Basic Education

KwaZulu-Natal Department of Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES: CHEMISTRY (P2)

PREPARATORY EXAMINATION

SEPTEMBER 2015

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

TIME : 3 Hours

This question paper consists of 17 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK**.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subsections, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE – CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The primary nutrient needed by plants for the promotion of leaf growth is . . .

A calcium.
B nitrogen.
C potassium.
D phosphorus. (2)

1.2 The equation below represents ONE of the steps during the industrial preparation of sulphuric acid:

$$SO_3(g) + H_2SO_4(aq) \rightarrow H_2S_2O_7(\ell)$$

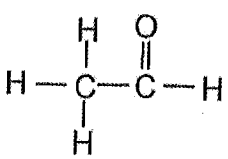
Which ONE of the following is the INCORRECT name for $H_2S_2O_7$?

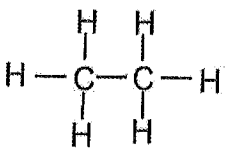
A oleum.
B sulphuric acid.
C pyro-sulphuric acid.
D fuming sulphuric acid. (2)

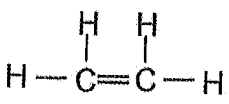
1.3 A solid **P** reacts with a solution **Q** in a flask to form products which remain in solution. Which ONE of the following changes will probably have little or no effect on the rate of the reaction?

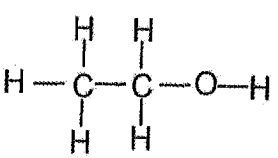
A Crushing the solid **P** into a fine powder.
B Increasing the concentration of solution **Q**.
C Reducing the pressure on the reaction mixture.
D Adding a suitable catalyst to the reaction mixture. (2)

1.4 Which ONE of the following compounds will decolourise bromine water the fastest at room temperature?

A 

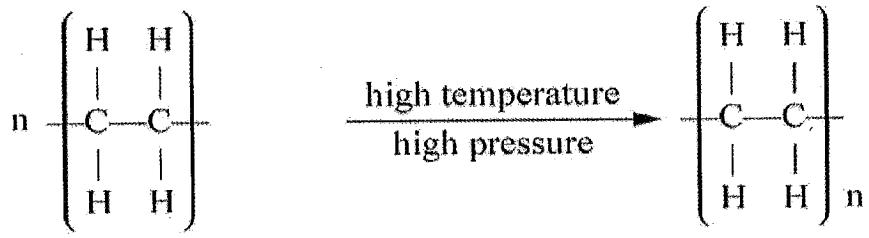
B 

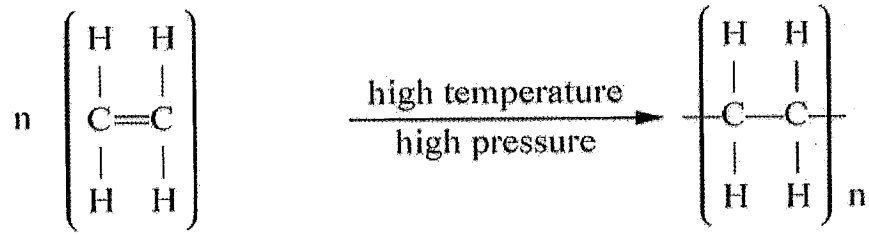
C 

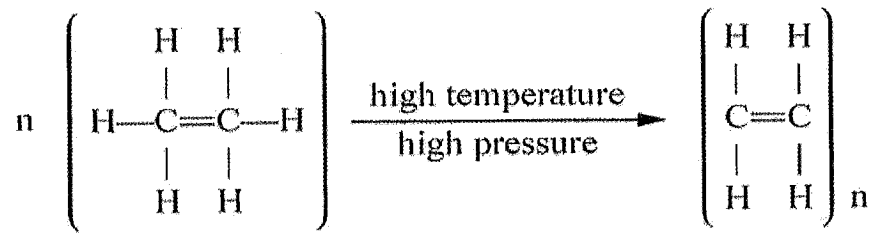
D 

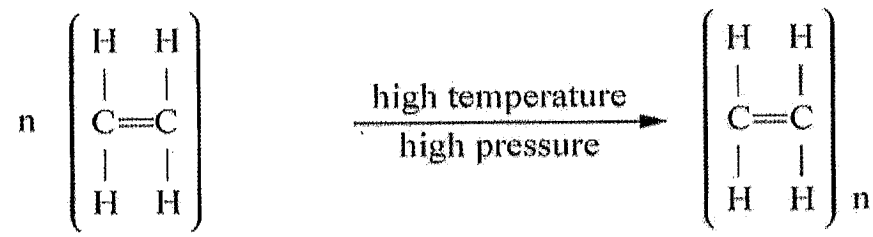
(2)

1.5 Polyethene is manufactured when ethene is heated to a relatively high temperature under a high pressure. The reaction is correctly illustrated in:

A 

B 

C 

D 

(2)

1.6 A learner is asked to name an organic compound X, according to the IUPAC system. She **incorrectly** names the compound as 2–chloro–4–ethylpentane. The correct name of the compound using the IUPAC system could be . . .

