Level 3 International Foundation Diploma for Higher Education Studies
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Chemistry for University Study

SAMPLE EXAMINATION

This specimen assessment material is devised from previous past papers to reflect the single examination assessment approach now taken for this unit in the Level 3 International Foundation Diploma for Higher Education Studies.

Time allowed: 2 hours

Marking Scheme

This marking scheme has been prepared as a guide only to markers. This is not a set of model answers, or the exclusive answers to the questions, and there will frequently be alternative responses which will provide a valid answer. Markers are advised that, unless a question specifies that an answer be provided in a particular form, then an answer that is correct (factually or in practical terms) must be given the available marks.

If there is doubt as to the correctness of an answer, the relevant NCC Education materials should be the first authority.

Throughout marking, please credit any valid alternative point.

Candidate Name and ID number:		
Marker's comments:		
Moderator's comments:		
Mark:	**Moderated mark:**	**Final mark:**
Penalties applied for academic malpractice:		

Section A – 24 MCQs. Total 24 marks

Answer these in your answer booklet – do NOT write on this Question Paper.
Write ONE (1) correct answer from A, B, C, or D for each question in your answer booklet.
Each question is worth 1 mark.

Marks

Question 1 *(AC 1.1)*

Which subatomic particles are found in the nucleus of an atom? **1**

A Electrons only
B Protons and electrons
C Protons and neutrons
D Neutrons and electrons

Mark Scheme:
C. Protons and neutrons

Question 2 *(AC 4.2)*

As temperature increases, what happens to the shape of the Boltzmann distribution curve? **1**

A It shifts to the left and becomes taller
B It shifts to the right and becomes spread-out
C It stays the same but moves upward
D It becomes narrower and taller

Mark Scheme:
B. It shifts to the right and becomes spread-out

Question 3 *(AC 1.2)*

How many isotopes of hydrogen are commonly known? **1**

A 1
B 2
C 3
D 4

Mark Scheme:
C. 3

Marks

Question 4 *(AC 5.1)*

Why does silicon (Si) have the highest melting point among the elements in Period 3? **1**

A It has metallic bonding
B It forms covalent network structures
C It has weak Van der Waals forces
D It has ionic bonding

Mark Scheme:
B. It forms covalent network structures

Question 5 *(AC 1.4)*

What causes the ionisation energy to decrease down a group? **1**

A Increased nuclear charge and atomic number
B Increased atomic radius and shielding
C Decreased electron shielding and attraction
D Decreased number of shells and energy levels

Mark Scheme:
B. Increased atomic radius and shielding

Question 6 *(AC 5.2)*

Which of the following chlorides undergoes hydrolysis when reacting with water, leading to an acidic solution? **1**

A $NaCl$
B $MgCl_2$
C $AlCl_3$
D KCl

Mark Scheme:
C. $AlCl_3$

Marks

Question 7 *(AC 2.3)*

What does the empirical formula of a compound represent? **1**

A The exact number of atoms of each element
B The simplest whole number ratio of atoms of each element
C The mass of each element in the compound
D The molecular weight of the compound

Mark Scheme:
B. The simplest whole number ratio of atoms of each element

Question 8 *(AC 5.3)*

Which of the following elements is expected to have the largest atomic radius? **1**

A Lithium
B Potassium
C Nitrogen
D Fluorine

Mark Scheme:
B. Potassium

Question 9 *(AC 2.5)*

Why do atoms form bonds? **1**

A To increase their atomic number through bonding
B To become radioactive and unstable over time
C To reach a stable outer electron arrangement
D To remove all electrons from the atom completely

Mark Scheme:
C. To reach a stable outer electron arrangement

Marks

Question 10 *(AC 5.5)*

Which Group 17 element has the highest electronegativity? **1**

A F
B Cl
C Br
D I

Mark Scheme:
A. F

Question 11 *(AC 2.6)*

What type of bond is formed between oppositely charged ions? **1**

A Covalent bond
B Metallic bond
C Hydrogen bond
D Ionic bond

Mark Scheme:
D. Ionic bond

Question 12 *(AC 5.7)*

Which of the following halide ions reacts with concentrated sulfuric acid without undergoing a redox reaction? **1**

A Fluoride ion (F^-)
B Chloride ion (Cl^-)
C Bromide ion (Br^-)
D Iodide ion (I^-)

Mark Scheme:
A. Fluoride ion (F^-)

