education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

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

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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 – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK , for example, 1.11 E.

1.1 Consider the reaction represented by the equation below:

$$CH_3CH_2CH_2Br + H_2O \rightarrow CH_3CH_2CH_2OH + HBr$$

This reaction is an example of ...

A Hydrogenation

B Halogenation

C Hydration

D Hydrolysis (2)

1.2 $C_nH_{2n}O_2$ is the general formula for...

A Both an ester and a carboxylic acid.

B An ester only.

C A carboxylic acid only.

D Both an alcohol and an ester. (2)

1.3 The compound $CH_3COOCH_2CH_3$ is formed by the reaction of ...

A Ethanol and methanoic acid.

B Methanol and ethanoic acid.

C Ethanol and ethanoic acid.

D Ethanol and an oxidizing agent. (2)

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1.4 The following equilibrium is established in a closed container at constant temperature.

$$2\ NO(g) + 2\ H_2(g) \rightleftharpoons N_2(g) + 2\ H_2O(g) \qquad \Delta H < 0$$

The conditions under which the yield of N_2 will be the highest, are when:

A Pressure is decreased and the temperature is decreased.

B Pressure is increased and the temperature is increased.

C Pressure is decreased and the temperature is increased.

D Pressure is increased and the temperature is decreased. (2)

1.5 Given the reaction $N_2(g) + O_2(g) \rightarrow 2\ NO(g)$

The activation energy for the forward reaction is 181,5 kJ and for the reverse reaction is 192,8 kJ. What is the heat of reaction for the forward reaction?

A -374,3 kJ

B +374,3 kJ

C -11,3 kJ

D +11,3 kJ (2)

1.6 Consider the following reversible reaction:

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

Which ONE of the following statements is correct if the temperature is increased?

A Only the rate of the forward reaction is increased.

B The rate of both the forward and the reversed reaction are increased.

C Only the rate of the reversed reaction is increased.

D The rate of the forward and reversed reactions won't change. (2)

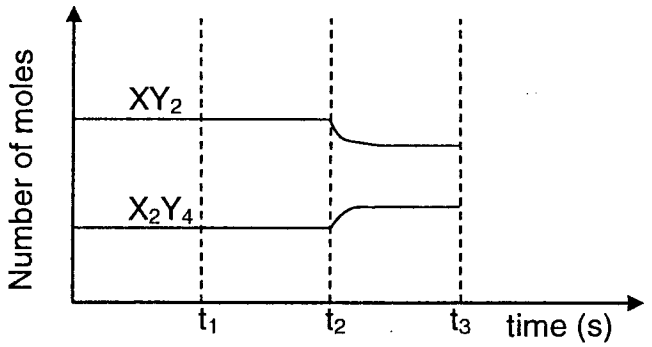
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1.7 The reaction represented by the equation

$$X_2Y_4(g) \rightleftharpoons 2\ XY_2(g) \quad \Delta H > 0$$

is initially at equilibrium.

The situation is represented by the graph below.



The value of Kc at BOTH TIMES t_1 and t_3 is 0,25.

Which ONE of the following BEST explains the change that occurred at t_2?

A X_2Y_4 was added to the reaction mixture.

B The pressure increased without any change in temperature.

C The temperature was lowered.

D A catalyst was added to the reaction mixture. (2)

1.8 A solution of ethanoic acid (acetic acid) is titrated against a standard sodium hydroxide solution. Which ONE of the following indicators would be the most suitable for this titration?

	Indicator	**pH range of the indicator**
A	Phenolphthalein	8,3 - 10
B	Methyl orange	3,1 – 4,4
C	Bromothymol blue	6,0 – 7,6
D	Universal indicator	Changes colour over a wide range of pH values

(2)

1.9 The reactions below take place in two different electrochemical cells, X and Y.

$$\text{Cell X: } CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2$$

$$\text{Cell Y: } Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$$

Which ONE of the following represents the product that is formed at the CATHODE of each cell correctly?