A 2–chloro–4–methylhexane.
B 4–chloro–2–methylhexane.
C 4–chloro–2–methylpentane.
D 2–chloro–2– methylpentane. (2)

1.7 The reactions below occur in two different electrochemical cells M and N.

Cell M: $CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$

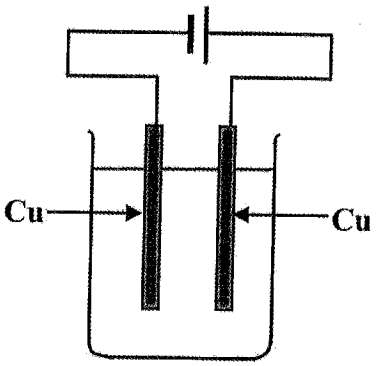
Cell N: $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

Which ONE of the following correctly describes the substance that forms at the CATHODE of each of these cells?

	Cell M	**Cell N**
A	$C\ell_2(g)$	Cu(s)
B	Cu(s)	Cu(s)
C	$C\ell_2(g)$	$ZnSO_4(aq)$
D	Cu(s)	$ZnSO_4(aq)$

( ) (2)

1.8 Copper is purified through electrolysis as represented in the simplified diagram below:



Which ONE of the following statements is CORRECT for this process?

( )
A Cu is reduced at the positive electrode.
B Cu is oxidised at the negative electrode.
C Cu^{2+} ions are reduced at the positive electrode.
D Cu^{2+} ions are reduced at the negative electrode. (2)

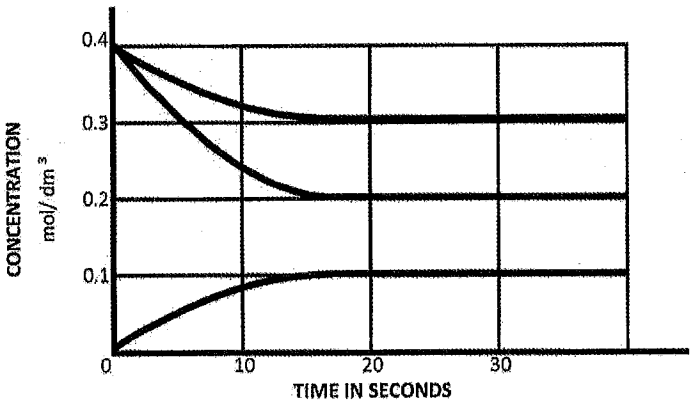
1.9 Consider the following hypothetical reaction that reached equilibrium in a closed container at 450 °C:

$PQ(s) \rightleftharpoons P(g) + Q(s) \quad \Delta H > 0$

Which ONE of the following changes will NOT affect the equilibrium position?

A Increase in temperature.
B Increase in the amount of Q(s).
C Decrease in pressure at constant volume.
D Increase in the volume of the container. (2)

1.10 Reactants **X** and **Y** react in a sealed 1 dm^3, container at constant temperature, to form product **Z**. The graphs below show the change in the concentration of the reactants, **X** and **Y**, and product, **Z**, with time.



Which ONE of the following chemical equations represents the above reaction at equilibrium?

A $X + 2Y \rightleftharpoons Z$

B $2X + Y \rightleftharpoons Z$

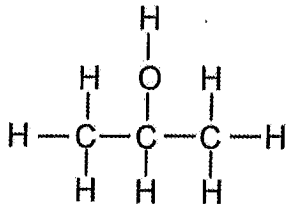
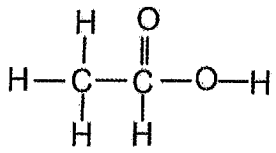
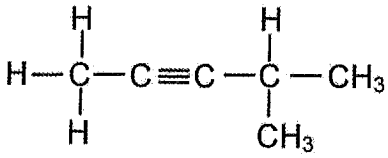
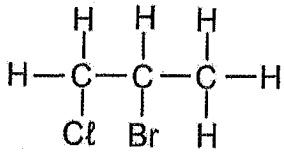
C $X + 2Y \rightleftharpoons 2Z$

D $3X + 2Y \rightleftharpoons Z$

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **G** in the table below represent seven organic compounds.

A		B	
C	2-methylpropan-2-ol	D	$CH_3CH_2CH_2CHO$
E		F	

Use the information in the table (where applicable) to answer the questions that follow.

2.1 Write down the LETTER that represents a compound that:
(A compound may be used more than once.)

2.1.1 Is an aldehyde. (1)

2.1.2 Is a tertiary alcohol. (1)

2.1.3 contains a carboxyl group. (1)

2.2 Write down the IUPAC name of compound:

2.2.1 **E** (2)

2.2.2 **F** (2)

2.3 Write down the structural formula of:

2.3.1 a functional isomer of compound **B**. (2)

2.3.2 the functional group of compound **A**. (2)

2.4 Write down the letters of two compounds that belong to the same homologous series. (1)

2.5 Write down the general formula for compound E. (1)

2.6 A mixture of compound B, propan-1-ol and concentrated sulphuric acid are together heated in a test tube to produce an organic compound G and water.

