Education and Sport Development

Department of Education and Sport Development
Departement van Onderwys en Sportontwikkeling
Lefapha la Thuto le Tlhabololo ya Metshameko

NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2015

MEMORANDUM

MARKS: 150

This memorandum consists of 17 pages.

GENERAL GUIDELINES

1. CALCULATIONS

1.1 **Award marks** for: correct formula, correct substitution and correct answer with unit.

1.2 **Do not award any marks** if **an incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

1.3 When an error is made during substitution into a correct formula, award a mark for the correct formula and for the correct substitutions, but do **not** give **any further marks**.

1.4 If **no formula** is given, but all substitutions are correct, the candidate forfeits **one mark**.
Example:

No K_c expression, correct substitution:

$$K_c = \frac{(2)^2}{(2)(1)^3} \checkmark = 2 \checkmark \qquad (\frac{2}{3})$$

1.5 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer is given.

1.6 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

1.7 All calculations, when not specified in the question, must be done correctly to TWO decimal places.

2. DEFINITIONS

Award TWO marks for a correct definition. Do not award any marks for an incorrect or partially correct definition.

3. UNITS

3.1 Candidates must be penalised only once for the repeated use of an incorrect unit **within a question or subquestion.**

3.2 Units are only required in the final answer of a calculation.

3.3 Award marks for an answer only and not for a unit *per se*. Candidates forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

3.4 Separate compound units with a multiplication dot, not a full stop, for example, mol·dm^{-3}. Accept mol.dm^{-3} (or mol/dm^3) for marking purposes.

4. **GENERAL**

4.1 If one answer or calculation is required, but the candidate gives two, mark only the first one, irrespective of which one is correct. If two answers are required, mark only the first two, etc.

4.2 When a chemical **FORMULA** is asked, and the **NAME** is given as answer, the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA is** given.

4.3 When redox half-reactions are to be written, the correct arrow should be used. If the equation

$$H_2S \rightarrow S + 2\,H^+ + 2e^- \quad (2/2)$$

is the correct answer, the marks must be given as follows:

$H_2S \rightleftharpoons S + 2\,H^+ + 2e^-$	(1/2)
$H_2S \leftarrow S + 2\,H^+ + 2e^-$	(0/2)
$S + 2H^+ + 2e^- \leftarrow H_2S$	(2/2)
$S + 2H^+ + 2e^- \rightleftharpoons H_2S$	(0/2)

4.4 When candidates are required to give an explanation involving the relative strength of oxidising and reducing agents, do not accept the following:

- Stating the position of a substance on table 4 only (e.g. Cu is above Mg).
- Using relative reactivity only (e.g. Mg is more reactive than Cu).
- The correct answer would be for instance: Mg is a stronger reducing agent than Cu and therefore Mg will be able to reduce Cu^{2+} ions to Cu. The answer can also be given in terms of the relative strength as electron acceptors and donors.

4.5 One mark is forfeited when the charge of an ion is omitted per equation.

4.6 The error carrying principle does not apply to chemical equations or half reactions. For example, if a learner writes the wrong oxidation/reaction half-reaction in the subquestion and carries the answer to another sub-question (balancing of equations or calculation of E^{θ}_{cell}) then the learner must not be credited for this substitution.

4.7 In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks must be deducted if hydrogen atoms are omitted.

4.8 When a structural formula is asked, marks must be deducted if the learner writes the condensed formula.

4.9 When an IUPAC name is asked and the candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks must be forfeited.

4.10 When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.
If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow is/are written, marks may be awarded for the reactant(s) or product(s). If only a reactant(s) or only a product(s) is written without an arrow, no marks are awarded for the reactant(s) or product(s).

