GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PROVINCIAL EXAMINATION 2023

NOVEMBER 2023

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY

PAPER 2

TIME: 3 hours

MARKS: 150

11 pages + 4 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space in the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL 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, 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, etc. where required.
12. Write neatly and legibly.

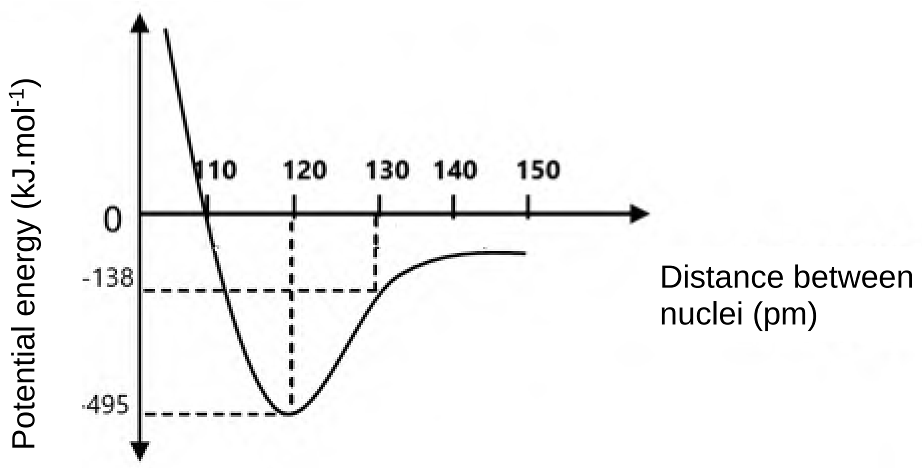
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 to 1.10) in the ANSWER BOOK, for example 1.11D.

1.1 Which of the bonds between the atoms below has the highest polarity?

A H – N
B H - Cℓ
C H – O
D H – C (2)

1.2 The graph below shows how the potential energy varies with distance between the nuclei of two oxygen atoms when a double bond between the oxygen atoms (O = O) is formed.



Choose from the table below, the bond length and bond energy for O = O.

	BOND LENGTH (pm)	BOND ENERGY ($kJ\cdot mol^{-1}$)
A	110	– 138
B	120	– 495
C	130	– 138
D	140	– 495

(2)

1.3 Consider the following statements: Which of the following is/are TRUE?

(i) Most elements consist of atoms.
(ii) Some elements consist of molecules.
(iii) All compounds consist of molecules.
(iv) Salt crystals are ionic compounds.

A Only (i)
B (i), (ii) and (iii)
C (ii) en (iv)
D (i), (ii) en (iv) (2)

1.4 Intermolecular forces influence some physical properties of materials like surface tension. Which of the following statements is correct?

A The stronger the intermolecular force, the higher the surface tension.
B The stronger the intermolecular force, the higher the rate of evaporation.
C The stronger the intermolecular force, the lower the melting point.
D The weaker the intermolecular force, the higher the boiling point. (2)

1.5 Determine what the new pressure in kPa will be if 750 ml nitrogen gas in the atmosphere is compressed to 500 ml, keeping the temperature constant?

A $2,70 \times 10^{-4}$ kPa
B 67,53 kPa
C 151,95 kPa
D 1,5 atm (2)

1.6 Hydrogen gas is a real gas that reacts like an ideal gas in the following situation:

A There are no attractive or repulsive forces between the molecules at high temperatures.
B The collisions between the molecules are perfectly elastic.
C There is no movement of the molecules at zero Kelvin.
D It forms a liquid at high pressures. (2)

1.7 A standard solution ...

A contains one mole of solute per dm^3.
B must always be made up to 1 dm^3.
C is a solution of which the concentration is precisely known.
D is a solution made up of oxalic acid. (2)

1.8 Which of the following is NOT a conjugate acid-base pair?

A $HC\ell$ and $C\ell^-$
B HCO_3^- and H_2CO_3
C HSO_4^- and H_2SO_4
D OH^- and H_3O^+

1.9 Instant hot and cold packs function by dissolving a salt into water. As the salt dissociates, heat is either released in an exothermic reaction or absorbed in an endothermic reaction. Which of the following reactions will be best suited to be used as a hot pack?

