DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS
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PROVINSIALE VOORBEREIDENDE EKSAMEN/ PROVINCIAL PREPARATORY EXAMINATION

GRAAD/GRADE 12

FISIESE WETENSKAPPE/PHYSICAL SCIENCES

VRAESTEL/PAPER 2

CHEMIE/CHEMISTRY

SEPTEMBER 2024

PUNTE/MARKS: 150

TYD/TIME: 3 uur/hours

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.

2. This question paper consists of NINE 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 subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following compounds is a ketone?

A $CH_3COCH_2CH_3$

B $CH_3COOCH_2CH_3$

C $CH_3CH_2CH_2CHO$

D $CH_3CH(OH)CH_2CH_3$ (2)

1.2 Consider the flow diagram below that represents an organic reaction:

$\boxed{\text{Compound } \mathbf{X}} \xrightarrow{\text{HBr}} \boxed{\text{2-bromo-3-methylbutane}}$

The IUPAC name of compound **X** is:

A 2-methylbutane

B 3-methylbutane

C 2-methylbut-3-ene

D 3-methylbut-2-ene (2)

1.3 Which ONE of the following pairs of reactants can be used to prepare ethyl propanoate in the laboratory?

A Ethane and propanoic acid

B Propanol and ethanoic acid

C Ethanol and propanoic acid

D Ethene and propanol (2)

1.4 Which ONE of the following compounds will enable butan-2-ol to undergo an elimination reaction?

A Concentrated $HC\ell$

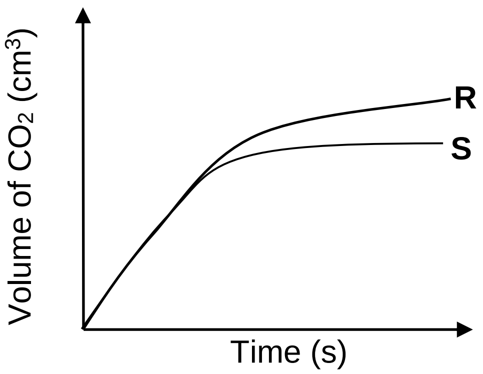
B Concentrated H_2SO_4

C Diluted HNO_3

D Diluted NaOH (2)

1.5 When zinc (II) carbonate reacts with excess hydrochloric acid, carbon dioxide is produced.

The graphs below were obtained under two different reaction conditions.



The change in the graph from **S** to **R** could be brought about by …

A decreasing the concentration of the acid.

B increasing the mass of the zinc (II) carbonate.

C decreasing the particle size of the zinc (II) carbonate.

D adding a catalyst. (2)

1.6 The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H < 0$$

How will the equilibrium be affected if the volume of the container is increased at constant temperature and then the temperature is increased at constant volume?

	EFFECT OF INCREASE IN VOLUME	**EFFECT OF INCREASE IN TEMPERATURE**
A	No effect	Reverse reaction is favoured
B	Reverse reaction is favoured	Reverse reaction is favoured
C	No effect	Forward reaction is favoured
D	Reverse reaction is favoured	Forward reaction is favoured

(2)

1.7 Nitric acid is titrated with an ammonium hydroxide solution.

The EQUIVALENCE POINT is the point in the titration where …

A the concentration of the indicator changes.

B $n_{acid} = n_{base}$.

C $[H_3O^+] = [OH^-]$.

D the pH = 7. (2)

1.8 Consider the equation:

$$H_2O + \textbf{A} \rightarrow OH^- + H_2SO_4$$

The reactant **A** represents a/an:

A base having the formula HSO_4^-

B acid having the formula HSO_4^-

C base having the formula SO_4^{2-}

D acid having the formula SO_4^{2-} (2)

1.9 Consider the following chemical reactions:

REACTION **X**: $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$

REACTION **Y**: $4H^+(aq) + O_2(g) + 4e^- \rightarrow 2H_2O(\ell)$

Which ONE of the following combinations is CORRECT for reaction **X** and **Y**?

