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KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

FINAL EXAMINATION

NOVEMBER 2025

GRADE 11

MARKS: 150

TIME: 3 hours

This question paper consists of 12 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions et cetera where required.
10. 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 correct 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 The tendency of an atom to attract a bonded pair of electrons is known as …

A polarity.

B electron affinity.

C electronegativity.

D ionisation energy. (2)

1.2 Which ONE of the following atomic combinations will have the shortest bond length?

A C – C

B C – O

C C = C

D C ≡ C (2)

1.3 Which ONE of the following substances has a tetrahedral shape?

A CO_2

B SO_2

C HCN

D NH_4^+ (2)

1.4 In which ONE of the following are ION-DIPOLE forces present?

A NH_3 gas

B CO_2 gas

C LiCℓ aqueous solution

D $MgCl_2$ solid (2)

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1.5 One mole of a gas, SEALED in a container of volume **V**, exerts pressure **p.** The volume of the container is decreased to ⅓**V**, while the temperature remains constant. What is the pressure now exerted by the gas?

A ⅓ p

B 3 p

C p

D 1,5 p (2)

1.6 Consider the following statements about ideal gases:

(i) The gas particles occupy no volume.
(ii) There are no intermolecular forces between the particles
(iii) The collisions between the particles are perfectly elastic

Which of the above statements are true?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

1.7 Which ONE of the following solutions will have the greatest concentration of H^+ ions?

A 2 mol·dm^{-3} NH_3

B 1,5 mol·dm^{-3} CH_3COOH

C 1,5 mol·dm^{-3} H_2SO_4

D 1,5 mol·dm^{-3} $HC\ell$ (2)

1.8 Consider the following reaction:

$$HNO_3(aq) + \mathbf{X} \rightarrow NO_3^-(aq) + HSO_4^-(aq)$$

In this reaction, **X** represents…

A SO_4^{2-} acting as a base

B SO_4^{2-} acting as an acid.

C H_2SO_4 acting as a base.

D H_2SO_4 acting as an acid. (2)

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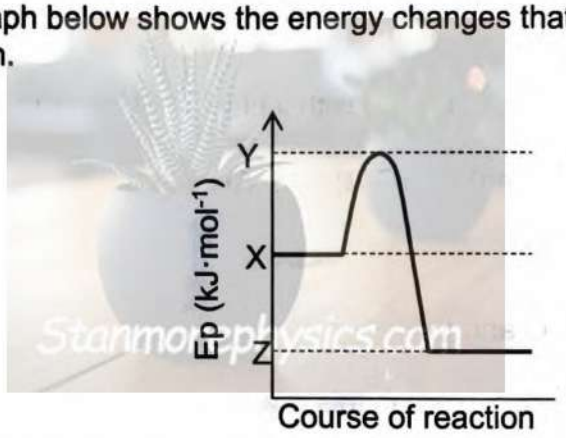
1.9 The graph below shows the energy changes that take place during a chemical reaction.



Which ONE of the following expressions corresponds to the activation energy of the reverse reaction?

A Y - X

B Y

C X - Z

D Y - Z

(2)

1.10 Consider the following redox reaction:

$$10Cl^- + 2MnO_4^- + 16H^+ \rightleftharpoons 2Mn^{2+} + 8H_2O + 5Cl_2$$

A product of the reduction half reaction is …

A Mn^{2+}

B Cl^-

C H^+

D Cl_2

(2)

[2 x 10 = 20]

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QUESTION 2 (Start on a new page.)

