basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages, 4 data sheets and 1 graph sheet.

* I P H S C E 2 *

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EASTERN CAPE

INSTRUCTIONS AND INFORMATION

1. Write your name and class (e.g. 11A) in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK, except QUESTION 4.2 that must be answered on the attached GRAPH SHEET.

3. Hand in the ANSWER SHEET with the ANSWER BOOK.

4. Start EACH question on a NEW page in the ANSWER BOOK.

5. Number the answers correctly according to the numbering system used in this question paper.

6. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

7. You may use a non-programmable calculator.

8. You may use appropriate mathematical instruments.

9. You are advised to use the attached DATA SHEETS.

10. Show ALL formulae and substitutions in ALL calculations.

11. Round off your FINAL numerical answers to a minimum of TWO decimal places.

12. Give brief motivations, discussions, etc. where required.

13. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E. Each question has only ONE correct answer.

1.1 The number of valence electrons in a silicon atom is …

A 4

B 6

C 14

D 28 (2)

1.2 In a polar covalent bond …

A the difference in electronegativity between two atoms is zero.

B electrons are shared unequally between two atoms.

C electrons are transferred from the less electronegative atom to the more electronegative atom.

D delocalised electrons are shared between atoms. (2)

1.3 The type of intermolecular forces present between N_2 molecules are …

A triple bonds.

B dipole-dipole forces.

C hydrogen bonds.

D London forces. (2)

1.4 Which ONE of the following contains ionic bonds?

A OF_2

B H_2O

C $CH_3C\ell$

D $NaC\ell$ (2)

1.5 The number of ions present in 3 moles of $MgC\ell_2$ is …

A $3 \times 6{,}02 \times 10^{23}$

B $6 \times 6{,}02 \times 10^{23}$

C $9 \times 6{,}02 \times 10^{23}$

D $12 \times 6{,}02 \times 10^{23}$ (2)

1.6 Two different gases of the same volume at STP will have the same …

A mass.

B density.

C molar mass.

D number of molecules. (2)

1.7 4 moles of nitrogen gas is sealed in a balloon at temperature **T** and pressure **p**. The volume of the balloon changes from **V** to **2V** when the temperature is increased to **1,5T**.

The new pressure in the balloon is …

A 0,75p

B 1,33p

C 1,5p

D 3p (2)

1.8 Consider the chemical equation below:

$$OH^-(aq) + HCO_3^-(aq) \rightleftharpoons CO_3^{2-}(aq) + H_2O(\ell)$$

The Lowry-Brønsted bases in the above reaction are …

A $HCO_3^-(aq)$ and $OH^-(aq)$

B $H_2O(\ell)$ and $OH^-(aq)$

C $H_2O(\ell)$ and $HCO_3^-(aq)$

D $OH^-(aq)$ and $CO_3^{2-}(aq)$ (2)

1.9 A few drops of bromothymol blue indicator are added to a hydrochloric acid solution, HCℓ(aq). When ammonium hydroxide, $NH_4OH(aq)$, is added to this solution, the colour of the indicator will change from …

A blue to yellow.

B yellow to blue.

C yellow to red.

D blue to red. (2)

1.10 Oxidation takes place when the …

A reducing agent loses electrons.

B oxidising agent loses electrons.

C reducing agent gains electrons.

D oxidising agent gains electrons. (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 Ammonia $NH_3(g)$ and hypochlorous acid HOCℓ(ℓ) are both examples of covalent compounds.