	REACTION X	**REACTION Y**
A	Pb is reduced	O_2 is oxidised
B	Pb is oxidised	H^+ is reduced
C	Pb is oxidised	O_2 is reduced
D	Pb is reduced	H^+ is oxidised

(2)

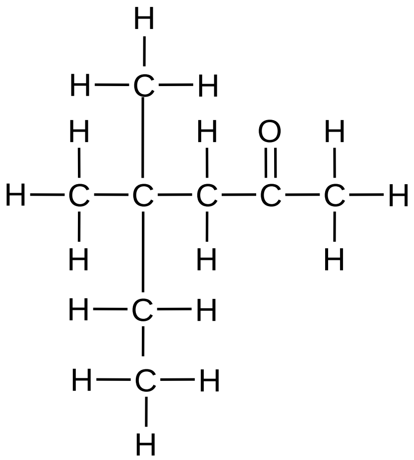
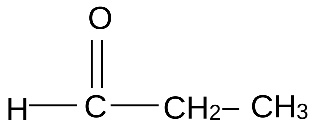
1.10 Which ONE of the following CORRECTLY shows the gases produced at the different electrodes during the electrolysis of a concentrated solution of sodium chloride?

	CATHODE	**ANODE**
A	Hydrogen gas	Chlorine gas
B	Chlorine gas	Water vapour
C	Oxygen gas	Chlorine gas
D	Chlorine gas	Hydrogen gas

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	$CH_3CH_2COOCH_3$	**D**	$CH_3CHCHCH_2CH_3$
B		**E**	
C	2-fluoro-3,4-dimethylhexane	**F**	Butanoic acid

Write down the:

2.1 LETTER of the compound that belongs to the halo-alkanes (1)

2.2 STRUCTURAL FORMULA of the functional group of compound **F** (1)

2.3 LETTER of the compound that represents an unsaturated hydrocarbon (1)

2.4 NAME of the functional group of compound **E** (1)

2.5 NAME of the inorganic acid needed to prepare compound **A** (1)

2.6 LETTER of the compound that represents an aldehyde (1)

2.7 Empirical formula of compound **A** (1)

2.8 STRUCTURAL FORMULA of compound **C** (3)

2.9 IUPAC NAME of compound **B** (2)

2.10 LETTERS of the compounds that are FUNCTIONAL isomers of each other (1)

[13]

QUESTION 3 (Start on a new page.)

An investigation was carried out to determine the relationship between the boiling point of different alkanes and one of their structural isomers.

The results obtained are shown in the table below:

	NAME	BOILING POINT (°C)		ISOMER	BOILING POINT (°C)
A	ethane	-88,5			
B	butane	-1	**E**	methyl propane	-12
C	pentane	34	**F**	2-methylbutane	28
D	hexane	68,7	**G**	2,3-dimethylbutane	58

3.1 Define the term *structural isomer.* (2)

3.2 What TYPE of isomerism is used during this investigation? (1)

3.3 Explain the difference in boiling points between butane and its isomer methyl propane. (3)

3.4 Consider compounds **A** to **D**.

For this part of the investigation, write down the:

3.4.1 Control variable (1)

3.4.2 Independent variable (1)

3.4.3 Which ONE of compounds **A** to **D** has the highest vapour pressure?

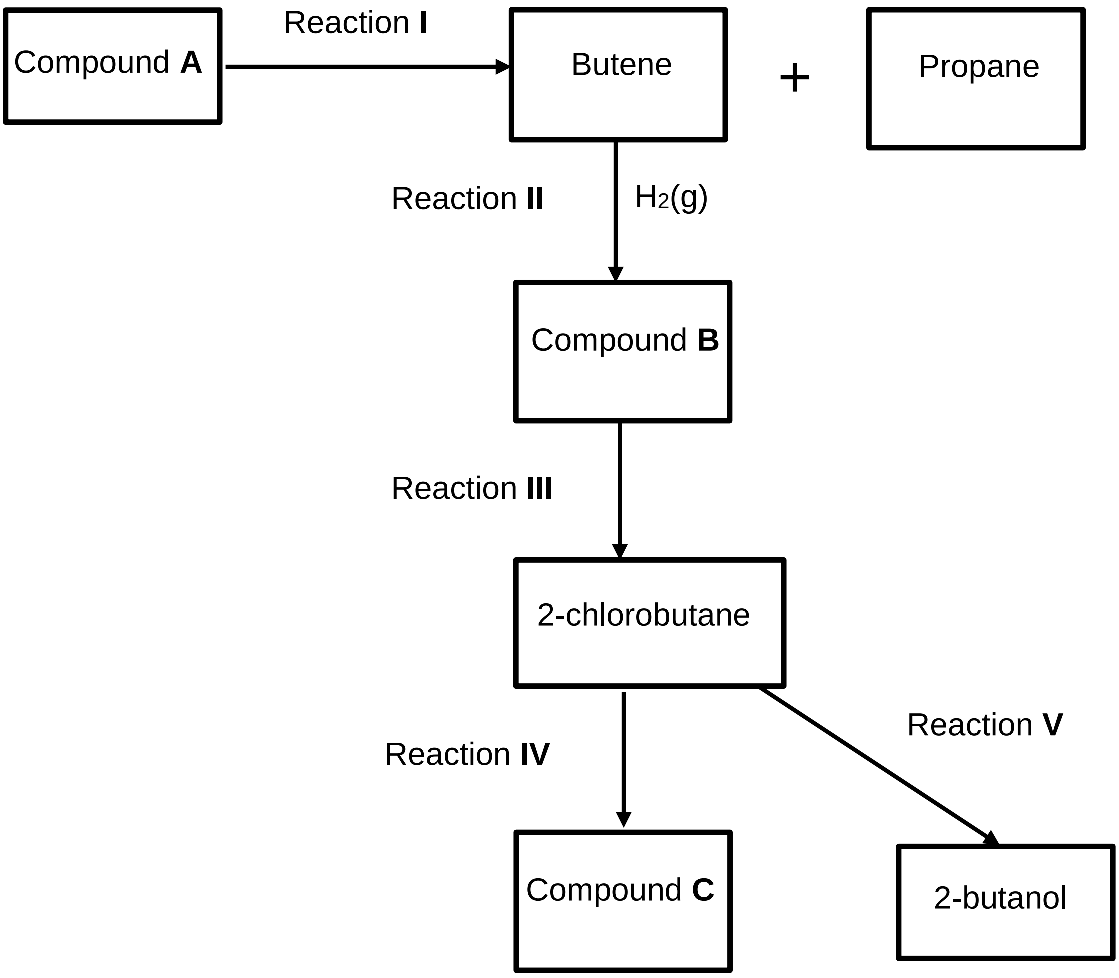
Explain the answer by referring to the intermolecular forces and the energy. (3)

3.5 Write down a conclusion for this investigation. (2)

3.6 Use molecular formulae to write down a balanced chemical equation for the combustion of pentane. (3)
[16]

QUESTION 4 (Start on a new page.)

Study the flow diagram of various organic reactions and answer the questions that follow.



4.1 For reaction **I**, write down the:

4.1.1 TYPE of the reaction (1)

4.1.2 IUPAC NAME of compound **A** (2)

4.2 Consider reaction **II** and write down the:

4.2.1 TYPE of the reaction (1)

4.2.2 IUPAC NAME of organic compound **B** (1)

4.2.3 NAME of a suitable catalyst (1)

4.3 Write down the TYPE of reaction represented by reaction **III**. (1)

4.4 Reaction **IV** is an elimination reaction. Write down the:

4.4.1 TYPE of elimination reaction (1)

4.4.2 Reaction conditions (2)

4.4.3 Balanced chemical equation for the formation of compound **C**, using STRUCTURAL FORMULAE (5)

4.5 Consider reaction **V**. Write down the:

4.5.1 NAME or FORMULA of the inorganic reactant needed (1)

4.5.2 Type of alcohol represented by 2-butanol

Choose from PRIMARY, SECONDARY or TERTIARY.