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

(2)

1.10 Which ONE of the following primary nutrients is obtained from BONE MEAL?

A Phosphorous

B Nitrogen

C Potassium

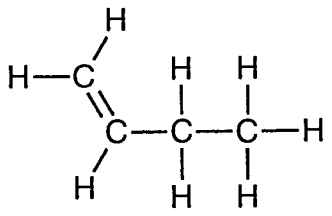
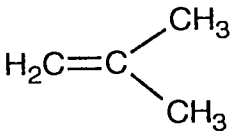
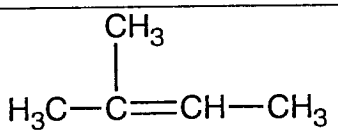
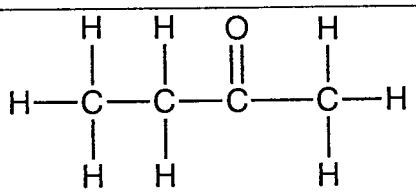
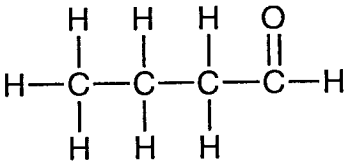
D Sulphur

(2)
[20]

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QUESTION 2 (Start on a new page)

Consider the organic compounds represented by the letters **A** to **H** in the table below:

A		**B**	
C	$CH_3CH_2CH_2COOH$	**D**	But-2-ene
E	Methyl propanoate	**F**	
G		**H**	

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

2.2 Write down the LETTER that represents ...

2.2.1 A chain isomer of compound **A**. (1)

2.2.2 A functional isomer of compound **G**. (1)

2.3 Write down the ...

2.3.1 IUPAC name of compound **B**. (2)

2.3.2 Structural formula of the functional group of compound **E**. (1)

2.3.3 Name of a weak, monoprotic acid. (1)

2.3.4 Name of the homologous series to which compound **H** belongs. (1)

2.4 Is compound **A** SATURATED or UNSATURATED? Give a reason for your answer. (2)

2.5 Use molecular formulae to write down a balanced equation for the complete combustion of compound **A**. (3)

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2.6 Compound **E** is the product of an esterification reaction.
For compound **E**, write down the:

2.6.1 STRUCTURAL FORMULA of the alcohol from which it is synthesized. (2)

2.6.2 The two reaction conditions that are needed for the reaction to take place. (2)
[18]

QUESTION 3 (Start on a new page)

The boiling points of compounds **A**, **B** and **C** were determined during a practical investigation and recorded in the table below.

COMPOUND	CONDENSED STRUCTURAL FORMULA	BOILING POINT (°C)
A	CH_3OH	78
B	$CH_3CH_2CH_2OH$	97
C	$CH_3C\ell$	39,6

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

3.2 Write down the type of intermolecular force that is responsible for the difference in the boiling points of compound **A** and **B**. (1)

3.3 Explain the difference in the boiling points of compound **A** and **C** by referring to the TYPE and STRENGTH of intermolecular forces. (3)

3.4 Compound **C** ($CH_3C\ell$), is prepared under standard conditions (STP) by the reaction between methane and chlorine as shown by the equation:

$$CH_4(g) + C\ell_2(g) \rightarrow CH_3C\ell(g) + HC\ell$$

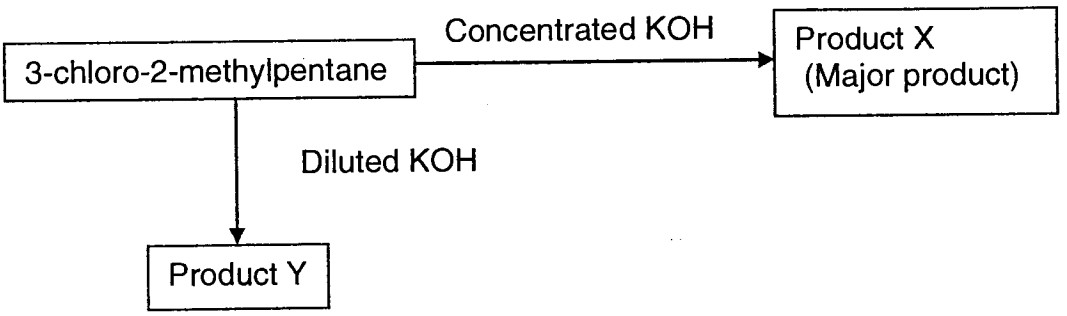
3.4.1 Write down the NAME of the type of reaction that leads to the formation of compound **C**. (1)

3.4.2 In the reaction, 12,8 g of CH_4 produces 0,035 kg $CH_3C\ell$. Calculate the percentage yield in this reaction. (5)
[12]

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QUESTION 4 (Start on a new page)

4.1 3-chloro-2-methylpentane can either undergo ELIMINATION or SUBSTITUTION in the presence of a strong base such as potassium hydroxide. The flow diagram below, represents the two different reactions.



