GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION
PREPARATORY EXAMINATION
2020

10842

PHYSICAL SCIENCES: CHEMISTRY
PAPER 2

TIME: 3 hours

MARKS: 150

19 pages + 4 information sheets and an answer sheet

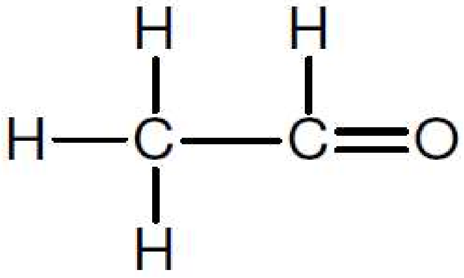
INSTRUCTIONS AND INFORMATION:

1. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
2. Start the answer to each question on a NEW page.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line open between sub-questions, for example, between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
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 discussions, et cetera where required.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK e.g. 1.11 D.

1.1 Consider the structural formula of an organic compound below.



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

A Ethanone

B Ethene

C Ethanol

D Ethanal (2)

1.2 Which of the following represents a balanced equation for the combustion of octane?

A $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

B $C_8H_{18} + 16O_2 \rightarrow 8CO_2 + 9H_2O$

C $C_8H_{18} + 32O_2 \rightarrow 8CO_2 + 18H_2O$

D $2C_8H_{18} + 8O_2 \rightarrow 16CO_2 + 9H_2O$ (2)

1.3 Which of the following compounds will decolourise bromine water the fastest under normal conditions?

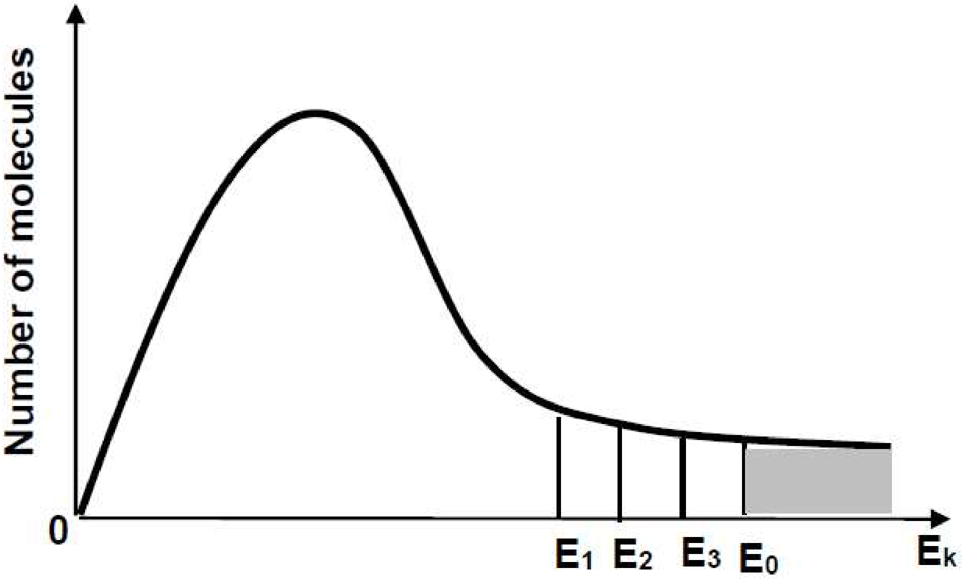
A Ethene

B Ethanal

C Ethanol

D Ethane (2)

1.4 Three catalysts are used separately to increase the rate of a hypothetical reaction. In the diagram below, $\mathbf{E_1}$, $\mathbf{E_2}$ and $\mathbf{E_3}$ represent the effect of each catalyst on the activation energy ($\mathbf{E_0}$) for the reaction.



Which of the following is the activation energy for the reaction with the HIGHEST rate?

A $\mathbf{E_3}$

B $\mathbf{E_2}$

C $\mathbf{E_1}$

D $\mathbf{E_0}$ (2)

1.5 50 cm^3 of a 0,1 mol.dm^{-3} solution of hydrochloric acid is poured on to 5 g granulated zinc which is inside a glass beaker at room temperature.
Which of the following factors will **not** increase the initial rate of the reaction?