2.1.1 Define the term *bonding pair*. (2)

2.1.2 Draw Lewis structures for the following molecules:

(a) NH_3 (2)

(b) HOCℓ (2)

2.1.3 Write down the:

(a) Number of bonding pairs in NH_3 (1)

(b) Number of lone pairs on the oxygen atom in HOCℓ (1)

(c) Shape of an ammonia molecule (1)

2.1.4 Which bond, N-H or O-H, is more polar? Give a reason for the answer. (2)

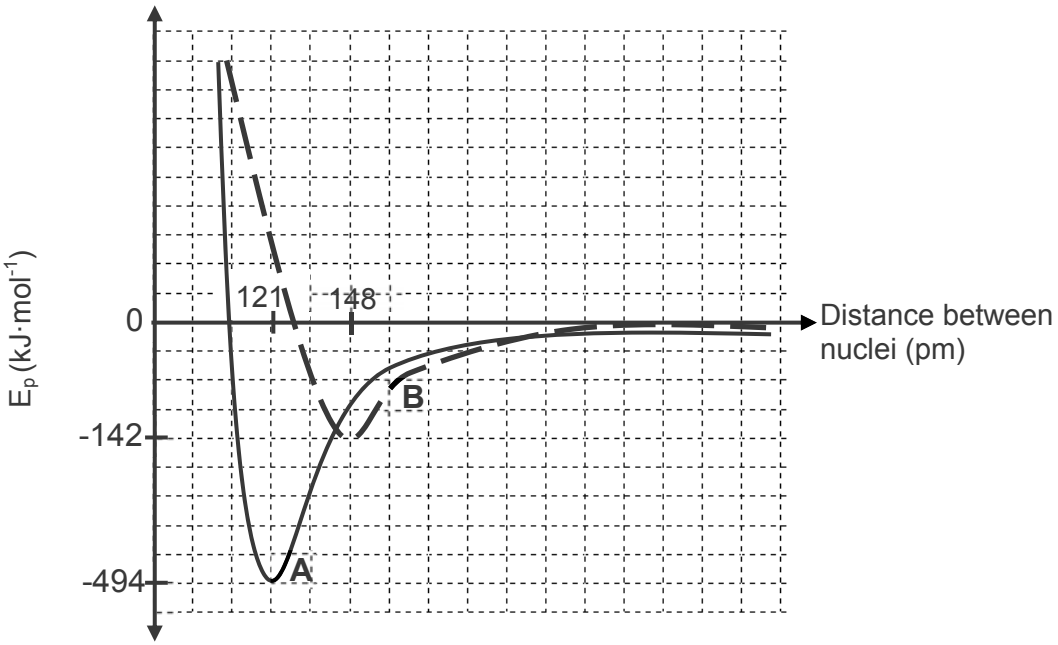
2.1.5 Write down the type of intermolecular forces present in BOTH ammonia and hypochlorous acid. (1)

2.1.6 When ammonia dissolves in water, the ammonium ion (NH_4^+) is formed.

What type of bond forms between the ammonia molecule and the hydrogen ion? (1)

2.2 The graph of potential energy versus distance between the nuclei of two oxygen atoms during bond formation is shown below.

Graph of potential energy versus distance between nuclei



2.2.1 Define the term *bond energy*. (2)

2.2.2 Which curve, **A** or **B**, represents the formation of the double bond (O=O) between oxygen atoms? Briefly explain the answer. (3)

2.2.3 Write down the bond length of the bond represented by curve **B**. (1)
[19]

QUESTION 3 (Start on a new page.)

The melting points and boiling points of four substances (**A**, **B**, **C** and **D**) are shown in the table below.

	SUBSTANCES	MELTING POINT (°C)	BOILING POINT (°C)
A	HF	- 83,11	19,54
B	HCℓ	- 114,2	- 81,7
C	CS_2	- 111	46,0
D	CO_2	- 56,6	- 78,5

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

3.2 Explain the difference in melting points of HF and HCℓ by referring to the TYPE of intermolecular forces. (4)

3.3 Which ONE of the substances (**A**, **B**, **C** or **D**) above is a liquid at 25 °C? (1)

3.4 Explain why CS_2 has a higher boiling point than CO_2. (3)

3.5 Which ONE of the substances (**A**, **B**, **C** or **D**) above has the highest vapour pressure? Give a reason for the answer by referring to the data in the table. (2)
[12]

QUESTION 4 (Start on a new page.)

The relationship between pressure and volume of an enclosed gas at 25 °C is investigated. The results obtained are shown in the table below.

