mixture? (All the volumes are measured at the same temperature and pressure.)

- A. 230
 B. 140
 C. 120
 D. 90

(2)

76. Consider the following diagram:



The name of product **X** as well as the type of reaction taking place respectively, are:

Product X	Type of reaction
A dichlorobutene	hydration
B butadiene	addition
C butane	hydrogenation
D butyne	elimination

77. Which ONE of the following molecular formula represents 2-methyl pentanal?

- A. C₂H₄O
 B. C₆H₁₂O
 C. C₅H₁₄O
 D. C₆H₁₃O₂

(2)

78. Which ONE of the following structures is the functional group of carboxylic acid?

A	$\begin{array}{c} \text{H}-\text{C}-\text{O}-\text{R} \\ \\ \text{O} \end{array}$	B	$\begin{array}{c} \text{O} \\ \\ \text{H}-\text{C}-\text{H} \end{array}$
C	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{OH}$	D	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{OH} \end{array}$

(2)

79. The conditions required for the thermal cracking of alkanes, are...

- A. H₂SO₄ and moderate heat.
 B. Pt-catalyst and water.
 C. Ni-catalyst and pressure.
 D. high temperatures and high pressures.

(2)

80. Which ONE of the following is the general formula of alkenes?

- A. C_{2n}H_{2n}
 B. C_nH_{2n - n}
 C. C_nH_{2n + 2}
 D. C_nH_{2n}

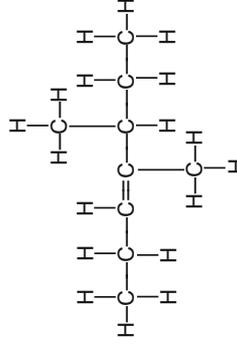
(2)

81. Which ONE of the following isomers has the LOWEST boiling point?

- A. CH₃CH₂CH₂CH₂CH₂CH₃
 B. CH₃CH(CH₃)CH₂CH₂CH₃
 C. CH₃CH₂C(CH₃)₂CH₃
 D. CH₃CH₂CH(CH₃)CH₂CH₃

(2)

82. The structural formula of an organic compound is shown below:



Which ONE of the following is the correct IUPAC name of this compound?

- A. 4-methyl-5-ethylhex-3-ene
 B. 4,5-dimethylhept-3-ene
 C. 3,4-dimethylhept-4-ene
 D. 3-methyl-4-ethylhept-4-ene

(2)

83. Consider the compound below.



To which homologous series does the compound belong?

- A. Alkanes
 B. Alkenes
 C. Alkynes
 D. Haloalkanes

(2)

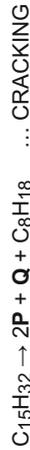
84. Study the structural formula of a ketone below.
Which ONE of the following compounds is a structural isomer of the ketone appearing below?



- A. Propane
B. Propanal
C. Propane-1-ol
D. Propane-2-ol

(2)

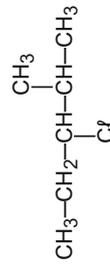
85. The CRACKING- and Polymerization-process are represented by the reactions given below. Compounds **P** and **Q** are organic compounds. Compound **P** is the same in both processes.



- Which ONE of the following gives the CORRECT IUPAC names of compound **P** and compound **Q**?

	P	Q
A	Ethene	Propene
B	Ethane	Propane
C	Ethene	Hex-1-ene
D	Ethane	Hexane

86. The correct IUPAC name of the following compound is:



- A. 3-chloro-4-methylpentane
B. 3-chloro-2-methylpentane
C. 2-methyl-3-chloropentane
D. 4-methyl-3-chloropentane

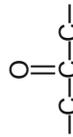
(2)

87. When ethene reacts with hydrogen gas in the presence of a catalyst, the product is ...

- A. ethane
B. ethyne
C. ethanol
D. ethanal

(2)

88. Study the structural formula of the functional group below.
The structure below is the functional group of ...



- A. esters
B. ketones
C. aldehydes
D. carboxylic acid

(2)

89. Which ONE of the following pairs of compounds belong to the same homologous series?

- A. C_2H_6 and C_4H_{12}
B. C_3H_6 and C_5H_8
C. CH_4O and $\text{C}_2\text{H}_4\text{O}_2$
D. C_2H_2 and C_3H_4

(2)

90. Which ONE of the following compounds is an isomer of $\text{CH}_3\text{CH}_2\text{COOH}$?

A	$\text{CH}_3-\text{C}(=\text{O})-\text{O}-\text{CH}_3$	B	$\text{H}-\text{C}(=\text{O})-\text{CH}_3$
C	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{OH}$	D	$\text{H}_3\text{C}-\text{C}(=\text{O})-\text{CH}_3$

(2)

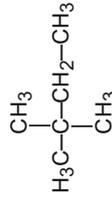
91. The hydrogenation of sunflower oil results in the production of margarine.