2.6.1 Give a reason why the above mixture must not be heated over an open flame. (1)

2.6.2 Write down the name of the type of reaction that occurs. (1)

2.6.3 Write down the IUPAC name for compound G. (2)

2.6.4 Write down the structural formula for compound G. (2)
[19]

QUESTION 3 (Start on a new page.)

Learners investigate factors that influence the boiling points of organic compounds, A, B and C shown below:

A	B	C
$CH_3(CH_2)_2COOH$	$CH_3(CH_2)_3CH_2OH$	$CH_3(CH_2)_3CHO$

3.1 Write down the dependant variable for this investigation. (1)

3.2 The learners observe that all the compounds have almost the same molecular mass and therefore conclude that the boiling points of the three compounds are the same. Briefly explain why their conclusion is incorrect. (3)

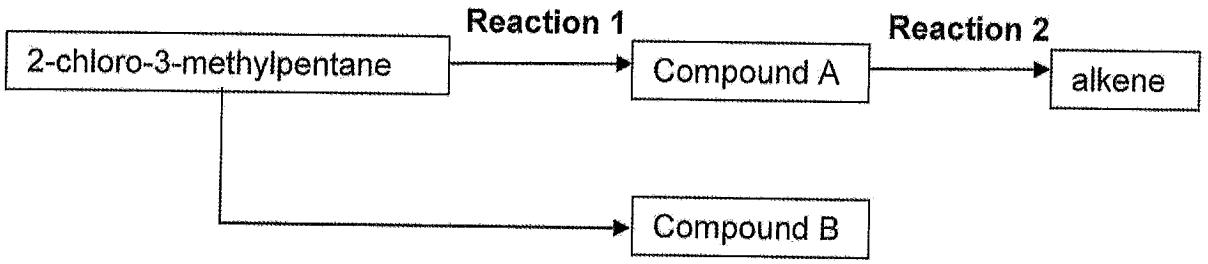
3.3 Define *vapour pressure*. (2)

3.4 Which compound **A**, **B** or **C** will have the lowest vapour pressure? Explain your answer by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (5)

3.5 Write down the letter that represents the compound with the highest boiling point. (1)
[12]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the reactions of 2-chloro-3-methylpentane under different conditions.



4.1 Classify 2-chloro-3-methylpentane as SATURATED or UNSATURATED and give a reason for the answer. (2)

4.2 Reaction 1 takes place in the presence of dilute sodium hydroxide. Name the type of substitution reaction that takes place. (1)

4.3 Write down the:

4.3.1 Structural formula for compound **A**. (2)

4.3.2 TWO reaction conditions for **reaction 2**. (2)

4.3.3 Name of the type of reaction of which **reaction 2 is an example.** (1)

4.3.4 Name of the alkene formed in **reaction 2**. (2)

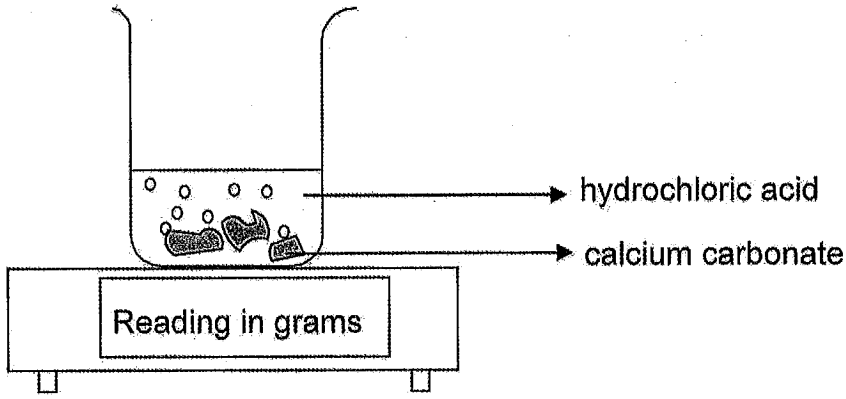
4.4 Compound **B** is formed when 2-chloro-3-methylpentane reacts in the presence of concentrated sodium hydroxide.

4.4.1 Write down another reaction condition required for this reaction. (1)

4.4.2 Classify this reaction as SUBSTITUTION, ADDITION or ELIMINATION. (1)
[12]

QUESTION 5 (Start on a new page.)

In an experiment to investigate factors that affect the rate of chemical reactions, a sample of calcium carbonate is placed in a beaker. The beaker is then placed on a sensitive mass meter and an **EXCESS** of hydrochloric acid is added to the beaker.



The experiment is repeated four times under different conditions, using the **same volume of HCℓ** in all four experiments. The HCℓ is **EXCESS** in all the experiments.

