basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages, 4 data sheets and 1 answer sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 11A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer QUESTION 4.2 and QUESTION 4.3 on the attached ANSWER SHEET. Answer ALL the other 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 et cetera 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. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 According to the Arrhenius theory, all bases …

A are proton donors.

B are proton acceptors.

C form H_3O^+ ions in solution.

D form OH^- ions in solution. (2)

1.2 The number of neutrons in an atom of ${}^{15}_{7}N$ is ...

A 5

B 7

C 8

D 15 (2)

1.3 Which ONE of the following has the strongest forces between its molecules?

A F_2

B $C\ell_2$

C Br_2

D I_2 (2)

1.4 Which ONE of the following has a tetrahedral shape?

A H_3O^+

B NH_4^+

C CO_2

D $A\ell C\ell_3$ (2)

1.5 Two moles of H_2 gas at STP occupy a volume of ...

A $2\ dm^3$

B $11,2\ dm^3$

C $22,4\ dm^3$

D $44,8\ dm^3$ (2)

1.6 Which ONE of the following statements CORRECTLY describes the characteristics of an endothermic reaction?

A ΔH is positive and the products have less potential energy than the reactants.

B ΔH is positive and the products have more potential energy than the reactants.

C ΔH is negative and the products have less potential energy than the reactants.

D ΔH is negative and the products have more potential energy than the reactants. (2)

1.7 Which ONE of the following balanced equations represents a redox reaction?

A $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$

B $Mg(s) + CuSO_4(aq) \rightarrow Cu(s) + MgSO_4(aq)$

C $2NaC\ell(aq) + Pb(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + PbC\ell_2(s)$

D $H_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + 2HNO_3(aq)$ (2)

1.8 During the extraction of gold, zinc powder is added to a solution of gold cyanide to produce gold according to the following balanced equation:

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

The oxidising agent in this reaction is ...

A Au^+

B Zn

C Na^+

D CN^- (2)

1.9 The volume of a gas at a certain temperature and pressure is *V*.

If the temperature is doubled and the pressure is halved, the volume of the gas will be …

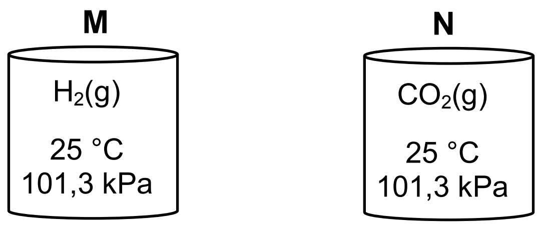
A $4V$

B $2V$

C V

D $\frac{1}{2}V$ (2)

1.10 Two identical containers, **M** and **N**, are shown below. Container **M** contains $H_2(g)$ and container **N** contains $CO_2(g)$. Both gases are at a temperature of 25 °C and a pressure of 101,3 kPa.



Consider the following statements:

(i) The average kinetic energy of the molecules is the same in both containers.
(ii) Container **M** contains more gas molecules than container **N**.
(iii) The mass of the gas in container **N** is greater than the mass of the gas in container **M**.

Which of the above statements is/are CORRECT?

A (i) only

B (iii) only

C (i) and (ii) only

D (i) and (iii) only (2)
[20]

QUESTION 2 (Start on a new page.)

Molecules such as CO_2 and H_2O are formed through covalent bonding.

2.1 Define the term *covalent bonding.* (2)

2.2 ONE of the above molecules has lone pairs of electrons on the central atom. Draw the Lewis diagram for this molecule. (2)

2.3 H_3O^+ is formed when H_2O forms a dative covalent bond with an H^+ ion.

2.3.1 Draw the Lewis diagram for H_3O^+. (1)

2.3.2 State TWO conditions for the formation of such a bond. (2)

2.4 The polarity of molecules depends on the DIFFERENCE IN ELECTRONEGATIVITY and the MOLECULAR SHAPE.

2.4.1 Define the term *electronegativity.* (2)

2.4.2 Calculate the difference in electronegativity between:

(a) C and O in CO_2 (1)

(b) H and O in H_2O (1)

2.4.3 Explain the difference in polarity between CO_2 and H_2O by referring to the polarity of the bonds and the shape of the molecules. (6)

[17]

QUESTION 3 (Start on a new page.)

