



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 SEVEN 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

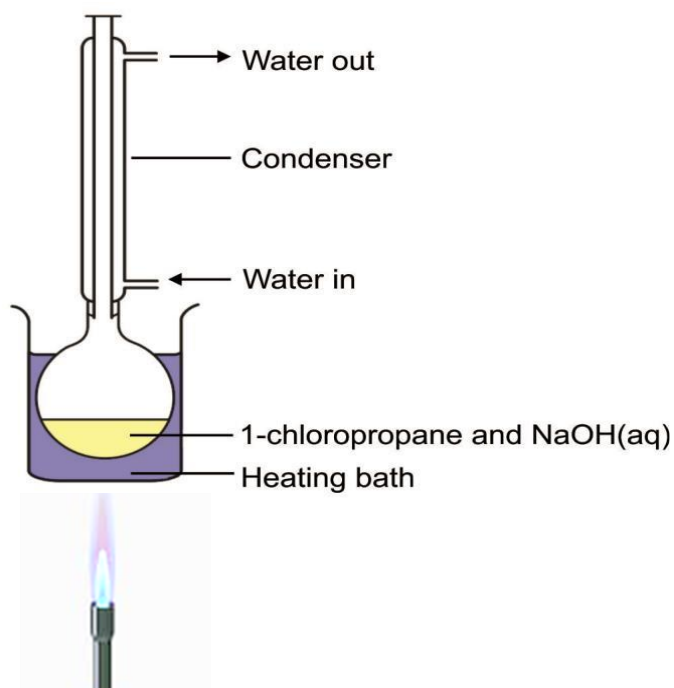
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter A, B, C or D next to the question number in the ANSWER BOOK, e.g. 1.11 A

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.

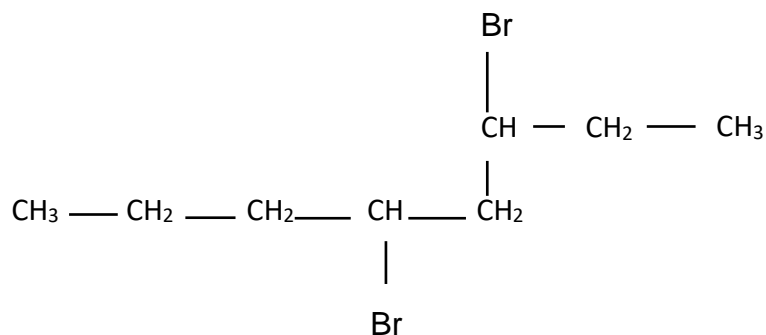


The TYPE of reaction taking place above, is

- A. Addition
- B. Hydrolysis
- C. Elimination
- D. Hydrohalogenation

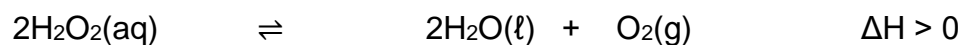
(2)

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. $\text{H}_4\text{C}_3\text{O}_2$
- B. H_2O
- C. $\text{H}_4\text{C}_2\text{O}_2$
- D. $\text{H}_3\text{C}_3\text{O}_2$ (2)
- 1.5 Which ONE of the following will DEFINITELY NOT INCREASE the rate at which oxygen is produced in the following reaction?



- 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:



2mol of each of HBr, H₂ and Br₂ 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 Br₂ would have decreased.
- C. the value of K_c 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:

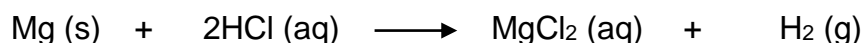
$$K_c = \frac{[\text{D}]^2[\text{C}]}{[\text{A}]^3}$$

Which ONE of the following equations represents this reaction?