5.1 Will the reading on the mass meter INCREASE, DECREASE or REMAIN THE SAME as the reaction progresses? Give a reason for your answer. (3)

5.2 Give a reason why the same volume of excess HCℓ is used in all the experiments. (1)

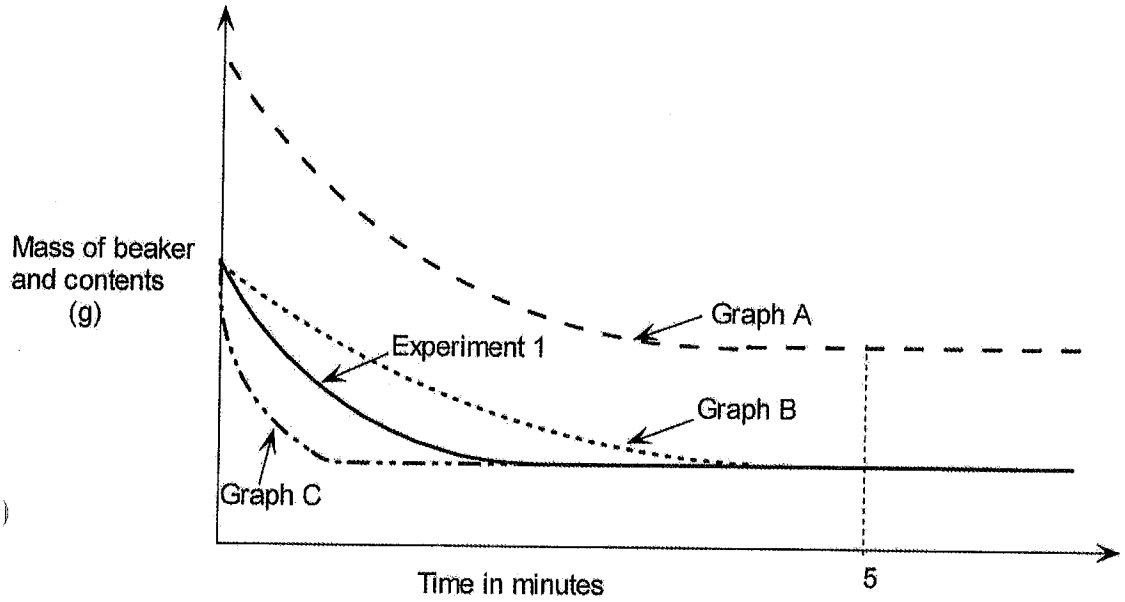
5.3 Write down the NAME or FORMULA of the limiting reagent in this experiment. (1)

The conditions for the experiments are shown in the table below:

Experiment	Mass of $CaCO_3$ (g)	Concentration of HCℓ ($mol.dm^{-3}$)	Temperature of HCℓ (°C)	State of $CaCO_3$(s)
1	10	2	25	Granules
2	20	2	25	Granules
3	10	2	15	Granules
4	10	2	25	Powder

During each experiment, the mass of the beaker and its contents is recorded every minute.

The graphs below indicate the changes in mass of the beaker and its contents during the reaction, as a function of time, for the four experiments:



5.4 Give a reason why the graphs are all straight lines after 5 minutes. (1)

5.5 Which ONE of the graphs **A**, **B** or **C**, represents the results of:

5.5.1 Experiment 2 (2)

5.5.2 Experiment 3 (2)

5.5.3 Experiment 4 (2)

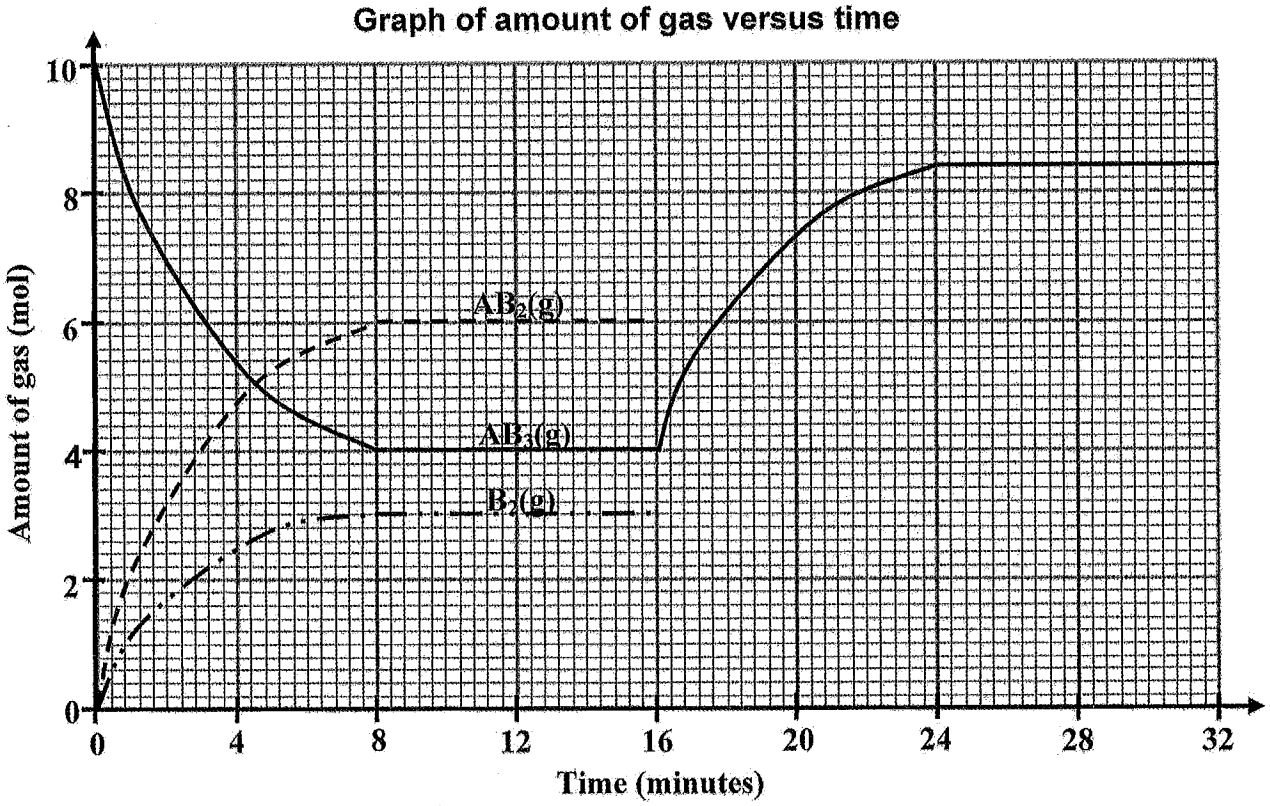
5.6 Use the collision theory to explain the answer to QUESTION 5.5.3 above. (3)
[15]