Consider the following reaction of nitric acid (HNO_3) with lithium oxide (Li_2O).

$$2HNO_3\,(aq) + Li_2O\,(s) \rightarrow 2LiNO_3\,(aq) + H_2O\,(\ell) \qquad \Delta H = -139\ kJ\cdot mol^{-1}$$

2.1 Define the term *ionic bond*. (2)

2.2 Show that the bond between Li and O is ionic. (2)

2.3 Write down the name of the salt formed in this reaction. (1)

2.4 Consider the H_2O molecule.

2.4.1 Write down the valency of the O atom. (1)

2.4.2 Draw the Lewis structure for the H_2O molecule. (3)

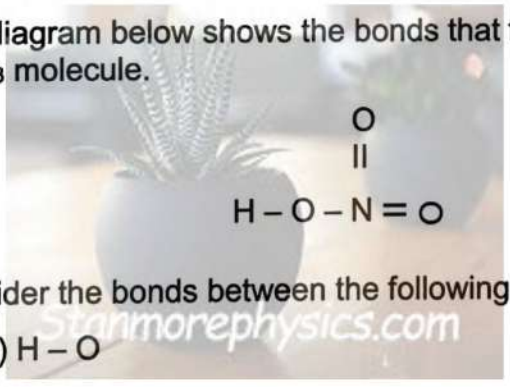
2.4.3 What is the shape of the H_2O molecule? (1)

2.4.4 NAME the ion that is formed when H_2O forms a dative covalent bond. (1)

2.5 The above reaction takes place in a beaker. How will the temperature of the contents of the beaker be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

2.6 Define *bond length*. (2)

2.7 The diagram below shows the bonds that form between the atoms in the HNO_3 molecule.



Consider the bonds between the following atoms:

(a) H – O

(b) N – O

(c) N = O

2.7.1 Is the bond length larger in (a) or in (b)? Explain the answer. (3)

2.7.2 Is the bond energy greater in (b) or in (c)? Give a reason for the answer. (2)

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QUESTION 3 (Start on a new page.)

The following table provides the bond energies between atoms.

Bond	Energy (kJ·mol^{-1})
C≡C	839
C=O	804
O=O	498
C–C	348
O–O	145
H–O	463
C–O	358
H–C	413

Consider the following reaction:

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g)$$

3.1 Define the term *activation energy*. (2)

3.2 Determine:

3.2.1 The activation energy for the reaction (3)

3.2.2 The heat of reaction in kJ·mol^{-1} (4)

3.3 How will the value calculated in QUESTION 3.2.2 be affected if a suitable catalyst is used? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

3.4 24 g of CH_4 reacts completely with excess O_2 at STP.

3.4.1 Is there a NET ABSORPTION or a NET RELEASE of energy? (1)

3.4.2 Calculate the energy referred to in QUESTION 3.4.1. (3)

3.4.3 If 5,5 moles of gas is present when the reaction is complete, calculate the initial number of moles of O_2 (g) used in the reaction. (5)