PRESSURE (kPa)	VOLUME (m^3)	$\frac{1}{V}$ (m^{-3})
50	0,121	8,2
80	0,076	13,2
125	0,049	20,6
140	0,043	23,1
175	0,035	28,8

4.1 State *Boyle's law* in words. (2)

4.2 ANSWER THIS QUESTION ON THE ATTACHED GRAPH PAPER.

Use the data in the table above to draw a graph of pressure (p) versus the inverse of the volume ($\frac{1}{V}$) on the attached graph paper. (3)

4.3 Which physical quantity can be determined from the gradient of the graph? Give a reason for the answer. (2)

4.4 It is found that, at high pressures, the shape of the graph deviates from that of the graph obtained in QUESTION 4.2. Explain this deviation. (3)

4.5 Calculate the number of moles of gas present in the sealed container at a pressure of 125 kPa. (4)
[14]

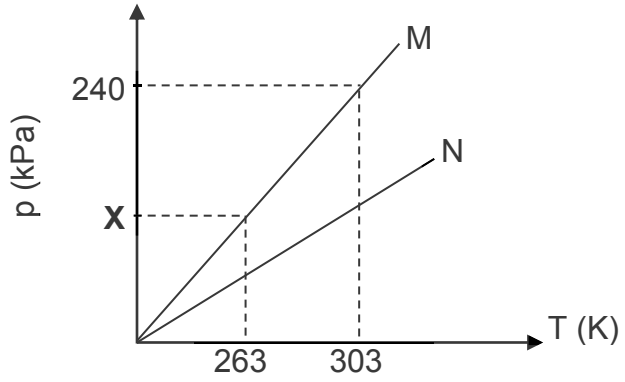
QUESTION 5 (Start on a new page.)

An unknown mass of gas is sealed in container **M**. The temperature is increased and the pressure inside the container is measured.

The experiment is now repeated using the same mass of the same gas in a different container, **N**.

The results obtained are represented in the sketch graph below.

Graph of pressure versus temperature



5.1 Determine the value of **X** as shown on the graph. (3)

5.2 How does the volume of container **N** compare to that of container **M**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.3 Explain the answer to QUESTION 5.2 with the aid of a relevant equation. (3)
[7]

QUESTION 6 (Start on a new page.)

6.1 Potassium permanganate, $KMnO_4$, burns with a bright flame when a few drops of glycerine are added to it.

The incomplete equation for the reaction is:

$$14KMnO_4 + \text{glycerine} \rightarrow 7K_2CO_3 + 7Mn_2O_3 + xCO_2 + 16H_2O$$

6.1.1 Define the term *molar mass*. (2)

6.1.2 The composition of glycerine is as follows:

39,13% carbon; 8,7% hydrogen; 52,17% oxygen

Determine the EMPIRICAL formula of glycerine. Show ALL calculations. (6)

6.1.3 Write down the value of x in the equation above if the MOLECULAR formula of glycerine is $C_3H_8O_3$. (1)

6.1.4 Calculate the mass of Mn_2O_3 that can be prepared if 18 g of $KMnO_4$ reacts with excess glycerine. (4)

6.2 The balanced equation for the reaction of sodium chloride, NaCℓ, with sulphuric acid, H_2SO_4, is as follows:

$$2NaC\ell(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2HC\ell(g)$$

During a reaction, 1,5 g of an impure sample of sodium chloride reacts with 100 cm^3 sulphuric acid of concentration 0,1 $mol \cdot dm^{-3}$ at room temperature.

6.2.1 Define the term *concentration*. (2)

6.2.2 Calculate the number of moles of sulphuric acid used in the reaction above. (3)

On completion of the reaction it is found that 460 cm^3 of HCℓ gas has formed.