Marks

Question 13 *(AC 2.7)*

In metallic bonding, what are the metal atoms transformed into after losing their valence electrons? **1**

A Non-metals
B Covalent molecules
C Negative ions
D Positive ions

Mark Scheme:
D. Positive ions

Question 14 *(AC 6.1)*

What is the International Union of Pure and Applied Chemistry (IUPAC) name of the compound CH_3-CH_2-OH? **1**

A Methanol
B Propanol
C Ethanol
D Butanol

Mark Scheme:
C. Ethanol

Question 15 *(AC 2.8)*

What type of bond is formed when TWO (2) atoms share electrons? **1**

A Covalent bond
B Ionic bond
C Metallic bond
D Hydrogen bond

Mark Scheme:
A. Covalent bond

Marks

Question 16 *(AC 6.2)*

Which class of organic compounds typically undergoes electrophilic addition reactions? **1**

A Alkanes
B Alcohols
C Carboxylic acids
D Alkynes

Mark Scheme:
D. Alkynes

Question 17 *(AC 2.9)*

Which of the following molecules has a bond angle of approximately 180°? **1**

A NH_3
B CH_4
C PF_5
D CO_2

Mark Scheme:
D. CO_2

Question 18 *(AC 6.4)*

Among the given options, which one does not represent a form of structural isomerism? **1**

A Chain isomerism
B Positional isomerism
C Geometrical isomerism
D Functional group isomerism

Mark Scheme:
C. Geometrical isomerism

Marks

Question 19 *(AC 2.11)*

In a dot and cross diagram, what do the dots and crosses represent? **1**

A Neutrons and protons
B Shared and unshared bonds
C Electrons from different atoms
D Atoms of different sizes

Mark Scheme:
C. Electrons from different atoms

Question 20 *(AC 6.6)*

Which of the following statements is true about the S_N1 mechanism? **1**

A It is favoured by primary halogenoalkanes
B It involves a carbocation intermediate
C It is a one-step mechanism
D It requires a strong nucleophile

Mark Scheme:
B. It involves a carbocation intermediate

Question 21 *(AC 3.2)*

Which of the following conditions is most likely to cause a gas to deviate from ideal behaviour? **1**

A Low temperature and high pressure
B High temperature and low pressure
C Low temperature and low pressure
D High temperature and high pressure

Mark Scheme:
A. Low temperature and high pressure

Marks

Question 22 *(AC 7.2)*

Hydroxynitriles are formed by the reaction of: **1**

A Aldehydes and ketones with HCN
B Aldehydes and ketones with NaCN in NaOH
C Alcohols and HCN
D Carboxylic acids and HCN

Mark Scheme:
A. Aldehydes and ketones with HCN

Question 23 *(AC 3.4)*

In a reaction pathway diagram, what does the peak represent? **1**

A The enthalpy of the reactants
B The enthalpy of the products
C The transition state
D The activation energy

Mark Scheme:
C. The transition state

Question 24 *(AC 7.4)*

When an alkyl halide is treated with sodium hydroxide in an aqueous solution, the main organic product is: **1**

A Alcohol
B Alkane
C Alkene
D Aldehyde

Mark Scheme:
A. Alcohol

Total 24 Marks

SECTION B – 16 questions. Total 45 marks Answer ALL questions

Marks

Question 25 *(AC 1.1)*

Define *atomic radius* and explain why atomic radii decrease across a period in the periodic table. **3**

Mark Scheme:
Atomic radius is the distance between the nucleus and the outermost shell of an atom (1 mark). Atomic radii decrease across a period because the number of protons increases (1 mark), creating a stronger attraction that pulls electrons closer to the nucleus (1 mark).

Question 26 *(AC 5.2)*

Explain how the oxides of Period 3 elements behave as acids or bases, using specific examples. Include the behaviour of aluminium oxide in your discussion. **3**

Mark Scheme:
Period 3 metal oxides, such as Na_2O and MgO, are basic and react with acids to form salt and water (e.g., $Na_2O + 2HCl$ à $2NaCl + H_2O$) (1 mark). Non-metal oxides, like SO_2 and SO_3, are acidic and react with bases (e.g., $SO_2 + 2NaOH$ à $Na_2SO_3 + H_2O$) (1 mark). Aluminium oxide (Al2O_3) is amphoteric — it reacts with acids ($Al_2O_3 + 3H_2SO_4$ à $Al_2(SO_4)_3 + 3H_2O$) and also with bases ($Al_2O_3 + 2NaOH + 3H_2O$ à $2NaAl(OH)_4$), showing both acidic and basic properties (1 mark).