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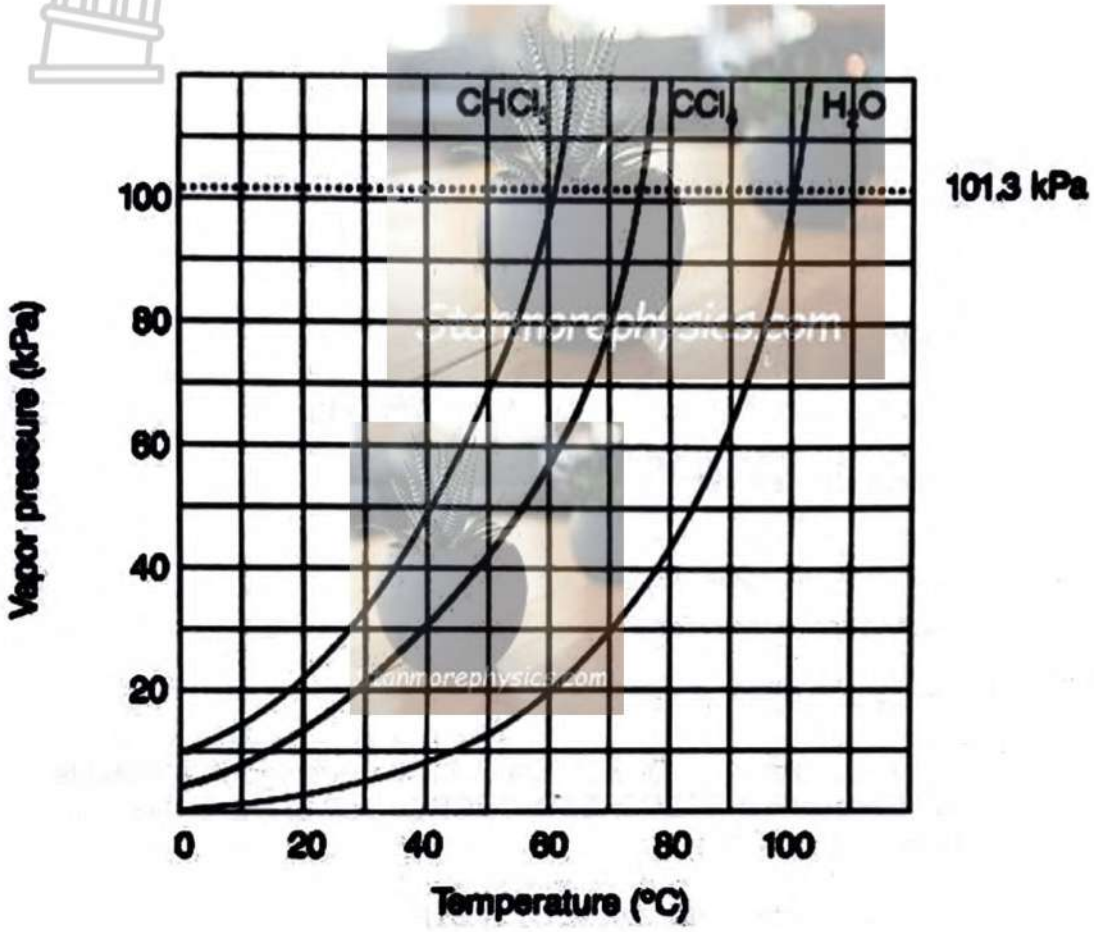
QUESTION 4 (Start on a new page.)

The graphs below show the relationship between vapour pressure and temperature for $CHC\ell_3$, $CC\ell_4$ and H_2O respectively. Atmospheric pressure is 101,3 kPa.



4.1 Define the term *vapour pressure*. (2)

4.2 Write down the:

4.2.1 Vapour pressure of $CC\ell_4$ at 70°C (1)

4.2.2 Temperature at which the vapour pressure of $CHC\ell_3$ is 100 kPa (1)

4.2.3 Phase of $CHC\ell_3$ at 65°C (1)

4.2.4 Boiling point of $CC\ell_4$ (2)

4.3 Fully explain the difference in the boiling points of $CC\ell_4$ and H_2O. (4)

4.4 Is $CC\ell_4$ soluble in H_2O? Choose from YES or NO.
Give a reason for the answer. (3)
[14]

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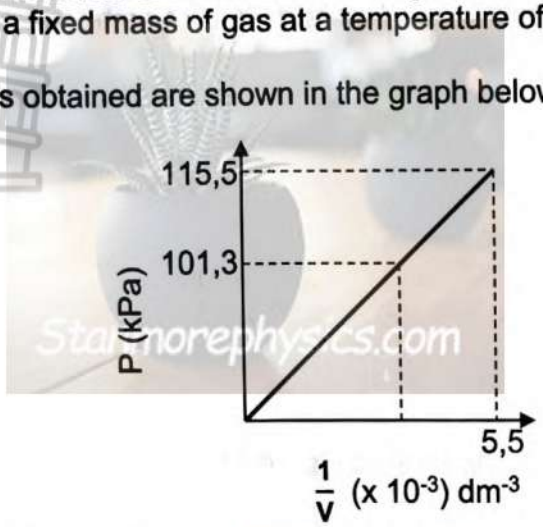
QUESTION 5 (Start on a new page.)

An experiment was conducted to investigate the relationship between pressure and volume of a fixed mass of gas at a temperature of 273 K.

The results obtained are shown in the graph below.