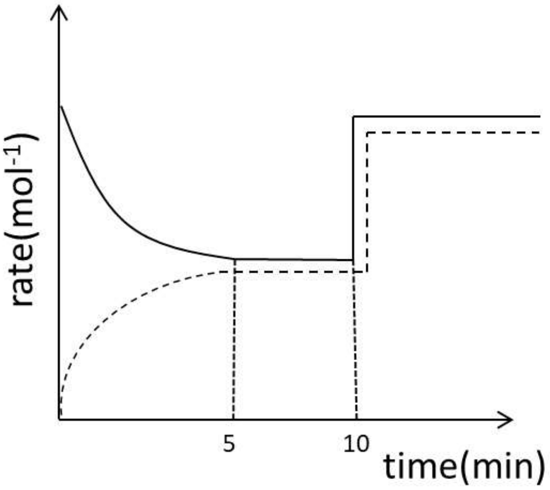
A Grinding the granulated zinc into powder

B Using 30 cm^{-3} of a 0,2 mol.dm^{-3} hydrochloric acid at room temperature

C Increasing the temperature of the acid solution to 50 °C

D Using 100 cm^3 of a 0,1 mol.dm^{-3} solution of hydrochloric acid at room temperature (2)

1.6 The graph below represents the change in the rate of reaction versus time for the reversible reaction that took place when an amount of hydrogen (H_2) gas and iodine (I_2) gas was sealed off in a container.
The equation for the reaction is: $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $\Delta H < 0$
Equilibrium was first established after 5 minutes.



What change in the conditions was made at 10 minutes to change the rate of the reaction as indicated on the graph?

A A catalyst was added.

B The temperature was increased.

C The temperature was decreased.

D The external pressure on the reaction mixture was decreased. (2)

1.7 Consider the four different solutions. Which of these solutions is a dilute weak acid solution?

A 0,1 mol·dm^{-3} HCℓ solution

B 5 mol·dm^{-3} CH_3COOH solution

C 0,5 mol·dm^{-3} oxalic acid solution

D 5 mol·dm^{-3} NaOH solution (2)

1.8 The following equations represent two hypothetical half-reactions.
The reduction potentials are also provided:

$X_2 + 2e^- \rightleftarrows 2X^-$ + 1,09 V

$Y^+ + e^- \rightleftarrows Y$ - 2,8 V

Which one of the following substances from these hypothetical half-reactions will be the strongest oxidising agent?

A X^-

B X_2

C Y^+

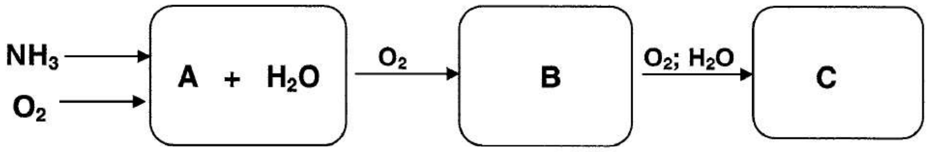
D Y (2)

1.9 Which of the following combinations CORRECTLY shows the products formed during the electrolysis of brine?

	ANODE	CATHODE
A	Chlorine	Hydrogen
B	Hydrogen	Oxygen
C	Oxygen	Hydrogen
D	Hydrogen	Chlorine

(2)

1.10 Study the diagram below illustrating the industrial production of product **C**.



Which process is used to produce product **C**?

