KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES P2 (CHEMISTRY)

FINAL EXAMINATION

NOVEMBER 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 10 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 9 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. 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 et cetera where required.
11. You are advised to use the attached DATA SHEETS.
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 – 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following is a chemical bond in the H_2 molecule?

A Non–polar covalent bond.
B Hydrogen bond.
C Polar covalent bond.
D Ionic bond. (2)

1.2 Which ONE of the following is a type of bond that forms between an H^+ ion and a NH_3 molecule?

A Ionic bond.
B Hydrogen bond.
C Pure covalent bond.
D Dative covalent bond. (2)

1.3 Which ONE of the following molecules is the MOST polar?

A HBr
B HI
C HCl
D HF (2)

1.4 Which of ONE of the following can result in a DISPERSION force?

A When the oppositely charged ends of induced dipoles attract each other.
B When there is a strong dipole-dipole attraction between a hydrogen atom and a polar-molecule.
C When an ion is attracted to a non-polar molecule.
D When the oppositely charged ends of permanent dipoles attract each other. (2)

1.5 Which ONE of the following statements is always true for bond length? The longer the bond length, the…

A greater the bond energy.
B lower the bond energy.
C higher the boiling point.
D lower the boiling point. (2)

1.6 Which ONE the following statements is an assumption made in the kinetic molecular theory for gases?

A The volume of the gas is the sum of the volumes occupied by each gas particle.
B The pressure exerted by an enclosed gas is due to the gas molecules colliding with the walls of the container.
C The gaseous molecules move with the same speed.
D The molecular collisions between gas particles are inelastic. (2)

1.7 A real gas behaves as an ideal gas at …

A low temperatures and low pressures.
B low temperatures and high pressures.
C high temperatures and high pressures.
D high temperatures and low pressures. (2)

1.8 A reaction between two substances takes place without a supply of any additional energy. If the temperature of the reaction mixture decreases, then the reaction is …

A spontaneous and exothermic.
B non-spontaneous and exothermic.
C spontaneous and endothermic.
D non-spontaneous and endothermic. (2)

1.9 Two acid-base reactions are given below:

$NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$
$SO_4^{2-}(aq) + HNO_3(aq) \rightarrow HSO_4^-(aq) + NO_3^-(aq)$

Which pair of substances act as proton acceptors?

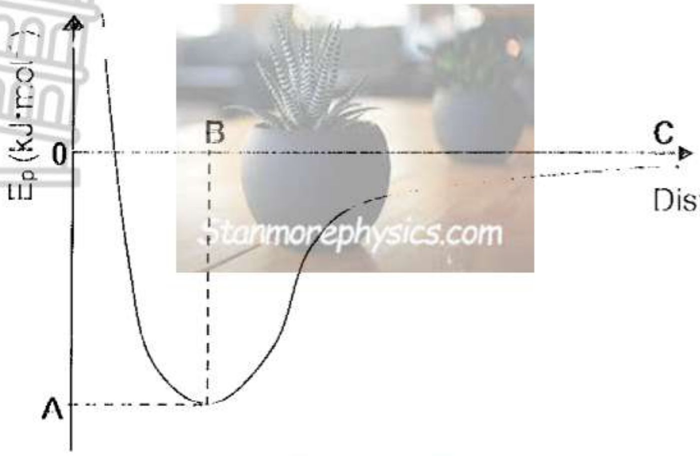
A H_2O and SO_4^{2-}
B NH_3 and HNO_3
C NH_3 and SO_4^{2-}
D H_2O and HNO_3 (2)

1.10 Which ONE of the following equations represent a REDOX reaction?

A $S + O_2 \rightarrow SO_2$
B $AgNO_3 + KI \rightarrow AgI + KNO_3$
C $NaOH + HCℓ \rightarrow NaCℓ + H_2O$
D $Na_2CO_3 + 2HCℓ \rightarrow 2NaCℓ + CO_2 + H_2O$ (2)
[20]

QUESTION 2: (Start on a new page)

The graph below illustrates the energy changes between two hydrogen atoms as they approach each other to form a bond.