Example: $N_2 + 3H_2$✓ $\rightarrow$ $2NH_3$✓ bal. ✓

$N_2 + 3H_2 \rightarrow$ ✓	1/3
$\rightarrow NH_3$ ✓	1/3
$N_2 + 3H_2$	0/3
NH_3	0/3

5. POSITIVE MARKING

Positive marking regarding calculations is followed in the following cases:

5.1 **Subquestion to subquestion**: When a certain variable is calculated in one subquestion (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, full marks must be awarded for the subsequent subquestions.

5.2 **A multi-step question in a subquestion**: if the candidate has to calculate, for example, the number of moles in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer is forfeited.

5.3 If the final answer of a calculation is correct, full marks are not automatically awarded. Markers must always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

SECTION A

QUESTION 1

1.1 B ✓✓

1.2 D ✓✓ **The correct option is B**

1.3 B ✓✓

1.4 C ✓✓

1.5 D ✓✓

1.6 D ✓✓

1.7 A ✓✓

1.8 A ✓✓

1.9 B ✓✓

1.10 C ✓✓ **[20]**

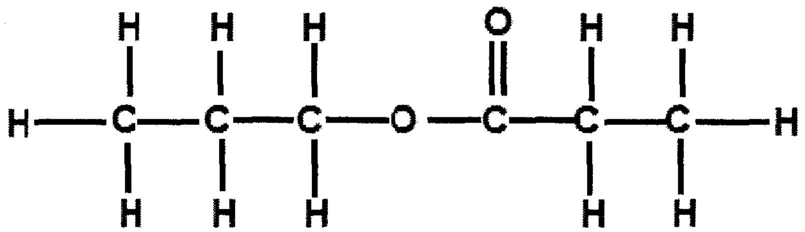
QUESTION 2

2.1. *Functional isomers* are compounds with the same molecular formula, but different functional groups / different homologous series. ✓ ✓ (2)

2.2 B ✓ & E ✓ (2)

2.3

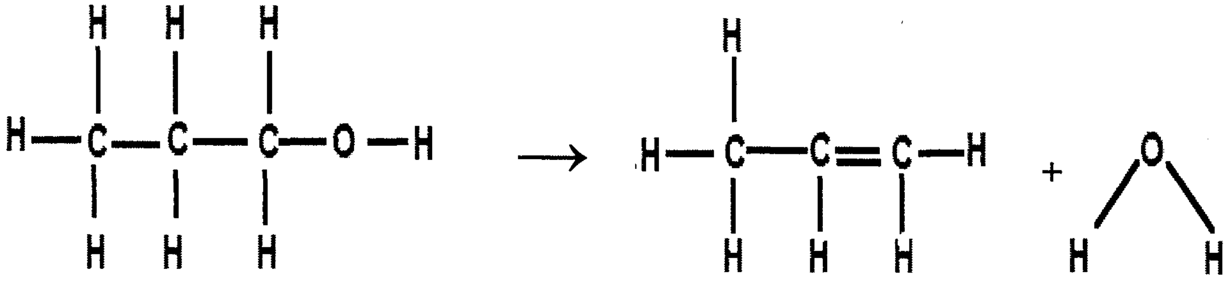
2.3.1



✓✓ (2)

2.3.2 Propylpropanoate ✓ (1)

2.4



✓✓ ✓ (3)

2.5

2.5.1 Dehydration ✓ (1)

2.5.2 Propene✓ (1)

2.6

2.6 .1 Propan-2-one ✓✓ (2)

2.6.2 Aldehydes ✓ (1)

[15]

QUESTION 3

3.1

3.1.1 Functional group ✓ (1)

3.1.2 Melting point. ✓ (1)

3.1.3 Number of C-atoms (All have single bonds). ✓ (1)

3.2 Carboxylic acid ✓✓ (2)

3.3 C_nH_{2n+2} ✓✓ (2)

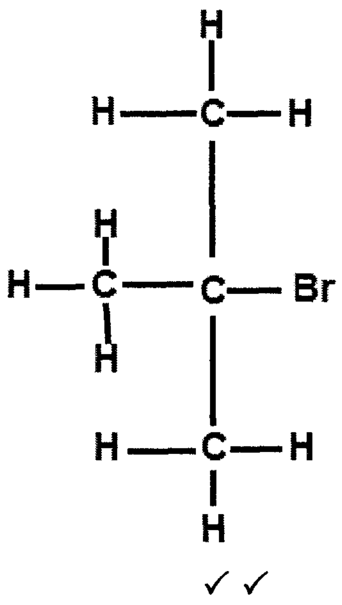
3.4 Melting points increases from **A–C**. ✓✓ (2)