- A. $3\text{A}(\text{l}) \rightleftharpoons \text{C}(\text{aq}) + 2\text{D}(\text{aq})$
- B. $3\text{A}(\text{s}) \rightleftharpoons \text{C}(\text{g}) + 2\text{D}(\text{g})$
- C. $3\text{A}(\text{aq}) + \text{B}(\text{s}) \rightleftharpoons \text{C}(\text{aq}) + 2\text{D}(\text{aq})$
- D. $3\text{A}(\text{aq}) + \text{B}(\text{s}) \rightleftharpoons \text{C}(\text{g}) + \text{D}_2(\text{g})$ (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:



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 10cm³ sample of a strong acid has a pH of 4. Addition of 990 cm³ 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	$\begin{array}{c} \text{H} \quad \text{Cl} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{Cl} \\ \quad \\ \text{Br} \quad \text{H} \end{array}$	B	3-methylpentan-2-one
C	$\left[\begin{array}{c} \text{O} \quad \quad \text{O} \\ \quad \quad \\ -\text{O}-\text{C}-\text{CH}_2-\text{C}- \end{array} \right]_n$	D	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{OH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
E	C_6H_8	F	$\begin{array}{c} \text{O} \\ \\ \text{HCCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \end{array}$
G	$\begin{array}{c} \text{Cl} \\ \\ \text{CH}_3\text{CH}_2\text{CH}_2\text{CCH}_3 \\ \\ \text{CH}_3 \end{array}$	H	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{OH} \end{array}$

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.

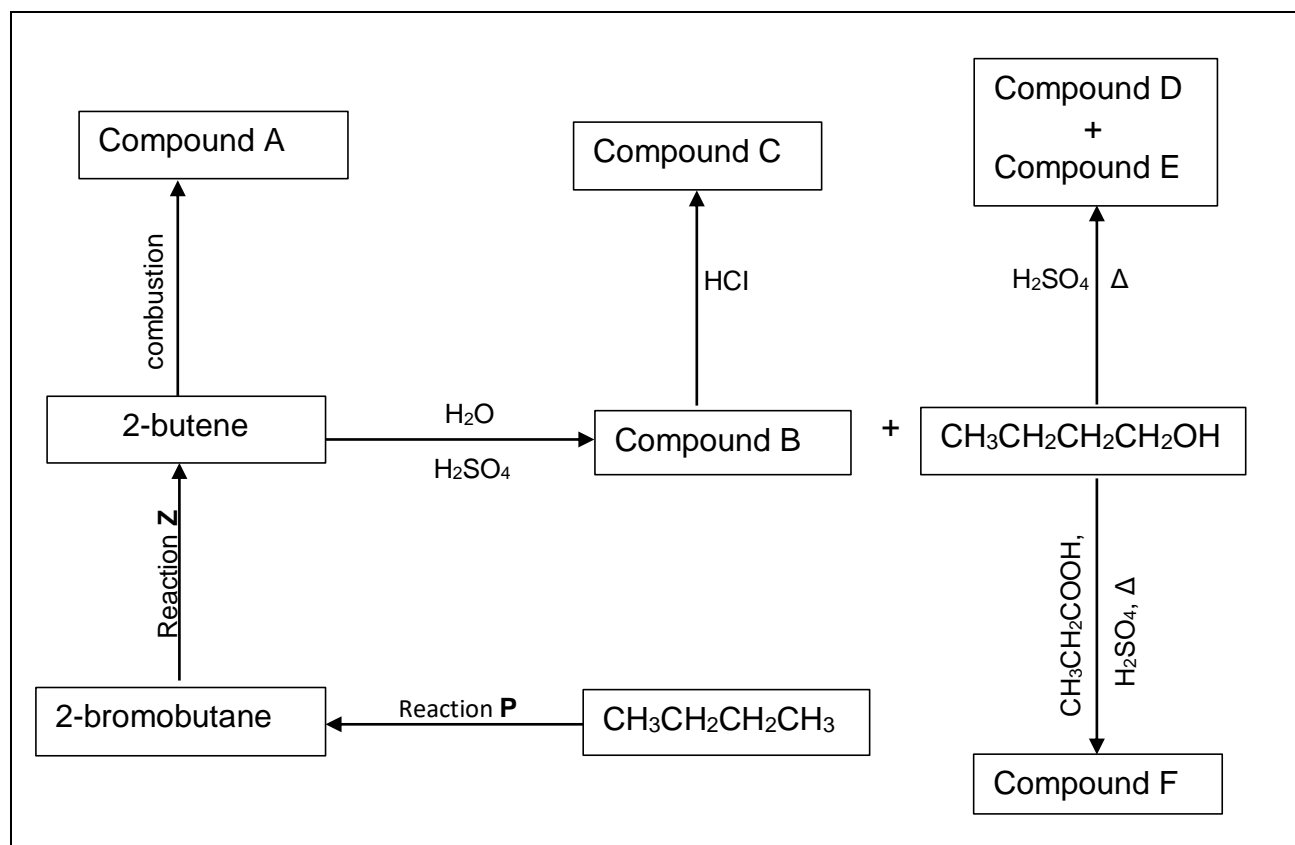
Compound	Molecular formula	Molecular mass g.mol^{-1}	Melting point $^{\circ}\text{C}$	Boiling point $(^{\circ}\text{C})$	Vapour pressure (KPa at 20°C)
A. Ethane	C_2H_6	30	-183	-89	3 750
B. Chloroethane	$\text{C}_2\text{H}_5\text{Cl}$	64,5	-136	12	132,4
C. Ethanol	$\text{C}_2\text{H}_5\text{OH}$	46	-89	78	5,8
D. Ethanoic acid	$\text{C}_2\text{H}_5\text{COOH}$	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.