3.1 The boiling point of compounds **A** to **E** are given in the table below.

COMPOUND	FORMULA	BOILING POINT (°C)
A	CH_4	–164
B	C_2H_6	–89
C	C_5H_{12}	36
D	C_6H_{14}	69
E	$C_{20}H_{42}$	343

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

3.1.2 Calculate the molecular mass of compound **D**. (1)

3.1.3 In what phase is compound **B** at 25 °C? (1)

3.1.4 Name the type of intermolecular force present in compound **A**. (1)

3.1.5 Explain why the boiling point increases from compound **A** to **E**. (3)

3.1.6 How does the vapour pressure of compound **B** compare to the vapour pressure of compound **C**? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

3.2 Consider the boiling points of the compounds in the table below.

SUBSTANCE	BOILING POINT (°C)
H_2S	–60
NH_3	–33
H_2O	100

3.2.1 Which ONE of the substances in the table above has the weakest forces between its molecules? (1)

3.2.2 Name the type of intermolecular force found between NH_3 molecules. (1)

3.2.3 Explain the following statement:

Although the shape of the molecules of H_2S and H_2O is similar, there is a remarkable difference in their boiling points. (4)

[15]

QUESTION 4 (Start on a new page.)

A learner investigates the relationship between the pressure and volume of an enclosed DIATOMIC gas at 25 °C. He records the volume of the gas for different pressures in the table below.

PRESSURE (kPa)	**VOLUME (cm^3)**	$\frac{1}{V}$ **(cm^{-3})**
40	43	0,02
80	27	0,04
100	22	(a)
120	18	(b)

4.1 Write down the name of the gas law being investigated. (1)

Answer QUESTION 4.2 and QUESTION 4.3 on the attached ANSWER SHEET.

4.2 Two $\frac{1}{V}$ values in the table, (a) and (b), have not been calculated. Calculate these values. (1)

4.3 Draw a graph of pressure versus $\frac{1}{V}$ on the attached ANSWER SHEET. (4)

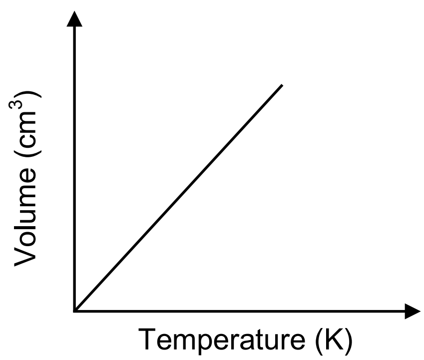
4.4 Use the graph to determine the volume of the gas at 68 kPa. (2)

4.5 The mass of the enclosed DIATOMIC gas is 2,49 x 10^{-2} g.

4.5.1 Use the conditions at a pressure of 100 kPa and calculate the molar mass of the enclosed gas. (6)

4.5.2 Write down the molecular formula of the enclosed gas. (1)

4.6 The sketch graph below shows the relationship between volume and temperature for an ideal gas.



4.6.1 Redraw the above graph in the ANSWER BOOK. On the same set of axes, use a BROKEN LINE to sketch the graph that will be obtained for the diatomic gas above. (1)

4.6.2 Fully explain why this diatomic gas deviates from ideal behaviour. (3)

[19]

QUESTION 5 (Start on a new page.)