Question 27 *(AC 1.4)*

Discuss THREE (3) factors that affect ionisation energy. **3**

Mark Scheme:
Nuclear Charge: More protons in the nucleus increase attraction (1 mark).
Distance from Nucleus: Electrons further from the nucleus experience less attraction (1 mark).
Shielding Effect: Inner electrons shield outer electrons from nucleus (1 mark).

Marks

Question 28 *(AC 5.4.4)*

Describe why Group 2 elements become more reactive as you move down the group, referring to trends in ionisation energy and atomic structure. **3**

Mark Scheme:
The reactivity of Group 2 elements increases down the group because the atoms become larger, as the outer electrons occupy a new principal quantum shell further from the nucleus (1 mark). This increased distance reduces the electrostatic attraction between the nucleus and the outer electrons (1 mark). As a result, both the first and second ionisation energies decrease down the group, making it easier for the atoms to lose their two outermost electrons and react, thereby increasing reactivity (1 mark).

Question 29 *(AC 2.3)*

A compound has an empirical formula of CH_2 and a relative molecular mass of FIFTY-SIX (56). **3**

Determine its molecular formula.

Mark Scheme:

Molar mass of CH_2 = 12 + (1×2) = 14 g/mol (1 mark)

Molecular formula mass ÷ Empirical formula mass = 56 ÷ 14 = 4 (1 mark)

Multiply each atom in CH_2 by 4 à C_4H_8

Molecular formula = C_4H_8 (1 mark)

Question 30 *(AC 5.6.3)*

Explain why hydrogen iodide (HI) is less thermally stable than hydrogen fluoride (HF), using ideas about atomic structure and bonding. **3**

Mark Scheme:
Hydrogen iodide (HI) is less thermally stable than hydrogen fluoride (HF) because iodine has a larger atomic radius than fluorine (1 mark). This results in a longer H–I bond, which leads to weaker bond strength due to poorer orbital overlap (1 mark). Weaker bonds require less energy to break, so HI decomposes more easily at high temperatures compared to HF, which has a short, strong H–F bond due to better orbital overlap. (1 mark).

Marks

Question 31 *(AC 2.5)*

State and explain THREE (3) factors that affect electronegativity. **3**

Mark Scheme:
Nuclear Charge: A higher number of protons in the nucleus increases attraction for electrons, increasing electronegativity (1 mark).

Atomic Radius: Smaller atoms have stronger attraction to bonding electrons, resulting in higher electronegativity. Larger atoms show weaker attraction (1 mark).

Shielding Effect: Inner electrons shield the attraction between nucleus and outer electrons. More inner shells mean more shielding and lower electronegativity (1 mark).

Question 32 *(AC 6.5.4)*

Explain, including THREE (3) reasons, why catalytic cracking is preferred over thermal cracking in the petrochemical industry, despite both processes achieving similar end results. **3**

Mark Scheme:
Catalytic cracking is preferred because it operates at a lower temperature (around 500°C) and only slight pressure (1 mark), which reduces energy costs compared to thermal cracking (which requires 1000°C and up to 70 atm) (1 mark). Additionally, the use of a zeolite catalyst increases the rate of reaction, making the process faster and more economically efficient (1 mark).

Question 33 *(AC 2.8)*

Describe a coordinate (dative) covalent bond? Give an example of a molecule that contains this type of bond. **2**

Mark Scheme:
A coordinate covalent bond is a type of covalent bond in which both electrons in the shared pair come from the same atom (1 mark). An example of a molecule with a coordinate covalent bond is the ammonium ion (NH_4^+) (1 mark).

Marks

Question 34 *(AC 6.5.10)*

Explain, using the mechanism of electrophilic addition, why bromine water rapidly decolourises when added to an **alkene** but not when added to an **alkane**. **3**

Mark Scheme:

Alkenes contain a pi-bond, which is an electron-rich region capable of inducing a dipole in the non-polar Br_2 molecule. (1 mark).

