GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PROVINCIAL EXAMINATION

NOVEMBER 2022

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY

(PAPER 2)

TIME: **2 hours**

MARKS: **100**

8 pages + 4 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example, between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, 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. Write only the letter (A – D) next to the question numbers (1.1 to 1.6) in the ANSWER BOOK, for example 1.7 A.

1.1 The electron configuration of an element is $1s^2$, $2s^2$, $2p^4$. The valency of this element is:

A 1
B 2
C 3
D 4 (2)

1.2 The intermolecular forces holding the molecules in ice together are …

A ion-dipole forces.
B Van der Waals forces.
C covalent bonds.
D hydrogen bonds. (2)

1.3 Which of the following variables could be used to determine the temperature of a gas in a closed container?

A The volume of the gas
B The average kinetic energy of the gas molecules
C The pressure of the gas
D The total mass of the gas (2)

1.4 Which of the following represents 1 mole? The number of …

A atoms in $6,02 \times 10^{23}$ g of sodium.
B molecules in 22,4 dm^3 of water at STP.
C protons in 1 g hydrogen gas.
D molecules in 34 g of ammonium gas. (2)

1.5 The enthalpy, in $kJ.mol^{-1}$ for the reverse reaction of the reaction below is:

$A_2 + B_2 \rightarrow 2C \quad \Delta H = -120\ kJ.mol^{-1}$

A – 75
B – 120
C + 75
D + 120 (2)

1.6 The process in which acids H^+ and bases OH^- react to form a salt and water is called:

A Redox reaction
B Displacement reaction
C Synthesis reaction
D Hydrolysis (2)

[12]

QUESTION 2 (Start on a new page.)

2.1 Draw a Lewis diagram of methane. (2)

2.2 What is the name of the special kind of bond found inside the methane molecule? (1)

2.3 Answer the following questions about magnesium chloride:

2.3.1 Make use of Lewis diagrams to indicate the transfer of electrons between magnesium and chlorine. (4)

2.3.2 Magnesium chloride is an ionic substance. Prove this statement with an appropriate calculation. (2)

[9]

QUESTION 3 (Start on a new page.)

In the table below the boiling points of four hydrogen halides are given.

Hydrogen halides	**A**	**B**	**C**	**D**
	HF	HCl	HBr	HI
Boiling points (˚C)	19,4	-85	-67	-35,5

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

3.2 What is the relationship between strength of the intermolecular forces and boiling point? (1)

3.3 Which of the hydrogen halides (A, B, C or D) in the table above has the …

3.3.1 highest vapour pressure? (Refer to the boiling point in the table above to give a reason for the answer.) (2)

3.3.2 strongest intermolecular forces? (1)

3.4 Draw a line graph to represent the boiling points of the hydrogen halides.

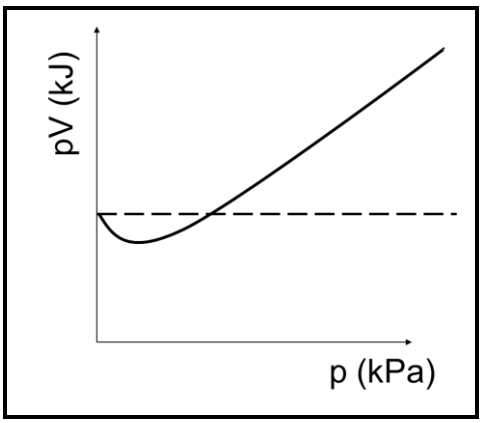
Label the axes clearly and give the graph a heading. (6)

3.5 Compare compounds **A** and **B**. Refer to the TYPE and the STRENGTH of intermolecular forces and ENERGY needed to explain the difference in boiling points between hydrogen halides. (4)

[16]

QUESTION 4 (Start on a new page.)

The diagram below shows a sketch graph of the product pV against p for 1 mole of oxygen gas at 0 °C. (Solid line)
The dashed line represents the same relationship for 1 mole of an ideal gas at 0 °C.



4.1 What is meant by the term *ideal gas*? (2)

4.2 Exactly 3 mol of a gaseous compound occupies a volume of 12 dm^3 at 15,8 °C. Calculate the pressure of the gas at this temperature in kPa. (5)

4.3 If the volume of the container in the reaction in QUESTION 4.2 is doubled, what will happen to the pressure of the gas? Write only INCREASES, DECREASES or REMAINS THE SAME. Explain the answer in terms of relationships. (2)
[9]

QUESTION 5 (Start on a new page.)