The fizz produced when an antacid dissolves in water is caused by the reaction between sodium hydrogen carbonate ($NaHCO_3$) and citric acid ($H_3C_6H_5O_7$). The balanced equation for the reaction is:

$$3NaHCO_3(aq) + H_3C_6H_5O_7(aq) \rightarrow Na_3C_6H_5O_7(aq) + 3CO_2(g) + 3H_2O(\ell)$$

5.1 Write down the FORMULA of the substance that causes the fizz when the antacid dissolves in water. (1)

A certain antacid contains 1,8 g of $H_3C_6H_5O_7$ and 3,36 g of $NaHCO_3$. The antacid is dissolved in 100 cm^3 distilled water in a beaker.

5.2 Define *1 mole of a substance.* (2)

5.3 Calculate the number of moles of $NaHCO_3$ in the antacid. (3)

5.4 Determine, using calculations, which substance is the limiting reagent. (4)

5.5 Calculate the mass of the reactant in excess. (3)

5.6 Calculate the mass decrease of the beaker contents on completion of the reaction. (3)

[16]

QUESTION 6 (Start on a new page.)

6.1 Sodium thiosulphate, $Na_2S_2O_3(s)$, reacts with 200 cm^3 of a hydrochloric acid solution, $HC\ell(aq)$, of concentration 0,2 $mol{\cdot}dm^{-3}$ according to the following balanced equation:

$$Na_2S_2O_3(s) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + S(s) + SO_2(g) + H_2O(\ell)$$

6.1.1 Define the term *concentration of a solution.* (2)

6.1.2 Calculate the number of moles of $HC\ell(aq)$ added to the sodium thiosulphate. (3)

6.1.3 Calculate the volume of $SO_2(g)$ that will be formed if the reaction takes place at STP. (3)

6.2 Menthol, the substance we can smell in mentholated cough drops, is composed of carbon (C), hydrogen (H) and oxygen (O).

During combustion of a 9,984 g sample of menthol, it is found that 28,160 g of CO_2(g) and 11,520 g of H_2O(g) is produced.

6.2.1 Calculate the mass of carbon (C) in the CO_2. (4)

6.2.2 Use relevant calculations to determine the empirical formula of menthol. (7)

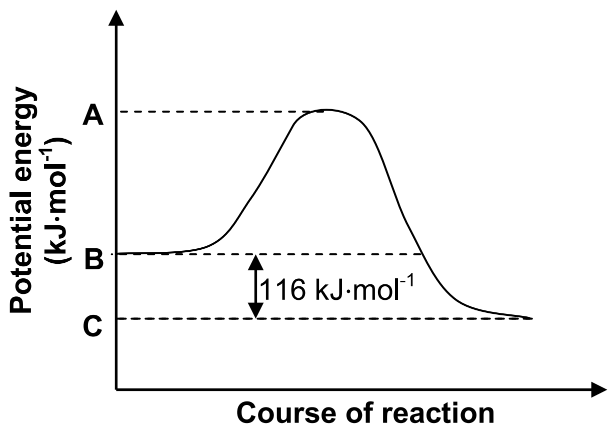
6.2.3 The molar mass of menthol is 156 $g \cdot mol^{-1}$. Determine the molecular formula of menthol. (2)
[21]

QUESTION 7 (Start on a new page.)

A barium hydroxide solution, $Ba(OH)_2$(aq), reacts with a nitric acid solution, HNO_3(aq), according to the following balanced equation:

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

The potential energy graph below shows the change in potential energy for this reaction.



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

7.2 Use energy values **A**, **B** and **C** indicated on the graph and write down an expression for each of the following:

7.2.1 The energy of the activated complex (1)

7.2.2 The activation energy for the forward reaction (1)

7.2.3 ΔH for the reverse reaction (1)

7.3 Calculate the amount of energy released during the reaction if 0,18 moles of $Ba(OH)_2$(aq) reacts completely with the acid. (3)
[8]

QUESTION 8 (Start on a new page.)

When sulphuric acid reacts with water, it ionises in two steps, as shown in the two balanced equations below.