The π-bond electrons attack the partially positive bromine atom, breaking the Br−Br bond heterolytically. A carbocation intermediate and a bromide ion (Br^-) are formed. (1 mark)

The Br^- then attacks the carbocation to complete the electrophilic addition leading to rapid decolourisation. Alkanes lack a pi-bond and cannot induce a dipole in Br_2, so no such reaction occurs under the same conditions. (1 mark).

Question 35 *(AC 2.11)*

Describe the main purpose of a dot and cross diagram? Give ONE (1) advantage and ONE (1) disadvantage of using these diagrams. **3**

Mark Scheme:
The main purpose of a dot and cross diagram is to show what atoms make up a molecule and how electrons are shared or transferred to form bonds (1 mark).
An advantage is that it clearly shows how the bonds form and where the electrons come from (which atom) (1 mark).
A disadvantage is that the diagram is 2D and cannot show the actual shape or relative sizes of the atoms (1 mark).

Marks

Question 36 *(AC 7.1)*

How can chloroethane (CH_3CH_2Cl) be converted into ethylamine ($CH_3CH_2NH_2$)? Name the type of reaction involved, state the reagents and conditions required, and write a balanced chemical equation for the process. **3**

Mark Scheme:

Chloroethane is converted into ethylamine through a nucleophilic substitution reaction (1 mark). Ammonia (NH_3) acts as the nucleophile and replaces the chlorine atom in chloroethane. The reaction is carried out with excess hot ethanolic ammonia under pressure (1 mark).
Balanced reaction:
C_2H_5Cl (chloroethane) + $2NH_3$ à $C_2H_5NH_2$ (ethylamine) + NH_4Cl (1 mark)

Question 37 *(AC 3.3)*

Explain the differing electrical conductivity in ionic, covalent and metallic substances. **3**

Mark Scheme:
• Ionic bonding: Conducts electricity only when molten or dissolved, as ions are free to move. (1 mark)
• Covalent bonding: Generally does not conduct electricity due to the absence of free ions or electrons. (1 mark)
• Metallic bonding: Conducts electricity in both solid and liquid states due to the presence of delocalised electrons. (1 mark)

Question 38 *(AC 7.3)*

Explain the process of addition polymerisation using ethene as an example. Describe how the polymer can be represented using a repeat unit, and why disposal of such polymers poses environmental concerns. **3**

Mark Scheme:
Addition polymerisation involves the reaction of many ethene (C=C) monomers, where the double bonds break and join together to form long chains called poly(ethene) (1 mark). The repeat unit is formed by converting the double bond in ethene to a single bond and adding extension bonds on each end, enclosed in brackets with a subscript "n". This is a structural representation, not part of the actual reaction (1 mark). These polymers are hard to dispose of because they are unreactive, non-biodegradable, and can release harmful gases when burned, leading to pollution (1 mark).

Marks

Question 39 *(AC 3.5)*

2-Methylpropan-1-ol can also be converted to produce diesel and jet fuel. The first step in the process is the production of 2-methylpropene. **2**

$C_4H_{10}O_{(l)}$	à	$C_4H_{8(g)}$	+	$H_2O_{(g)}$
2-methylpropan-1-ol		2-methylpropene		

Using the data below, calculate the enthalpy change for the production of 2-methylpropene from 2-methylpropan-1-ol.

$4C_{(s)} + 5H_{2(g)} + ½O_{2(g)}$ à $C_4H_{10}O_{(l)}$ ΔH = -335 kJ mol-1

$4C_{(s)} + 4H_{2(g)}$ à $C_4H_{8(g)}$ ΔH = -17 kJ mol-1

$H_{2(g)} + ½O_{2(g)}$ à $H_2O_{(g)}$ ΔH = -242 kJ mol-1

Mark Scheme:
ΔH = [+ 335 + (−17) + (−242)] (1 mark)
= (+) 76 (kJ mol-1) (1 mark)

Question 40 *(AC 3.6)*

Explain the disproportionation in the following reaction: **2**

$3Cl_2(aq) + 6NaOH(aq)$ à $5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$

Mark Scheme:
In this reaction, chlorine (Cl_2) has an oxidation state of 0.
In NaCl, chlorine is reduced to -1 (1 mark).
In $NaClO_3$, chlorine is oxidised to +5 (1 mark).