QUESTION 6 (Start on a new page.)

The following equation represents a hypothetical reaction that reaches equilibrium in a 2 dm^3 closed container at 500 °C after 8 minutes.

$$2AB_3(g) \rightleftharpoons 2AB_2(g) + B_2(g) \qquad \Delta H < 0$$

Graph of amount of gas versus time



6.1 At 16 minutes, one of the conditions affecting the equilibrium is changed at constant volume and a new equilibrium is thereafter established. Calculate, the K_c value at the new equilibrium. (8)

6.2 Which condition, CONCENTRATION or TEMPERATURE was changed? (2)

6.3 Was the condition identified in QUESTION 6.2 INCREASED or DECREASED? (1)

6.4 Use Le Chatelier's principle to explain the answer to QUESTION 6.3. (3)

6.5 How does the equilibrium constant, K_c, between t = 8 minutes and t = 16 minutes compare to that between t = 24 minutes and t = 32 minutes? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

6.6 How will the K_c value be affected if the volume of the container, is decreased from 2 dm^3 to 1 dm^3 after 32 minutes, while keeping the temperature constant. (1)

[16]

QUESTION 7 (Start on a new page.)

7.1 A solution of an unknown, diprotic acid has a concentration of 0,02 mol.dm^{-3} and a pH of 3,5.

7.1.1 Explain what is meant by a *diprotic acid*. (1)

7.1.2 Calculate the concentration of the hydrogen ions in this solution. (2)

7.1.3 How does the strength of this unknown acid compare to that of sulphuric acid of the same concentration? Choose from, STRONGER THAN, WEAKER THAN or EQUAL TO. (1)

7.1.4 Explain the answer to QUESTION 7.1.3. (2)

7.2 A solution of vinegar can be neutralised by a solution of sodium hydroxide. The following reaction occurs:

$$CH_3COOH(aq) + NaOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(\ell)$$

Phenolphthalein is colourless in an acidic medium and pink in an alkaline medium.

7.2.1 The sodium acetate formed during the neutralisation of vinegar by sodium hydroxide can undergo hydrolysis. What will the colour of phenolphthalein be in a solution of sodium acetate. (1)

7.2.2 Write a balanced equation to explain the answer to QUESTION 7.2.1. (3)

7.3 An unknown carbonate has the formula X_2CO_3. A grade 12 learner is requested to identify element X.
The learner adds 0,212 g of the carbonate into a conical flask containing 25 cm^3 of nitric acid solution of concentration 0,2 mol.dm^{-3}. The nitric acid is in excess. She notices that the carbonate reacts completely.

The balanced equation for the reaction reaction:

$$HNO_3(aq) + X_2CO_3(s) \longrightarrow XNO_3(aq) + CO_2(g) + H_2O(\ell)$$

She uses 10 cm^3 of a NaOH solution of concentration 0,1 mol.dm^{-3} to exactly neutralise the excess nitric acid.

The balanced equation for the reaction reaction is:

$$HNO_3(aq) + NaOH(aq) \longrightarrow NaNO_3(aq) + H_2O(\ell)$$

7.3.1 Calculate the number of moles of $HNO_3(aq)$, that reacted with the unknown carbonate. (5)

7.3.2 Provide a name for X, by performing the relevant calculations. (5)
[20]

QUESTION 8 (Start on a new page.)