4.1.1 Which reaction will preferably take place when 3-chloro-2-methylpentane is heated in the presence of CONCENTRATED potassium hydroxide? Choose either SUBSTITUTION or ELIMINATION. (1)

4.1.2 Write down the IUPAC name of product X. (2)

4.1.3 Using STRUCTURAL FORMULAE write down a balanced equation for the reaction that takes place when 3-chloro-2-methylpentane reacts with DILUTE potassium hydroxide. (3)

4.1.4 Write down the IUPAC name of the organic compound formed in QUESTION 4.1.3. (2)

4.2 Petroleum companies use an elimination reaction to break longer hydrocarbons into shorter, more usable hydrocarbons.
An example of such a reaction is given:

$$C_8H_{18} \rightarrow C_6H_{14} + X$$

4.2.1 Name the type of elimination reaction referred to in the equation above. (1)

Molecules of compound X can undergo polymerisation.

4.2.2 Name the TYPE of polymerisation that will take place. (1)

4.2.3 Use STRUCTURAL FORMULAE to write down a balanced equation for the polymerisation reaction. (2)
[12]

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OUESTION 5 (Start on a new page)

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

5.2 A student investigates the rate of reaction between magnesium and sulphuric acid. The balanced equation for the reaction taking place is:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

The results are shown in the table below:

Concentration of sulphuric acid ($mol \cdot dm^{-3}$)	Rate of reaction ($cm^3 \cdot s^{-1}$)
1,6	17,0
0,8	8,5
0,4	4,2

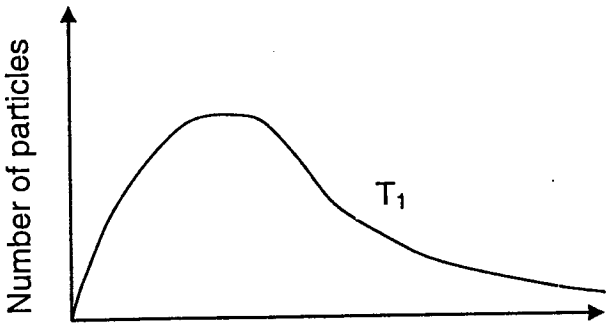
5.2.1 State ONE variable that must be controlled during this investigation. (1)

5.2.2 What conclusion can be drawn from the results obtained. (2)

5.2.3 What will happen to the rate of the reaction if lumps of magnesium are used instead of magnesium powder? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

5.2.4 Explain the answer for QUESTION 5.2.3 using the collision theory. (3)

5.2.5 The following diagram shows the distribution curve of the reaction at 20°C.



Redraw the graph in your answer book. Label this graph T_1. Draw a second graph to show how a higher temperature will affect the shape of this graph. Label it T_2. (2)

5.3 Calculate the mass of magnesium needed to produce 100 cm^3 of $H_2(g)$ at 20 °C. The molar gas volume at 20 °C is 24,04 cm^3. (5)
[16]

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QUESTION 6 (Start on a new page)

The reaction below represents the catalysed step in the Haber process.

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g) \qquad \Delta H<0$$

The reaction takes place in a closed container and reaches equilibrium at 427 °C.

6.1 What will the influence of a drop in temperature be on the following:
Choose from INCREASES, DECREASES or REMAIN THE SAME.

6.1.1 The rate of the forward reaction. (1)

6.1.2 The yield of $NH_3(g)$. (1)

6.1.3 Explain the answer in QUESTION 6.1.2 by using Le Chatelier's principle. (3)

6.2 The reaction is investigated on a small scale in the laboratory. Initially 4 mole $N_2(g)$ and an unknown mass, *x*, of $H_2(g)$ are sealed in a 2 dm^3-flask and allowed to reach equilibrium at a certain temperature.

At equilibrium, the concentration of $NH_3(g)$ present in the flask is 1,5 $mol{\cdot}dm^{-3}$. Calculate the initial mass of $H_2(g)$ present in the flask if the equilibrium constant (K_c) at this temperature is 1,8. (8)
[13]

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QUESTION 7 (Start on a new page)

7.1 Given the equation

$$HPO_4^{2-} + H_2O \rightleftharpoons H_3O^+ + PO_4^{3-}$$

7.1.1 By referring to the Brønsted-Lowry theory, explain why the H_3O^+ ion is regarded as an acid. (2)

7.1.2 Select another acid from the equation. (1)

7.1.3 Give a single term for a substance which can act as both an acid and a base. (1)

7.2 In a reaction, 25 cm^3 of a $Ba(OH)_2$ with a pH of 13,6 are added to 40 cm^3 of 0,15 $mol \cdot dm^{-3}$ H_2SO_4. The following reaction takes place:

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

7.2.1 Calculate the concentration of the solution of $Ba(OH)_2$ used in the reaction. (4)

7.2.2 Calculate the number of moles of $Ba(OH)_2$ used in the reaction. (3)

7.2.3 Calculate the pH of the final solution. (7)

7.3 The salt $BaSO_4$ undergoes hydrolysis.

7.3.1 Define the term *hydrolysis*. (2)

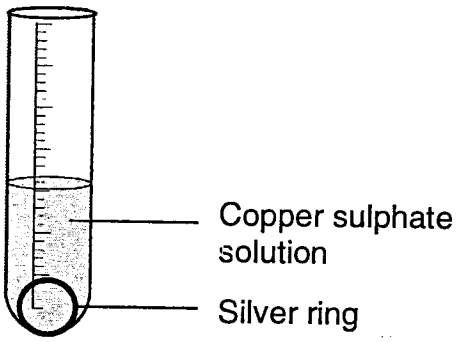
7.3.2 Will an aqueous $BaSO_4$, the solution be ACIDIC, NEUTRAL or BASIC. (1)

[21]

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QUESTION 8 (Start on new page)

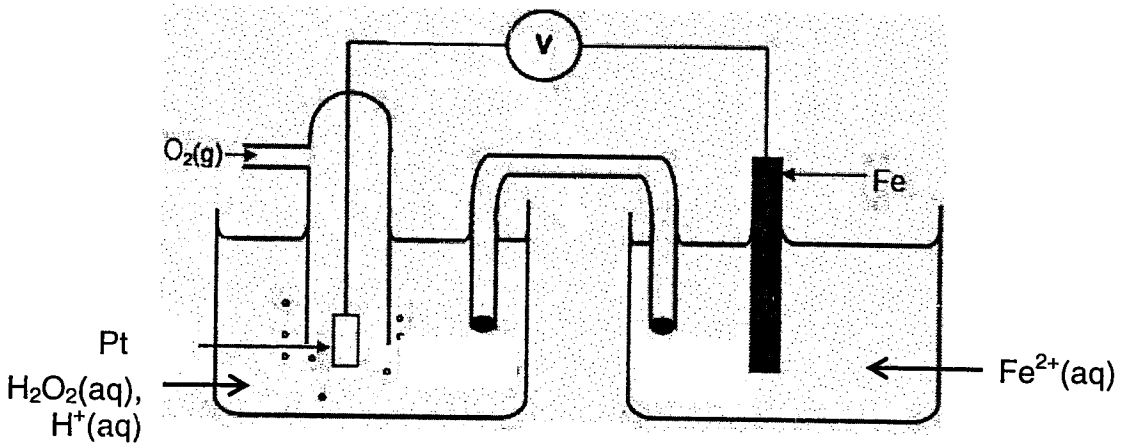
8.1 A silver ring is placed in a 1 mol·dm^{-3} copper sulphate solution.



Use the table of standard reduction potentials to determine whether or not a spontaneous reaction will take place by refering to the strengths of the reducing agents present in the test tube. (2)

8.2 The diagram below represents a standard electrochemical cell.

A saturated potassium chloride (KCℓ) solution is used in the salt bridge.



8.2.1 Which electrode is the cathode? Give a reason for the answer. (2)

8.2.2 Write down the oxidation half-reaction. (2)

8.2.3 Write down the reduction half-reaction. (2)

8.2.4 Calculate the emf of the cell. (4)

8.2.5 Write down the cell notation for this cell. (3)

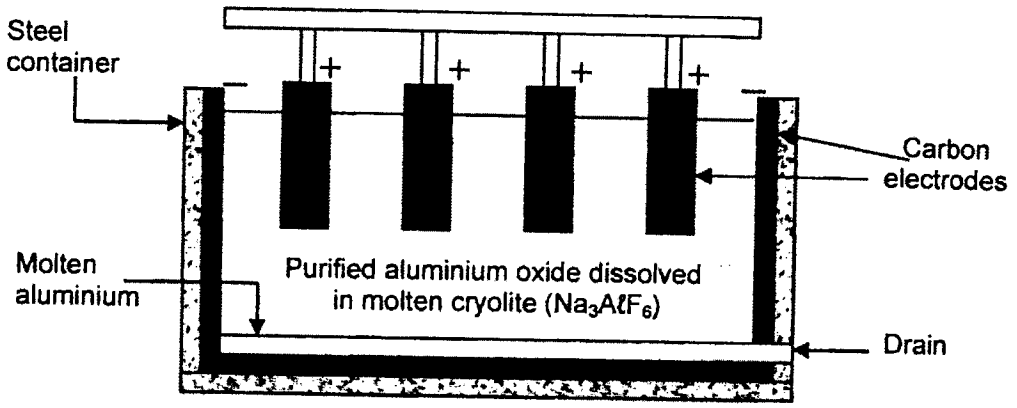
8.2.6 Which ion will increase in the O_2/H_2O_2 half-cell while the cell is operating? Choose from: K^+, $Cℓ^-$ or H^+. (1)

