education

Department:
Education
PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE EXAMINATION

2020

NATIONAL
SENIOR CERTIFICATE

GRADE 12

Time: 3 hours

Marks: 150

NB. This question paper consists of 15 pages and 4 Data Sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions, FIFTEEN pages and FOUR data sheets.
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 sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.
12. Answer ALL the questions in the ANSWER BOOK.

QUESTION 1 MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter A, B, C or D next to the question number in the ANSWER BOOK, e.g. 1.11 A

1.1 The number of isomers for C_4H_{12} is:

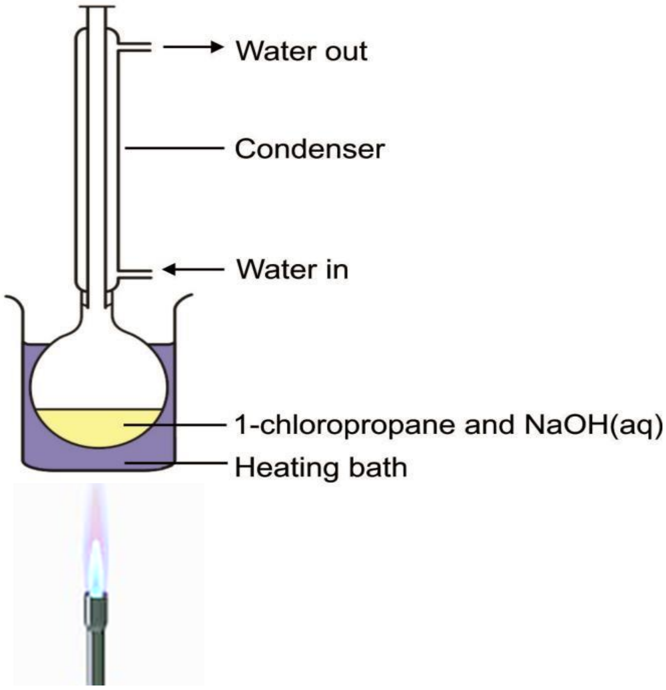
A. 5

B. 4

C. 3

D. 2 (2)

1.2 1-chloropropane is heated under reflux with an aqueous solution of sodium hydroxide as shown in the diagram.



The TYPE of reaction taking place above, is

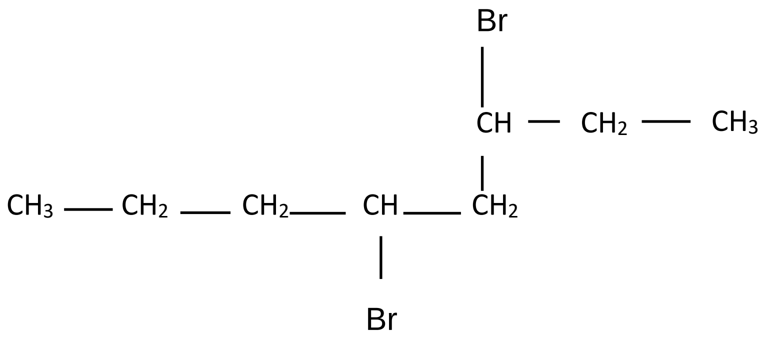
A. Addition

B. Hydrolysis

C. Elimination

D. Hydrohalogenation (2)

1.3 The condensed structural formula of an organic compound is shown below:



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

A. 4,6-dibromooctane

B. 4-bromo-5-bromo-5-propylpentane

C. 3,5-dibromooctane

D. 2-bromo-1-bromo-1-propylpentane (2)

1.4 When methanol reacts with methanoic acid, the molecular formula of the organic product formed is:

A. $H_4C_3O_2$

B. H_2O

C. $H_4C_2O_2$

D. $H_3C_3O_2$ (2)

1.5 Which ONE of the following will DEFINITELY NOT INCREASE the rate at which oxygen is produced in the following reaction?