The cell notation of a **standard galvanic (voltaic) cell** containing an unknown metal electrode X is shown below:

$$A\ell(s)\,|\,A\ell^{3+}(aq)\,||\,X^{2+}(aq)\,|\,X(s)$$

8.1 State the function of the component of the cell represented by the double vertical lines in the above cell notation. (1)

8.2 State TWO standard conditions that are applicable to the $A\ell^{3+}\,|A\ell$ half-cell. (2)

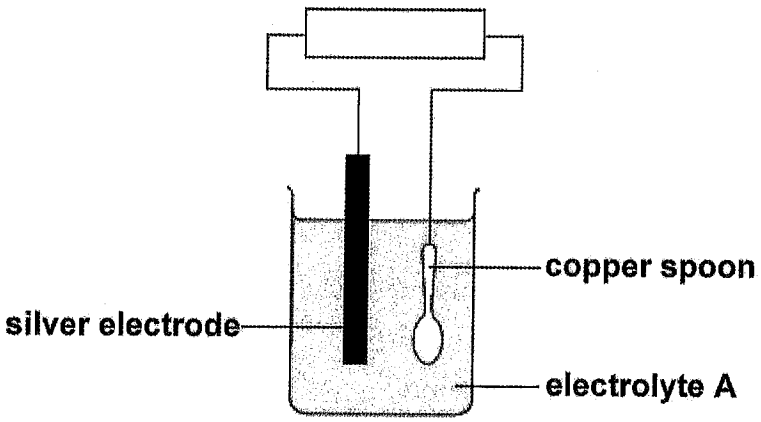
8.3 The emf of the above cell under standard conditions is 2,0 V. Identify metal X, using a calculation. (5)

8.4 Refer to the relative strengths of reducing agents, to explain why aluminium is the anode of this cell. (3)

8.5 Will the intensity of the colour of the electrolyte in the cathode half-cell INCREASE or DECREASE as the cell operates? Explain the answer with the aid of a relevant half-reaction. (4)
[15]

QUESTION 9

The diagram below illustrates one of the uses of electrolysis.



9.1 Give the use of electrolysis illustrated in the above diagram. (1)

9.2 Which electrode (CATHODE/ANODE) will the copper spoon represent? (1)

9.3 Write down the FORMULA of the cation present in electrolyte **A**. (1)

9.4 Write down the half-reaction responsible for the change that occurs at the surface of the spoon. (2)

9.5 Give a reason why the concentration of the electrolyte remains constant during electroplating. (2)
[7]

QUESTION 10 (Start on a new page.)

10.1 One of the processes during the industrial preparation of fertilisers involves the reaction between nitrogen and hydrogen to produce ammonia.

10.1.1 Write down the name of the process during which ammonia is produced in the industry. (1)

Ammonia reacts with oxygen to produce a **GAS B**, in the presence of a catalyst.

10.1.2 Write down the name given to the reaction described above. (1)

10.1.3 Write down a balanced equation for the reaction between ammonia and oxygen. (3)

The flow diagram below shows further reactions of **GAS B**, to form NITRIC ACID.

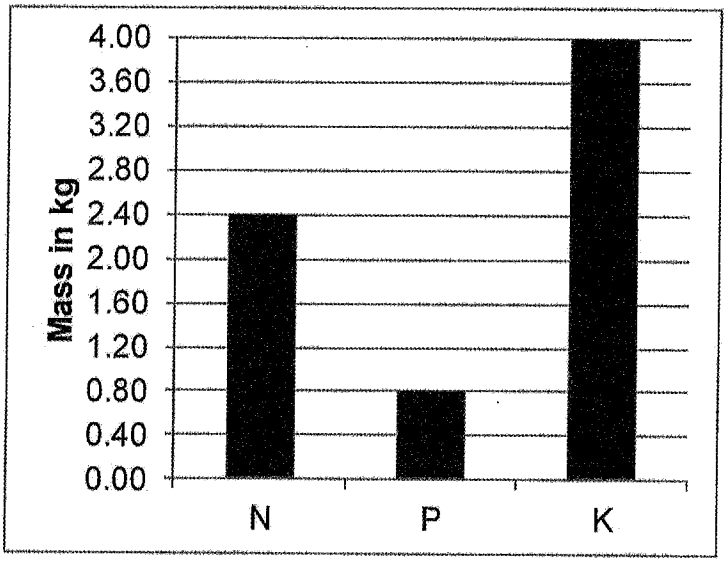
GAS B ⟶ **GAS C** ⟶ **nitric acid**

10.1.4 Write down the name or formula of the reagent required to react with **GAS B** to produce **GAS C**. (1)

Ammonia reacts with sulphuric acid to produce a fertilizer **E**.

10.1.5 Write down a balanced equation to show the preparation of fertilizer **E**. (3)

10.2 The following bar graph represents the mass, in kg, of nitrogen, phosphorous and potassium present in the 20 kg bag of fertilizer represented next to the graph.