During this process the ...

- A. number of double bonds increases.
B. carbon chain increases.
C. number of double bonds decreases.
D. compound becomes less saturated.

(2)

92. Which ONE of the following is the IUPAC name for the structure below?



- A. 2-ethyl-e-methylpropane
B. 3,3-dimethylbutane
C. 2,2-dimethylbutane
D. 2-methylbutane

(2)

93. Which ONE of the following changes is a possible product after the addition of Cl_2 to but-1-ene?

- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHCl}_2$
B. $\text{CH}_3\text{CH}_2\text{CHClCH}_2\text{Cl}$
C. $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$
D. $\text{CH}_3\text{CH}_2\text{CCl}_2\text{CH}_3$

(2)

94. Methyl ethanoate is the compound that forms from...

- A. Ethanol and methanoic acid
B. Methanol and ethanoic acid
C. Ethanol and ethanoic acid
D. Ethanol and an oxidizing agent.

(2)

108. The flow diagram below shows the conversion of compounds with the general formula C_nH_{2n} to other compounds.

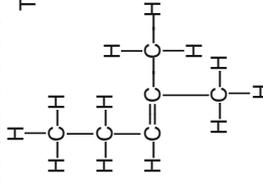


Which ONE of the following CORRECTLY gives the formula of catalyst Y and the formula of the inorganic reagent X?

	Formula of catalyst Y	Formula of inorganic reagent X
A	Pd	H ₂ O
B	Pd	Dilute KOH
C	H ₂ SO ₄	H ₂ O
D	Ethanal	Dilute KOH

(2)

109. Consider the following structural formula of an organic compound.



The IUPAC name of this compound is:

- 2-methyl-3-ethylprop-1-ene
- 2-methyl-1-ethylprop-1-ene
- 4-methylpent-3-ene
- 2-methylpent-2-ene

(2)

110. Which ONE of the following represents condensation polymerization?

- Hydration
- Esterification
- Hydrolysis
- Dehydration

(2)

111. Which ONE of the following is the functional group of the carboxylic acid?

- >C=C<
- $-\text{O}-\text{H}$
- $-\text{C}\equiv\text{C}-$
- >C(=O)-O-H

(2)

112. Which ONE of the following compounds has the highest boiling point?

- CH₃CH₃
- CH₃CH₂CH₃
- CH₃CH₂CH₂CH₃
- CH₃CH₂CH₂CH₂CH₃

(2)

113. Which ONE of the following organic compounds is a FUNCTIONAL (group) isomer of butanoic acid?

- 2-methylpropanoic acid
- Methylpropanoate
- Ethylpropanoate
- 2-methylpropane-2-ol

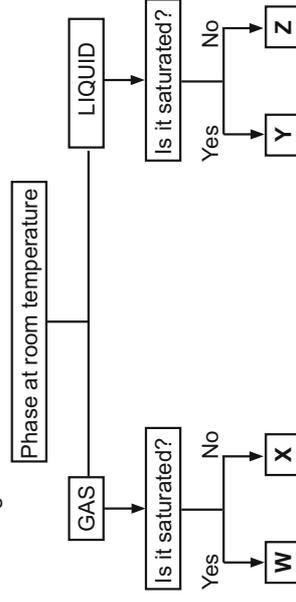
(2)

114. Which ONE of the following organic compounds has the LOWEST vapour pressure?

- Ethanoic acid
- Ethanal
- Ethanol
- Chloromethane

(2)

115. Consider the diagram below:

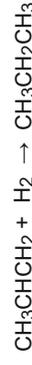


Which ONE of the following letters can represent PROPANE?

- W
- X
- Y
- Z

(2)

116. Which type of reaction is illustrated by the following chemical equation?



- Esterification
- Addition
- Elimination
- Substitution

(2)

117. A compound with molecular formula $C_4H_8O_2$ could be:

- an alcohol
- a carboxylic acid
- an ester

Which ONE of the following statements is CORRECT?