3.5 Compound **A** has weak Van der Waal's forces (London forces) whilst **B** and **C** have strong hydrogen bonds between their molecules.✓ Hence, less energy is needed to break the weak intermolecular forces in **A** than in **B** and **C.**✓ Compound **B** has one site of hydrogen-bonding whilst compound **C** has two sites of H-bonding.✓ Thus, **C** has stronger intermolecular forces between its molecules than **B**,✓ hence more energy is needed to overcome the intermolecular forces in **C** than in **B**. ✓ (5)

[14]

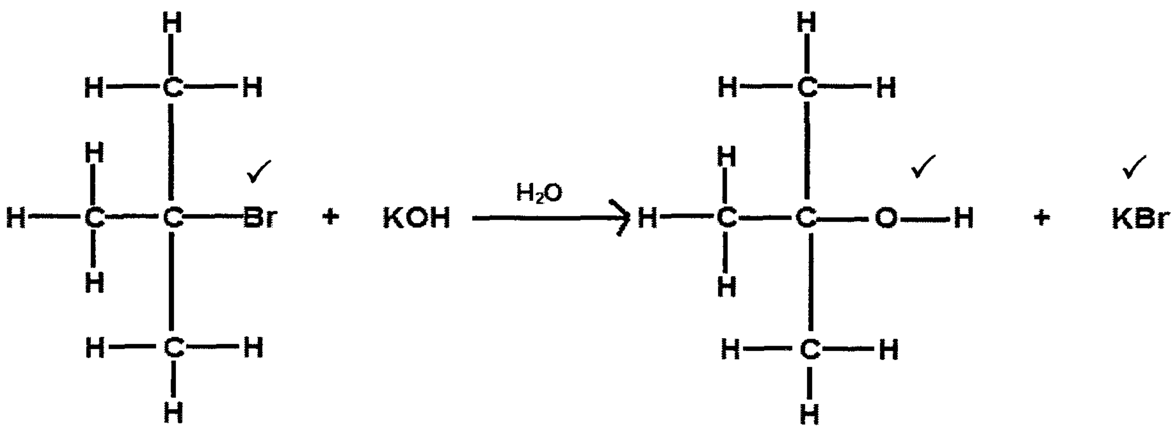
QUESTION 4

4.1.1



(2)

4.1.2



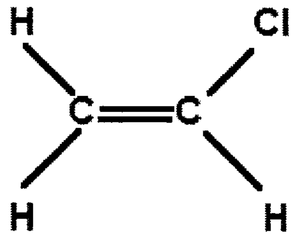
(3)

4.1.3 Ethanol as solvent✓ / NaOH(aq) ✓ or KOH(aq) / Mild heat (2)

4.1.4 Hydrolysis / Substitution reaction ✓ ✓ (2)

4.2.1 *Condensation polymer* is a polymer formed by two monomers with different functional groups ✓ that are linked together in a condensation reaction in which a small molecule (usually water) is lost. ✓ (2)

4.2.2 ✓ ✓ (2)



4.2.3 Chloroethylene /Chloroethene/Vinyl chloride. ✓✓ (2)

4.3.1 Condensation polymer ✓ (1)

4.3.2 Addition polymer ✓ (1)

4.4 ANY of the following:

- Blood transfusion sets✓; - Transparent food packaging trays;
- Plumbing pipes; - Synthetic leather, etc. (1)