A $CH_3COOMg + 4 H_2O \rightarrow CH_3COOMg.4H_2O$ $\Delta H = -13,3 \text{ kJ.mol}^{-1}$
B $CH_3COONa + 3 H_2O \rightarrow CH_3COONa.3H_2O$ $\Delta H = -19,7 \text{ kJ.mol}^{-1}$
C $Ba(OH)_2 + H_2O \rightarrow Ba^{2+} + 2OH^- + H_2O$ $\Delta H = +21,9 \text{ kJ.mol}^{-1}$
D $NH_4NO_3 + H_2O \longrightarrow NH_4^+ + NO_3^- + H_2O$ $\Delta H = +25,4 \text{ kJ.mol}^{-1}$ (2)

1.10 Consider the reaction: Pb(s) + Cu^{2+}(aq) $\longrightarrow$ Pb^{2+}(aq) + Cu(s)

The oxidised product is ...

A Pb.
B Pb^{2+}.
C Cu.
D Cu^{2+}. (2)

[20]

QUESTION 2 (Start on a new page.)

Calcium carbonate is a dietary supplement used when the intake of calcium through the diet is not enough. The body requires calcium to maintain healthy bones, muscles, nervous system and heart. Calcium carbonate can also be used as an antacid to relieve heartburn. Calcium carbonate can be produced with the following reaction:

$$\mathbf{CaO + CO_2 \longrightarrow CaCO_3}$$

2.1 Draw a Lewis diagram for:

2.1.1 CO_2 (2)

2.1.2 Ca^{2+} (2)

2.2 Define a *covalent bond*. (2)

2.3 Identify the metal in the above reaction. (1)

2.4 Explain a *metallic bond*. (2)

2.5 Which of the two reactants in this reaction would most likely be:

2.5.1 A gas at room temperature? (1)

2.5.2 A solid at room temperature? (1)

2.6 Define *electronegativity*. (2)

2.7 Use electronegativity to determine the type of bonds that will form in CaO. (2)

2.8 Will CO_2 be a polar or non-polar molecule? (1)

2.9 Explain the answer to QUESTION 2.8 by using a calculation and referring to the shape of the molecule. (2)

[18]

QUESTION 3 (Start on a new page.)

The physical properties of matter, such as vapour pressure, melting or boiling points, depend on intermolecular forces.

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

3.2 Group 17 on the periodic table forms diatomic molecules, e.g. F_2 and $C\ell_2$.

3.2.1 What type of intermolecular forces will there be between the molecules? (1)

3.2.2 Which ONE of the following halogens will have the highest boiling point? $C\ell_2$ or I_2. (1)

3.2.3 Explain your answer to QUESTION 3.2.2. (3)

3.3 Study the following substances:

$HC\ell$, $C\ell_2$, NH_3, CO_2, $CaC\ell_2$

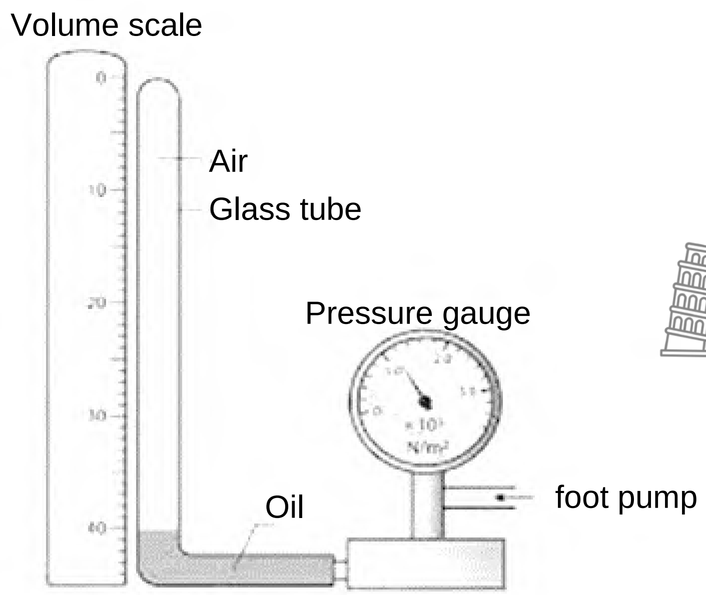
Which of the above will have:

3.3.1 Hydrogen bonds? (1)

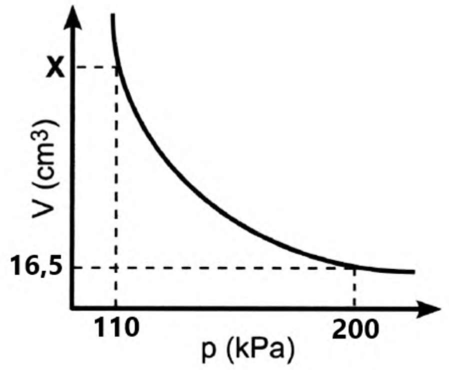
3.3.2 Dipole-dipole forces? (1)
[9]

QUESTION 4 (Start on a new page.)

Learners conducted an investigation to determine the relationship between the pressure and volume of a given mass of O_2 gas, while keeping the temperature constant.



They made the sketch graph below, to show their results:



4.1. Write a suitable investigative question for this investigation. (2)

4.2. Write down the:

4.2.1 Independent variable (1)

4.2.2 Controlled variable (1)

4.3 Name and state the law that is being investigated here. (3)

4.4 Calculate the value of **X** using other values given on the graph. (3)

4.5 Like all real gases, this gas will liquify at very low temperatures. Explain why this happens. (2)

4.6 If this experiment was conducted at a room temperature of 25 ˚C, calculate the amount of mole of O_2(g) at a pressure of 200kPa. (4)

A sealed glass tube with 20 cm^3 of nitrogen gas is heated.

4.7 Define *temperature*. (2)

4.8 Use the kinetic theory to describe how the above change will influence the pressure experienced by the 20 cm^3 N_2(g). (3)
[21]

QUESTION 5 (Start on a new page.)

5.1. Aspirin is known by the chemical name acetylsalicylic acid. The empirical formula of aspirin consists of 60,0% carbon and 4,44% hydrogen and oxygen.

5.1.1 Define the term empirical formula. (2)

5.1.2 Determine the empirical formula of aspirin. (6)

5.1.3 If the molecular mass of aspirin is 180 $g.mol^{-1}$, what is its molecular formula? (2)

5.2 The molar mass of hydrated sodium carbonate is found to be 268 $g{\cdot}mol^{-1}$. The formula of the hydrated sodium carbonate is $Na_2CO_3.xH_2O$.
Calculate the number of moles of water (x) in the compound. (4)

[14]

QUESTION 6 (Start on a new page.)

6.1 If a solution of silver nitrate ($AgNO_3$) is mixed with solution of potassium chloride ($KC\ell$), a precipitate of $AgC\ell$ is produced according to the following reaction:

$$KC\ell(aq) + AgNO_3(aq) \rightarrow AgC\ell(s) + KNO_3(aq)$$

55 cm^3 of a potassium chloride solution with a concentration of 0,25 $mol.dm^{-3}$ is added to 70 cm^3 of a silver nitrate solution with a concentration of 0,15 $mol.dm^{-3}$.

6.1.1 What is meant by limiting reagent? (2)

6.1.2 Determine which substance is the limiting reagent. (5)

6.1.3 What mass of AgCl has precipitated? (4)

6.2 Mary heats 50 g of $CaCO_3$ that reacts according to the following reaction:

$$CaCO_3 \rightarrow CaO + CO_2$$

She collects the formed CO_2 gas.

6.2.1 Determine the number of moles of the $CaCO_3$. (3)

6.2.2 She obtains only 18,2 g CO_2 gas. Determine the percentage purity of the $CaCO_3$. (5)

6.2.3 Calculate the mass of CO_2 gas that Mary could collect if $CaCO_3$ was only 70% pure. (5)

[24]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid is a strong acid and an example of a diprotic acid.

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Give a reason why sulphuric acid is referred to as a diprotic acid. (2)

$HS0_4^-$ can <u>behave either as an acid or a base</u>.