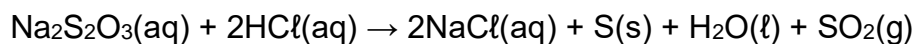
- 4.1 Using MOLECULAR FORMULAE, write a balanced equation showing the formation of compound **A**. (3)
- 4.2 Write down the reaction conditions for:
- 4.2.1 Reaction P (2)
- 4.2.2 Reaction Z. (2)
- 4.3 Study the formation of compound **B**:
- 4.3.1 Write down the IUPAC name and STRUCTURAL FORMULA of 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)

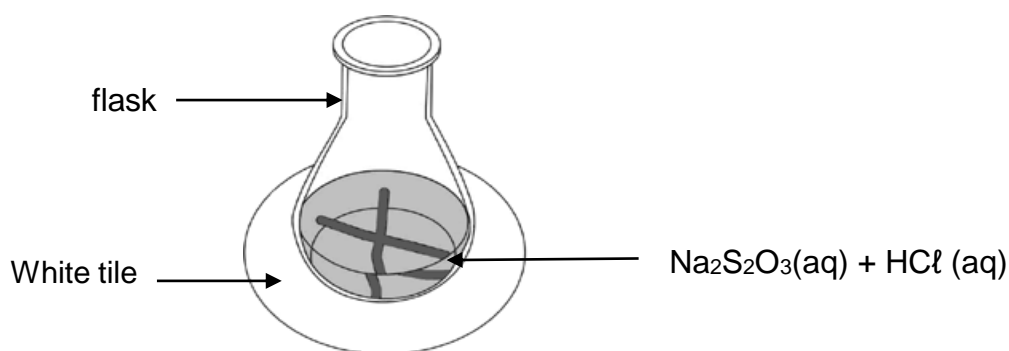
[25]

QUESTION 5 (Start on a new page)

The reaction between dilute hydrochloric acid and sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) is used to investigate one of the factors that influences reaction rate. The balanced equation for the reaction is:



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.