2.1 Consider the values labelled **A, B** and **C**. Which label represents the:

2.1.1 Bond length? (1)

2.1.2 Lowest potential energy? (1)

2.1.3 Bond energy? (1)

2.2 Define *valence electrons.* (2)

2.3 Using Lewis Dot diagrams, show the bond formation in the hydrogen molecule. (3)

2.4 Explain, in terms of electrostatic forces and energy considerations, why the two H atoms form an H_2 molecule. (4)

2.5 Explain why two helium atoms do not bond to form a He_2 molecule. (2)

[14]

QUESTION 3: (Start on a new page)

An experiment is conducted to find the boiling points of the following substances:

H_2S, O_2 and CH_3OH.

The substances have approximately the SAME molecular weights.

3.1 Define *boiling point.* (2)

3.2 Why is it important that the three substances used in the experiment have approximately the SAME molecular weights? (1)

3.3 Distinguish between INTERMOLECULAR forces and INTERATOMIC forces. (2)

3.4 Identify the:

3.4.1 Strongest type of intermolecular force in each substance (3)

3.4.2 Substance with the highest boiling point (1)

3.4.3 Substance with the highest vapour pressure (1)

3.5 Explain the answer to QUESTION 3.4.2. (2)

[12]

QUESTION 4: (Start on a new page)

During an investigation to find the relationship between the pressure exerted and the volume occupied by an enclosed gas, the following results were obtained.

V (dm^3)	400	300	240	200	171	150	133	120
p(Kpa)	12	16	20	24	28	32	36	40

4.1 State Boyle's Law in words. (2)

4.2 Identify the TWO controlled variables in this experiment. (2)

4.3 Determine the volume of the gas when the pressure is 30 kPa. (3)

4.4 Sketch a graph of p vs $\frac{1}{V}$. Do not include values on the axes. (2)

4.5 A sample of the above gas is trapped in a narrow glass tube by a column of mercury (Hg). The atmospheric pressure is **x** kPa.

When the glass tube is held horizontally, the volume occupied by the gas is 5,61 cm^3.

When the glass tube is held vertically, the mercury exerts a pressure of 8,6 kPa on the trapped gas, which now occupies a volume of 5,17 cm^3.

See the diagrams below.

4.5.1 Write down an expression for the pressure exerted by the trapped gas, in terms of **x**, when the glass tube is held:

a) Horizontally (1)

b) Vertically (1)

4.5.2 If the temperature remains constant, calculate **x**, the atmospheric pressure. (4)
[15]

QUESTION 5: (Start on a new page)

When 1 g of solid calcium oxide is reacted with 2 g of carbon dioxide gas, 1,786 g of solid calcium carbonate is formed, and 1,214 g of carbon dioxide remains unreacted.

5.1 Using chemical symbols, write down a balanced equation for the above reaction. (4)

5.2 The *Law of the conservation of atoms* states that in a chemical reaction in a closed system, the total number of atoms of each reacting element is conserved.

5.2.1 Explain why atoms, and not molecules, are conserved in a chemical reaction. (2)

5.2.2 State the law of conservation of mass. (1)

5.2.3 Show that mass is conserved in the above reaction. (3)

5.3 The empirical formula of a certain compound is determined.
An analysis of a sample of the compound showed that it contained 40% C, 6,67% H and 53,33% O.