7.1.3 Write down ONE word for the underlined phrase in the above sentence. (1)

7.2 A learner uses a standard solution of sodium hydrogen carbonate to determine the concentration of a sulphuric acid solution.

7.2.1 What is meant by a "standard solution"? (2)

7.2.2 Write down the balanced equation for the reaction of sulphuric acid with water. (3)

7.3 In a titration, the learner finds that 20 cm^3 of a 0,2 $mol.dm^{-3}$ solution of sodium hydrogen carbonate neutralises 12 cm^3 of the sulphuric acid solution. The balanced equation for this reaction is:

$$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2CO_2 + 2H_2O$$

7.3.1 Calculate the concentration of the H_2SO_4 solution. (5)

7.3.2 Which of the indicators listed below should be used in this titration? Briefly explain your answer.

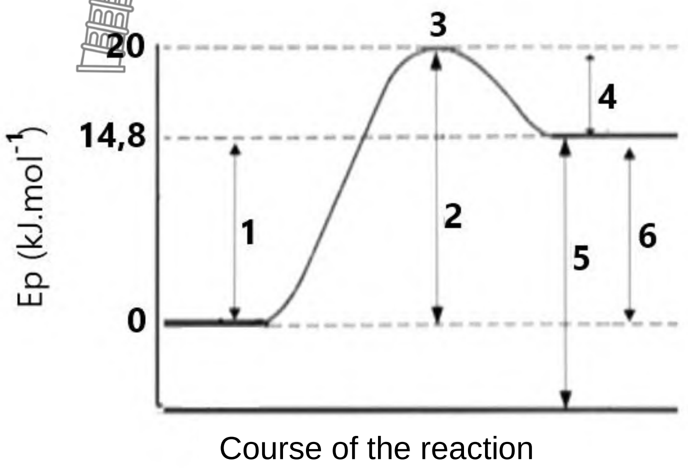
Indicator	pH range in which the colour changes
Methyl orange	3,1 – 4,4
Bromothymol blue	6,0 – 7,6
Phenolphthalein	8,3 – 10,0

(3)
[18]

QUESTION 8 (Start on a new page.)

Certain chemical reactions are often used to reduce swelling after an athletic injury. In a lab experiment the following reaction was tested and the sketch graph below was obtained.

$NH_4Cl + H_2O \rightarrow NH_4^+ + Cl^- + H_2O$



8.1	Is this an exothermic or endothermic reaction?	(1)
8.2.	Explain the answer to QUESTION 8.1.	(2)
8.3.	State the enthalpy of this reaction.	(2)
8.4	Which number on the graph represents the enthalpy for the reverse reaction?	(1)
8.5	Define *activation energy*.	(2)
8.6	Give the number on the graph that represents the activated complex.	(1)
8.7	Explain how a catalyst would affect the activation energy in the reaction.	(2)
8.8	Redraw the sketch graph on you answer sheet and use a dotted line to indicate the changes after adding a catalyst.	(2)
		[13]

QUESTION 9 (Start on a new page.)

9.1 Oxidation numbers make it easier to determine whether an element or a substance is oxidised or reduced during a chemical reaction.

9.1.1 Define *oxidation* in terms of oxidation numbers. (2)

9.1.2 Calculate the oxidation number of chromium in $Cr_2O_7^{2-}$. (2)

9.2 Consider the UNBALANCED equation below:

$$Fe^{2+}(aq) + C\ell_2(g) \rightarrow Fe^{3+}(aq) + C\ell^-$$

9.2.1 Give a reason why the reaction above is a redox reaction. (1)

9.2.2 Identify the FORMULA of the reducing agent. Explain the answer in terms of the oxidation number. (2)

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

9.2.4 Write down the balanced net redox reaction. (4)
[13]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro se konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}
Molar gas constant *Molêre gaskonstante*	R	$8{,}31$ J·K^{-1}·mol^{-1}
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·mol^{-1}
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$\frac{p_1V_1}{T_1}=\frac{p_2V_2}{T_2}$	$pV=nRT$
$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$n=\frac{V}{V_m}$	$c=\frac{n}{V}$ **OR/*OF*** $c=\frac{m}{MV}$
$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b}$	$n=\frac{Q}{e}$ or/of $n=\frac{Q}{q_e}$