Give a reason for the answer. (2)
[18]

QUESTION 5 (Start on a new page.)

The reaction of magnesium (Mg) and EXCESS diluted hydrochloric acid (HCℓ) is used to investigate some factors affecting the reaction rate. The balanced equation for the reaction is:

$$Mg(s) + 2HC\ell(\ell) \rightarrow MgC\ell_2(aq) + H_2(g)$$

The table below summarises the reaction conditions.

EXPERIMENT	STATE of Mg	MASS of Mg	TEMPERATURE (°C)
1	ribbon	x	25
2	powder	x	25
3	powder	½x	20

5.1 Define the term *reaction rate.* (2)

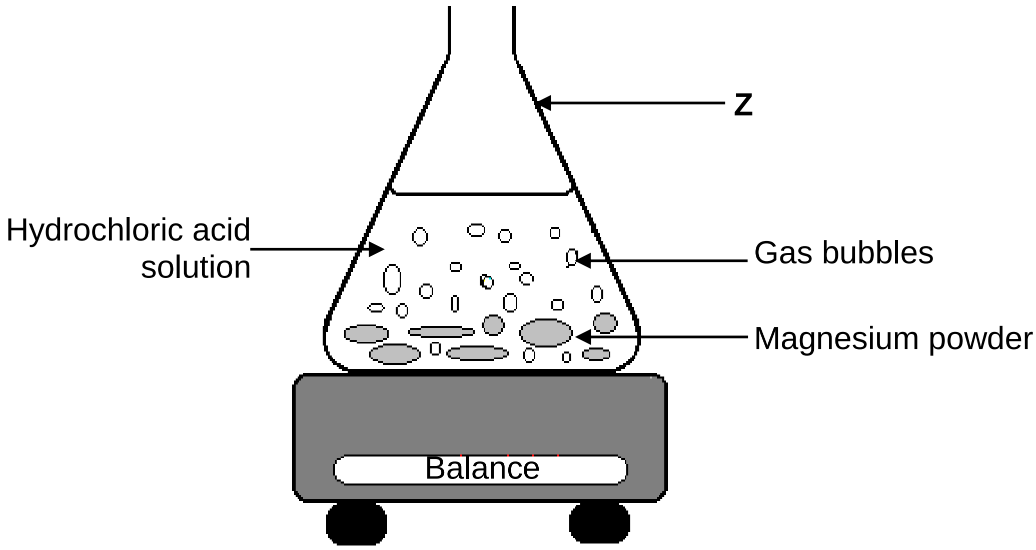
5.2 Which experiment will have the highest reaction rate?

Choose from EXPERIMENT 1, EXPERIMENT 2 or EXPERIMENT 3. (1)

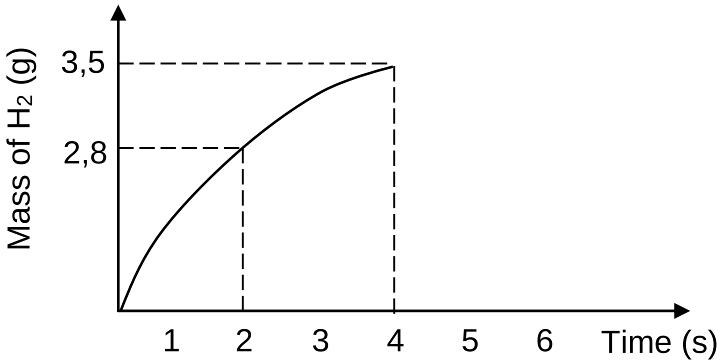
5.3 Use the collision theory to explain the answer to QUESTION 5.2. (2)

5.4 Besides temperature, write down ONE other way to increase the reaction rate in EXPERIMENT 2. (1)

The mass of gas produced in EXPERIMENT 2 is obtained by measuring the loss in mass of the flask and its contents at one-second intervals.