- Only (i)
- Only (i) and (ii)
- Only (i) and (ii)
- Only (ii) and (iii)

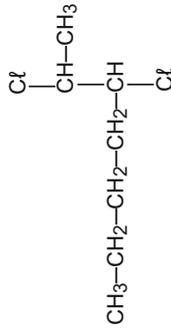
(2)

118. Which ONE of the homologous series below contains a carbonyl group?

- Alcohols
- Alkenes
- Esters
- Haloalkanes

(2)

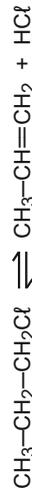
119. The formula for an organic compound is shown below:



The CORRECT IUPAC name for this compound is ...

- A. 5,6-dichloroheptane
 B. 4-chloro-5-chloro-5 ethylpentane
 C. 2,3-dichloroheptane
 D. 2-chloro-1-chloro-1-ethylpentane

120. The following equation represents a chemical reaction:



What type of reaction is represented by the equation above?

- A. Dehydrogenation
 B. Dehydration
 C. Dehalogenation
 D. Dehydrohalogenation

121. Which ONE of the following compounds represents the first member of the ketones?

- A. HCHO
 B. CH₃OH
 C. CH₃COCH₃
 D. CH₃CH₂COOH

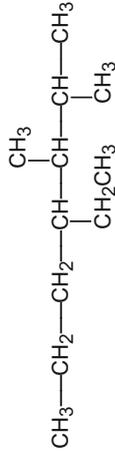
122. Which ONE of the following compounds is a PRODUCT of the HYDROGENATION of ethene?

A	$\left[\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ -\text{C}-\text{C}- \\ \quad \\ \text{H} \quad \text{H} \end{array} \right]_n$	B	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
C	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	D	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$

123. An example of an unsaturated hydrocarbon is:

- A. C₂H₃Cl₃
 B. C₄H₈
 C. C₃H₈
 D. C₃H₇OH

124. The condensed structural formula of an organic compound is indicated below.



Choose the correct IUPAC name for the above compound

- A. 3,4-dimethylhexane
 B. 4-ethyl-2,3-dimethylheptane
 C. 4-ethyl-5,6-dimethylheptane
 D. 2,3-dimethyl-4-ethylheptane

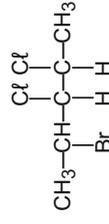
125. Which ONE of the following reaction types can be used to prepare ethene from octane?

- A. Cracking
 B. Addition
 C. Substitution
 D. Hydrogenation

126. Which ONE of the following compounds is a ketone?

- A. CH₃COOH
 B. CH₃CH(OH)CH₃
 C. CH₃COCH₃
 D. CH₃CH₂CHO

127. The condensed structural formula of an organic compound is:



Which ONE of the following is the correct IUPAC name for this compound?

- A. 2,3-dichloro-4-bromo-1-methylbutane
 B. 4-bromo-2,3-dichloropentane
 C. 2-bromo-3,4-dichloropentane
 D. 2-bromo-3,4,-dichloro-1-methylbutane

128. Which ONE of the following pairs of organic compounds contains members of the same homologous series?

- A. C₃H₈ and C₄H₈
 B. C₃H₇Br and C₃H₇Cl
 C. C₃H₆O₂ and C₃H₈O
 D. C₃H₆O and C₃H₈O

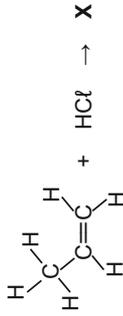
129. The reaction of propane with bromine can be classified as ...

- A. an elimination reaction
 B. an addition reaction
 C. a redox reaction
 D. a substitution reaction