[18]

QUESTION 5

5.1 An acid is a proton donor. ✓ ✓ (2)

5.2

5.2.1 H_2O ✓ (1)

5.2.2 H_3O^+ ✓ (1)

5.3

5.3.1 Ionises / dissociates completely (in water) ✓ ✓ (2)

5.3.2 pH = -log $[H_3O^+]$

Ratio: 1: 2

0,025 mol H_2SO_4 $\rightarrow$ 0,05 mol H_3O^+ ✓

pH = -log $[H_3O^+]$ ✓

= -log [0,05] ✓

= 1,3 ✓ (4)

5.4

5.4.1 OH^- ✓ (1)

5.4.2 DECREASE ✓ (1)

5.5 $n(H_2SO_4) = cV$ ✓ $= (0,4)(15\times10^{-3})$ ✓
$= 6\times10^{-3}$ mol ✓

$n(NaOH) = cV = (0,2)(25\times10^{-3})$ ✓

$= 5\times10^{-3}$ mol ✓

From the balanced equation:
1 mol of H_2SO_4 = 2 mol of NaOH
Hence, n(NaOH) needed to neutralise the acid = $2(6\times10^{-3}) = 12\times10^{-3}$ mol ✓
Therefore insufficient NaOH was added to the acid since 5×10^{-3} mol
is less than the required 12×10^{-3} mol ✓ (6)

[18]

QUESTION 6

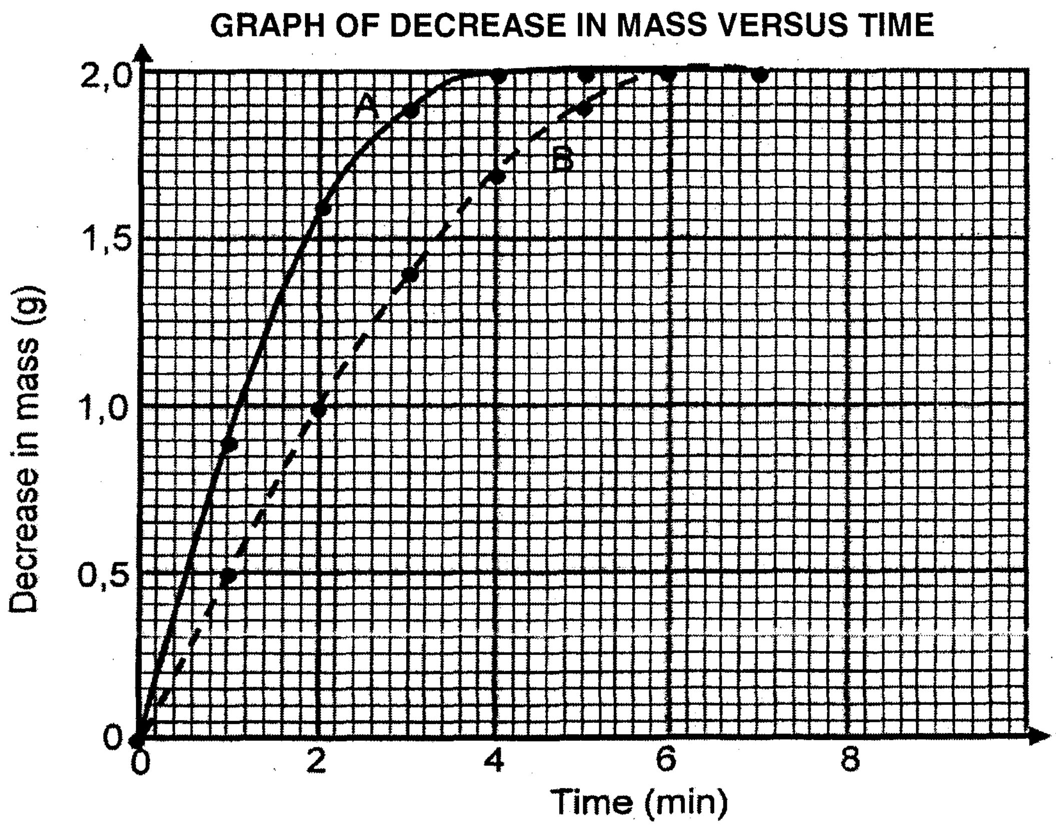
6.1 What is the relationship between the reaction surface or state of division of a solid and the rate of a reaction? / How does reaction surface (or state of division) influence the rate of a chemical reaction? ✓ ✓