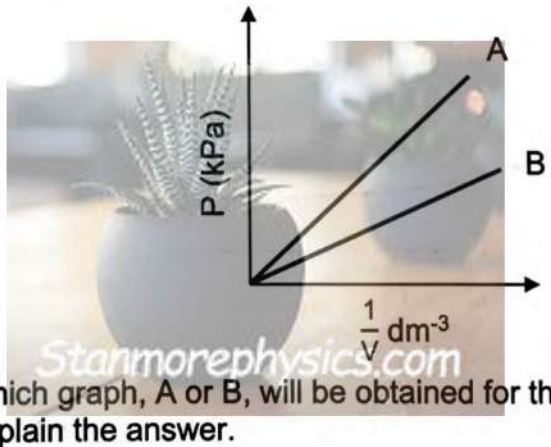
5.1 Named and state the law that was investigated. (3)

5.2 Calculate the volume of the gas when the pressure exerted by the gas is 101,3 kPa. (4)

5.3 Do real gases deviate from ideal gases at LOW pressures or HIGH pressures? Explain the answer. (3)

5.4 Draw a sketch graph of pressure (y-axis) vs volume (x-axis) for this experiment. No values or labels are required on the axes. (2)

The experiment is repeated using a greater mass of gas at 273 K. The results obtained are plotted on the same system of axes.



5.5 Which graph, A or B, will be obtained for the greater mass? Explain the answer. (3)

[15]

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QUESTION 6 (Start on a new page.)

6.1 A 1,50 g sample of a compound containing carbon, hydrogen and oxygen was completely burned in air. The products formed were 1,74 g of carbon dioxide and 0,70 g of water.

6.1.1 Define the term *empirical formula*. (2)

6.1.2 Determine, by calculation, the empirical formula of the compound. (7)

6.1.3 If the ratio of empirical formula to molecular formula is 1:3, determine the molecular formula of the compound (2)

6.2 An iron ore (impure sample) contains 30% Fe_2O_3.

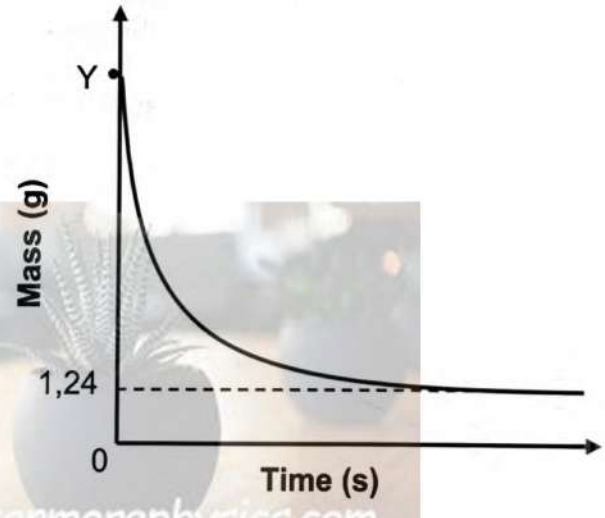
6.2.1 Write down the oxidation number of iron in Fe_2O_3 (1)

6.2.1 Calculate the mass of Fe that can be obtained from 150 g of this ore. (4)

6.3 In an experiment, a learner reacts 1,51 dm^3 of sulphuric acid, H_2SO_4, of concentration 0,43 $mol \cdot dm^{-3}$ with solid lithium. The balanced equation for the reaction is:

$$H_2SO_4 + 2Li \rightarrow Li_2SO_4 + H_2$$

The graph below shows how the mass of lithium changes with time during the reaction:



6.3.1 Define the term *limiting reagent*. (2)

6.3.2 Identify the limiting reagent in this reaction. Give a reason for the answer. (2)

6.3.3 Calculate the value of Y as shown in the graph. (7)

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QUESTION 7 (Start on a new page.)