5.3.1 Distinguish between *empirical formula* and *molecular formula*. (2)

5.3.2 Determine the empirical formula of the compound.
Show ALL working. (7)

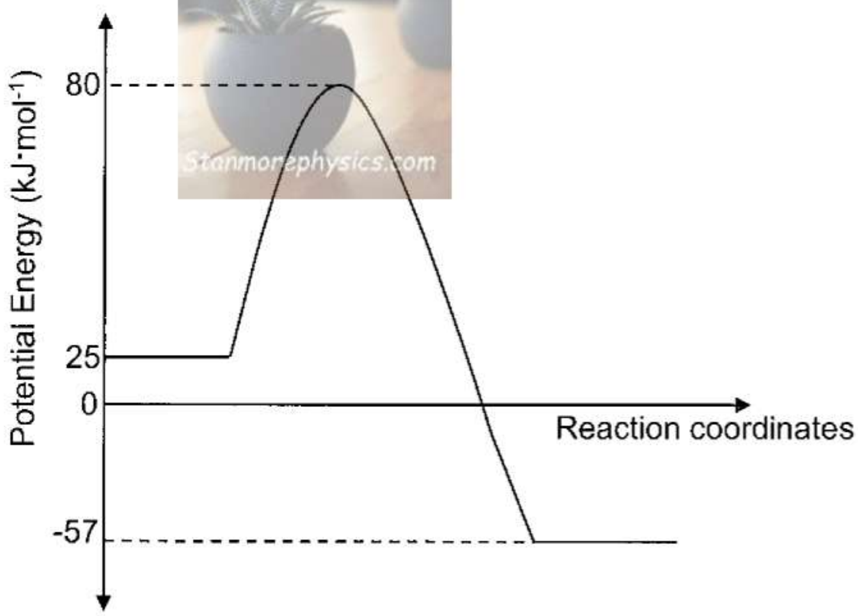
5.3.3 If the molecular mass of the compound is 60 $g \cdot mol^{-1}$, determine the molecular formula of the compound. (3)

[22]

QUESTION 6: (Start on a new page)

Consider the following reversible reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

The graph below, not drawn to scale, shows the energy changes during this reaction.



6.1 Is the reaction represented by above graph EXOTHERMIC or ENDOTHERMIC? Explain the answer. (3)

6.2 Define *heat of reaction*. (2)

6.3 Calculate the enthalpy change for this reaction. (3)

The energy of the activated complex is 80 $kJ \cdot mol^{-1}$.

6.4 Define the term *activated complex*. (2)

6.5 Calculate the activation energy for the reverse reaction. (2)

A catalyst is added to the above reaction.

6.6 Redraw the above graph in your answer book. Labels are not required on the axes, but the energy of the activated complex must be shown. On the same set of axes, draw the graph for the reaction with the catalyst. (3)
[15]

QUESTION 7: (Start on a new page)

11.5 g of C is reacted with 114.5 g of Cu_2O, to obtain 87.4 g of Cu according to the following balanced equation:

$$Cu_2O(s) + C(s) \rightarrow 2Cu(s) + CO(g)$$

7.1 Determine the limiting reactant in the reaction. (4)

7.2 Calculate the percent yield of Cu. (6)
[10]

QUESTION 8: (Start on a new page)

A learner uses **x** grams of sodium hydrogen carbonate, $NaHCO_3(s)$, to prepare a 250 cm^3 standard solution.

8.1 Define a *standard solution*. (2)

The balanced equation for the reaction between $NaHCO_3$ and sulphuric acid (H_2SO_4) is given below:

$$2NaHCO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2CO_2(g) + 2H_2O(l)$$

8.2 Write down TWO substances that are ampholytes in the above reaction. (2)

8.3 Sulphuric acid is classified as a strong acid.

8.3.1 Define a *strong acid*. (2)

8.3.2 Write down the chemical formula of the conjugate base of sulphuric acid. (1)

8.4 20 cm^3 of the prepared $NaHCO_3$ solution is neutralised by 12 cm^3 of a sulphuric acid solution that has a H_3O^+ concentration of 0,1 $mol \cdot dm^{-3}$. Calculate:

8.4.1 The pH of the H_2SO_4 solution (3)

8.4.2 The concentration of the sodium hydrogen carbonate solution (5)

8.4.3 **x**, the mass of sodium hydrogen carbonate used to prepare the standard solution (4)
[19]

QUESTION 9: (Start on a new page)