$$2H_2O_2(aq) \rightleftharpoons 2H_2O(\ell) + O_2(g) \qquad \Delta H > 0$$

A. Increase in temperature

B. Increase in pressure

C. Increasing the concentration of H_2O_2

D. Adding a suitable catalyst (2)

1.6 Hydrogen bromide decomposes according to the following equation:

$$2HBr(g) \rightleftharpoons H_2(g) + Br_2(g) \qquad Kc = 0{,}006 \text{ at } 420K$$

2mol of each of HBr, H_2 and Br_2 were placed in a sealed container and heated to 420K. When equilibrium is established it was found that:

A. the number of moles of HBr would be unchanged.

B. the number of moles of Br_2 would have decreased.

C. the value of Kc would have increased to 1.

D. the number of moles of gas would have decreased. (2)

1.7 The expression for the equilibrium constant (K_C) of a hypothetical reaction is given as follows:

$$\mathbf{Kc = \frac{[D]^2[C]}{[A]^3}}$$

Which ONE of the following equations represents this reaction?

A. $3A(\ell) \rightleftharpoons C(aq) + 2D(aq)$

B. $3A(s) \rightleftharpoons C(g) + 2D(g)$

C. $3A(aq) + B(s) \rightleftharpoons C(aq) + 2D(aq)$

D. $3A(aq) + B(s) \rightleftharpoons C(g) + D_2(g)$ (2)

1.8 Two learners, X and Y, prepared hydrogen gas in the laboratory by adding hydrochloric acid to an excess of magnesium.

The equation for the reaction is:

$$Mg\ (s) + 2HCl\ (aq) \longrightarrow MgCl_2\ (aq) + H_2\ (g)$$

Each learner was given the same mass of Mg and the same volume of HCl. Their results were tabulated as follows:

	Time (minutes)	**1**	**2**	**3**	**4**
Learner X	Volume of H_2 (cm^3)	20	30	35	35
Learner Y	Volume of H_2 (cm^3)	30	35	40	40

The reasons for the different volumes that X and Y obtained are:
Y used …

A. a catalyst and a higher concentration of HCl than X.

B. a catalyst and a higher temperature than X.

C. a catalyst and powdered magnesium. (2)

D. powdered magnesium and a higher temperature than X.

1.9 A $10cm^3$ sample of a strong acid has a pH of 4. Addition of 990 cm^3 of pure water to this sample will form a solution of pH of …

A. 2,0

B. 4,0

C. 5,5

D. 6,0 (2)

1.10 Which one of the indicator ranges below is most suitable in the titration of ethanoic acid and sodium hydroxide.

A. 3,1-4,4

B. 6,0-7,6

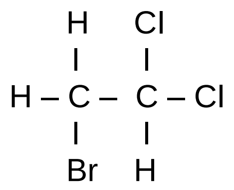
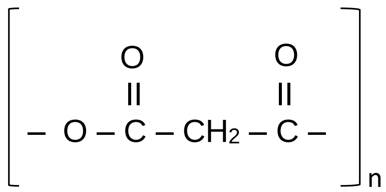
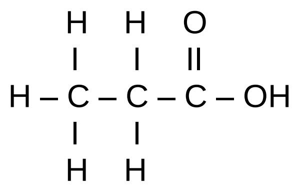
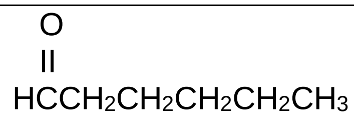
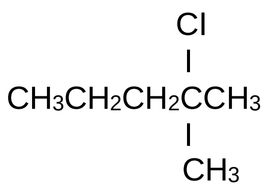
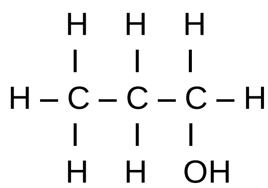
C. 8,4-10,0

D. 10,0-14,0 (2)

[20]

QUESTION 2 (Start on a new page)

The letters A to F in the table below represent six organic compounds. Use the information in the table to answer the questions that follow.