I: $H_2SO_4(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$

II: $HSO_4^-(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + SO_4^{2-}(aq)$

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

8.2 Write down the FORMULA of:

8.2.1 The conjugate base of $HSO_4^-(aq)$ (1)

8.2.2 The conjugate acid of $HSO_4^-(aq)$ (1)

8.2.3 A substance that acts as ampholyte in these reactions (1)

8.3 A few drops of bromothymol blue indicator are added to a potassium hydroxide solution in a beaker. A dilute sulphuric acid solution is now gradually added to this solution until the colour of the indicator changes.

Write down the:

8.3.1 Type of reaction that takes place
(Write down only REDOX, PRECIPITATION or NEUTRALISATION.) (1)

8.3.2 Balanced equation for the reaction that takes place (3)

8.3.3 Colour change of the indicator (2)

8.3.4 NAME of the salt formed in this reaction (1)
[12]

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 the term *oxidation* with reference to oxidation numbers. (2)

9.1.2 Calculate the oxidation number of chromium in $Cr_2O_7^{2-}$. (1)

9.1.3 Calculate the oxidation number of oxygen in H_2O_2. (1)

9.2 Consider the UNBALANCED equation below:

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

9.2.1 Define the term *reducing agent* with reference to electron transfer. (2)

From the above equation, write down the:

9.2.2 FORMULA of the reducing agent (1)

9.2.3 FORMULA of the oxidising agent (1)

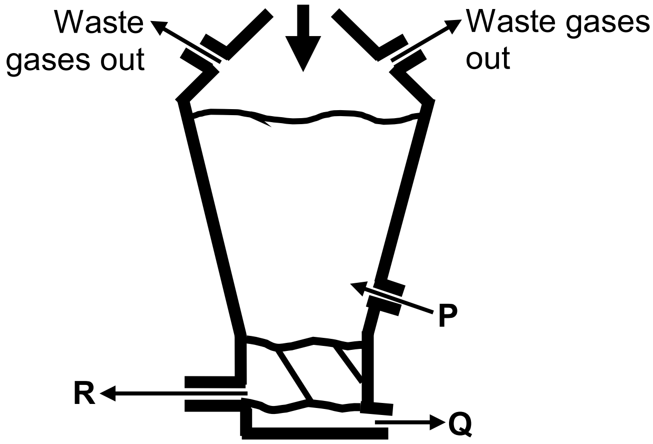
9.2.4 Reduction half-reaction (2)

9.2.5 Oxidation half-reaction (2)

9.2.6 Balanced net redox reaction (2)
[14]

QUESTION 10 (Start on a new page.)

The simplified diagram below shows a blast furnace used for the extraction of iron from iron ore. **P** represents a reactant added to the blast furnace. **Q** and **R** represent products that leave the blast furnace.



Limestone and coke are added to the blast furnace, as shown in the diagram above. Write down the function of:

10.1.1 Limestone (1)

10.1.2 Coke (1)

10.2 Write down the NAME of the substance represented by:

10.2.1 **P** (1)

10.2.2 **Q** (1)

10.2.3 **R** (1)

10.3 Write down the NAME or FORMULA of ONE waste gas formed during the extraction of iron from iron ore. (1)

10.4 The balanced equation for the extraction of iron from iron ore is:

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

Write down the:

10.4.1 Function of carbon monoxide in this reaction (1)

10.4.2 FORMULA of the substance that is reduced (1)
[8]

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-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*

KEY/*SLEUTEL*

- Atomic number/*Atoomgetal*: 29
- Electronegativity/*Elektronegatiwiteit*: 1,9
- Symbol/*Simbool*: Cu
- 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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 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
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 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

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
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

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QUESTION 4.2 and 4.3

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PRESSURE (kPa)	**VOLUME (cm^3)**	**$\frac{1}{V}$ (cm^{-3})**
50	43	0,02
80	27	0,04
100	22	
120	18	

Graph of pressure versus $\frac{1}{V}$