Hydrogen sulphide gas, H_2S, is bubbled into a beaker containing an acidified solution of permanganate ions, $MnO_4^-(aq)$. The following ionic reaction takes place:

$$H_2S + MnO_4^- + H^+ \rightarrow Mn^{2+} + S + H_2O$$

9.1 Define *oxidation*. (2)

9.2 Write down the oxidation number of Mn in the MnO_4^- ion. (2)

9.3 Identify the oxidising agent in the above reaction. (2)

9.4 Using the Table of Standard Reduction Potentials, write down the:

9.4.1 Oxidation half–reaction (2)

9.4.2 Reduction half–reaction (2)

9.5 Hence determine the overall balanced reaction in ionic form.
Show ALL the relevant steps in the balancing of the reaction. (4)
[14]

QUESTION 10: (Start on a new page)

Iron, Fe(s), can be converted to $Fe^{3+}(aq)$ in a two-step process.

STEP 1: Fe(s) is first reacted with an acid to form Fe^{2+} ions in $FeC\ell_2(aq)$.

STEP 2: $Fe^{2+}(aq)$ is reacted with $Ag^+(aq)$ to form $Fe^{3+}(aq)$.

10.1 Write down a balanced equation for the reaction in STEP 1, in the non-ionic form. (3)

10.2 Calculate the NUMBER of electrons transferred in STEP 1 if 3g of Fe(s) reacts completely with excess acid. (3)

10.3 Is the $Fe^{2+}(aq)$ OXIDISED or REDUCED In STEP 2?
Write down a relevant half-reaction to support the answer. (3)
[9]

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* $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b}=\frac{n_a}{n_b}$	$pH=-\log[H_3O^+]$
$K_w=[H_3O^+][OH^-]=1\times10^{-14}$ 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* $E^{\theta}_{cell}=E^{\theta}_{oxidising\,agent}-E^{\theta}_{reducing\,agent}\ /\ E^{\theta}_{sel}=E^{\theta}_{oksideermiddel}-E^{\theta}_{reduseermiddel}$	
$I=\frac{Q}{\Delta t}$	$n=\frac{Q}{e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

- Atomic number / *Atoomgetal*: 29
- Symbol / *Simbool*: Cu
- Electronegativity / *Elektronegatiwiteit*: 1,9
- 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
$Cl_2(g) + 2e^-$	⇌	$2Cl^-$	+ 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
$\mathbf{2H^+ + 2e^-}$	⇌	$\mathbf{H_2(g)}$	**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
$Al^{3+} + 3e^-$	⇌	Al	− 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
TABEL4B: 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

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

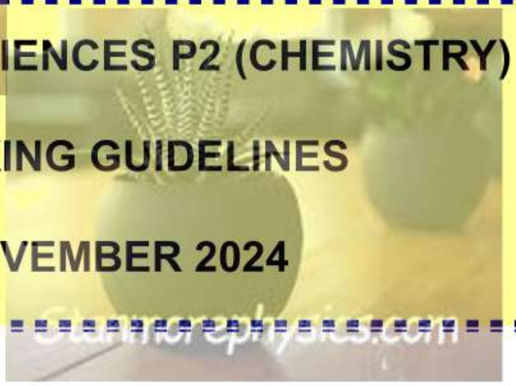
Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 11

NATIONAL SENIOR CERTIFICATE



PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKING GUIDELINES

NOVEMBER 2024

MARKS: 150

These marking guidelines consists of 8 pages.

QUESTION 1: MULTIPLE CHOICE QUESTIONS

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

[20]

QUESTION 2

2.1

2.1.1 B✓ (1)

2.1.2 A✓ (1)

2.1.3 A✓ (1)

2.2 Valence electrons are <u>electrons in the highest / outermost energy level of an atom</u>. ✓✓ (2 OR 0) (2)

2.3

H^{*} ✓ $_{\circ}H$ ✓ ⟶ $H\overset{*}{\circ}H$✓

(3)

2.4 There <u>are forces of attraction (between unlike charges / protons and electrons)</u> ✓and <u>forces of repulsion (between like charges / protons and protons and electrons and electrons)</u>. ✓ When two H atoms approach each other, there is a distance between their nuclei where <u>the forces of attraction and repulsion are balanced / the resultant force between them is zero.</u> ✓ For this distance the <u>potential energy of the system (the 2 atoms) is at its lowest</u> / <u>a stable bond is formed.</u> ✓ (4)