6.2.3 Calculate the percentage purity of the sodium chloride. Use 24,45 dm^3 as the molar gas volume (V_m) at room temperature. (6)

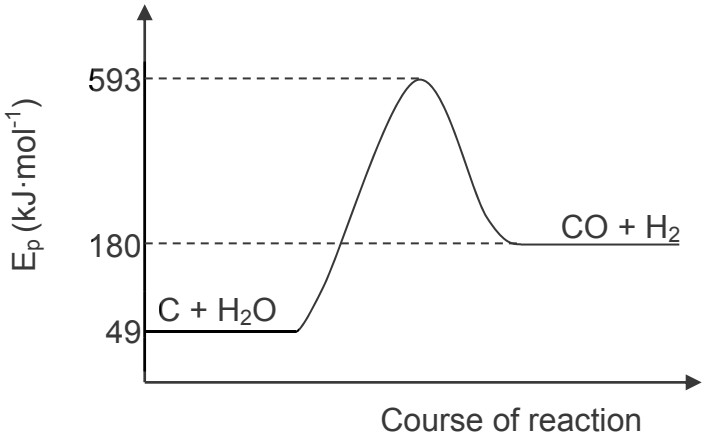
[24]

QUESTION 7 (Start on a new page.)

The balanced equation for the reaction of carbon with steam is as follows:

$$C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$$

The graph below, NOT drawn to scale, represents the change in potential energy of the substances during the reaction.



7.1 Define the term *heat of reaction*. (2)

7.2 Is the reaction ENDOTHERMIC or EXOTHERMIC? Give a reason for the answer. (2)

7.3 Use the information on the graph and write down the value of the:

7.3.1 Activation energy (2)

7.3.2 Heat of reaction (2)
[8]

QUESTION 8 (Start on a new page.)

8.1 Consider the balanced equations for the reaction of water with nitric acid and ammonia below:

Reaction 1: $HNO_3(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + NO_3^-(aq)$

Reaction 2: $NH_3(g) + H_2O(\ell) \rightarrow NH_4^+(aq) + OH^-(aq)$

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

8.1.2 Write down the FORMULA of ONE conjugate acid-base pair in **Reaction 1**. (2)

8.1.3 Is the solution formed in **Reaction 1** ACIDIC or BASIC (ALKALINE)? Give a reason for the answer. (2)

8.1.4 Define the term *ampholyte*. (2)

8.1.5 Write down the FORMULA of a substance that acts as an ampholyte in the reactions above. (1)

8.1.6 Explain the answer by referring to the role of this substance in **Reaction 1** and **Reaction 2**. (2)

100 cm^3 of HNO_3 of a concentration of 0,2 $mol \cdot dm^{-3}$ is diluted to 0,16 $mol \cdot dm^{-3}$.

8.1.7 Calculate the volume of water that must be added to the 0,2 $mol \cdot dm^{-3}$ HNO_3. (4)

8.2 Zinc oxide, ZnO, is insoluble in water and can be harmful to the environment. Nitric acid can be used to neutralise zinc oxide.

The incomplete equation for the reaction is:

$$ZnO(s) + 2HNO_3(aq) \rightarrow \text{salt } \mathbf{X}(aq) + H_2O(\ell)$$

8.2.1 Calculate the mass of zinc oxide that can be neutralised by 80 cm^3 of nitric acid with a concentration of 0,16 $mol \cdot dm^{-3}$. (5)

8.2.2 Write the NAME and FORMULA of salt **X** that forms during this reaction. (2)

[22]

QUESTION 9 (Start on a new page.)

The unbalanced equations for two redox reactions, in which SO_2 is involved, are shown below.

Reaction 1: $SO_2(g) + H_2S(g) \rightarrow S(s) + H_2O(\ell)$

Reaction 2: $SO_2(g) + KMnO_4(s) + H_2O(\ell) \rightarrow MnSO_4(aq) + K_2SO_4(aq) + H_2SO_4(aq)$

9.1 Explain what is meant by the term *redox reaction*. (2)

9.2 Write down the oxidation number of Mn in:

9.2.1 $KMnO_4$ (1)

9.2.2 $MnSO_4$ (1)

9.3 Is Mn in **Reaction 2** OXIDISED or REDUCED? Give a reason for the answer. (2)

9.4 In which reaction, **Reaction 1** or **Reaction 2**, does SO_2 act as an oxidising agent? Give a reason for the answer. (2)

9.5 Write down the oxidation half-reaction in **Reaction 1**. (2)

9.6 Use the Table of Standard Reduction Potentials and write down the balanced net ionic equation for **Reaction 1**. Show the half-reactions and how you arrived at the final equation. (4)
[14]

QUESTION 10 (Start on a new page.)