Total 45 Marks

SECTION C – 7 questions. Total 31 marks Answer ALL questions

Marks

Question 41 *(AC 5.2)*

Discuss why sodium and phosphorus show different types of reactions with chlorine and water and explain how the oxidation states in their chlorides and oxides relate to their positions in the Periodic Table. **4**

Mark Scheme:
Sodium, a Group 1 element, reacts vigorously with both chlorine and water, forming sodium chloride (NaCl) and sodium hydroxide (NaOH) respectively. Its oxidation number in both compounds is +1, corresponding to its single valence electron (1 mark).

Phosphorus, a Group 15 element, reacts with chlorine to form PCl_3 and PCl_5, showing variable oxidation numbers of +3 and +5, due to its ability to expand its octet by using 3d orbitals (1 mark). It does not react with water as vigorously as sodium does. In oxides, phosphorus can also show multiple oxidation numbers such as +3 in P_2O_3 and +5 in P_2O_5, consistent with its position in the Periodic Table (1 mark).

Thus, sodium shows a fixed oxidation number and highly reactive behaviour, while phosphorus shows variable oxidation states and selective reactivity, illustrating the variation in chemical behaviour across Period 3. (1 mark).

Marks

Question 42 *(AC 1.4)*

The table below shows successive ionisation energies of an element in Period 3. **4**

Explain in FOUR (4) points, how you would use this data to determine the group number of the element.

Ionisation Number	**Ionisation Energy (kJ/mol)**
1st	578
2nd	1817
3rd	2745
4th	11,578
5th	14,830

Mark Scheme:
There is a large jump between the 3rd and 4th ionisation energies (1 mark).

The first three electrons are relatively easier to remove, meaning they are in the outer shell (1 mark).

The fourth electron is much harder to remove because it comes from an inner shell, closer to the nucleus and more strongly attracted (1 mark).

Therefore, the element has 3 electrons in its outer shell and belongs to Group 3 of the periodic table (1 mark).

Question 43 *(AC 5.5.3)*

Explain the trend in bond strength and volatility of halogens as you move down Group 17. **4**

Mark Scheme:
As we move down Group 17, the atomic size of halogens increases (1 mark). This results in the bonding pair of electrons being further away from the nucleus, reducing the strength of the covalent bond between atoms in diatomic molecules (1 mark). Therefore, the covalent bond becomes weaker down the group. Additionally, larger halogen molecules have more electrons, leading to stronger instantaneous dipole-induced dipole (van der Waals') forces between molecules (1 mark). This increases the melting and boiling points and decreases the volatility of the halogens down the group (1 mark).

Marks

Question 44 *(AC 2.4)*

What volume of oxygen gas (in m³) is produced when 32 g of potassium chlorate ($KClO_3$) decomposes at 300 K and a pressure of 101 kPa? (R = 8.31 J/mol·K). **5**

Where the balanced equation for the decomposition reaction is:
$2KClO_3(s)$ à $2KCl(s) + 3O_2(g)$

Mark Scheme:
Balanced equation:
$2KClO_3(s)$ à $2KCl(s) + 3O_2(g)$

Step 1: Calculating moles of $KClO_3$
Molar mass of $KClO_3$ = 39.1 + 35.5 + (16 × 3) = 122.6 g/mol (1 mark)
Moles of $KClO_3$ = 32 / 122.6 = 0.261 moles (1 mark)

Step 2: Use molar ratio to find moles of O_2
From the equation: 2 mol $KClO_3$ à 3 mol O_2
So O_2 = (0.261 / 2) × 3 = 0.3915 moles (1 mark)

Step 3: Use the ideal gas equation: $pV = nRT$
Converting pressure to Pa: 101 kPa = 101000 Pa
$V = nRT / p$
$V = (0.3915 \times 8.31 \times 300) / 101000$ (1 mark)
$V \approx 0.00966\ m^3$
Answer: 0.00966 m³ of O_2 (1 mark)

Marks

Question 45 *(AC 6.2.1)*

Differentiate between homolytic and heterolytic fission by explaining:

a) the manner in which the bond breaks **1**

Mark Scheme:

In homolytic fission, a bond splits equally, and each atom gets one electron, forming carbon free radicals (1 mark).

b) how electrons are redistributed and how this is depicted in reaction mechanisms. **1**

Mark Scheme:

It is represented using curly arrows with only half a head, indicating the movement of a single electron (1 mark).

c) the types of species produced **1**

Mark Scheme:

In heterolytic fission, the bond splits unevenly, with both electrons going to the more electronegative atom (1 mark).

d) the influence of electronegativity. **1**

Mark Scheme:

This results in either a carbocation (if electrons move away from carbon) or a carbanion (if electrons move to carbon), depending on the electronegativity or electro positivity of the atoms involved (1 mark).