7.1 Acetic acid (CH_3COOH) ionises in water according to the following balanced equation:

$$CH_3COOH(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$$

7.1.1 Define an *acid* according to the Arrhenius theory (2)

7.1.2 Write down the FORMULAE of TWO acids in this reaction. (2)

7.1.2 Is acetic acid a STRONG acid or a WEAK acid? Give a reason for the answer. (2)

7.2 A nitric acid solution, $HNO_3(aq)$, has a concentration of 0,15 $mol \cdot dm^{-3}$. In a reaction, 31,3 cm^3 of the HNO_3 solution neutralises 24,5 cm^3 of a calcium hydroxide solution, $Ca(OH)_2(aq)$, according to the following balanced equation:

$$2HNO_3(aq) + Ca(OH)_2(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(\ell)$$

7.2.1 Calculate the concentration of the $Ca(OH)_2$ solution. (5)

250 cm^3 of the Nitric acid HNO_3 solution, with the same concentration of 0,15 $mol \cdot dm^{-3}$ is now reacted with pure Zn.

$$Zn(s) + 2HNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + H_2(g)$$

The pH of the final solution is 2,174.
Assume that the volume of the solution does not change.

7.2.2 Calculate the mass of Zn that reacted. (8)

7.2.3 Determine the volume that the hydrogen gas produced will occupy at 25^0C.
Take molar gas volume as $24000 cm^3 \cdot mol^{-1}$ at 25^0C (3)
[22]

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QUESTION 8 (Start on a new page.)

8.1 A solution of iron (II) nitrate reacts with Aℓ (s) according to the following unbalanced ionic equation:

$$A\ell\ (s) + Fe^{2+}\ (aq) \rightleftharpoons A\ell^{3+}\ (aq) + Fe\ (s)$$

8.1.1 Define the term *redox reaction.* (2)

8.1.2 Identify the reducing agent in the above reaction. (1)

8.1.3 Give a reason why the nitrate ion, NO_3^-, is a spectator ion in the reaction. (1)

8.1.4 Give a reason why the reaction is unbalanced. (2)

8.2 The incomplete ionic reaction between dichromate ions ,$Cr_2O_7^{2-}$, and tin (II) ions, Sn^{2+}, in an acid medium is given below.

$$Cr_2O_7^{2-} + Sn^{2+} + H^+ \rightarrow Cr^{3+} + Sn^{4+}$$

8.2.1 Write down the oxidation number of Cr in the $Cr_2O_7^{2-}$ ion. (1)

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

8.2.3 Using the Table of Standard Reduction Potentials, write down the balanced net ionic equation. (3)
[12]

TOTAL:150

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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*
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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$		$pH = -\log[H_3O^+]$
$P_1V_1 = P_2V_2$		$PV = nRT$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K		

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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

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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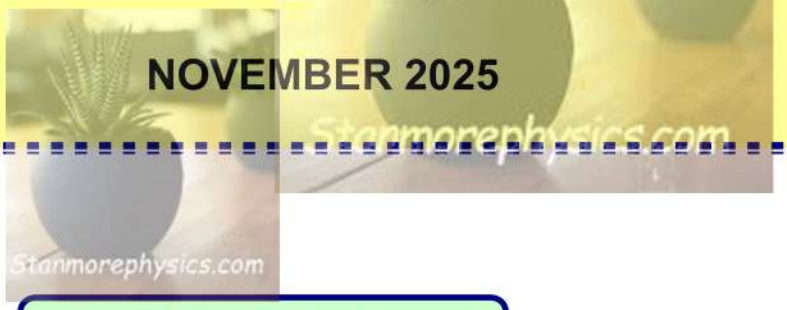
KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

FINAL EXAMINATION

NOVEMBER 2025



GRADE 11

These marking guidelines consist of 10 pages.

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QUESTION 1

1.1 C ✓✓ (2)

1.2 D ✓✓ (2)

1.3 D ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B ✓✓ (2)

1.6 D ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

1.10 A ✓✓ (2)

[2 x 10 = 20]

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QUESTION 2

2.1. The force of attraction between oppositely charged ions,✓ formed as a result of the transfer of electrons.✓ (2)

2.2 ΔEN = 3.5 – 1
= 2.5 } Any one ✓
ΔEN > 2.1 ✓ (2)

2.3 lithium nitrate ✓ (1)

2.4.1 2 ✓ (Accept: -2) (1)

2.4.2

Marking criteria/*Nasienriglyne*
✓ Correct number of electrons surrounding each atom.
✓ Single bond between O and each of the two H atoms.
✓ Whole structure correct (3)

2.4.3 Bent / Angular ✓ (1)

2.4.4 hydronium ✓ (1)