OR

What is the relationship between the reaction surface (of a reactant) and the time that reaction takes to progress completely? (2)

6.2 $CaCO_3(s) + 2HCl(aq)$ ✓ $\rightarrow$ $CaCl_2(aq) + H_2O(l) + CO_2(g)$ ✓ bal ✓ (3)

6.3



CHECKLIST	MARK ALLOCATION
Heading	✓
Correct scale on both axes	✓
Correct labelling of both axes	✓
Plotting of points	✓ ✓
Correct shape of curves	✓

(6)

6.4 Reaction A is faster than Reaction B✓ (1)

6.5 The same (2 g) ✓ (1)

6.6 The greater the reaction surface, the higher the rate of reaction will be.✓ ✓ (2)

[15]

QUESTION 7

7.1 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.

OR

Le Chatelier's principle: When conditions (concentration, temperature and pressure) are changed in equilibrium in a closed system, equilibrium is shifted to the side which opposes the change. (2)

7.2.

OPTION 1: CALCULATION USING CONCENTRATION

	1 H_2	1CO	1H_2O	1CO
Initial concentration	X/10	0,03 ✓	0	0
Reacted/produced	0,02	0,02	0,02 ✓	0,02 ✓
Equilibrium	X/10 - 0,02	0,01	0,02	0,02 ✓

$$K_C = \frac{[CO][H_2O]}{[H_2][CO_2]} \checkmark$$

$$4 \checkmark = \frac{(0{,}02)(0{,}02)}{X/10-0{,}02)(0{,}01)} \checkmark$$

$$X = 0{,}3$$

$n(H_2)$ = 0,3 mol ✓

No Kc expression, correct substitution	Max. 7/8
Wrong Kc expression	Max. 4/8

OPTION 2: CALCULATION USING NUMBER OF MOLES

	1H_2	1CO_2	1H_2O	1CO	
Initial quantity (mol)	X	0,3	0	0	
Change (mol)	-0,2	-0,2	0,2	0,2	Mole ratio ✓
Quantity at equilibrium (mol)	X-0,2	0,1	0,2 ✓	0,2	✓
Equilibruim concentration ($mol.dm^{-3}$)	$\frac{X-0{,}2}{10}$	0,01	0,02	0,02	Divide by 10 ✓

$$K_C = \frac{[CO][H_2O]}{[H_2][CO_2]} \checkmark$$

$$4 \checkmark = \frac{(0{,}02)(0{,}02)}{X/10-0{,}02)(0{,}01)} \checkmark$$

X = 0,3 Thus $n(H_2)$ = 0,3 mol ✓ (8)

7.3. **-ve marking**

Exothermic ✓

A decrease in K_c value at a higher temperature implies the reverse reaction (endothermic)/ the reaction that uses energy is favoured. ✓Results in lower product concentration (less products) OR higher reactant concentration (more reactants). ✓ Equilibrium position shifts to the right/ lies to the right. ✓ (4)

[14]

QUESTION 8

8.1 - Temperature of 25 ^0C ✓

- Concentration of 1mol·dm^{-3} ✓ (2)

8.2 $Ag^+(aq) + e^- \rightarrow Ag(s)$ ✓ ✓ (2)

8.3 Ni ✓ (1)

8.4 The emf decreases. ✓ (1)

8.5 $Ni(s) + 2Ag^+(aq)$ ✓ $\rightarrow Ni^{2+}(aq) + 2Ag(s)$. ✓✓ (3)