[16]

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QUESTION 9 (Start on a new page)

The diagram below shows a cell that is used to extract aluminium metal.



9.1 Write down all the ions which will be present in the aluminium oxide. (2)

9.2 Define the term *electrolyte*. (2)

9.3 Give a reason why the aluminium oxide is dissolved in cryolite? (1)

9.4 Write down the half-reaction that occurs at the anode. (2)

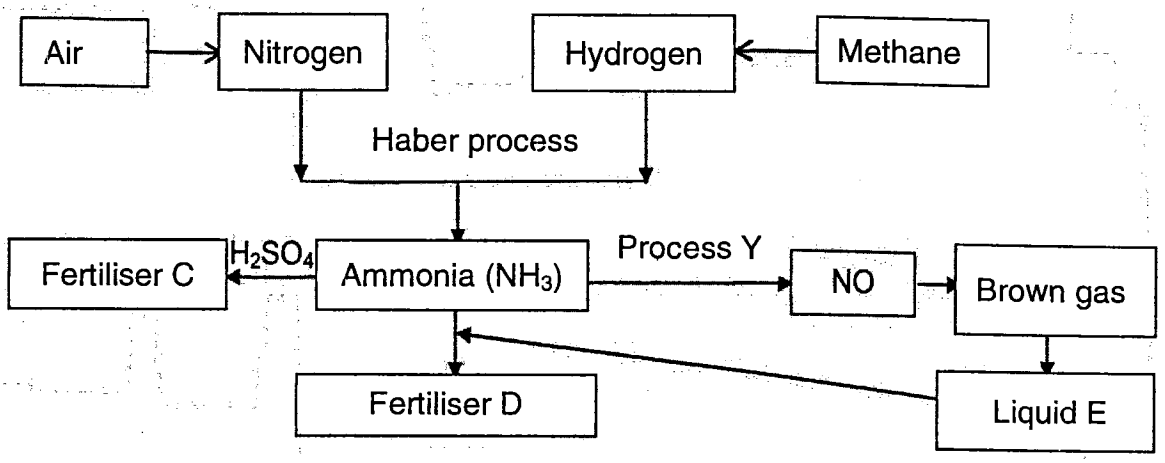
9.5 The anode corrodes during the operation of the cell. Write an appropriate equation for the reaction that takes place. (3)

[10]

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QUESTION 10 (Start on a new page)

10.1 The flow diagram below shows the most important steps in the industrial preparation of two important solid fertilisers.



Write down the:

10.1.1 Balanced equation for the formation of the brown gas. (3)

10.1.2 Name of process Y. (1)

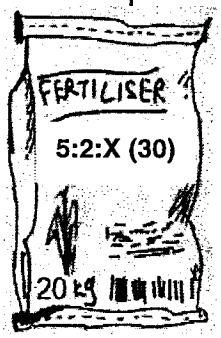
10.1.3 FORMULA of liquid E. (1)

10.1.4 FORMULA of fertiliser C. (1)

10.1.5 NAME of fertiliser D. (1)

10.1.6 Name of the process that takes place when excess fertiliser D ends up in the rivers. (1)

10.2 The diagram below shows a bag of fertiliser with an unknown NPK ratio. After analysing the fertiliser, it is found that the percentage of nitrogen is 18,75%.



Calculate the value of **X** in the N:P:K ratio. (4)

[12]

GRAND TOTAL: 150

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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 x 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 x 10^{-19}C

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^+]
Kw = [H_3O^+][OH^-] = 1 x 10^{-14} at 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

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 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	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	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140	Pr 141	Nd 144	Pm	Sm 150	Eu 152	Gd 157	Tb 159	Dy 163	Ho 165	Er 167	Tm 169	Yb 173	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

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

29
1,9 Cu
63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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TABLE 4A: STANDA CTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

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

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TABLE 4B: STANDAR CTION POTENTIALS
TABEL 4B: STANDAARD REDUKSIEPOTENSIALE

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

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