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

KEY/*SLEUTEL*

Electronegativity/*Elektronegatiwiteit*	Atomic number/*Atoomgetal*	Symbol/*Simbool*	Approximate relative atomic mass/*Benaderde relatiewe atoommassa*
1,9	29	Cu	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* (↑)

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

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

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

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

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

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

GAUTENG PROVINCE
EDUCATION
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PROVINCIAL EXAMINATION/
PROVINSIALE EKSAMEN

NOVEMBER 2023

GRADE/*GRAAD* 11

MARKING GUIDELINES/*NASIENRIGLYNE*

PHYSICAL SCIENCES: CHEMISTRY/
FISIESE WETENSKAPPE: CHEMIE

PAPER/*VRAESTEL* 2

9 pages/*bladsye*

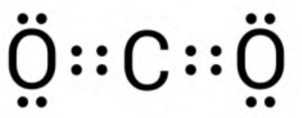
QUESTION/*VRAAG1*

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

[20]

QUESTION/*VRAAG 2*

2.1 2.1.1.



✓✓ (2)

2.1.2.

✓✓ Without brackets only 1 mark/
✓✓ *Sonder hakies slegs 1 punt* (2)

2.2. A covalent bond is a bond in which electron pairs are shared between the two atoms to form a molecule. ✓✓
'n Kovalente binding is 'n binding waar elektronpare gedeel word tussen twee atome om 'n molekule te vorm. ✓✓ (2)

2.3 Calcium/Ca ✓
Kalsium/Ca ✓ (1)

2.4 The bond between positive ions and delocalised valence electrons in a metal. ✓✓
'n Binding tussen positiewe ione en gedelokaliseerde elektrone in 'n metaal. ✓✓ (2)

2.5 2.5.1 CO_2/carbon dioxide ✓
CO_2/koolstofdioksied ✓ (1)

2.5.2 CaO ✓ (1)

2.6 Electronegativity is a measure of the tendency of an atom in a molecule to attract bonding electrons. ✓✓
Elektronegatiwiteit is die maatstaf van die neiging van 'n atoom in 'n molekuul om bindingselektrone aan te trek. ✓✓ (2)

2.7 ΔEN = 3,5 – 1 = 2,5 ✓
∴ Ionic bond ✓/*Ioniese binding* ✓ (2)

2.8 Non-polar molecule ✓/*Nie-polêre molekule* ✓ (1)

2.9 ΔEN = 3.5 – 2,5 = 1,0
∴ polar bond ✓/
∴ polêre binding ✓
But shape is symmetrical thus the molecule is polar ✓/*Maar die vorm is simmetries en dus is die molekule polêr.* ✓ (2)
[18]

QUESTION/*VRAAG* 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk van 'n stof gelyk is aan die atmosferiese druk. ✓✓ (2)

3.2 3.2.1 London/dispersion forces ✓
London/dispersiekragte ✓ (1)

3.2.2 I_2 ✓ (1)

3.2.3 As the molecular mass increases, ✓
the strength of the intermolecular forces increases ✓
Therefore more energy is needed to overcome/weaken the intermolecular forces. ✓ (no mark if BROKEN is used instead of overcome or weaken)
Thus the boiling boiling point increases. ✓✓
Indien die molekulêre massa toeneem, ✓
word die sterkte van die intermolekulêre kragte groter, ✓✓
Meer energie word benodig om die intermolekulêre kragte te oorkom/te verswak. ✓*(geen punte indien GEBREEK in plaas van oorkom gebruik word nie.)* (3)

3.3 3.3.1 NH_3/ammonium ✓
NH_3/ammoniak ✓ (1)

3.3.2 HCℓ/hydrogen chloride ✓
HCℓ/*waterstofchloried* ✓ (1)
[9]

QUESTION/*VRAAG* 4

4.1 What is the relationship between the pressure and volume of an enclosed mass of gas, when the temperature is kept constant? ✓✓
Wat is die verband tussen die druk en volume van 'n ingeslote massa gas, indien die temperatuur konstant gehou word. ✓✓ (2)