Total 4 Marks

Marks

Question 46 *(AC 6.5.11)*

Explain why tertiary carbocations are more stable than secondary and primary carbocations. **4**

Mark Scheme:
Tertiary carbocations are more stable than secondary and primary carbocations because the electron-deficient carbon in a tertiary carbocation is attached to three alkyl groups, while in a secondary it is attached to two, and in a primary only one (1 mark).
Alkyl groups have an inductive effect — they push electron density toward the positively charged carbon, helping to stabilise the positive charge (1 mark).
The more alkyl groups attached; the more electron donation occurs (1 mark).
Therefore:
Tertiary carbocations are the most stable,
Secondary are less stable, and
Primary carbocations are the least stable. (1 mark)

Question 47 *(AC 3.7)*

Explain how *Le Chatelier's Principle* is applied to the Haber and Contact processes, to maximise product yield and discuss the role of catalysts in these processes. **6**

Mark Scheme:
According to Le Chatelier's Principle, if conditions change, the equilibrium shifts to counteract that change (1 mark).

In the Haber process, the reaction is reversible and exothermic, so a low temperature increases ammonia yield. But low temperatures also slow the rate, so a compromise temperature of 450°C is used (1 mark). The reaction has more gas molecules on the left, so high pressure favours the forward reaction and increases ammonia yield. However, high pressure is expensive and dangerous, so a compromise pressure of 200 atm is used (1 mark).

The Contact process also involves a reversible reaction where sulphur dioxide reacts with oxygen to form sulphur trioxide, which is then used to make sulfuric acid. (1 mark) Conditions are so chosen (moderate temperature and high pressure) to shift the equilibrium towards SO_3 production. (1 mark)

In both processes, a catalyst is used (iron in the Haber process and vanadium(V) oxide in the Contact process) to increase the rate of reaction without affecting the position of equilibrium. Use of catalysts improves efficiency without needing more extreme conditions. (1 mark).

Total 31 Marks

End of paper

Periodic Table with the mass number and atomic number of each element.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.0026
3 **Li** 6.94	4 **Be** 9.0122											5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.085	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.630	33 **As** 74.922	34 **Se** 78.97	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.95	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-71 *	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89-103 #	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (280)	112 **Cn** (285)	113 **Nh** (286)	114 **Fl** (289)	115 **MC** (289)	116 **Lv** (293)	117 **Ts** (294)	118 **Og** (294)

* Lanthanide Series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** [145]	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
# Actinide Series	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

Nuclear Magnetic Spectroscopy data table

Approximate proton chemical shift values (δ) relative to TMS peak (0 on the scale)

Type of proton	Chemical Shift (ppm)
R----$\mathbf{CH_3}$	0.9-1.1
R----$\mathbf{CH_2}$----R	1.31.5
O H_3C---C O R$\mathbf{CH_2}$-C O R_2**HC**--C Aldehyde, Ketone, CAcid and Ester fragment	2.0-.2.7
H_2**C=C**	4.8-5.0
R----CH_2---**X**	3.2-4.3
R----**OH**	4.0-4.5
R------**COOH**	11.0-11.3
R----**CHO**	9.8-10.2
Ar----CH_3	2.3-3.0
Ar----OH	7.0-7.3
Ar----H	7.4-7.6

R = alkyl group
Ar = aryl (aromatic) group
X = halogen

Infrared Spectroscopy data table

Type of bond	Type of compound	Wave number range (cm^{-1})
Hydrogen bonded O − H stretch, strong and broad. Free (non-hydrogen bonded) O − H stretch, medium and sharp	Alcohol	3200 to 3550 3584 to 3700
C − H stretch C − H bend	Alkane	2853 to 2962 1340 to 1485
C − H stretch in C = C – H C = C stretch	Alkene	3010 to 3095 1620 to 1680
C=O stretch	Aldehyde, Ketones, Carboxylic acids and Esters	1680 to 1750
hydrogen bonded O − H stretch in −COOH	Carboxylic acids	2500 to 3500
 C-Br C-Cl	Halogenalkanes	 500 to 600 650-800
C − H stretch	benzene ring	3000 to 3100