2.5 Increases. ✓ There is a (net) release of energy / the reaction is exothermic. ✓ (2)

2.6 The average distance between the nuclei of two bonded atoms. ✓✓ (2 or 0) (2)

2.7.1 (b) ✓
Nitrogen atoms are larger than hydrogen atoms. ✓
The nuclei will be further apart. ✓ (3)

2.7.2 (c) ✓
The bond length in (c) is shorter OR there is a stronger force of attraction wih the double bond ✓ (2)
[20]

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QUESTION 3

3.1 The minimum energy needed for a reaction to take place. ✓✓ (2)

3.2.1 $E_{absorbed}$ = (4 x C–H) + (2 x O = O)
= (4 x 413) ✓+ (2 x 498) ✓
= 2648 kJ·mol^{-1} ✓
(3)

3.2.2 **POSITIVE MARKING FROM Q3.2.1:**

$E_{released}$ = (2 x C = O) + (4 x O – H)
= (2 x 804) ✓+ (4 x 463) ✓
= 3460 kJ·mol^{-1}

$\Delta H = \sum E_{absorbed} - \sum E_{released}$ (4)
= 2648 – 3460 ✓
= –812 kJ·mol^{-1} ✓

3.3 REMAINS THE SAME ✓
A catalyst has no effect on energy of reactants or products✓ OR A catalyst only affects activation energy. (2)

3.4.1 Net release. ✓ (1)

3.4.2 **POSITIVE MARKING FROM Q3.2.2**

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

$= \frac{24}{16}$ ✓

= 1,5 mol

Energy released = 1,5 x 812 kJ ✓ = 1218 kJ ✓ (3)

3.4.3 **POSITIVE MARKING FROM Q3.4.2**

n_{O2} that reacted = 2 x n_{CH4} that reacted = 2 x 1,5 = 3 mol✓

n_{CO2} that formed = 1 x n_{CH4} that reacted = 1 x 1,5 = 1,5 mol✓

n_{H2O} that formed = 2 x n_{CH4} that reacted = 2 x 1,5 = 3 mol✓

n_{O2} in excess = 5,5 – (1,5 + 3) = 1 mol✓

Initial n_{O2} = 3 + 1 = 4 mol✓ (5)
[20]

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QUESTION 4

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

4.2.1 80 kPa ✓ (1)

4.2.2 60°C ✓ [Accept answers between 60°C and 62°C] (1)

4.2.3 Gas ✓ (1)

4.2.4 75°C✓✓ (2)

4.3 H_2O has a higher boiling point than CCl_4✓
Intermolecular forces between H_2O molecules is hydrogen bonding, while intermolecular forces between CCl_4 molecules is London/Dispersion forces.✓
Intermolecular forces in H_2O are stronger / Intermolecular forces in CCl_4 are weaker. ✓
More energy is required to overcome the intermolecular forces in H_2O. ✓ (4)

4.4 No. ✓
OPTION 1: CCl_4 molecules are polar ✓while H_2O molecules are non-polar✓

OPTION 2: the imtermolecular forces in H_2O are stronger than in CCl_4 ✓ so they are not of comparable strength. ✓ (3)
[14]

QUESTION 5

5.1.

Marking guidelines
If any of the underlined key words/phrases are omitted: minus 1 mark.

Boyle's Law ✓
Pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature. ✓✓ (3)

5.2 **OPTION 1**:

$$V = \frac{1}{5,5 \times 10^{-3}}$$ ✓

$p_1V_1 = p_2V_2$ ✓

$(115,5)(181,82) = (101,3)V_2$ ✓

$V_2 = 207,31\ dm^3$ ✓

OPTION 2:

$$\frac{115 - 101,3}{5,5 - \frac{1}{V}} = \frac{115}{5,5}$$ ✓✓

$V = 207,45\ dm^3$✓

(4)