A Fractional distillation of air

B Oxidation of ammonia

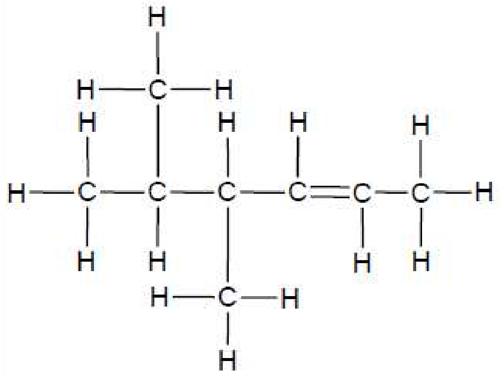
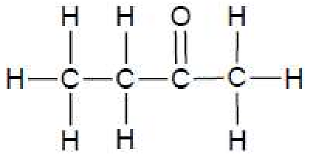
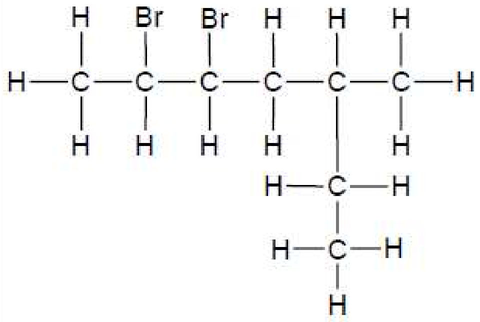
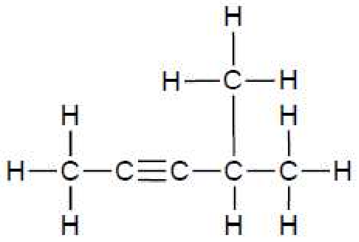
C Haber process

D Ostwald process (2)

[20]

QUESTION 2 (Start on a new page.)

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

A		**B**	
C	$CH_3CH=CHCH_2CH_2CH_3$	**D**	Pentyl propanoate
E		**F**	

2.1 Write down the letter(s) that represent(s) the following:

2.1.1 Alkene (1)

2.1.2 A ketone (1)

2.1.3 A compound with the general formula C_nH_{2n-2} (1)

2.1.4 A structural isomer of octanoic acid (1)

2.2 Write down the IUPAC name of compound:

2.2.1 A (2)

2.2.2 E (2)

2.2.3 F (2)

2.3 Compound **D** is prepared by reacting two organic compounds in the presence of an acid as a catalyst.

Write down the:

2.3.1 Structural formula of compound **D** (2)

2.3.2 IUPAC name of the organic acid used to prepare compound **D**. (1)

2.3.3 NAME or FORMULA of the catalyst used (1)
[14]

QUESTION 3 (Start on a new page.)

The melting points of four organic compounds, represented by the letters **A**, **B**, **C** and **D**, are given in the table below.

	COMPOUND	MELTING POINT (°C)
A	2-methylhexane	-118
B	Heptane	-91
C	Octan-1-ol	-16
D	Octanoic acid	16,7

3.1 Define the term *melting point.* (2)

3.2 Which ONE of **C** or **D** has the higher vapour pressure?
Give a reason for your answer. (2)

3.3 **A** and **B** are structural isomers.

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

3.3.2 Explain why **B** has a higher melting point than **A**. Refer to structure, intermolecular forces, and energy in your explanation (3)

3.4 Explain the difference in the boiling points of **C** and **D**. Refer to intermolecular forces and energy in your explanation. (3)

[12]

QUESTION 4 (Start on a new page.)

4.1 But-1-ene, an UNSATURATED hydrocarbon, and compound **X**, a SATURATED hydrocarbon, reacts with bromine, as represented by the incomplete equations below.

Reaction I But-1-ene + $Br_2 \rightarrow$

Reaction II: **X** + $Br_2 \rightarrow$ 2-bromobutane + **Y**

4.1.1 Give a reason why but-1-ene is classified as unsaturated. (1)

4.1.2 What type of reaction (ADDITION or SUBSTITUTION) takes place in the following:

(a) Reaction I (1)

(b) Reaction II (1)

4.1.3 Write down the reaction condition necessary for Reaction II to take place. (1)

4.1.4 Write down the IUPAC name of reactant **X.** (1)

4.1.5 Write down the name or formula of product **Y.** (1)

4.2 2-chlorobutane can either undergo ELIMINATION or SUBSTITUTION in the presence of a strong base such as sodium hydroxide.