A		**B**	3-methylpentan-2-one
C		**D**	
E	C_6H_8	**F**	
G		**H**	

2.1 Write down the letter from the table that represents the following:

2.1.1 An unsaturated hydrocarbon. (1)

2.1.2 Two compounds that are FUNCTIONAL ISOMERS of each other. (2)

2.1.3 A tertiary haloalkane. (1)

2.1.4 An aldehyde (1)

2.2 Write down the:

2.2.1 IUPAC name of compound **A.** (2)

2.2.2 IUPAC name of compound **F.** (2)

2.2.3 IUPAC name of a POSITIONAL ISOMER of **H**. (1)

2.2.4 the FUNCTIONAL group of compound **D**. (2)

2.2.5 GENERAL FORMULA of homologous series of compound **G.** (2)

2.3 Identify the letter of the polymer in the table. (1)

2.4 Name **and** define the type of polymerization that the compound identified in 2.3 has undergone. (3)

[18]

QUESTION 3 (Start on a new page)

The table below compares melting point, boiling point and vapour pressure of organic compounds with different functional groups with regards to type and strength of intermolecular forces between molecules.

Compound	Molecular formula	Molecular mass g.mol^{-1})	Melting point ^oC)	Boiling point (^oC)	Vapour pressure (KPa at 20^oC)
A. Ethane	C_2H_6	30	-183	-89	3 750
B. Chloroethane	C_2H_5Cl	64,5	-136	12	132,4
C. Ethanol	C_2H_5OH	46	-89	78	5,8
D. Ethanoic acid	C_2H_5COOH	60	16	118	1,6

3.1 Define melting point. (2)

3.2 By referring to the **type and strength** of intermolecular forces, explain the following:

3.2.1 The differences in the boiling point between compound A and B. (3)

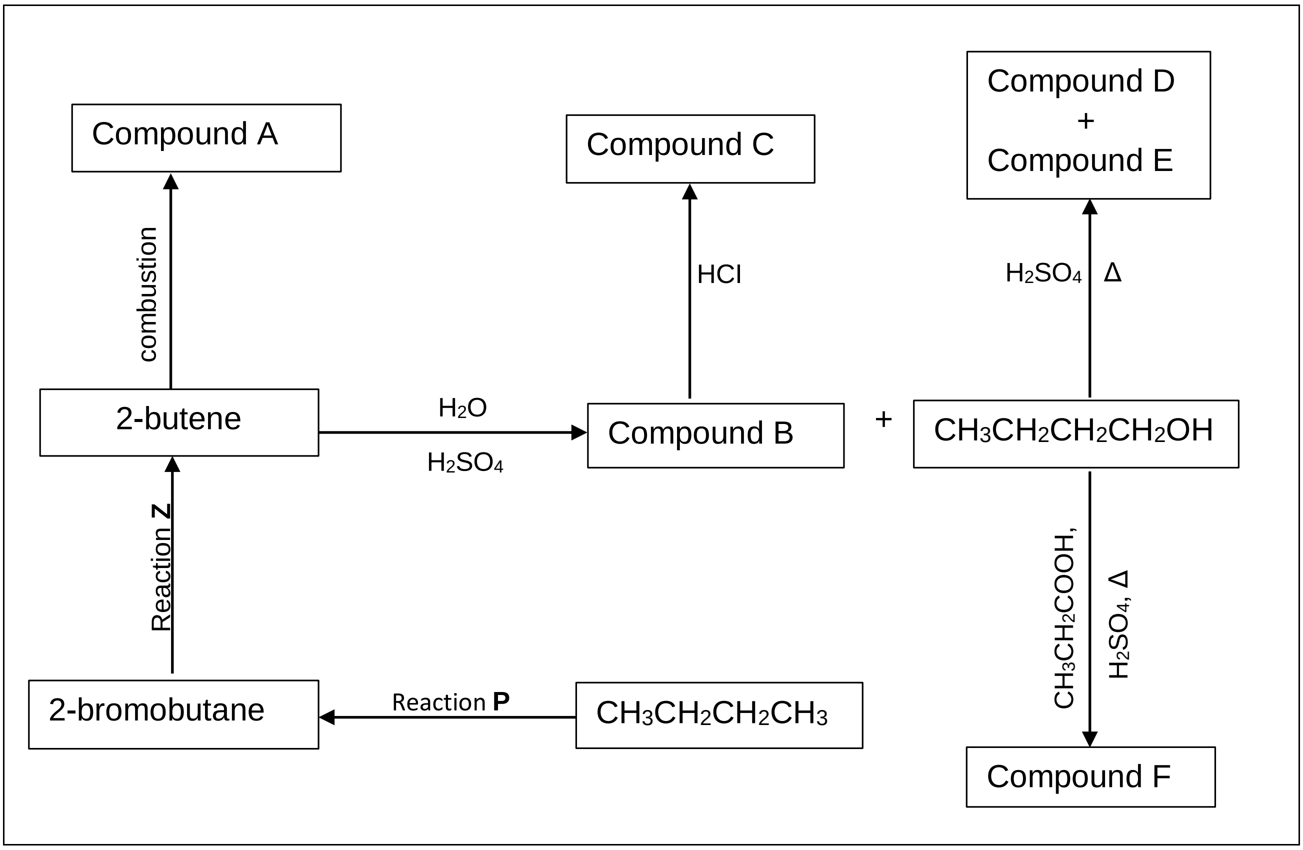
3.2.2 The differences in the melting point between compound C and D. (3)