The results of this experiment is displayed in the graph below.



5.5 Write down the name of apparatus **Z**. (1)

5.6 Give a reason why this experimental setup cannot be classified as a closed system. (1)

5.7 Calculate the AVERAGE RATE (in $g \cdot s^{-1}$) of this reaction during the first four seconds. (2)

5.8 Write down the loss in mass of the flask and its contents. (1)

5.9 Use the graph to calculate the mass of magnesium powder (x) used in EXPERIMENT 2. (5)

5.10 Why is the magnesium in EXPERIMENT 2 the *limiting reagent*? (1)

5.11 Redraw the graph given in your ANSWER BOOK and name it Graph 2.

On the same set of axes, draw the graph for EXPERIMENT 3 and label this Graph 3. (2)

[19]

QUESTION 6 (Start on a new page.)

The table below shows the effect of temperature changes on the value of the equilibrium constant (K_c) when the following reaction takes place in a closed container of volume 500 cm^3.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$
(brown gas) (colourless gas)

TEMPERATURE (K)	Equilibrium constant (K_c)
300	1×10^1
400	3×10^{-2}
500	1×10^{-3}
600	1×10^{-4}
700	$8{,}33 \times 10^{-5}$

6.1 Define the term *chemical equilibrium.* (2)

6.2 Which colour will be seen at 300 K?

Choose from BROWN, COLOURLESS or LIGHT BROWN. (1)

6.3 Is the forward reaction exothermic or endothermic?

Explain the answer. (3)

6.4 **X** g of NO_2 is sealed in the container at 300 K.

At equilibrium, the concentration of N_2O_4 was 3 mol·dm^3.

Calculate **X**. (8)

6.5 How will an increase in the reactant (NO_2) at 700 K effect the rate of the reverse reaction?

Choose from INCREASES, DECREASES or STAYS THE SAME. (1)

6.6 The pressure on the system is increased by decreasing the volume of the container at 300 K.

How will this change affect the:

6.6.1 Value of K_C?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for the answer. (2)

6.6.2 Concentration of the products?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer using Le Chatelier's principle. (3)
[20]

QUESTION 7 (Start on a new page.)

7.1 Hydrofluoric acid (HF) is a weak acid.

7.1.1 Define the term *weak acid.* (2)

7.1.2 A sample of hydrofluoric acid has a pH of 4,5 at 25 °C.

Calculate the concentration of the hydronium ions ($H_3O^+(aq)$) in the sample. (3)

When hydrofluoric acid reacts with sodium hydroxide, sodium fluoride is formed.

7.1.3 Will the pH of the sodium fluoride solution be GREATER THAN 7, SMALLER THAN 7 or EQUAL TO 7?

Give a reason for the answer. (2)

7.2 In REACTION A, 3,5 g of pure $MgCO_3(s)$ reacted completely in 50 cm^3 of $HC\ell$. The balanced equation for the reaction is given below:

REACTION A: $MgCO_3 + 2HC\ell \rightarrow MgC\ell_2 + CO_2 + H_2O$

The EXCESS $HC\ell$ neutralises exactly 20 cm^3 of a NaOH solution with a concentration of 1,2 $mol{\cdot}dm^{-3}$ in REACTION B.