2.5 Helium <u>has a completely filled outer energy level consisting of a single electron pair.</u> ✓ The atom is <u>at its lowest energy level.</u>✓ (2)

[14]

QUESTION 3

3.1

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark

The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓ (2)

3.2 For the experiment to be fair / have only one independent variable.✓ (1)

3.3 Intermolecular forces are forces of attraction between molecules. ✓
Interatomic forces (chemical bonds) bond atoms to form molecules. ✓ (2)

3.4.1 H_2S - dipole-dipole forces✓
O_2 - London forces / Dispersion forces✓
CH_3OH - hydrogen bonding✓ (3)

3.4.2 CH_3OH✓ (1)

3.4.3 O_2✓ (1)

3.5 More energy is required to separate molecules✓ with strongest intermolecular forces.✓ (2)

[12]

QUESTION 4

4.1

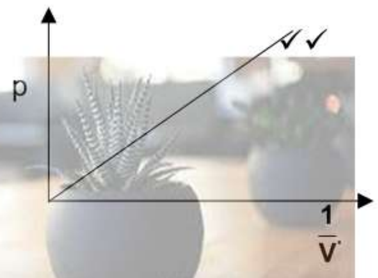
Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark

The pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature. ✓✓ (2)

4.2 Temperature✓ and mass✓ (of the gas). (2)

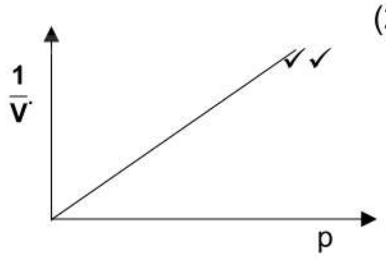
4.3
$$p_1V_1 = p_2V_2 \checkmark$$
$$400 \times 12 = 30 \times V_{2G} \checkmark$$
$$V_2 = 160 \text{ dm}^3 \checkmark$$
(3)

4.4 (2)



OR

Straight line through the origin ✓✓



4.5.1 a) x
b) x + 8,6 (2)

4.5.2 **POSITIVE MARKING FROM Q5.5.1:**

$p_1V_1 = p_2V_2$✓
x (5,61) ✓ = (x + 8,6) (5,17)✓
x = 101,5 kPa✓ (4)

[15]

QUESTION 5

5.1 CaO ✓ + CO_2 ✓→ $CaCO_3$ ✓ Balancing ✓ (4)

5.2.1 The total mass in a reaction (the mass of its atoms) stays the same, but because the atoms are re-arranged, ✓the number and type of molecules can change. ✓ (2)

5.2.2 The total mass before a reaction takes place is equal to the total mass after the reaction ✓
OR
In a chemical reaction, the total mass of the reactants and the products remains constant. (1)

5.2.3 Reactant mass: 1 g CaO + 2 g CO_2 = 3 g ✓
Product mass: 1,78 g $CaCO_3$ + 1,22 Unreacted CO_2= 3 g ✓
Therefore, the mass of the reactants and the products is the same, i.e. mass has been conserved in the reaction. ✓ (3)

5.3.1 Empirical formula is the simplest whole number ratio in which the elements combine✓ to form a compound whereas the molecular formula shows the actual numbers of each element✓ in a compound. (2)

5.3.2 Take 100 g of the compound.

	C	H	O
Mass in 100 g	✓ 40 g	6,67 g	53,33 g
$n = \frac{m}{M}$✓	$n = \frac{40}{12}$✓	$n = \frac{6,67}{1}$✓	$n = \frac{53,33}{16}$✓
	n = 3,33	n = 6,67	n = 3,33
Ratio:	✓ 1	2	1

Empirical formula = CH_2O✓ (7)