4.2.1 Which reaction will preferably take place when 2-chlorobutane is heated in the presence of CONCENTRATED sodium hydroxide in ethanol? Write down only SUBSTITUTION or ELIMINATION (1)

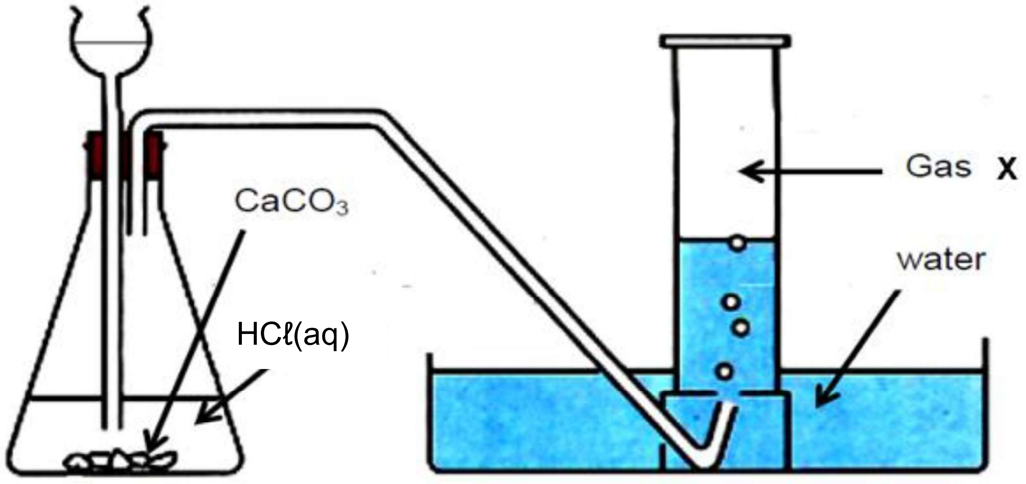
4.2.2 Write down the IUPAC name of the major organic compound formed in QUESTION 4.2.1 (2)

4.2.3 Use structural formulae to write down a balanced equation for the reaction that takes place when 2-chlorobutane reacts with a DILUTE sodium hydroxide solution. (6)

[15]

QUESTION 5 (Start on a new page.)

A group of Grade 12 learners uses the reaction between calcium carbonate and hydrochloric acid to investigate one of the factors that influence reaction rate. They use the apparatus shown below.



The reaction that takes place is represented by the following chemical equation:

$CaCO_3(s) + 2HCℓ(aq) \rightarrow CaCℓ_2(aq) + \mathbf{X}(g) + H_2O(ℓ)$ $\Delta H < 0$

5.1 Identify the gas **X.** (1)

5.2 Two experiments are conducted by using the apparatus shown above. The conditions for each experiment are given in the table below.

Experiment	**Mass of $CaCO_3$(s)(g)**	**State of division of $CaCO_3$(s)**	**Concentration of HCl (mol·dm^{-3})**	**Temperature of HCl(aq)(°C)**
1	4	lumps	0,2	40
2	4	lumps	0,4	40

5.2.1 Define, in words, the term *reaction rate* in terms of THIS investigation. (2)

5.2.2 From the table above, write down the independent variable for this investigation. (1)

5.2.3 Give a reason why the learners must use equal masses and the same state of division of $CaCO_3$(s). (1)

5.3 The learners observe that the reaction rate is HIGHER in **experiment 2** than in **experiment 1.**

5.3.1 Use the collision theory to explain this observation (4)

5.3.2 Refer to **experiment 2** and calculate the volume of hydrochloric acid (in cm^3) that reacts with $CaCO_3$(s).
Assume that $CaCO_3$ is the LIMITING REAGENT. (4)

5.4 Sketch a POTENTIAL ENERGY versus REACTION COORDINATE graph for this reaction. Label the axes and indicate the following on the graph:

(a) Heat of reaction
(b) Activation energy
(c) Activated complex (4)

[17]

QUESTION 6 (Start on a new page.)

The following equation represents a key reaction in the preparation of sulphuric acid:

$$2SO_2(g) \ + \ O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H < 0$$

The process of the reaction is controlled in such a way that the temperature inside the container remains between 370°C and 550°C at all times.