3.3 Explain the relationship between boiling point and vapour pressure, by referring to the trend of compound A and D in the table. (2)

[10]

QUESTION 4 (Start on a new page)

Study the following flow diagram that illustrates reactions of organic compounds.



4.1 Using MOLECULAR FORMULAE, write a balanced equation showing the formation of compound **A**. (3)

4.2 Write down the reaction conditions for:

4.2.1 Reaction P (2)

4.2.2 Reaction Z. (2)

4.3 Study the formation of compound **B**:

4.3.1 Write down the IUPAC name and STRUCTURAL FORMULA of compound **B**. (3)

4.3.2 Name the homologous series to which compound B belongs. (1)

4.3.3 Is compound **B** a primary, secondary or tertiary product? Give a reason for your answer. (2)

4.3.4 Name the TYPE of reaction that results in the formation of compound **B**. (1)

4.4 Write down the STRUCTURAL FORMULA of compound C. (2)

4.5 Name the TYPE of reaction where compound C is formed. (1)

4.6 Write down the IUPAC name of *organic* compound D. (2)

4.7 Write down the STRUCTURAL FORMULA for inorganic product E. (2)

4.8 Write down the IUPAC name and draw the STRUCTURAL FORMULA of compound **F**. (3)

4.9 Name the TYPE of reaction that results in the formation of product **F.** (1)

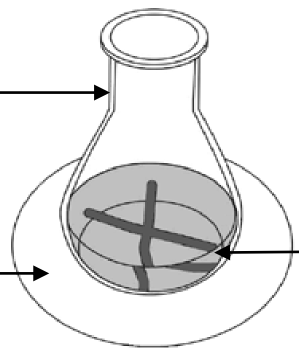
[25]

QUESTION 5 (Start on a new page)

The reaction between dilute hydrochloric acid and sodium thiosulphate ($Na_2S_2O_3$) is used to investigate one of the factors that influences reaction rate. The balanced equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + S(s) + H_2O(\ell) + SO_2(g)$$

The hydrochloric acid solution is added to the sodium thiosulphate solution in a flask. The flask is placed over a cross drawn on a sheet of white paper, as shown in the diagram below. The time that it takes for the cross to become invisible is measured to determine the reaction rate.



Four experiments, A to D, are conducted during this investigation. The volumes of reactants used in each of the four experiments and the times of the reactions are summarised in the table below.

Experiment	Volume of $Na_2S_2O_3$(aq) (cm^3)	Volume of $H_2O(\ell)$ (cm^3)	Volume of $HC\ell$(aq) (cm^3)	Time (s)
A	25	0	5	50,0
B	20	5	5	62,5
C	15	10	5	83,3
D	10	15	5	125,0

5.1 Define *reaction rate*. (2)

5.2 State TWO factors that can affect the rate of the above reaction. (2)

5.3 Write down the NAME of the product that causes the cross to become invisible. (1)

5.4 Write down an investigative question for this investigation. (2)

5.5 In which experiment (A, B, C or D) is the reaction rate the highest. (2)

5.6 Use the collision theory to explain the difference in reaction rate between experiments B and D. (3)

5.7 Experiment D was carried out in a sealed container. If the volume of $SO_2(g)$ collected was $50cm^3$, calculate the reaction rate in $cm^3.s^{-1}$. (3)