8.6 $Ni \rightarrow Ni^{2+} + 2e^-$

mol ratios: from the balanced equation is

0,2 : 0,2 : 0,4

m = n(Ni). M ✓

= 0,2 x 59 ✓

= 11,8g of Ni is lost from the anode. ✓ (3)

8.7 **-ve marking**

Second (2nd) or **B**. ✓

Magnesium (Mg) is a better reducing agent than Nickel (Ni) and its potential difference is -2,36 V whilst that of Ni is -0,27 V. ✓

Silver (Ag) has the same oxidising ability in both galvanic cells. ✓ (3)

[15]

QUESTION 9

9.1 The process in which electricity is used to bring about a chemical change in an electrolytic cell/ decompose /break compounds into components. ✓✓

OR

A process in which electrical energy is converted to chemical energy. (2)

9.2 **P**✓, it is the positive electrode/ anode. ✓
Oxidation takes place at the positive electrode /anode. ✓ (3)

9.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓ ✓ (2)

9.4 The rate at which copper is oxidised (at the anode) is equal to the rate at which copper ions are reduced (at the cathode). ✓ ✓

OR

Rate of oxidation equals the rate of reduction. (2)

9.5 - Ornaments ✓; Electrical conductors ✓/Jewellery (2)
[11]

QUESTION 10

10.1 $4NH_3(q) + 5\ O_2(aq)$ ✓ $\longrightarrow$ $4NO(g) + 6H_2O(g)$ ✓ ✓ (3)

10.2 Pt or Platinum ✓ (1)

10.3 Catalytic oxidation of NH_3 ✓✓ (2)

10.4 HNO_3 ✓ (1)

10.5 Ostwald (process). ✓ (1)

10.6 - Brown or yellow scorching around the edges of the leaves. ✓
- Flowers become dull and sparse. ✓
- Fruit yield low and of poor quality. (2)
[10]

TOTAL: 150

PHYSICAL SCIENCES GRADE 12 PAPER 2 **ANALYSIS 2015**

Question No.		Taxonomy													Knowledge area				
		KNOWLEDGE, RECALL, Low Demand			COMPREHENSION, Basic Questions			APPLICATION, ANALYSIS, Problem Solving			SYNTHESIS, EVALUATION, Higher Abilities, Hard new problems, Challenge Level			TOTAL	MATTER & MATERIALS	CHEMICAL CHANGE	CHEMICAL SYSTEMS	TOTAL MARKS	Question Totals
	Content	E	M	D	E	M	D	E	M	D	E	M	D		Marks				
1.1	MOLECULAR STRUCTURES				2										2			2	
1.2	PHYSICAL PROPERTIES					2									2			2	
1.3	RATE OF REACTION					2										2		2	
1.4	TYPES OF REACTIONS							2							2			2	
1.5	ACID–BASED REACTION					2										2		2	
1.6	TYPES OF REACTIONS									2					2			2	
1.7	REDOX REACTION						2									2		2	
1.8	RATE OF REACTION					2										2		2	
1.9	CHEMICAL EQUILIBRIUM								2							2		2	
1.10	ACIDS AND BASES				2											2		2	**20**
2.1	ISOMERS					2									2			2	
2.2	ISOMERS				2										2			2	
2.3.1	STRUCTURAL FORMULAE								2						2			2	
2.3.2	ORGANIC PRODUCT								1						1			1	
2.4	TYPE OF REACTION		3													3		3	
2.5.1	STRUCTURAL FORMULAE							1							1			1	
2.5.2	STRUCTURAL FORMULAE							1							1			1	
2.6.1	IUPAC NAMING		2												2			2	
2.6.2	HOMOLOGOUS SERIES		1												1			1	**15**
3.1.1	PHYSICAL PROPERTIES	1													1			1	
3.1.2	PHYSICAL PROPERTIES	1													1			1	
3.1.3	PHYSICAL PROPERTIES			1											1			1	
3.2	HOMOLOGOUS SERIES				2										2			2	
3.3	GENERAL FORMULAE					2									2			2	
3.4	PHYSICAL PROPERTIES		2												2			2	
3.5	INTERMOLECULAR FORCES									5					5			5	**14**