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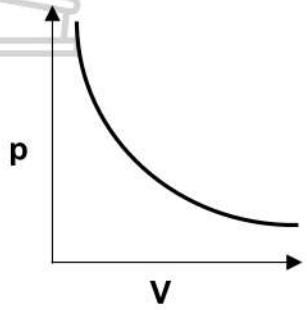
5.3 High✓
The volume of the gas particles is no longer negligible ✓ **OR** Intermolecular forces become significant.
Increasing the pressure does not decrease the volume as predicted by Boyle's Law✓ (3)

5.4



Marking criteria
Correct shape (hyperbola) ✓✓

(2)

5.5 A ✓
The gradient is proportional to the number of moles.
A has a larger gradient, ✓ and hence a larger number of moles of gas✓. (3)
[15]

QUESTION 6

6.1.1 The smallest whole number ratio of elements in a compound. ✓✓ (2 OR 0) (2)

6.1.2 Mass of C = $\frac{12}{44}$ x 1,74 ✓ = 0,475 g

Mass of H = $\frac{2}{18}$ x 0,70 ✓ = 0,078 g

Mass of O = 1,5 – (0,475 + 0,078) ✓ = 0,947 g

C:	H:	O:
$n = \frac{m}{M}$	$n = \frac{m}{M}$	$n = \frac{m}{M}$
$= \frac{0,475}{12}$ ✓	$= \frac{0,078}{1}$ ✓	$= \frac{0,947}{16}$ ✓
= 0,04	= 0,078	= 0,059

C : H : O
0,04 : 0,078 : 0.059
2 : 4 : 3

Molecular formula: $C_2H_4O_3$ ✓ (7)

6.1.3 $(C_2H_4O_3)_3$✓
Molecular formula is $C_6H_{12}O_9$ ✓ (2)

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6.2.1 +3 ✓ (1)

6.2.2 Mass of $Fe_2O_3 = \frac{30}{100} \times 150$ ✓

$= 45g$

Mass of Fe $= \frac{112}{160}$ ✓ $\times 45$ ✓

$= 31,5$ g ✓ (4)

6.3.1 Limiting reagent is the reactant that is used up completely in a reaction. ✓✓
OR Limiting reagent determines the maximum amount of product formed in a reaction. (2)

6.3.2 H_2SO_4 ✓
Lithium was left over after the reaction OR All the H_2SO_4 was used up during the reaction. ✓ (2)

6.3.3

Marking criteria:

(a) Use of formula $c = \frac{n}{V}$ ✓
(b) Substitution into formula $c = \frac{n}{V}$ to calculate no fo mol of H_2SO_4 ✓
(c) Apply ratio (2:1) to calculate no of mol of Li used. ✓
(d) Substitution into formula $n = \frac{m}{M}$ to calculate mass of Li used / initial mass of Li. ✓
(e) Addition of mass of Li used to final mass of Li OR Addition of moles of Li used to final moles of Li. ✓✓
(f) Final answer. ✓

$c = \frac{n}{V}$ ✓(a)

$0,43 = \frac{n}{1,51}$ ✓(b)

$n_{H2SO4} = 0,65$ mol H_2SO_4

n_{Li} used $= 2 \times n_{H2SO4}$ used
$= 2 \times 0,65$ ✓(c)
$= 1,3$ mol

$n = \frac{m}{M}$	$n = \frac{m}{M}$
$1,3 = \frac{m}{7}$ ✓(d)	$n = \frac{1,24}{7}$
$m = 9,1$ g Li used	$m = 0,18$ mol Li used
Initial mass of Li = 9,1 + 1,24 ✓✓(e)	Initial moles of Li = 0,18 + 1,3 ✓✓(e)
Y = 10,34 g ✓(f)	= 1,48 mol
	$n = \frac{m}{M}$
	$1,48 = \frac{m}{7}$ ✓(d)
	Y = m = 10,33 g ✓(f)

(7)
[27]