4.2.1 Pressure ✓
Druk ✓ (1)

4.2.2 Temperature/mass of gas ✓
Temperatuur/massa van gas ✓ (1)

4.3 Boyle's Law.✓ The pressure of an enclosed gas is inversely proportional to the volume it occupies at a constant temperature ✓✓
Boyle se wet. ✓*Die druk van 'n ingeslote gas is omgekeerd eweredig aan die volume van die gas by 'n konstante temperatuur.* ✓✓ (3)

4.4 **OPTION/*OPSIE 1***
$p_1V_1 = p_2V_2$ ✓
$(200)(16,5) = (110)X$ ✓
$X = 30\ cm^3$ ✓

OPTION/*OPSIE 2*
$p_1V_1 = p_2V_2$ ✓
$(150)(1,65 \times 10^{-2}) = (110)X$ ✓
$X = 3 \times 10^{-2}\ dm^3$ ✓ (3)

4.5 At low temperatures, a real gas's particles will occupy space and have volume. ✓✓
By lae temperature sal 'n werklike gas se deeltjies spasie inneem en volume besit. ✓✓
OR/*OF*
The attraction and repulsive forces between the particles become significant. ✓✓ Thus, a real gas will liquify at low temperatures.
Die aantrekkings- en afstotingskragte tussen deeltjies raak noemenswaardig. ✓✓*Dus sal 'n werklike gas vervloei by lae temperature*. (2)

4.6 $pV = nRT$ ✓
$200 \times 10^3 (50 \times 10^{-6})$ ✓$= n\ 8,31\ (298)$ ✓
$n = 0,00403\ mol/4,30 \times 10^{-3}\ mol$ ✓ (4)

4.7 The average kinetic energy of the molecules of the gas. ✓✓
Die gemiddelde kinetiese energie van die molekules van die gas. ✓✓ (2)

4.8 The volume of the container is constant thus: ✓
As the kinetic energy of the molecules of the gas increases, the number of collisions on the sides of the container increases. ✓
Pressure will increase. ✓
Die volume van die houer is konstant dus: ✓
Soos wat die kinetiese energie van die molekules van die gas toeneem, sal die aantal botsings teen die kante van die houer toeneem. ✓
Die druk sal toeneem. ✓ (3)

[21]

QUESTION/*VRAAG* 5

5.1 5.1.1 The simplest ratio in which the elements of the compound are bonded to each other.✓✓
Die eenvoudigste verhouding waarin die elemente van 'n verbinding aanmekaar gebind is. ✓✓ (2)

5.1.2 O% = 100 – (60,0+ 4,44) ✓
= 35,56%

C: $n = \frac{m}{M} = \frac{60,0}{12}$ ✓ = 5 mol

H: $n = \frac{m}{M} = \frac{4,44}{1}$ ✓ = 4,44 mol

O: $n = \frac{m}{M} = \frac{35,56}{16}$ ✓ = 2,22 mol

C : H : O

$\frac{5}{2,22} : \frac{4,44}{2,22} : \frac{2,22}{2,22}$ ✓

2,25 : 2 : 1
9 : 8 : 4

Empirical formula/*Empiriese formule*: $C_9H_8O_4$ ✓ (6)

5.1.3 $M(C_9H_8O_4) = 9(12) + 8(1) + 4(16)$
$= 180\ g.mol^{-1}$

$$\frac{\text{molar mass}/\textit{molêre mass}}{\text{emprical mass}/\textit{empiriese massa}} = \frac{180}{180} = 1 \checkmark$$

molecular formula/*molekulêre formule*: $C_9H_8O_4$ ✓ (2)

5.2 $M(Na_2CO_3) = 106 g \cdot mol^{-1}$
$M(x\ H_2O) = 268 – 106$ ✓✓ $= 162 g \cdot mol^{-1}$
$n(H_2O) = m/M = 162/18$ ✓
$n(H_2O) = 9$ mol ✓ (4)

[14]