Formulae

$\Delta H = cm\Delta T$ (4·18 kJ kg^{-1} $^{o}C^{-1}$)

% yield= $\frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$

% atom economy= $\frac{\text{Mass of desired product(s)}}{\text{Total mass of reactants}} \times 100$

$n = cV$

$\frac{C_1 x V_1}{n_1} = \frac{C_2 x V_2}{n_2}$

n= mGFM

rate = $\frac{\Delta \text{quantity}}{\Delta \text{ time}}$

pH+ pOH=14

pH= $-\log_{10} [H^+]$

$K_w = [H^+] \times [OH^-]$

$pK_a = -\log_{10} K_a$

pH =1/2 pK_a -1/2 $\log_{10}$ [Concentration]

Physical constants

Avogadro's Constant 6.02 × 10^{23} mol^{-1}
Charge on electron 1.60 × 10^{-19} C

Learning Outcomes Matrix

Question	Learning Outcomes / Assessment Criteria assessed	Marker can differentiate between varying levels of achievement
	Section A	
1	AC 1.1	Yes
2	AC 4.2	Yes
3	AC 1.2	Yes
4	AC 5.1	Yes
5	AC 1.4	Yes
6	AC 5.2	Yes
7	AC 2.3	Yes
8	AC 5.3	Yes
9	AC 2.5	Yes
10	AC 5.5	Yes
11	AC 2.6	Yes
12	AC 5.7	Yes
13	AC 2.7	Yes
14	AC 6.1	Yes
15	AC 2.8	Yes
16	AC 6.2	Yes
17	AC 2.9	Yes
18	AC 6.4	Yes
19	AC 2.11	Yes
20	AC 6.6	Yes
21	AC 3.2	Yes
22	AC 7.2	Yes
23	AC 3.4	Yes
24	AC 7.4	Yes
	Section B	
25	AC 1.1	Yes
26	AC 5.2	Yes
27	AC 1.4	Yes
28	AC 5.4.4	Yes
29	AC 2.3	Yes
30	AC 5.6.3	Yes
31	AC 2.5	Yes
32	AC 6.5.4	Yes
33	AC 2.8	Yes
34	AC 6.5.10	Yes
35	AC 2.11	Yes
36	AC 7.1	Yes
37	AC 3.3	Yes
38	AC 7.3	Yes
39	AC 3.5	Yes
40	AC 3.6	Yes

Section C		
41	AC 5.2	Yes
42	AC 1.4	Yes
43	AC 5.5.3	Yes
44	AC 2.4	Yes
45	AC 6.2.1	Yes
46	AC 6.5.11	Yes
47	AC 3.7	Yes

Grade Descriptors

<table>
<tr><th>Learning Outcome</th><th>Pass
(40-59%)</th><th>Merit
(60-69%)</th><th>Distinction
(70-100%)</th></tr>
<tr><td>1. Be able to define, analyse and discuss the atom and its particles as well as isotopes, electrons, energy levels, atomic orbitals and ionisation energy.</td><td rowspan="7">Demonstrates an adequate awareness and understanding of concepts, terminology and processes with a reasonable discussion and application of principles and satisfactory reference to theory and science.</td><td rowspan="7">Demonstrates a consistent and accurate awareness and understanding of concepts, terminology and processes with a detailed discussion and application of principles and precise reference to theory and science.</td><td rowspan="7">Demonstrates an outstanding awareness and understanding of concepts, terminology and processes with a highly comprehensive and sophisticated discussion and application of principles and critical and meticulous reference to theory and science.</td></tr>
<tr><td>2. Be able to define, analyse and discuss atoms, molecules, stoichiometry and chemical bonding.</td></tr>
<tr><td>3. Be able to define, analyse and discuss states of matter, energy changes in chemistry as well as electrochemistry and chemical equilibria.</td></tr>
<tr><td>4. Be able to define, analyse and discuss the kinetics of reactions.</td></tr>
<tr><td>5. Be able to recognise, analyse and discuss the Periodic Table and chemical periodicity with focus on Group 2 and Group 17 elements.</td></tr>
<tr><td>6. Be able to recognise, analyse and discuss Hydrocarbons, compounds (Halogen, Hydroxy, Carbonyl), Esters, Carboxylic acids and their derivatives.</td></tr>
<tr><td>7. Be able to recognise, analyse and discuss nitrogen compounds, polymerisation, organic synthesis and analytical techniques.</td></tr>
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