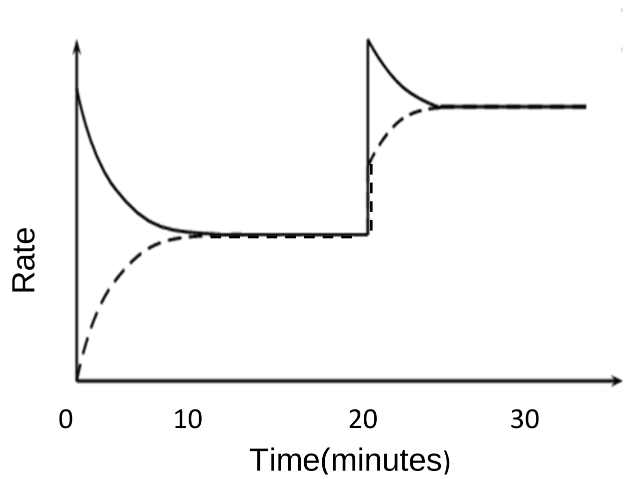
5.8 The original $Na_2S_2O_3$ solution was prepared by dissolving 100g of crystals in 250ml of water in a volumetric flask. Calculate the mass of the sulphur, S, that will form in experiment A if the $Na_2S_2O_3$ is limiting. (7)

[22]

QUESTION 6 (Start on a new page)

6.1 Methanol vapour is sealed in a closed container and it reaches equilibrium after 10 minutes at a temperature of 400K. After 20 minutes, the temperature is increased to 600K. Study the graph of rate verses time for the reaction and answer the questions.

$$2CH_2OH(g) \leftrightarrows 2CO(g) + 3H_2(g)$$



6.1.1 Is the above reaction homogenous or heterogeneous at equilibrium? Give reason for your answer. (2)

6.1.2 Write down a balanced equation for the reaction represented by the dotted line. (2)

6.1.3 Provide a reason for the decrease in reaction rate represented by the solid line between the times, 0 minutes and 10 minutes. (1)

6.1.4 Is the reaction represented by the dotted line exothermic or endothermic? Give a reason for your answer. (3)

6.1.5 By referring to the graph explain what is happening between 10 and 20 minutes. (2)

6.1.6 How does the value of Kc compare between the 18th and 28th minute? Write only INCREASES, DECREASES OR REMAINS THE SAME. (1)

6.1.7 Draw a sketch graph showing the addition of a catalyst to the above reaction after 30 minutes. (4)

6.2 Sulphur trioxide is formed industrially during the Contact Process. This reaction is an example of dynamic equilibrium:

$$2\,SO_2\,(g) + O_2(g) \leftrightarrows 2\,SO_3\,(g) \qquad \Delta H = -197\ kJ.mol^{-1}$$

6.2.1 State Le Chatelier's principle. (2)

6.2.2 Use Le Chatelier's principle to determine what happens to the concentration of SO_3 when:
[Write only INCREASE, DECREASE, NO CHANGE]

6.2.2.1 temperature is increased. (1)

6.2.2.2 pressure is increased. (1)

6.2.3 0,3 moles of SO_2(g) is mixed with an unknown mass of O_2(g) in a sealed 10 dm^3 container. When equilibrium is reached at a certain temperature, it is found that 0,2 moles of SO_3 (g) is present. If the equilibrium constant (Kc) for the reaction at the temperature of 300K is 4, calculate the initial mass of O_2 that was present in the container. (8)

[27]

QUESTION 7 (Start on a new page)

7.1 Define a Bronsted Lowry acid. (2)

7.2 A group of learners wish to identify element X, in weak base X_2CO_3.
They first dissolve 0,795g of X_2CO_3 in 250 ml volumetric flask with water to prepare a standard solution.
They then titrate this solution with 0,5 mol.dm^{-3} hydrochloric acid.
The results of their titration is found in the table below.