FERTILISER

W : X : Y (Z)

20 kg

Use the above information to determine the values for:

10.2.1 W : X : Y (2)

10.2.2 Z (3)

[14]

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

29 1,9 Cu 63,5

- Atomic number / *Atoomgetal*: 29
- Electronegativity / *Elektronegatiwiteit*: 1,9
- Symbol / *Simbool*: Cu
- Approximate relative atomic mass / *Benaderde relatiewe atoommassa*: 63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD- REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*	$E^{\ominus}$(V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2(g)}$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Li^+ + e^- \rightleftharpoons Li$	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD- REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*	E^{θ} (V)
$Li^+ + e^- \rightleftharpoons Li$	− 3,05
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Cs^+ + e^- \rightleftharpoons Cs$	− 2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	− 1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	− 1,18
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	− 0,91
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	− 0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	− 0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	− 0,44
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	− 0,41
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	− 0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	− 0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	− 0,27
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	− 0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	− 0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	− 0,06
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

Basic Education

KwaZulu-Natal Department of Basic Education
REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES P2

MEMORANDUM

SEPTEMBER 2015

PREPARATORY EXAMINATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

N.B. This memorandum consists of 8 pages.

QUESTION 1

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B ✓✓ (2)

1.6 A ✓✓ (2)

1.7 B ✓✓ (2)

1.8 D ✓✓ (2)

1.9 B ✓✓ (2)

1.10 D ✓✓ (2)

10 x 2 = [20]

QUESTION 2

2.1

2.1.1 D ✓ (1)

2.1.2 C ✓ (1)

2.1.3 B ✓ (1)

2.2

2.2.1 4-methyl✓pent-2-yne ✓ (2)

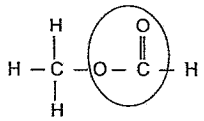
IF 4 methylpent 2 yne ½

2.2.2 2–bromo-1-chloro✓propane ✓ (2)

IF 2 bromo 1 chloropropane ½

2.3

2.3.1



Marking criteria:

Whole structure correct 2/2

Only functional group correct ½

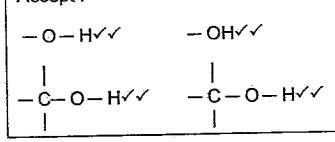
Notes:

- If two or more functional groups 0/2
- Condensed or semi-structural formula Max 1/2
- Molecular formula 0/2

(2)

2.3.2 R — O — H ✓✓

Accept :



(2)

2.4 A , C ✓ (1)

2.5 C_nH_{2n-2} ✓ (1)

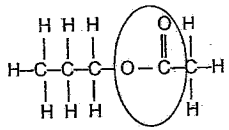
2.6

2.6.1 alcohols are flammable/burn easily✓ (1)

2.6.2 esterification/condensation✓ (1)

2.6.3 propyl✓ ethanoate✓ (2)

2.6.4



Marking criteria:
Whole structure correct ½
Only functional group correct ½

(2)
[19]

QUESTION 3

3.1 Boiling point ✓ (1)

3.2 The compound contains different functional groups✓ and different types of intermolecular forces with varying degrees of strength ✓
The amount of energy required to overcome the intermolecular forces is therefore different✓ (3)

3.3 The pressure exerted by a vapour✓ in equilibrium with its solid/liquid phase.✓ (2)

3.4 A ✓
A: In addition to London forces and dipole-dipole forces, there are two sites for hydrogen bonding. ✓
B: In addition to London forces and dipole-dipole forces, there is one site for hydrogen bonding. ✓
C: In addition to London forces , there are also dipole-dipole forces. ✓
The intermolecular forces in A is the strongest. ✓ (5)

3.5 A ✓ (1)
[12]

QUESTION 4

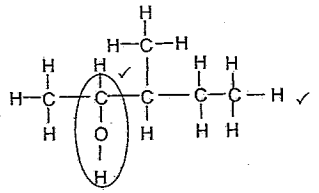
4.1 saturated✓
ANY ONE
- It has ONLY single bonds. ✓
- It has single bonds between C atoms. ✓
- It has no double OR triple bonds OR multiple bonds. ✓
- It contains the maximum number of H atoms bonded to C atoms. ✓
- Each C atom is bonded to four other atoms. ✓

(2)

4.2 hydrolysis✓ (1)

4.3

4.3.1



Marking criteria:
Whole structure correct ½
Only functional group correct ½

Notes
• Accept -OH as condensed in structural formula.
• If two or more functional groups 0/2
• Condensed or semi-structural formula: Max. ½
• Molecular formula/*Molekulêre formule*: 0/2

(2)

4.3.2 Concentrated sulphuric acid✓
Heat✓ (2)

4.3.3 Elimination or dehydrohalogenation✓ (1)

4.3.4 3-methyl✓pent-2-ene✓ (2)

Accept: 3-methyl-2-pentene
If hyphens missing ½

4.4.1 heat✓ (1)

4.4.2 elimination✓ (1)
[12]

QUESTION 5

5.1 decrease ✓
A gaseous product ✓ forms which escapes. ✓ (3)

5.2 To ensure a fair test ✓ OR
To have ONLY ONE independent variable. ✓ (1)

5.3 $CaCO_3$ /calcium carbonate ✓ (1)

5.4 The reaction is complete ✓/All the calcium carbonate has reacted. ✓/The calcium carbonate is completely used up. ✓ (1)

5.5.1 A ✓✓ (2)

5.5.2 B ✓✓ (2)

5.5.3 C ✓✓ (2)

5.6 In experiment 4 the $CaCO_3$ was powder.
Largest surface area ✓
Greater number of effective collisions occurred per unit time ✓
Greater gradient of graph/shorter time to reach completion. ✓ (3)