130. The compound $C_4H_8O_2$ can:
 I be an alcohol
 II be a carboxylic acid
 III be an ester
 Which of the statements above are CORRECT?
 A. Only I
 C. Only I and III (2)
131. Which ONE of the following organic compounds does NOT contain a carbonyl group?
 A. Aldehydes
 C. Alcohols (2)
132. Which ONE of the following is an unsaturated hydrocarbon?
 A. $CH_3CH_2CH_2OH$
 C. $CH_3CH_2(CH_3)CH_2CH_3$ (2)
133. A family of carbon compounds in which one member differs from the next member with a $-CH_2$ -group, is known to be ...
 A. Isomers
 C. a carbon series (2)
134. The group of atoms that determine the physical and chemical properties of ketones is a ...
 A. carboxylic group
 C. carbonyl group (2)
135. In which ONE of the following options are the three compounds arranged in order of increasing (lowest to highest) boiling points?
- | | | | |
|---|------------------------|------------------------|----------------------|
| A | CH_3CH_2COOH | $CH_3CH_2CH_2CH_2CH_3$ | $CH_3CH_2CH_2CH_2OH$ |
| B | $CH_3CH_2CH_2CH_2OH$ | $CH_3CH_2CH_2CH_2CH_3$ | CH_3CH_2COOH |
| C | $CH_3CH_2CH_2CH_2CH_3$ | $CH_3CH_2CH_2CH_2OH$ | CH_3CH_2COOH |
| D | $CH_3CH_2CH_2CH_2CH_3$ | CH_3CH_2COOH | $CH_3CH_2CH_2CH_2OH$ |
136. Which ONE of the following statements is INCORRECT?
 A. Sunflower oil undergoes hydrogenation to form margarine.
 B. Alkynes are more reactive than alkenes.
 C. Alkynes will discolour a bromine solution without the assistance of UV-light.
 D. Alkanes only undergo addition reactions and alkenes undergo elimination reactions. (2)

137. Which ONE of the following represents a molecular formula of a compound that belongs to the same homologous series as but-2-yne.
 A. C_6H_6
 C. C_6H_{12} (2)
138. Which ONE of the following organic compounds will have the LOWEST boiling point?
 A. Propanoic acid
 C. Propan-2-ol (2)
139. The monomer of polythene is ...
 A. ethane
 C. propene (2)
140. The melting points of four straight chain hydrocarbons (A, B, C and D) are shown below.
- | hydrocarbon | Melting point ($^{\circ}C$) |
|-------------|-------------------------------|
| A | -182,5 |
| B | -95 |
| C | 28 |
| D | -56,5 |
- Which ONE of the hydrocarbons above has the strongest intermolecular forces?
 A. A
 C. C (2)
141. An example of an unsaturated hydrocarbon is:
 A. $CHCl_3$
 C. C_3H_8 (2)
142. The semi-condensed structural formula of an organic compound is shown below:
- $$\begin{array}{ccccccc}
 & & CH_3 & & & & \\
 & & | & & H & & H \\
 & & CH_2 & & H & & CH_3 \\
 & & | & & | & & | \\
 H_3C & - & C & - & C & - & C & - & H \\
 & & | & & | & & | \\
 & & CH_3 & & H & & H
 \end{array}$$
- What is the correct IUPAC name for this organic compound?
 A. 2,4,4-trimethylhexane
 C. 2,4-dimethyl-4-ethylpentane (2)
- B. 2-ethyl-2,4-dimethylpentane
 D. 3,3,5-trimethylhexane

143. A simple organic reaction is given below:



Which one of the formulae below represents the major organic product X formed in this reaction?

- A. $\text{CH}_3\text{CHClCH}_2\text{Cl}$
 B. $\text{CH}_2\text{ClCH}_2\text{CH}_3$
 C. $\text{CH}_3\text{CHClCH}_3$
 D. $\text{CH}_3\text{CH}_3\text{CH}_2\text{Cl}$

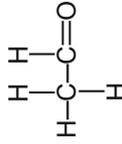
(2)

144. $\text{C}_n\text{H}_{2n+1}\text{OH}$ is the GENERAL FORMULA for ...

- A. Alkanes
 B. Aldehydes
 C. Alcohols
 D. Alkenes

(2)

145. Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

- A. Ethanone
 B. Ethene
 C. Ethanol
 D. Ethanal

(2)

146. Which ONE of the following reaction types can be used to prepare ETHENE from ETHANE?

- A. Hydrogenation
 B. Substitution
 C. Dehydrogenation
 D. Addition

(2)

147. Which ONE of the following compounds is an aldehyde?

- A. Butanol
 B. Butanoic acids
 C. Butane
 D. Butanal

(2)

148. Which ONE of the following compounds will decolourise bromine water the fastest under normal conditions?

- A. $\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{C}=\text{C} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$
 B. $\begin{array}{c} \text{H} \quad \text{O} \\ | \quad || \\ \text{H}-\text{C}-\text{C}-\text{H} \\ | \\ \text{H} \end{array}$
 C. $\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$
 D. $\begin{array}{c} \text{H} \quad \text{H} \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$

(2)

149. Ethene can be converted into other carbon-containing compounds using the reactants shown in the following flow chart.