$$X_2CO_3\,(aq) + 2HCl\,(aq) \longrightarrow 2XCl(aq) + H_2O(aq) + CO_2(g)$$

	Volume of Acid(cm^3)	**Volume of base(cm^3)**
	14,8	12,5
	15,2	12,8
	15,1	11,9
	14,9	12,8
Average:	**15,0 cm^3**	**12,5 cm^3**

Identify element X in the equation by means of a suitable calculation. (8)

7.3 A learner spills a little hydrochloric acid on concentration 5 mol.dm^{-3} by accident on the laboratory desk. She quickly neutralizes the acid by sprinkling small amounts of sodium hydrogen carbonate on it. When all the acid was neutralized, he noticed that bubbles of carbon dioxide stops forming after 7g of sodium hydrogen carbonate was sprinkled.

$$NaHCO_3(aq) + 2HCl\,(aq) \longrightarrow 2NaCl(aq) + H_2O(aq) + CO_2(g)$$

7.3.1 Calculate the volume of hydrochloric acid that was spilled (in cm^3) if all the sodium hydrogen carbonate reacted with the acid. (6)

7.3.2 The learner dilutes some of the 5 mol.dm^{-3}, acid to 0,1 mol.dm^{-3}. Calculate the volume of the 5 mol.dm^{-3},hydrochloric acid needed to prepare 1 dm^3 of diluted acid. (3)

7.4 In a separate experiment the learner takes 3.68 g of an impure sample $NaHCO_3$ and adds it to distilled water to make up a 275cm^3 solution. During the titration he found that 25 cm^3 of this solution neutralized 23,5 cm^3 of a 0,11 mol.dm^{-3} solution of HCl.

7.4.1 If the concentration of the base at endpoint was 0,052 mol.dm^{-3}, calculate the percentage purity of the $NaHCO_3$ sample. (6)

7.4.2 Calculate the pH of the HCl solution. (3)

[28]

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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^{+}]$
$K_w = [H_3O^{+}][OH^{-}] = 1 \times 10^{-14}$ 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

KEY

Atomic number: 29
Electronegativity: 1,9
Symbol: Cu
Relative atomic mass (approximately): 63,5

I	II											III	IV	V	VI	VII	0
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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

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

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE EXAMINATION

MARKING GUIDELINE

2020

NATIONAL
SENIOR CERTIFICATE

GRADE 12

Time: 3 hours

Marks: 150

NB. This marking guideline consists of 9 pages.

QUESTION 1

1.1	D✓✓	(2)
1.2	B ✓✓	(2)
1.3	C ✓✓	(2)
1.4	C✓✓	(2)
1.5	B✓✓	(2)
1.6	B✓✓	(2)
1.7	C ✓✓	(2)
1.8	A✓✓	(2)
1.9	D✓✓	(2)
1.10	C ✓✓	(2)
		[20]

QUESTION 2

2.1.1	E✓	(1)
2.1.2	B and F✓✓	(2)
2.1.3	G✓	(1)
2.1.4	F✓	(1)
2.2.1	1-bromo✓-2,2-dichloro✓ethane	(2)
2.2.2	hexanal✓✓	(2)
2.2.3	2-propanol/propan-2-ol✓	(1)
2.2.4	Carboxyl group✓✓	(2)
2.2.5	C_nH_{2n}✓✓	(2)
2.3.	C✓	(1)
2.4	Condensation polymerization. ✓ Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water. ✓✓	(3)
		[18]

QUESTION 3

3.1 The temperature at which the solid and liquid phases of a substance are at equilibrium. ✓✓ (2)

3.2.1 Compound A, ethane has only weak London forces between the molecules. ✓
Compound B, chloroethane has weak London forces and dipole-dipole forces between the molecules. ✓
Since compound B has stronger intermolecular forces than compound A, compound B has a higher boiling point. ✓ (3)

3.2.2 Compound C, ethanol, has strong hydrogen bonds in addition to dipole-dipole forces and weak London forces are between the molecules. ✓

Compound D, ethanoic acid has very strong hydrogen bonds (2 sites for hydrogen bonding) in addition to dipole-dipole forces and weak London forces (induced dipole forces) are between the molecules. ✓