	Content	E	M	D	E	M	D	E	M	D	E	M	D		Marks				
4.1.1	STRUCTURAL FORMULAE		2												2			2	
4.1.2	STRUCTURAL FORMULAE						3								3			3	
4.1.3.	REACTION CONDITIONS		2												2			2	
4.1.4	TYPE OF REACTION		2													2		2	
4.2.1	POLYMERS		2												2			2	
4.2.2	POLYMERS						2								2			2	
4.2.3	POLYMERS					2									2			2	
4.3.1	POLYMERS		1												1			1	
4.3.2	POLYMERS		1												1			1	
4.4	POLYMERS										1				1			1	**18**
5.1	ACIDS & BASES				2											2		2	
5.2.1	ACIDS & BASES									1						1		1	
5.2.2	ACIDS AND BASES								1							1		1	
5.3.1	ACIDS & BASES								2							2		2	
5.3.2	ACIDS AND BASES								4							4		4	
5.4.1	ACIDS & BASES								1							1		1	
5.4.2	ACIDS & BASES					1										1		1	
5.5	ACIDS & BASES									6						6		6	**18**
6.1	RATE OF REACTION				2											2		2	
6.2.	BALANCING REACTIONS					3										3		3	
6.3	GRAPHS INTERPRETATIONS									6						6		6	
6.4	RATE OF REACTION				1											1		1	
6.5	REDOX REACTIONS						1									1		1	
6.6	RATE OF REACTION					2										2		2	**15**
7.1	APPLICATION OF EQUILIBRIUIM						2									2		2	
7.2.	APPLICATION OF EQUILIBRIUM												8			8		8	
7.3.	APPLICATION OF EQUILIBRIUM									4						4		4	**14**
8.1	ELECTROCHE-MICAL REACTIONS				2											2		2	
8.2	ELECTROCHE-MICAL REACTIONS								2							2		2	

8.3	ELECTROCHE-MICAL REACTIONS	1														1		1	
8.4	ELECTROCHE-MICAL REACTIONS				1											1		1	
8.5	ELECTROCHE-MICAL REACTIONS							3								3		3	
8.6	ELECTROCHEMISTRY (APPLICATION)								3							3		3	
8.7	ELECTROCHEMISTRY (APPLICATION)									3						3		3	**15**
9.1	ELECTROLYSIS				2											2		2	
9.2	ELECTROLYTIC CELLS											3				3		3	
9.3	ELECTROLYTIC CELLS											2				2		2	
9.4	ELECTROLYTIC CELLS				2											2		2	
9.5	ELECTROLYTIC CELLS					2										2		2	**11**
10.1	ELECTROCHEMICAL CELL								3								3	3	
10.2	ELECTROCHEMICAL CELL				1												1	1	
10.3	ELECTROCHEMICAL CELL		2														2	2	
10.4	ELECTROCHEMICAL CELL	1															1	1	
10.5	ELECTROCHEMICAL CELL				1												1	1	
10.6	FERTILISERS			2													2	2	**10**
	ACTUAL MARKS			**27**			**54**			**55**			**14**		**50**	**90**	**10**	**150**	
	% ACHIEVED			18%			36%			37%			9%		33%	60%	7%	100%	
	EXPECTED MARKS			**15**			**35**			**40**			**10**		**48**	**84**	**18**	**150**	

Overall	**Easy**	**Medium**	**Difficult**
ACTUAL MARKS	34	68	48
% ACHIEVED	23%	45%	32%
EXPECTED MARKS	30	40	30