QUESTION/*VRAAG* 6

6.1 6.1.1 The limiting reagent is the reactant that is used up first. ✓✓
Die beperkende reagens is die een wat eerste opgebruik word. ✓✓ (2)

6.1.2 n(KCl) = cV✓
= 0,25 (0,055) ✓
= 0,0138
$n(AgNO_3)$ = cV
= 0,15(0,07) ✓
= 0,0105
KCℓ : $AgNO_3$
1 : 1 ✓
0,0105 : 0,0105
$AgNO_3$ is the limiting reagent/*die beperkende reagens* ✓ (5)

6.1.3 n(AgCl) = $n(AgNO_3)$ = 0,0105 mol ✓
m = nM ✓
= 0,0105(143,5) ✓
= 1,51 g ✓ (4)

6.2 6.2.1 $n(CaCO_3) = \frac{m}{M}$ ✓
$= \frac{50}{100}$ ✓
= 0,5 mol✓ (3)

6.2.2 $n(CO_2) = \frac{m}{M} = \frac{18,2}{44}$ ✓
= 0,414 mol
$n(CaCO_3) = n(CO_2)$ = 0,414 mol ✓

$m(CaCO_3)$ = nM
= 0,414(100) ✓
= 41,4 g
% purity/*suiwerheid* = $\frac{41,4}{50}$ x 100 ✓
= 82,8%✓ (5)

6.2.3 % purity/*suiwerheid* = 70% = $\frac{m}{50}$ ✓
m = 35 g $CaCO_3$
$n(CaCO_3) = \frac{m}{M} = \frac{35}{100}$ ✓
= 0,35 mol
$n(CO_2) = n(CaCO_3)$
= 0,35 mol ✓
$m(CO_2)$ = nM
= 0,35(44) ✓
= 15,4 g ✓ (5)
[24]

QUESTION/*VRAAG* 7

7.1 7.1.1 An acid is a proton (H^+ ion) donor. ✓✓
'n Suur is 'n proton (H^+- ioon) skenker. ✓✓ (2)

7.1.2 It ionises to form 2 protons/2 moles of H^+ ions. ✓✓/
Dit ioniseer om 2 protone/2 mol H^+ ione te vorm. ✓✓
OR/*OF*
It donates 2 H^+ ions per H_2SO_4 molecule. ✓✓
Dit skenk 2 H^+ ione per H_2SO_4 molekule. ✓✓ (2)

7.1.3 Ampholyte ✓
Amfoliet ✓ (1)

7.2 7.2.1 A solution of precisely known concentration. ✓✓
'n Oplossing waarvan die konsentraise presies bekend is. ✓✓ (2)

7.2.2 $H_2SO_4(\ell) + 2H_2O(\ell)$ ✓ $\rightarrow 2H_3O^+(aq) + SO_2^{-4}(aq)$ ✓ ✓
(balancing/*balansering*) (3)

7.3 7.3.1 $\frac{n_a}{n_b} = \frac{c_aV_a}{c_bV_b}$ ✓

$\frac{1}{2}$ ✓ $= \frac{c_a\,(0{,}012)✓}{0{,}2\,(0{,}02)✓}$

$c_a = 0{,}17\ mol.dm^{-3}$ ✓ (5)

7.3.2 Methyl orange ✓, reaction of strong acid ✓ and strong base ✓.
Metieloranje ✓, reaksie van 'n sterk suur ✓ en 'n sterk basis. ✓ (3)
[18]

QUESTION/*VRAAG* 8

8.1 Endothermic✓
Endotermies ✓ (1)

8.2 The Products have more Potential energy than the reactants. ✓✓
Die produk het meer Potensiële energie as die reaktante. ✓✓
OR/*OF*
More energy is absorbed than released ✓✓
Meer energie word geabsorbeer as vrygestel. ✓✓ (2)

8.3 + 14,8 $kJ.mol^{-1}$✓✓ without a + sign only 1 mark/*sonder 'n + teken slegs een punt* (2)