Since compound D has stronger intermolecular forces than compound C, compound D has a higher melting point. ✓ (3)

3.3 The higher the boiling point, the lower the vapour pressure. ✓✓ (2)

[10]

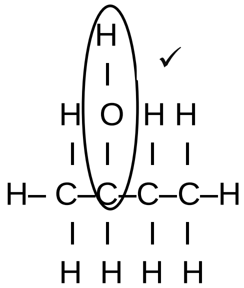
QUESTION 4

4.1 $2C_5H_{10} + 15O_2 \longrightarrow 10CO_2 + 10H_2O$ ✓ ✓ ✓bal (3)

4.2.1 Br_2 ✓ (2)
Heat/ UV light✓

4.2.2 Concentrated strong base(NaOH/KOH) in ethanol✓ (2)
Heat strongly under reflux✓

4.3.1



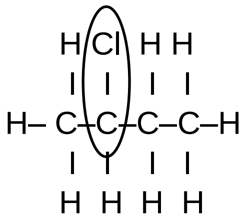
✓ ✓ 2-butanol/butan-2-ol✓ (3)

4.3.2 Alcohols✓ (1)

4.3.3 secondary✓
The OH group is joined to the carbon atom that is bonded to two other carbons✓ (2)

4.3.4 Addition/hydration✓ (1)

4.4

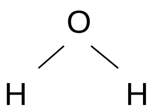


✓ ✓ (2)

4.5 Substitution✓ (1)

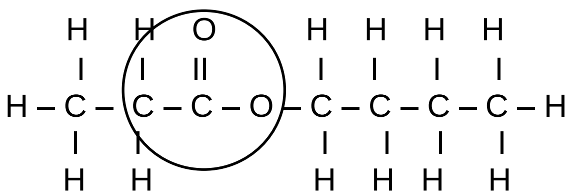
4.6 but-1-ene/1-butene✓✓ (2)

4.7



✓✓ (2)

4.8



✓ butyl propanoate✓

✓whole structure (3)

4.9 Esterification✓ (1)

[25]

QUESTION 5

5.1 Change in concentration of reactants or products per unit time. ✓✓ (2)

5.2 Temperature✓
Concentration✓ (any 2) (2)
Catalyst

5.3 Sulphur✓ (1)

5.4 What is the relationship between concentration and reaction rate? ✓✓ (2)

5.5 A✓✓ (2)

5.6 In experiment B:

The concentration of $Na_2S_2O_3$(aq) is higher. /More $Na_2S_2O_3$ particles per unit volume. ✓
More particles with correct orientation✓ (3)
More effective collisions per unit time / Higher frequency of effective collisions. ✓

5.7 Rate of Reaction = $\frac{\Delta V}{\Delta t}$

$= \frac{50 - 0}{125 - 0}$ ✓ ✓

$= 0,4\ cm^3 \cdot s^{-1}$ ✓ (3)

5.8

$$C = \frac{m}{MV}$$

$$= \frac{100}{(158)(0,25)} \checkmark$$

$$= 2.53 \text{ mol.dm}^{-3}$$

$n\ (Na_2S_2O_3 \text{ in D}) = C \times V$ ✓
$= (2.53)(0,01)$ ✓
$= 0,025\text{mol}$

$n_S : n_{Na_2S_2O_3}$
1 : 1 ✓

$$n_S = \frac{m}{M}$$

✓ $0,025 = \frac{m}{32}$ ✓ (7)

$m = 0,8\text{g}$ ✓

[22]

QUESTION 6

6.1.1 Homogenous. ✓
The reactants and products are all in the same phase. ✓ (2)

6.1.2 $2CO(g) + 3H_2(g) \longrightarrow 2CH_2OH(g)$ ✓✓ (2)

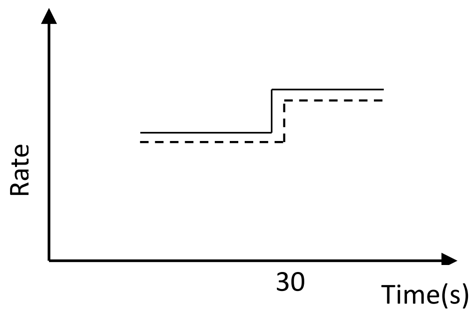
6.1.3 Reactants are being used up to form products. ✓ (1)