REACTION B: $HC\ell + NaOH \rightarrow NaC\ell + H_2O$

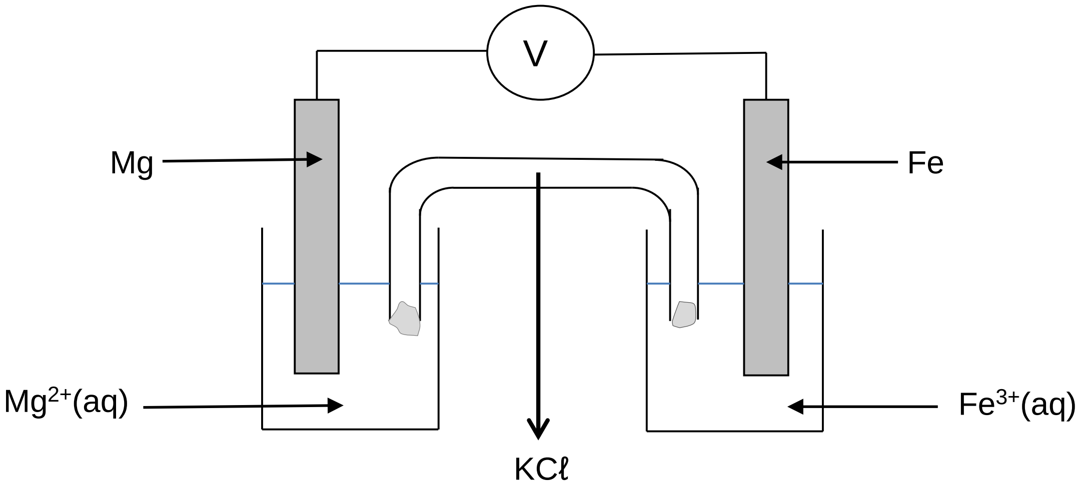
7.2.1 Calculate the number of moles of $HC\ell$ reacted in REACTION A. (3)

7.2.2 Calculate the concentration of the original solution of $HC\ell$. (6)
[16]

QUESTION 8 (Start on a new page.)

The diagram below represents a galvanic cell functioning under standard conditions with magnesium and iron as electrodes. The nett cell equation for this cell is:

$$2Fe^{3+}(aq) + 3Mg(s) \rightarrow 2Fe(s) + 3Mg^{2+}(aq)$$



8.1 For this cell, write down:

8.1.1 The energy conversion that takes place (1)

8.1.2 TWO standard conditions (2)

8.1.3 The electrode which acts as the CATHODE

Give a reason for the answer. (2)

8.1.4 The oxidation half-reaction (2)

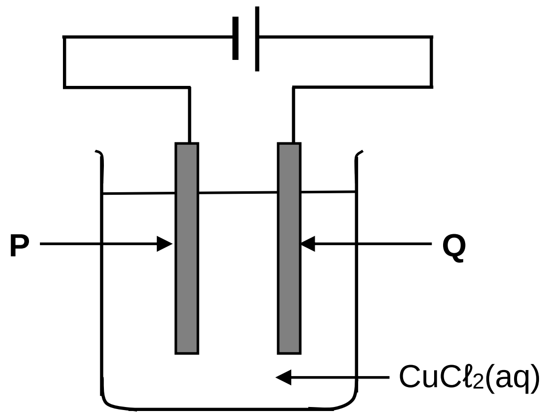
8.1.5 The cell notation (3)

8.1.6 The NAME of the component responsible for electrical neutrality of the half cells (1)

8.2 Calculate the initial EMF of the cell. (4)
[15]

QUESTION 9 (Start on a new page.)

In the electrolytic cell represented below, two CARBON RODS, **P** and **Q**, are used as electrodes and concentrated copper (II) chloride solution is used as electrolyte.



9.1 Define the term *electrolysis.* (2)

9.2 What observation can be made at electrode **P** while the cell is operating? (1)

9.3 Write down the half-reaction that takes place at electrode **Q**. (2)

9.4 Write down the NAME or FORMULA of the reducing agent in this reaction. (1)

9.5 What is the function of $CuC\ell_2$(aq) as electrolyte in this cell? (1)

This cell is now used for the refining of copper.

9.6 Which electrode (**P** or **Q**) will have to be replaced with pure copper during the refining process?

Give a reason for the answer. (2)

9.7 Explain why the concentration of the ions in the solution remains constant. (1)

9.8 Silver and platinum are formed at the bottom of the container during the refining process of impure copper.

Refer to the relative strength of the reducing agents to explain why these two metals do not form ions. (3)
[13]

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*

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^θ (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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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 strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↑

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↓

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

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels*

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