6.1 What is represented by the double arrow in the equation? (1)

6.2 Why is this reaction known as the contact process? (1)

6.3 Explain why the temperature is preferably not

6.3.1 lower than 370°C. (2)

6.3.2 higher than 550°C. (3)

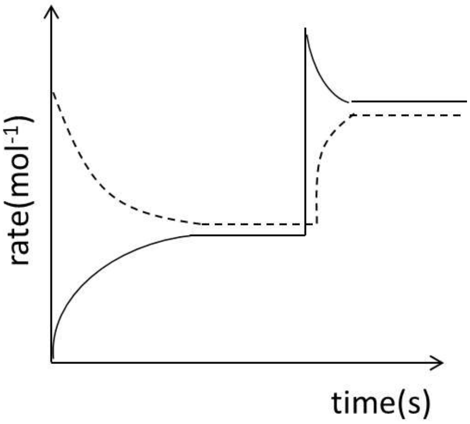
6.4 For the process above, the following information is obtained from the analysis of the equilibrium mixture at 400°C:

Volume of the container = 200 dm^3
Initial quantity of SO_2 = 50 mol
Equilibrium quantity of SO_3 = 22 mol
K_c at 400°C = 7,328

Use the above information to calculate the initial mass of oxygen that was used for this reaction. (7)

6.5 The temperature for the process above is increased to 500°C.

Consider the following graph



Which reaction, FORWARD or REVERSE, is represented by the dotted line? (2)

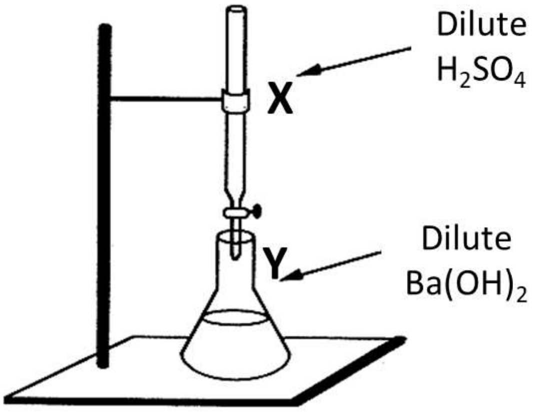
[16]

QUESTION 7 (Start on a new page.)

7.1 The following apparatus is used for the titration of a dilute alkali ($Ba(OH)_2$) with a dilute acid (H_2SO_4).

Balanced equation:

$$H_2SO_4\,(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2H_2O(\ell)$$



7.1.1 What type of reaction takes place when an acid is added to an alkali? (1)

7.1.2 Write down the name of the dilute alkali. (1)

7.1.3 Name the pieces of apparatus labelled **X**. (1)

7.1.4 Methyl orange is used as an indicator. What will you **observe** in Y, when the acid is added, before the endpoint is reached? (2)

7.1.5 State whether each of the following INCREASES, DECREASES or REMAINS CONSTANT, while the acid is being added before the endpoint is reached.

(a) $[Ba^{2+}]$
(b) $[OH^-]$
(c) pH (3)

7.1.6 During the reaction, 50 cm^3 of the dilute alkali reacts completely with 30 cm^3 of the dilute acid. Calculate the mass of barium sulphate that will form during the reaction if the concentration of the dilute alkali is 0,1 $mol \cdot dm^{-3}$. (5)

7.2 Two test tubes contain solutions of $NH_4C\ell$ and CH_3COONa. Their pH values are less than 7 and greater than 7 respectively. Rewrite the following hydrolysis equations in the ANSWER BOOK and complete them to explain this behaviour.

7.2.1 $NH_4^+(aq) + H_2O(\ell) \rightarrow$ __________ + __________ (2)

7.2.2 $CH_3COO^-(aq) + H_2O(\ell) \rightarrow$ _________ + __________ (2)

[17]

QUESTION 8 (Start on a new page.)

A pupil sets up an electrochemical cell based on the following reaction:

$$A\ell(s) + Cu^{2+}(aq) \rightarrow A\ell^{3+}(aq) + Cu(s)$$

8.1 Identify the type of electrochemical cell represented by this reaction. (1)

8.2 Represent this cell by writing its cell notation. (3)

8.3 Do the electrons in the external circuit flow from the Aℓ- to the Cu- electrode or from the Cu- to the Aℓ- electrode? (1)

8.4 For this cell, write down the half reaction that take place at the anode. (2)

8.5 Calculate the initial emf of the cell under standard conditions. (4)

8.6 5 g of $A\ell C\ell_3$ is dissolved in the aluminium half-cell of the standard cell.