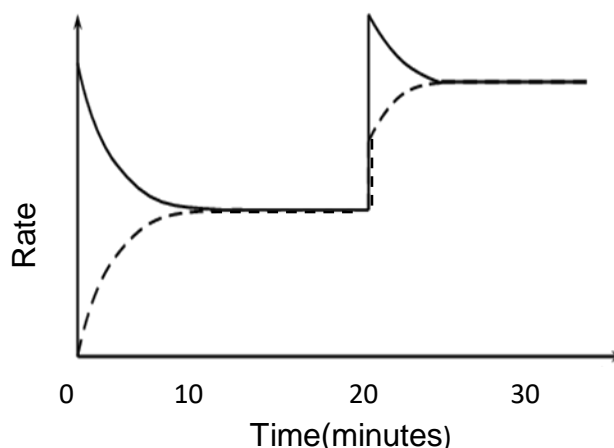
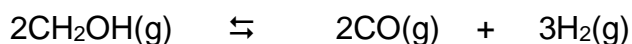
Experiment	Volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ (cm^3)	Volume of $\text{H}_2\text{O}(\text{l})$ (cm^3)	Volume of $\text{HCl}(\text{aq})$ (cm^3)	Time (s)
A	25	0	5	50,0
B	20	5	5	62,5
C	15	10	5	83,3
D	10	15	5	125,0

- 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 $\text{SO}_2(\text{g})$ collected was 50cm^3 , calculate the reaction rate in $\text{cm}^3.\text{s}^{-1}$. (3)
- 5.8 The original $\text{Na}_2\text{S}_2\text{O}_3$ 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 $\text{Na}_2\text{S}_2\text{O}_3$ 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.



- 6.1.1 Is the above reaction homogenous or heterogeneous at equilibrium? (2)
Give reason for your answer.
- 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 K_c 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:
- $$2 \text{SO}_2 (\text{g}) + \text{O}_2 (\text{g}) \rightleftharpoons 2 \text{SO}_3 (\text{g}) \quad \Delta H = -197 \text{ kJ} \cdot \text{mol}^{-1}$$
- 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 $\text{SO}_2(\text{g})$ is mixed with an unknown mass of $\text{O}_2(\text{g})$ in a sealed 10 dm^3 container. When equilibrium is reached at a certain temperature, it is found that 0,2 moles of $\text{SO}_3 (\text{g})$ is present. If the equilibrium constant (K_c) 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)

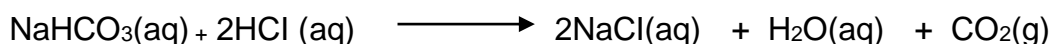
7.2 A group of learners wish to identify element X, in weak base X_2CO_3 . They first dissolve 0,795g of X_2CO_3 in 250 ml volumetric flask with water to prepare a standard solution. They then titrate this solution with $0,5 \text{ mol.dm}^{-3}$ hydrochloric acid. The results of their titration is found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



	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.



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 $0,1 \text{ mol.dm}^{-3}$. 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 275 cm^3 solution. During the titration he found that 25 cm^3 of this solution neutralized $23,5 \text{ cm}^3$ of a $0,11 \text{ mol.dm}^{-3}$ solution of HCl.

7.4.1 If the concentration of the base at endpoint was $0,052 \text{ mol.dm}^{-3}$, 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 FISIESTE WETENSAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

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

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at/by 298 K	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$ / $E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY

Atomic number

→ 29
←

Electronegativity

→ 2 ←

Symbol

← Cu →

63,5

↑

Relative atomic mass (approximately)