A brisk effervescence is seen when diluted hydrochloric acid (HC*l*) reacts with sodium carbonate (Na_2CO_3). The balanced equation for the reaction is:

$$Na_2CO_3(s) + 2HC\ell\,(aq) \longrightarrow 2NaC\ell(aq) + CO_2(g) + H_2O(\ell)$$

5.1 Write down the FORMULA of the substance that causes the brisk effervescence that is seen. (1)

5.2 In a reaction, 10,6 g of sodium carbonate reacts completely with excess hydrochloric acid.

5.2.1 Define *one mole of a substance*. (2)

5.2.2 Which substance is the limiting reagent? Give a reason for your answer. (2)

5.2.3 Calculate the mass of CO_2 produced during this reaction. (5)

5.2.4 Calculate the mass of sodium chloride produced if 4,87 dm^3 of carbon dioxide is produced at STP. (5)

5.3 The empirical formula of a gas is NO_2. Exactly 46 g of this occupies 11,2 dm^3 at STP.

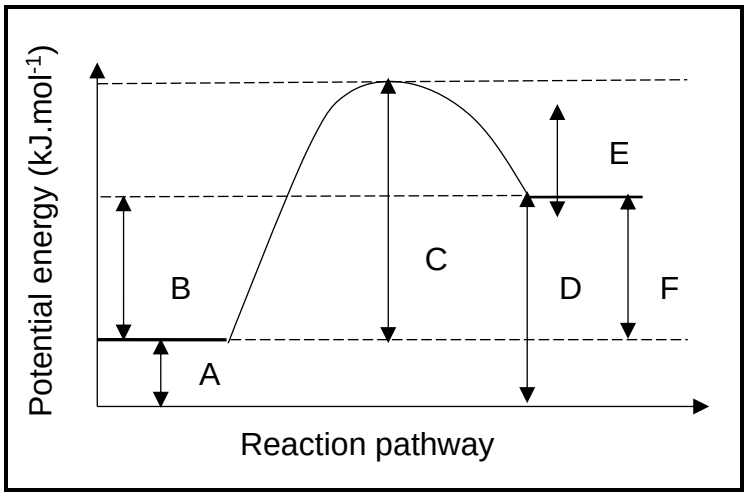
5.3.1 State Avogadro's Law that you will use with this information. (2)

5.3.2 Find the molecular formula of this compound. (3)

[20]

QUESTION 6 (Start on a new page.)

The diagram below represents the potential energy changes for an endothermic reaction.



6.1 What will happen to the temperature of the surroundings of the above reaction? (2)

6.2 Which lettered interval (or combination of letters) on the diagram represents the activation energy of the reverse reaction? (1)

6.3 If a catalyst could be used to improve efficiency of the reaction,:

6.3.1 Explain how a catalyst would affect the potential energy in the reaction. (2)

6.3.2 Redraw the graph in your ANSWER BOOK and indicate the changes of the reaction when using a catalyst in a dotted/dashed line. (2)

6.4 Using ONLY the letters from the graph above, derive a mathematical formula to calculate the change in the enthalpy of this reaction. (2)

[9]

QUESTION 7 (Start on a new page.)

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

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

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

7.1.1 Give the Lowry-Brønsted definition of an acid. (2)

7.1.2 Write down the FORMULA of the conjugate acid of HSO_4^- and the conjugate base of HSO_4^-. (2)

7.1.3 Which ONE of the compounds in reactions (I) and (II) is an ampholyte? (2)

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

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

7.2.1 Why is H_2SO_4 regarded as a strong acid? (2)

7.2.2 How many moles of $NaHCO_3$ are present in 20 cm^3 of the 0,2 $mol \cdot dm^{-3}$ $NaHCO_3$ solution? (3)

7.2.3 Determine the number of moles of H_2SO_4 that are neutralised by 20 cm^3 of the 0,2 $mol \cdot dm^{-3}$ $NaHCO_3$ solution. (2)

7.2.4 Calculate the concentration of the H_2SO_4 solution. (3)

[16]

QUESTION 8 (Start on a new page.)

The lab assistant stored zinc sulphate ($ZnSO_4$) in an aluminium ($A\ell$) container. After a while the teacher notices that the aluminium container is eroding and she suspects a redox reaction. The teacher writes down the following unbalanced reaction.

$$ZnSO_4 + A\ell \rightarrow A\ell_2(SO_4)_3 + Zn$$

8.1 Define a *redox reaction*. (2)

8.2 Calculate:

8.2.1 The oxidation half reaction for this reaction (2)

8.2.2 The reduction half reaction for this reaction (2)

8.2.3 A balanced net reaction (2)

8.3 Identify the reducing agent in this reaction. (1)
[9]

TOTAL: 100

END

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro se konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
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 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*

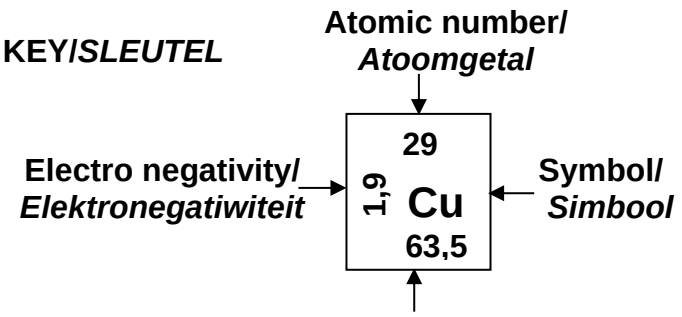


TABLE 4A: STANDARD REDUCTION POTENTIALS/ *TABEL 4A: STANDAARD REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

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

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

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* ↑