JUNE EXAM 2018

HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2- CHEMISTRY

JUNE 2018

TIME: 2 HRS
TOTAL 100

Instructions

1. Answer ALL the questions.

2. This question paper consists of TWO sections:

3. SECTION A (6)
SECTION B (94)

   Answer SECTIONS A and B in the ANSWER BOOK.

4. Non-programmable calculators may be used.

5. Appropriate mathematical instruments may be used.

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

7. Data sheets and periodic tables are attached for your use.

8. Give brief motivations, discussions, et cetera where required.

9. Numbers must be rounded off to **two decimal** places

SECTION A

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.

1.1 Consider the reaction represented by the equation below:

$$CH_3CH_2CH_2Br + H_2O \rightarrow CH_3CH_2CH_2OH + HBr$$

This reaction is an example of …

A Hydrogenation

B Halogenation

C Hydration

D Hydrolysis

1.2 The following equilibrium is established in a closed container at constant temperature.

$$2\ NO(g) + 2\ H_2(g) \rightleftharpoons N_2(g) + 2\ H_2O(g) \qquad \Delta H < 0$$

The conditions under which the yield of N_2 will be the highest, are when:

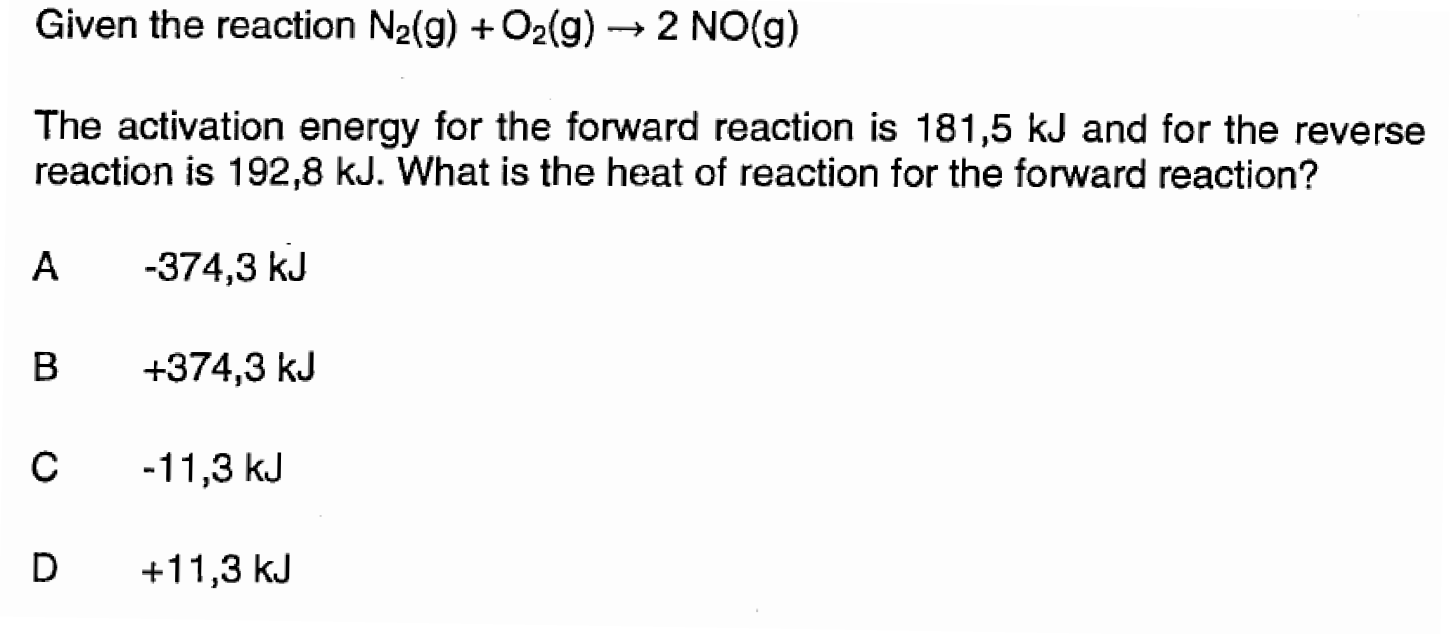
A Pressure is decreased and the temperature is decreased.