The balanced chemical equation for the EXTRACTION of gold from its ore is as follows:

$$4Au(s) + 8NaCN(aq) + 2H_2O(\ell) + O_2(g) \rightarrow 4NaAu(CN)_2(aq) + 4NaOH(aq)$$

10.1 State ONE disadvantage of using cyanide (CN^-) in the extraction of gold. (1)

10.2 Will the final solution of the extraction process be ACIDIC or BASIC (ALKALINE)? Give a reason for the answer. (2)

10.3 Determine the oxidation number of gold in $NaAu(CN)_2$. (1)

10.4 Write down the FORMULA of the reducing agent in the reaction above. (1)

Zinc powder is now used to PRECIPITATE the gold.

The balanced equation for the reaction is:

$$Zn(s) + 2NaAu(CN)_2(aq) \rightarrow 2Au(s) + Zn(CN)_2(aq) + 2NaCN(aq)$$

10.5 Does zinc undergo OXIDATION or REDUCTION during the precipitation reaction? (1)

10.6 Write down a half-reaction to support the answer to QUESTION 10.5. (2)

10.7 Calculate the percentage of gold in $NaAu(CN)_2$. (2)
[10]

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*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
Standard pressure Standaarddruk	p^{θ}	$1{,}013 \times 10^{5}\ Pa$
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3{\cdot}mol^{-1}$
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* $c=\frac{m}{MV}$

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 3 7	1,5 Be 4 9											2,0 B 5 11	2,5 C 6 12	3,0 N 7 14	3,5 O 8 16	4,0 F 9 19	10 Ne 20
0,9 Na 11 23	1,2 Mg 12 24											1,5 Aℓ 13 27	1,8 Si 14 28	2,1 P 15 31	2,5 S 16 32	3,0 Cℓ 17 35,5	18 Ar 40
0,8 K 19 39	1,0 Ca 20 40	1,3 Sc 21 45	1,5 Ti 22 48	1,6 V 23 51	1,6 Cr 24 52	1,5 Mn 25 55	1,8 Fe 26 56	1,8 Co 27 59	1,8 Ni 28 59	1,9 Cu 29 63,5	1,6 Zn 30 65	1,6 Ga 31 70	1,8 Ge 32 73	2,0 As 33 75	2,4 Se 34 79	2,8 Br 35 80	36 Kr 84
0,8 Rb 37 86	1,0 Sr 38 88	1,2 Y 39 89	1,4 Zr 40 91	Nb 41 92	1,8 Mo 42 96	1,9 Tc 43	2,2 Ru 44 101	2,2 Rh 45 103	2,2 Pd 46 106	1,9 Ag 47 108	1,7 Cd 48 112	1,7 In 49 115	1,8 Sn 50 119	1,9 Sb 51 122	2,1 Te 52 128	2,5 I 53 127	54 Xe 131
0,7 Cs 55 133	0,9 Ba 56 137	La 57 139	1,6 Hf 72 179	Ta 73 181	W 74 184	Re 75 186	Os 76 190	Ir 77 192	Pt 78 195	Au 79 197	Hg 80 201	1,8 Tℓ 81 204	1,8 Pb 82 207	1,9 Bi 83 209	2,0 Po 84	2,5 At 85	Rn 86
0,7 Fr 87	0,9 Ra 88 226	Ac 89															

Ce 58 140	Pr 59 141	Nd 60 144	Pm 61	Sm 62 150	Eu 63 152	Gd 64 157	Tb 65 159	Dy 66 163	Ho 67 165	Er 68 167	Tm 69 169	Yb 70 173	Lu 71 175
Th 90 232	Pa 91	U 92 238	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