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QUESTION 7

7.1.1 An acid is a substance that produces hydrogen ions (H+)/hydronium ions (H_3O^+) when it dissolves in water. ✓✓ (2)

7.1.2 CH_3COOH ✓ and H_3O^+ ✓ (2)

7.1.2 Weak acid. ✓ It ionises incompletely/partially in water to form a low concentration of H_3O^+ ions. ✓ (2)

7.2.1

OPTION 1

$$\frac{C_BV_B}{C_AV_A} = \frac{n_B}{n_A} \checkmark$$

$$\frac{C_B(24,5)\checkmark}{(0,15)(31,3)\checkmark} = \frac{1}{2} \checkmark$$

$$C_B = 0,1 \text{ mol·dm}^{-3} \checkmark$$

OPTION 2

$$C = \frac{n}{V} \checkmark$$

$$0,15 = \frac{n}{0,0313} \checkmark$$

$$n = 4,7 \times 10^{-3} \text{ mol } HNO_3$$

$HNO_3 : Ca(OH)_2$

2 : 1 ✓

$4,7 \times 10^{-3} : 2,35 \times 10^{-3}$ mol $Ca(OH)_2$

$$C = \frac{n}{V}$$

$$C = \frac{2,35 \times 10^{-3}}{0,0313} \checkmark$$

$$C = 0,1 \text{ mol·dm}^{-3} \checkmark$$

(5)

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7.2.2

Marking criteria:
(a) Substitution into formula n = cV to calculate initial concentration of HNO_3.
(b) Substitution of pH value (2,174) in pH formula.
(c) Substitution into formula n = cV to calculate final concentration of H_3O^+.
(d) Apply ratio $n_{final}(H_3O^+)$: $n_{final}(HNO_3)$ =1:1 to calculate final moles of HNO_3.
(e) Subtraction: $n_{reacted}$ (HNO_3) = n_{final} (HNO_3) - $n_{rnitial}$ (HNO_3).
(f) Apply ratio $n_{reacted}$ (Zn) = ½ $n_{reacted}$ (HNO_3) to calculate $n_{reacted}$ (Zn).
(g) Substitute in formula m = nM to calculate mass of Zn that reactd.
(h) Final answer.

$n_{initial}(HNO_3) = cV$

$= \underline{0,15 \times 0,25}$ ✓(a) = 0,0375 mol

$pH = -\log[H_3O^+]$

$\underline{2,174 = -\log[H_3O^+]}$ ✓(b)

$[H_3O^+] = 6,7 \times 10^{-3}$ mol·dm^{-3}

$n_{final}(H_3O^+) = cV$

$= \underline{6,7 \times 10^{-3} \times 0,25}$ ✓(c) $= 1,675 \times 10^{-3}$ mol

$n_{final}(HNO_3) = 1,675 \times 10^{-3}$ mol ✓(d)

$n_{reacted}(HNO_3) = \underline{0,0375 - 1,675 \times 10^{-3}}$ ✓(e)

$= 0,0358$ mol

$n_{reacted}$ (Zn) = ½ (0,0358) ✓(f)

= 0,018 mol

$m = nM$

$= \underline{0,018 \times 65}$ ✓(g)

= 1,16 g ✓(h)

(8)

7.2.3

$n_{produced}$ (H_2) = ½ $n_{reacted}$ (HNO_3) OR 1 x $n_{reacted}$ (Zn)

= ½ (0,0358) ✓ OR 1(0,018)

= 0,018 mol

$V = nV_m$

= 0,018 x 24 000 ✓

= 429,6 cm^3 ✓ (0,4296 dm^3)

(3)
[22]

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QUESTION 8

8.1.1 A reaction in which electrons are transferred. ✓✓ (2)

8.1.2 Al ✓ (1)

8.1.3 NO_3^- ions do not undergo oxidation nor reduction ✓
OR
The oxidation numbers stay the same. (1)

8.1.4 The net charge on the left-hand side / for the reactants is not equal to the net charge on the right-hand side / for the products. ✓✓ (2)

8.2.1 +6 ✓ (1)

8.2.2 $Cr_2O_7^{2-} + 14H^+ + 6e^- \checkmark \rightarrow 2Cr^{3+} + 7H_2O$ ✓ (2)

8.2.3 $3Sn^{2+} \rightarrow 3Sn^{4+} + 6e^-$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
$Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \checkmark \rightarrow 2Cr^{3+} + 3Sn^{4+} + 7H_2O$ ✓ Balancing✓
(3)
[12]

TOTAL:150

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