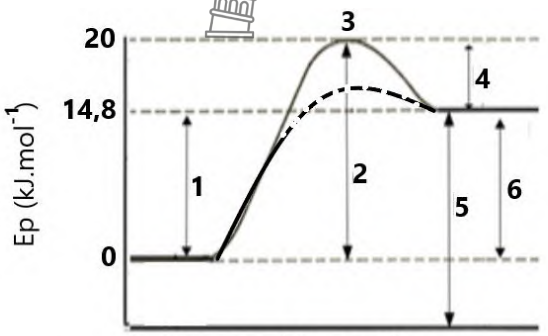
8.4 4 + 6 ✓ (1)

8.5 the minimum energy needed for a reaction to take place. ✓✓
die minimum energie benodig vir 'n reaksie om plaas te vind, ✓✓ (2)

8.6 3 ✓ (1)

8.7 It decreases the activation energy, ✓
by providing an alternative pathway for the reaction. ✓
Dit verminder die aktiveringsenergie, ✓
deur 'n alternatiewe roete vir die reaksie te skep. ✓ (2)

8.8



Course of the reaction/*verloop van die reaksie*

NOTE/*LET WEL*:
- ✓ Dotted line from reactants to products
- ✓ *Stippellyn van reaktante na produkte*
- ✓ Lower that 3 and higher than 4
- ✓ *Laer as 3 en hoër as 4*

(2)
[13]

QUESTION/*VRAAG* 9

9.1 9.1.1 An increase in the oxidation number. ✓✓
'n Toename in die oksidasiegetal. ✓✓ (2)

9.1.2 +6 ✓✓ (2)

9.2 9.2.1 Electrons are transferred. ✓/
Elektrone word oorgedra. ✓
OR/*OF*
The oxidation number of Fe^{2+}/$C\ell_2$ changes. ✓
Die oksidasiegetal van Fe^{2+}/$C\ell_2$ *verander.* ✓
OR/*OF*
Fe^{2+} is oxidised/$C\ell_2$ is reduced. ✓
Fe^{2+} *is geoksideer*/$C\ell_2$ *is gereduseer.* ✓ (1)

9.2.2 Fe^{2+} ✓ The oxidation number increases from +2 to +3. ✓
Fe^{2+} ✓ *Die oksidasiegetal neem toe van +2 na +3.* ✓
(2)

9.2.3 $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ ✓✓ (2)

9.2.4 $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ ✓
$Fe^{2+} \rightarrow Fe^{3+} + e^-$ ✓
$2Fe^{2+} + C\ell_2 \rightarrow 2Fe^{3+} + 2C\ell^-$ ✓ ✓(balancing/*balansering*) (4)
[13]

TOTAL/*TOTAAL*: 150

TAXONOMY GRID

	Recall		Comprehension		Analysis		Evaluation	
	Q no:	Mark	Q no:	Mark	Q no:	Mark	Q no:	Mark
	1.1	2	1.3	2	1.2	2		
	1.7	2	1.4	2	1.5	2		
			1.6	2	1.10	2		
			1.8	2				
			1.9	2				
	2.2	2	2.1.1	2	2.7	2		
			2.1.2	2	2.9	2		
	2.3	1	2.4	2				
	2.6	2	2.5	2				
			2.8	1				
	3.1	2	3.2.1	1				
			3.2.2	1				
			3.2.3	3				
			3.3.1	2				
	4.7	2	4.1	2	4.4	3	4.8	3
			4.2	2	4.6	4		
			4.3	3				
			4.5	2				
	5.1.1	2			5.1.2	6	5.2	4
					5.1.3	2		
			6.1.1	2	6.1.2	5		
					6.1.3	4		
					6.2.1	3		
					6.2.2	5		
					6.2.3	5		
	7.1.1	2	7.1.2	2	7.3.1	5		
	7.1.3	1	7.2.1	3	7.2.2	2		
			7.3.2	3				
	8.1	1	8.2	2	8.8	2		
	8.5	2	8.3	2				
			8.4	1				
			8.6	1				
			8.7	2				
	9.1.1	2	9.1.2	2				
			9.2.1	1				
			9.2.2	2				
			9.2.3	2				
			9.2.4	4				
Actual Total	15%	23	43%	64	37%	56	5%	7
Target Total	15%	15	40%	40	35%	35	10%	10