6.1.4 Exothermic✓An increase in temperature favoured the endothermic reaction. ✓✓ (3)

6.1.5 Equilibrium is reached.✓✓ / the rate of the forward reaction is equal to the rate of the reverse reaction. (2)

6.1.6 Increases. ✓ (1)

6.1.7



✓ shape
✓ two curves
✓axes
✓ 30

(4)

6.2.1 When the equilibrium in a closed system is disturbed, the system will reinstate a new equilibrium by favouring the reaction that will oppose the disturbance.✓✓ (2)

6.2.2.1 Decrease✓ (1)

6.2.2.2 Increase✓ (1)

6.2.3

	SO_2	O_2	SO_3	
Ratio	2	1	2	✓
Initial mole	0,3	x	0	
Change in mole	0,2	0,1	0,2	✓
Equilibrium Mole	0,1	x - 0,1	0,2	
Equilibrium concentration	0,01	$\frac{x - 0,1}{10}$	0,02	

$$Kc = \frac{[SO_3]^2}{[SO_2]^2[O_2]} \checkmark$$

$$15 \checkmark = \frac{(0,02)^2}{(0,01)^2\left(\frac{X - 0,1}{10}\right)} \checkmark$$

$$x = 2,77 \text{ mol} \checkmark$$

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

$$2,77 = \frac{m}{32} \checkmark$$

$$m = 88,64 \text{ g}\checkmark$$

(8)

[27]

QUESTION 7

7.1 An acid is a substance that releases hydronium ions in solution. ✓✓ (2)

7.2

$\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b}$ ✓

✓ $\frac{(0,5)(15)}{C_b(12,5)} = \frac{2}{1}$ ✓

$C_b = 0,3\ mol.dm^{-3}$

$C = \frac{m}{MV}$

$0,03 = \frac{0,795}{M(0,25)}$ ✓

$M = 106\ g.mol^{-1}$ ✓

$106 = 2M_x + 12 + 3(16)$ ✓

$M_x = 23\ g.mol^{-1}$ ✓

Therefore X is Na/Sodium✓

n (HCl) = c x V ✓
= (0,5)(0,015) ✓
= 0,0075mol
n_{HCl} : n_{X2CO3}
2 : 1 ✓
$n_{X2CO3} = \frac{0,0075}{2}$
= 0,00375 mol ✓
$n_{X2CO3} = \frac{m}{M}$
$0,00375 = \frac{0,798}{M}$ ✓
$M = 106\ g.mol^{-1}$
$106 = 2M_x + 12 + 3(16)$ ✓
$M_x = 23\ g.mol^{-1}$ ✓
Therefore X is Na/Sodium ✓

(8)

7.3.1 $n(NaHCO_3) = \frac{m}{M}$

$= \frac{7}{84}$ ✓

= 0,083mol

$n(NaHCO_3) : n(HCl)$

1 : 2 ✓

n(HCl) = 0,16mol ✓

$C = \frac{n}{V}$ ✓

$5 = \frac{0,16}{V}$ ✓

$V = 0,032\ dm^3$

$= 32\ cm^3$ ✓

(6)

7.3.2 $(C_aV_a)_{initial} = (C_aV_a)_{final}$
✓ $(5)V_a = (0,1)(1)$ ✓
$V_a = 0,02\ dm^3$ ✓

(3)

7.4.1 $M(NaHCO_3) = 23 + 1 + 12 + 3(16) = 84\ g.mol^{-1}$ ✓

$n = C \times V$
$= (0,052)(0,275)$ ✓
$= 0,0143\ mol$

$m = nM$
$= (0,0143)(84)$ ✓
$= 1,20g$ ✓

$\% \text{ Purity} = \frac{1,20}{3,68} \times \frac{100}{1}$ ✓

$= 32,61\%$ ✓ (6)

7.4.2 $pH = -log[H_3O^+]$ ✓
$= -log(0,11)$ ✓
$= 0,96$ ✓ (3)

[28]

TOTAL: 150