5.3.3 $M(CH_2O) = 30\ g{\cdot}mol^{-1}$✓

$$\frac{\text{Actual molecular mass}}{\text{Empircal formula mass}} = \frac{60}{30} ✓ = 2$$

∴ Molecular formula = $C_2H_4O_2$✓ (3)

[22]

QUESTION 6

6.1 Exothermic✓
Products have a lower energy than the reactants✓✓
OR energy of products is less than energy of reactants.
OR $\Delta H < 0$ / ΔH is negative. (3)

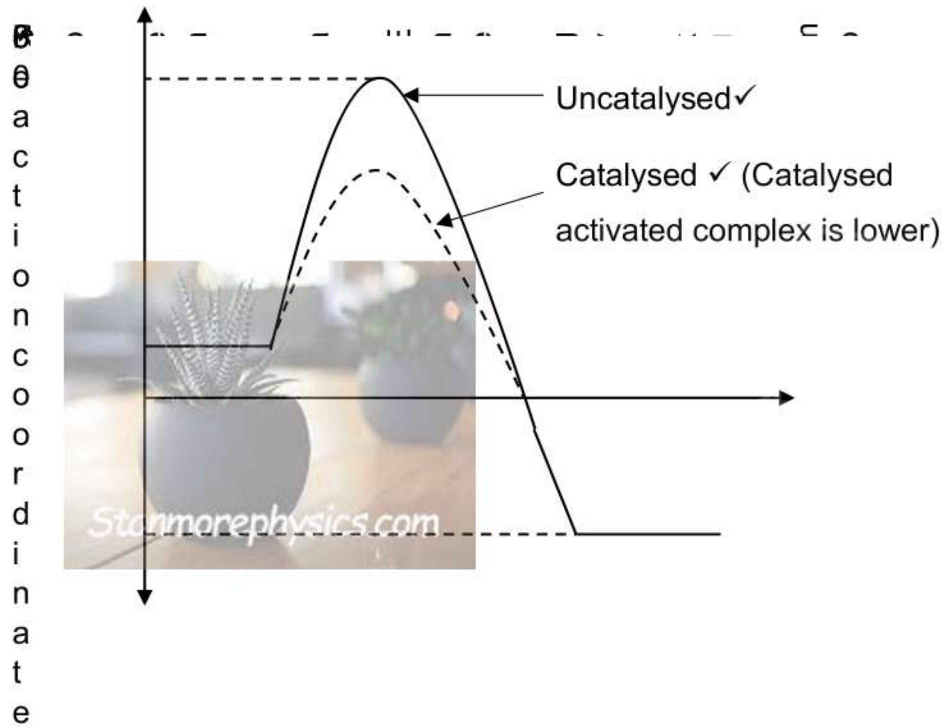
6.2 Heat of reaction (ΔH) is the energy absorbed or released per mole in a chemical reaction. ✓✓ (2)

6.3 $\Delta H = E_P - E_R$ ✓ $= -57 - 25$✓ $= -82\ kJ{\cdot}mol^{-1}$ ✓ (3)

6.4 The high energy / unstable / transition state when the reactants are converted to products. ✓✓ (2)

6.5 $E_a = 80 - (-57)$ ✓ $= 1137\ kJ{\cdot}mol^{-1}$✓ (2)

6.6 (3)



[15]

QUESTION 7

7.1

Cu_2O

$n = \frac{m}{M}$ ✓

$n = \frac{114,5}{143}$ ✓ = 0,80 mol

C

$n = \frac{m}{M}$

$n = \frac{11,5}{12}$ ✓ = 0,96 mol

Hence, the limiting reactant is Cu_2O ✓ (4)

7.2 **POSITIVE MARKING FROM Q7.1:**

Marking criteria:

- $m = nM$ / $n = \frac{m}{M}$ ✓
- Correct substitution of 63,5 for M in the above formulae. ✓
- Correct application of ratio of $NaHCO_3$ to H_2SO_4 (2:1). ✓
- Formula for percentage yield. ✓
- Correct substitution into formula for percent yield. ✓
- Final answer. ✓