B Pressure is increased and the temperature is increased.

C Pressure is decreased and the temperature is increased.

D Pressure is increased and the temperature is decreased.

1.3



Given the reaction $N_2(g) + O_2(g) \rightarrow 2\ NO(g)$

The activation energy for the forward reaction is 181,5 kJ and for the reverse reaction is 192,8 kJ. What is the heat of reaction for the forward reaction?

A -374,3 kJ

B +374,3 kJ

C -11,3 kJ

D +11,3 kJ

[2 X 3 = 6]

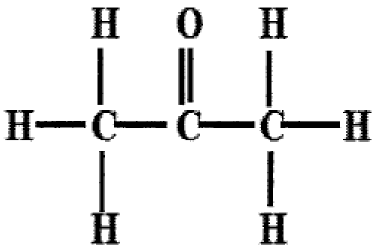
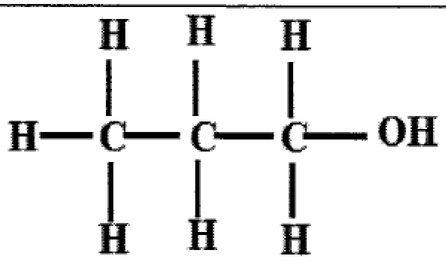
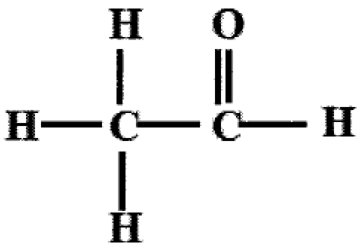
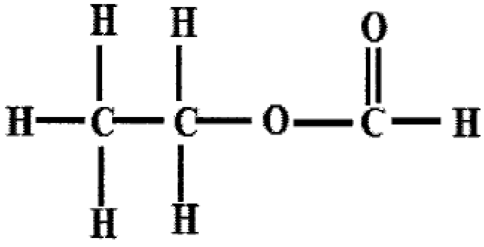
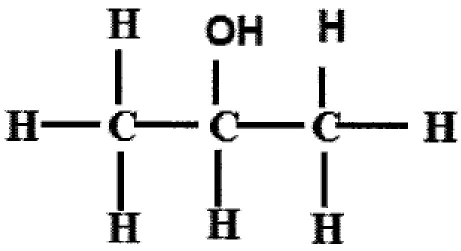
SECTION B

INSTRUCTIONS

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitution in all calculations.
3. Round off your final numerical answers to TWO decimal places.

QUESTION 2

Study the following organic compounds, represented by the letters **A** to **F** in the table below:

 **A**	**Propanoic acid** **B**	 **C**
 **D**	 **E**	 **F**

2.1 Define the term *functional isomers*. (2)

2.2 Identify **TWO** FUNCTIONAL ISOMERS. Only write down the corresponding LETTERS for the correct answers. (2)

2.3 Compound **B** and **C** react in the presence of an organic acid.

2.3.1 Write down the structural formula of the main organic product. (2)

2.3.2 Name the ORGANIC product. (1)

2.4 Compound **C** undergoes an ELIMINATION reaction in the presence of concentrated sulphuric acid. Use structural formulae to write down a balanced equation for the reaction. (3)

2.5 Name the:

2.5.1 Specific type of ELIMINATION reaction taking place in QUESTION 2.4 (1)

2.5.2 Organic PRODUCT formed (1)

[12]

QUESTION 3

The table shows the data collected for three organic compounds **A**, **B** and **C**, with different functional groups, during a practical investigation.