29 Cu 1,9 63,5

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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 ↑

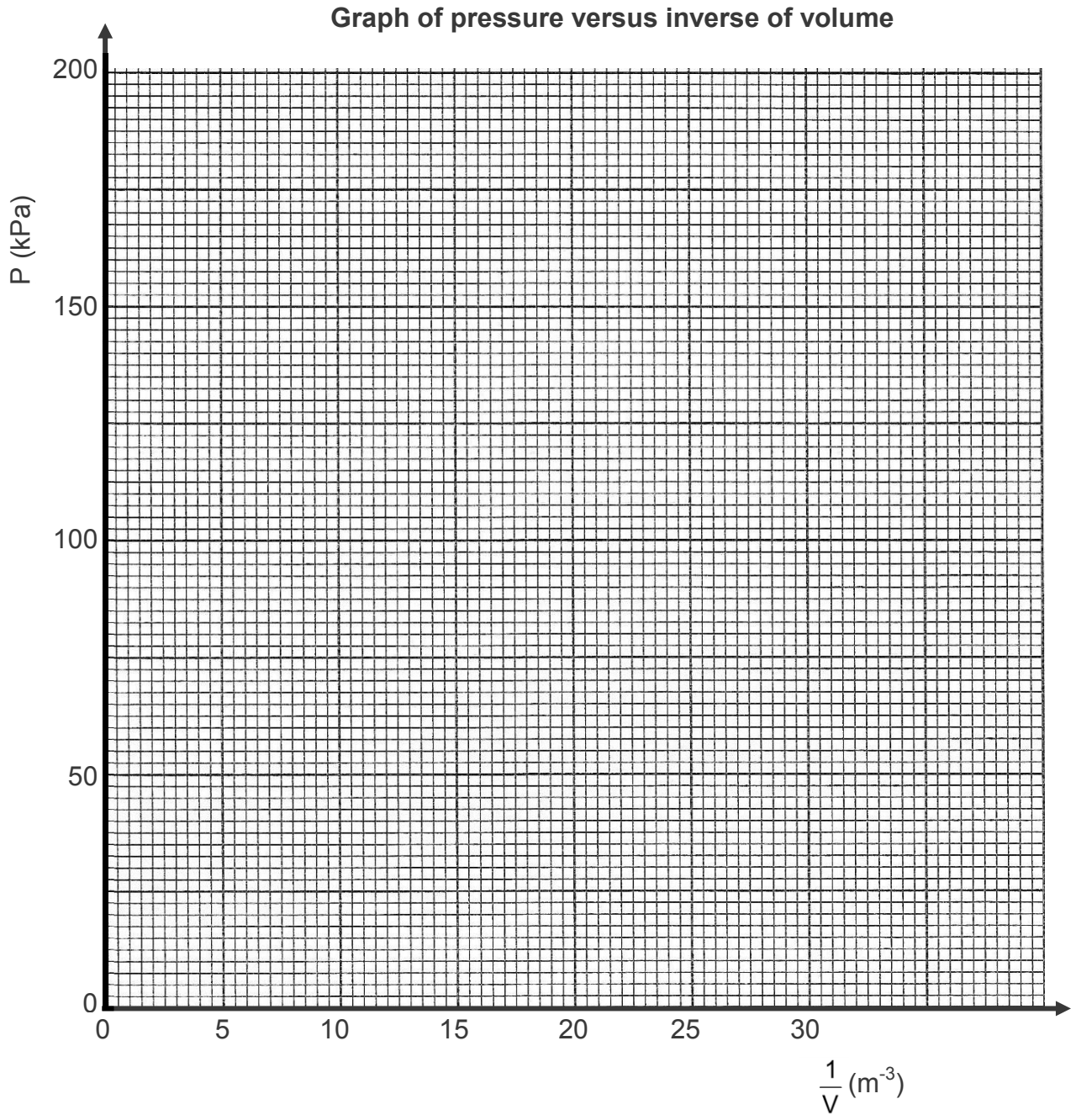
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QUESTION 4.2



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