OPTION 1:	**OPTION 2:**
Theoretical yield = nM ✓ = (0,8 x 2) ✓ x 63,5 ✓ = 101,6 g Percent Yield = $\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$ ✓ $= \frac{87,4}{101,6} \times 100\%$ ✓ = 86,02 % ✓	Actual yield = $\frac{m}{M}$ ✓ $= \frac{87,4}{63,5}$ ✓ = 1,38 mol Percent Yield = $\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$ $= \frac{1,38}{(2 \times 0,8)}$ ✓ × 100% ✓ = 86,25 % ✓

(6)

[10]

QUESTION 8

8.1 A solution whose concentration is accurately known. ✓✓ (2)

8.2 H_2O ✓ and HCO_3^- ✓ [Accept $NaHCO_3$ instead of HCO_3^-] (2)

8.3.1 A substance that ionises completely in solution / water, ✓ to form a large concentration of H_3O^+ ions. ✓ (2)

8.3.2 HSO_4^- ✓ (1)

8.4.1 pH = $-\log[H_3O^+]$ ✓

= $-\log(0,1)$ ✓

= 1 ✓ (3)

8.4.2

OPTION 1:	OPTION 2:
$[H_2SO_4] = ½ [H^+] = ½(0,1)$ ✓ $= 0,05\ mol·dm^{-3}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓ $\frac{(0,05)(12)}{c_b(20)}$ ✓ $= \frac{1}{2}$ ✓ $c_b = 0,06\ mol·dm^{-3}$ ✓	$[H_2SO_4] = ½ [H^+] = ½(0,1)$ ✓ $= 0,05\ mol·dm^{-3}$ $n_a = c_aV_a$ $= (0,05)(0,012)$ $= 6x10^{-4}$ mol $n(NaHCO_3) = (2)(6x10^{-4})$ ✓ $n(NaHCO_3) = 12\ x10^{-4}$ mol $c = \frac{n}{V}$ ✓ $c = \frac{12 \times 10^{-4}}{0,02}$ ✓ $= 0,06\ mol·dm^{-3}$ ✓

(5)

8.4.3 **POSITIVE MARKING FROM Q 8.4.2:**

OPTION 1:	OPTION 2:
$c = \frac{m}{MV}$ ✓ $0,06$ ✓ $= \frac{x}{(84)(0,25)}$ ✓ $x = 1,26$ g ✓	$n = cV$ $= (0,06)(0,25)$ ✓ $= 0,015$ mol $n = \frac{m}{M}$ ✓ $0,015 = \frac{x}{(84)}$ ✓ $x = 1,26$ g ✓

(4)

[19]

QUESTION 9

9.1 The loss of electrons. /An increase in oxidation number. ✓✓ (2)

9.2 +7✓✓ (2)

9.3 MnO_4^- / Mn^{7+}/ permanganate ion. ✓✓ (2)

9.4.1 $H_2S \rightarrow S + 2H^+ + 2e^-$ ✓✓ (2)

9.4.2 $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ✓✓ (2)

9.4.3 $(H_2S \rightarrow S + 2H^+ + 2e^-) \times 5$
$(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O) \times 2$ ✓
$\underline{5H_2S + 2MnO_4^- + 6H^+}$ ✓ $\rightarrow \underline{2Mn^{2+} + 5S + 8H_2O}$ ✓ Balancing✓ (4)

[14]

QUESTION 10

10.1 $Fe + 2HC\ell$ ✓ $\rightarrow FeC\ell_2 + H_2$ ✓ Balancing✓ (3)

10.2 $n = \frac{m}{M}$

$= \frac{3}{56}$✓

$= 0,054$ mol

$n_e = 2 \times 0,054$✓

$= 0,108$ mol

$N_e = 6,02 \times 10^{23} \times 0,108$

$= 6,5 \times 10^{25}$ electrons. ✓ (3)

10.3 Oxidised. ✓

$Fe^{2+} \rightarrow Fe^{3+} + e^-$✓✓ (3)

[9]

TOTAL: 150