[15]

QUESTION 6

6.1

	AB_3	AB_2	B_2	
Initial quantity (mol)	4	6	3✓	
Change (mol)	+4,4	-4,4	-2,2 ✓	ratio✓
Quantity at equilibrium (mol)	8,4	1,6	0,8 ✓	
Equilibrium concentration ($mol.dm^{-3}$)	4,2	0,8	0,4	Divide by 2✓

$$K_c = \frac{[AB_2]^2[B_2]}{[AB_3]^2} \checkmark$$

$$= \frac{(0,8^2)(0,4)}{4,2^2} \checkmark$$

$$= 0,015 \checkmark$$ (8)

Reading of number of initial number of moles correctly from the graph✓
Using the correct ratio to calculate the change✓
Correct calculation of the change✓
Subtracting the change from the initial number of moles to get values at equilibrium✓
Dividing by 2 to get concentration at equilibrium✓
Correct Kc expression(formulae in square brackets)✓
Substitution of concentrations into Kc expression✓
Correct answer: 0,015✓

6.2 Temperature ✓✓ (2)

6.3 Increased ✓ (1)

6.4 According to LCP an increase in temperature favours the endothermic reaction.✓
In this case the reverse reaction✓
Number of mol of AB_3 increased. ✓ (3)

6.5 Smaller than ✓ (1)

6.6 No change ✓ (1)

[16]

QUESTION 7

7.1.1 An acid that contains 2 protons (H^+)✓ (1)

7.1.2

$$pH = -\log[H^+] \checkmark$$

$$3,5 = -\log[H_3O^+]$$

$$[H_3O^+] = 3,16 \times 10^{-4}\ mol.dm^{-3} \checkmark$$ (2)

7.1.3 weaker than✓ (1)

7.1.4 The calculated concentration of the H^+ ions is less than the concentration of the acid. ✓

The acid does not ionise completely while sulphuric ionises completely. ✓ (2)

7.2.1 pink✓ (1)

7.2.2 $CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ LHS✓ RHS✓ BAL✓ (3)

7.3.1 $n(HNO_3)_{initial} = cV \checkmark = 0,2 \times 0,025 = 0,005$ mol ✓ (5×10^{-3})

$n(HNO_3)_{reacted\ with\ NaOH} = n(NaOH) = 0,1 \times 0,01 = 0,001$ mol✓ (1×10^{-3})

$n(HNO_3)_{reacted\ with\ X_2CO_3} = 0,005 - \checkmark\ 0,001 = 0,004$ mol✓ (4×10^{-3}) (5)

Positive marking from question 7.3.1

7.3.2 $n(X_2CO_3) = \frac{1}{2}n(HNO_3) = \frac{1}{2}(0,004) \checkmark = 0,002$ mol (2×10^{-3})

$$n = \frac{m}{M} \checkmark$$

$$0,002 = \frac{0,212}{M} \checkmark$$

$$M = 106\ g.mol^{-1}$$

$$M(X) = \frac{106 - (12 + 3(16))}{2} \checkmark$$

$$= 23\ g.mol^{-1} \checkmark$$ (5)

[20]

QUESTION 8

8.1 - complete the internal circuit ✓ or
- maintain electrical neutrality✓ (1)

8.2 - c(electrolyte) = 1 mol.dm^3 ✓
- T = 25 °C /298 K ✓ (2)

8.3 E° cell = E° cathode - E° anode ✓
2✓ = E° cathode - (-1,66) ✓
E° anode = 0,34 V ✓
X is Cu ✓ (5)

8.4 Cu^{2+} is a stronger oxiding agent (than Aℓ).
Aℓ is therefore oxidized .✓
Oxidation takes place at the anode .✓ (3)

8.5 decrease ✓
$Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓
c(Cu^{2+}) decreases ✓ (4)
[15]

QUESTION 9

9.1 electroplating ✓ (1)

9.2 cathode ✓ (1)

9.3 Ag^+ ✓ (1)

9.4 $Ag^+ + e^- \rightarrow Ag$✓✓ (2)

9.5 The rate at which Ag^+ is reduced at the cathode is equal to the rate at which the silver anode is oxidized✓ to produce Ag^+ ✓ (2)
[7]

QUESTION 10

10.1.1 Haber process ✓ (1)

10.1.2 catalytic oxidation of ammonia✓ (1)

10.1.3 $4\,NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ LHS ✓ RHS ✓ BAL ✓ (3)

10.1.4 oxygen (O_2) ✓ (1)

10.1.5 $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ LHS ✓ RHS ✓ BAL ✓ (3)

10.2.1 mass W : X : Y
2,4 : 0,8 : 4
Ratio $\frac{2,4}{0,8} : \frac{0,8}{0,8} : \frac{4}{0,8}$ ✓
3 : 1 : 5

W : 3
X : 1
Y : 5 ✓ (2)

10.2.2 $Z = \frac{2,4 + 0,8 + 4}{20} \times 100$ ✓ ✓

= 36% ✓ (3)
[14]

TOTAL MARKS: [150]