8.6.1 What will be the effect on the cell potential? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

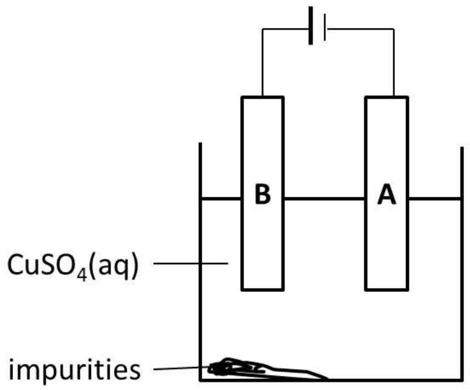
8.6.2 Explain your answer to QUESTION 8.6.1. (3)

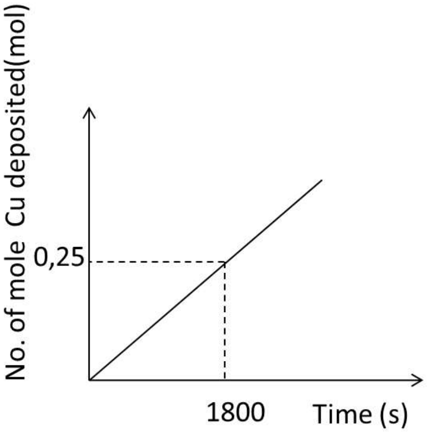
8.7 What energy conversion takes place when the cell is in operation? (1)

[16]

QUESTION 9 (Start on a new page.)

High purity copper is obtained by electrolysis using a thin, pure copper cathode and an ACIDIFIED solution of copper (II) sulphate.





9.1 At which electrode would pure copper be deposited?
Write only **A** or **B**. (1)

9.2 Write down the reduction half-reaction for this cell. (2)

9.3 Use the graph to calculate the percentage purity of the impure copper that was used as the anode.
The mass of the impurities formed in an hour is 15,8 g when a constant current is used. (4)

9.4 The copper (II) sulphate is an electrolyte and the concentration remains constant for the duration of the reaction.

9.4.1 Define an *electrolyte*. (2)

9.4.2 Explain why the concentration of the solution remains constant. (1)

[10]

QUESTION 10 (Start on a new page.)

The use of fertilizer in the agricultural industry is very important. Research has proven that the yield of maize has increased many times by the application of fertilizer to the soil.

10.1 Fertilizer contains three primary nutrients.

10.1.1 Name the three primary nutrients. (3)

10.1.2 Which ONE of the three nutrients is neither produced nor mined in South Africa? (1)

10.1.3 One of the primary nutrients is mined in South Africa. State the mineral form in which it is found. (1)

10.1.4 Name an industrial process by which the third primary nutrient (not mentioned in 10.1.2 and 10.1.3) is made available as fertilizer. (1)

10.2 The use of fertiliser has one important negative effect, called "eutrophication". Define *eutrophication*. (2)

10.3 A farmer plans to plant maize. His research shows that he needs 18 kg of N, 3 kg of P and 3,25 kg K in the soil to produce 1 ton of maize per hectare. A fertilizer company advises him to either use 100 kg of **Fertilizer A** that has an NPK ratio of 4:1:1 (36) or 2 packs of 50 kg of **Fertilizer B** that has an NPK ratio of 7:2:2 (15). Do the necessary calculations to advice the farmer on which fertilizer he should buy to avoid over nutrition of the plants. (5)

[13]

TOTAL: 150

END

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1,013 \times 10^{5}$ Pa
Molar gas volume at STP	V_m	22,4 $dm^{3} \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Charge on electron	e	$-1,6 \times 10^{-19}$ C
Avogadro's' constant		$6,02 \times 10^{23}$

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = $-\log[H_3O^{+}]$
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$	

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

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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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
$Pt^{2+} + 2\,e^-$	$\rightleftharpoons$	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
$H_2O_2 + 2H^+ + 2\,e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

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