I	II	III	IV	V	VI	VII	0
1 H	2 He						
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os
87 Fr	88 Ra	89 Ac	91 Zr	92 Nb	93 Mo	94 Tc	95 Ru
			101 Rh	102 Pd	103 Ag	104 Cd	105 In
			119 Sn	120 Sb	121 Te	122 I	123 Xe
			137 Bi	138 Po	139 At	140 Rn	
			207 Pb	208 Bi	209 Po	210 At	
			201 Hg	202 Tl	203 Pb	204 Bi	
			80 Zn	81 Ga	82 Ge	83 As	
			65 Cu	66 Zn	67 Ga	68 Ge	
			47 Ni	48 Cu	49 Zn	50 Ga	
			27 Co	28 Ni	29 Cu	30 Zn	
			59 Fe	60 Co	61 Ni	62 Cu	
			56 Mn	57 Fe	58 Co	59 Ni	
			25 Cr	26 Mn	27 Fe	28 Co	
			24 V	25 Cr	26 Mn	27 Fe	
			23 Ti	24 V	25 Cr	26 Mn	
			22 Sc	23 Ti	24 V	25 Cr	
			19 K	20 Ca	21 Sc	22 Ti	
			39 K	40 Ca	41 Sc	42 Ti	
			37 Rb	38 Sr	39 Y	40 Zr	
			86 Rb	87 Sr	88 Y	89 Zr	
			55 Cs	56 Ba	57 La	58 Ce	
			133 Cs	134 Ba	135 La	136 Ce	
			87 Fr	88 Ra	89 Ac	90 Th	
			209 Bi	210 Po	211 At	212 Rn	
			204 Tl	205 Pb	206 Bi	207 Po	
			81 Tl	82 Pb	83 Bi	84 Po	
			49 In	50 Sn	51 Sb	52 Te	
			31 Ga	32 Ge	33 As	34 Se	
			13 Al	14 Si	15 P	16 S	
			5 B	6 C	7 N	8 O	
			27 Al	28 Si	29 P	30 S	
			11 Na	12 Mg	13 Al	14 Si	
			3 Li	4 Be	5 B	6 C	
			1 H	2 He	3 Li	4 Be	
			103 Lr	104 No	105 Nh	106 Fl	
			101 Md	102 Nh	103 Nh	104 Nh	
			169 Tm	170 Yb	171 Lu	172 Hf	
			69 Tm	70 Yb	71 Lu	72 Hf	
			167 Er	168 Tm	169 Yb	170 Lu	
			68 Er	69 Tm	70 Yb	71 Lu	
			100 Fm	101 Md	102 No	103 Nh	
			99 Es	100 Fm	101 Md	102 No	
			98 Cf	99 Es	100 Fm	101 Md	
			163 Dy	164 Ho	165 Er	166 Tm	
			66 Dy	67 Ho	68 Er	69 Tm	
			97 Bk	98 Cf	99 Es	100 Fm	
			96 Cm	97 Bk	98 Cf	99 Es	
			157 Gd	158 Tb	159 Dy	160 Ho	
			64 Gd	65 Tb	66 Dy	67 Ho	
			95 Am	96 Cm	97 Bk	98 Cf	
			94 Pu	95 Am	96 Cm	97 Bk	
			150 Sm	151 Eu	152 Gd	153 Tb	
			62 Sm	63 Eu	64 Gd	65 Tb	
			93 Np	94 Pu	95 Am	96 Cm	
			92 U	93 Np	94 Pu	95 Am	
			238 U	239 Np	240 Pu	241 Am	
			61 Pm	62 Sm	63 Eu	64 Gd	
			59 Pr	60 Nd	61 Pm	62 Sm	
			141 Pr	142 Nd	143 Pm	144 Nd	
			60 Nd	61 Pm	62 Sm	63 Eu	
			140 Ce	141 Pr	142 Nd	143 Pm	
			58 Ce	59 Pr	60 Nd	61 Pm	

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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 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
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	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
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 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/ <i>Halfreaksies</i>	E^\ominus (V)
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	- 3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	- 2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	- 2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	- 2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	- 2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	- 2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	- 2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	- 2,36
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	- 1,66
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	- 1,18
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	- 0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	- 0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	- 0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	- 0,41
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	- 0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	- 0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	- 0,27
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	- 0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	- 0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	- 0,06
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+ 0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+ 0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+ 0,52
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+ 0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+ 0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\ell)$	+ 0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\ell) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+ 1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+ 1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+ 2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*