Compounds X and Y is, respectively:

	X	Y
A	bromoethane	methanol
B	bromoethane	ethanol
C	bromoethene	ethanoic acid
D	bromoethene	ethane hydroxide

(2)

150. Which ONE of the following structural formulae represents a compound which is NOT the same as the other three?

A	$\text{CH}_3-\text{CH}_2-\text{C}(\text{CH}_3)=\text{CH}_2$	B	$\begin{array}{c} \text{CH}_2 \\ \\ \text{CH}_3-\text{C}-\text{CH}_2-\text{CH}_3 \end{array}$
C	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3-\text{C}=\text{CH}-\text{CH}_3 \end{array}$	D	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2=\text{C}-\text{CH}_2-\text{CH}_3 \end{array}$

(2)

151. Which ONE of the following chemical reactions will yield a major product that is saturated?

- A. 2-chlorobutane reacts with ethanol and potassium hydroxide to form but-2-ene and hydrogen chloride.
 B. The acid-catalyzed dehydration of pentan-2-ol to form pent-2-ene.
 C. Bromethane is refluxed to form ethylene and hydrogen bromide.
 D. Ethene reacts with hydrogen chloride to form chloroethane.

(2)

152. A renewable source of energy that can be produced by the fermentation of the sugar in sugarcane of corn is ...

- A. ethane
 B. ethanol
 C. methanol
 D. methane

(2)

153. Which ONE of the following is a balanced equation for the combustion of octane?

- A. $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$
 B. $\text{C}_8\text{H}_{18} + 16\text{O}_2 \rightarrow 8\text{CO}_2 + 9\text{H}_2\text{O}$
 C. $\text{C}_8\text{H}_{18} + 32\text{O}_2 \rightarrow 8\text{CO}_2 + 18\text{H}_2\text{O}$
 D. $2\text{C}_8\text{H}_{18} + 8\text{O}_2 \rightarrow 16\text{CO}_2 + 9\text{H}_2\text{O}$

(2)

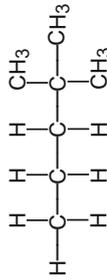
154. Which ONE of the following polymers is the product of a condensation polymerization reaction?
 A. Polypropylene
 B. Polyvinyl chloride
 C. Polytetrafluoroethene
 D. Polylactic acid (2)
155. Which of the following statements are INCORRECT?
 A. Sunflower oil undergoes a substitution reaction to form margarine.
 B. Alkynes are more reactive than alkenes
 C. Aldehydes and ketones contain a carbonyl group
 D. Propyl ethanoate can be made from propanoic acid and ethanol. (2)

156. Which ONE of the following is the structural formula of the functional group of the KETONES?

A	$\begin{array}{c} \text{O} \\ \parallel \\ \text{---C---} \end{array}$	B	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H---C---} \end{array}$
C	$\begin{array}{c} \text{O} \\ \parallel \\ \text{---C---C---} \end{array}$	D	$\begin{array}{c} \text{---C---O---H} \end{array}$

157. Which ONE of the formulas below represents an ALKANE?
 A. C₂H₄
 B. C₅H₁₀
 C. C₁₄H₃₀
 D. C₈H₁₄ (2)

158. Consider the organic compound below.



The IUPAC name of this compound is ...

- A. 2,3-dimethyl pentane
 B. 3,3-dimethyl butane
 C. 2,2-dimethyl pentane
 D. 1,1,1-trimethyl propane (2)

SECTION 2 : STRUCTURED QUESTIONS

I. ORGANIC MOLECULES : NOMENCLATURE

QUESTION 1

The letters **A** to **E** in the table below represent six organic compounds.

A	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{O}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	B	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
C	Butan-1-ol	D	Butan-2-one
E	$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{CH}_3 \quad \text{CH}_2 \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$		$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{OH} \quad \text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$

- 1.1 Write down the LETTER that represents EACH of the following:

- 1.1.1 A tertiary alcohol (1)
 1.1.2 An aldehyde (1)
 1.1.3 A ketone (1)
 1.1.4 A functional isomer of compound **B** (1)

- 1.2 Write down the IUPAC name of:

- 1.2.1 Compound **B** (1)
 1.2.2 Compound **E** (4)

- 1.3 Define *positional isomers*. (2)

- 1.4 Write down the STRUCTURAL FORMULA of:

- 1.4.1 A positional isomer of compound **C** (2)
 1.4.2 Compound **D** (2)
 1.4.3 The organic acid that will react with compound **C** to form butyl propanoate (2)

[17]