COMPOUND		MELTING POINTS (°C)
A	CH_3CH_3	–183,3
B	CH_3CH_2OH	–114
C	CH_3COOH	16,6

3.1 Name the following in this investigation:

3.1.1 The independent variable (1)

3.1.2 The dependent variable (1)

3.1.3 The control variable (1)

3.2 Write down the homologous series to which compound **C** belongs. (2)

3.3 Write down the general formula for compound **A**. (2)

3.4 Describe the trend in the melting points from **A** to **C**, as shown in the table. (2)

3.5 Explain the trend in QUESTION 3.4 above. Make reference to INTERMOLECULAR FORCES and ENERGY involved. (5)

[14]

QUESTION 4

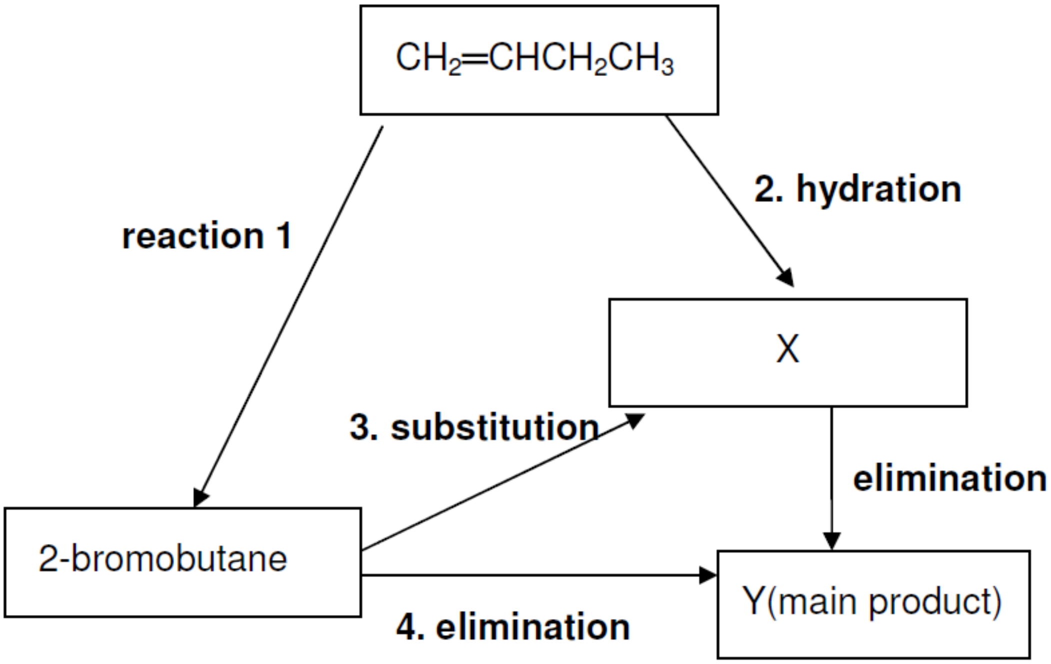
Bromine water can be used to distinguish between saturated and unsaturated compounds. Equal amounts of hex-2-ene and hexane are added to respective test tubes A and B at room temperature; 2cm^3 of bromine water is added to each and the test tubes shaken. The solution in test tube A becomes clearer, while the solution in test tube B has a brownish colour.

4.1 What is meant by an *unsaturated* compound? (2)

4.2 Using structural formulas, write down the equation for the reaction in test tube A. (3)

4.3 Name the reaction condition required for a reaction to take place in test tube B. (1)

4.4 Consider the flow diagram below:



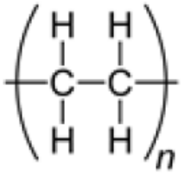
4.4.1 Name the type of reaction in reaction 1. (1)

4.4.2 State the reaction condition required for reaction 2, which is the hydration reaction that forms compound X. (1)

4.4.3 State the reaction conditions for reaction 3, that is the substitution reaction where X forms from 2-bromobutane. (2)

4.4.4 Draw the structural formula of Y and give its IUPAC name. (2)

4.5 The diagram below shows the structural formula for polyethylene.



4.5.1 Write down the IUPAC name of the monomer that formed polyethylene. (1)

4.5.2 State the type of polymerization that occurs when polyethylene is formed from its monomer. (1)

[14]

QUESTION 5

5.1 Define the term *reaction rate* in words. (2)

Learners use the reaction between IMPURE POWDERED zinc and excess hydrochloric acid to investigate reaction rate. The balanced equation for the reaction is:

$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

They perform four experiments under different conditions of concentration, mass and temperature as shown in the table below. They use identical apparatus in the four experiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	**2**	**3**	**4**
Concentration of acid (mol·dm^{-3})	1	0,5	1	1
Mass of impure zinc powder (g)	15	15	15	25
Initial temperature of acid (°C)	30	30	40	40

5.2 The results of experiments **1** and **3** are compared in one of these investigation.

Write down the:

5.2.1 Independent variable (1)

5.2.2 dependent variable for this investigation. (1)

5.3 Use the collision theory to explain why the reaction rate in experiment **1** will be higher than that in experiment **2**. (3)

5.4 Experiment 3 and experiment 4 are now compared with each other.

5.4.1 How will the reaction rate of experiment **3** compare to that of experiment **4**? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.4.2 Draw a sketch graph to show the difference between experiment **3** and **4**. Place the volume H_2 gas on the y axis and time on the x axis. No values have to be indicated on the graph. Clearly mark the line graphs as **experiment 3** and **experiment 4**. (4)

5.5 When the reaction in experiment 4 reaches completion, the volume of the gas formed is 8,6 dm^3. Determine the percentage purity of the zinc powder. PLEASE NOTE: The molar gas volume at 40° C is equal to 25,7 dm^3. (NOT 22,4 dm^3) (5)

[17]

QUESTION 6

112,84 g of mercury(II) oxide is heated in a 250 cm^3 sealed container. The decomposition that takes place in the container is represented by the following equation:

$$2HgO(s) \rightleftharpoons 2Hg(\ell) + O_2(g) \qquad \Delta H > 0$$

Equilibrium is reached at 650 ° C. Analysis shows that, at equilibrium, the mass of mercury(II) oxide (HgO) is 69,44 g.

6.1 For this reaction, a sealed container is classified as a CLOSED SYSTEM. Explain why this is so. (2)

6.2 Calculate the equilibrium constant (K_c) at 650 ° C for this reaction. (9)

6.3 The volume of the container is now decreased to 125 cm^3 while the temperature is KEPT CONSTANT. The system reaches a NEW equilibrium. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The number of moles of HgO(s) present in the NEW equilibrium mixture (1)

6.3.2 The value of the equilibrium constant (K_c) (1)

6.3.3 The concentration of O_2(g) in the new equilibrium mixture. (1)

6.4 Use Le Chatelier's Principle to explain the answer to QUESTION 6.3.1. (2)

[16]

Question 7

7.1 Given the equation

$$HPO_4^{2-} + H_2O \rightleftharpoons H_3O^+ + PO_4^{3-}$$

7.1.1 By referring to the Brønsted-Lowry theory, explain why the H_3O^+ ion is regarded as an acid. (2)

7.1.2 Select another acid from the equation. (1)

7.1.3 Give a single term for a substance which can act as both an acid and a base. (1)

7.2 In a reaction, 25 cm^3 of a $Ba(OH)_2$ with a pH of 13,6 are added to 40 cm^3 of 0,15 mol·dm^{-3} H_2SO_4. The following reaction takes place:

$$H_2SO_4(aq) + Ba(OH)_2\,(aq) \rightarrow BaSO_4\,(aq) + 2\,H_2O\,(\ell)$$

7.2.1 Calculate the concentration of the solution of $Ba(OH)_2$ used in the reaction. (4)

7.2.2 Calculate the number of moles of $Ba(OH)_2$ used in the reaction. (3)

7.2.3 Calculate the pH of the final solution. (7)

7.3 The salt $BaSO_4$ undergoes hydrolysis.

7.3.1 Define the term *hydrolysis*. (2)

7.3.2 Will an aqueous $BaSO_4$, the solution be ACIDIC, NEUTRAL or BASIC. (1)

[21]

TOTAL SECTION B [94]

Total 100

CAPS

INFORMATION FOR PHYSICAL SCIENCES GR 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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

Half-reactions			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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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 ↑

Increasing reducing ability/ ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			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 ↓

Increasing reducing ability ↑