Hillcrest High School

PHYSICAL SCIENCE P2

TRIALS 2023

Grade 12

MARKS: 150 **EXAMINER:** Mrs J. Knox-Whitehead

TIME: 3 Hours **MODERATOR:** Ms N. Badenhorst

Instructions:

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

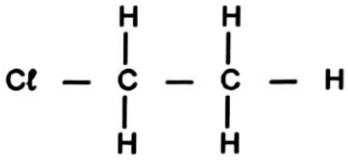
   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

<u>SECTION A:</u> QUESTION 1 (Multiple-choice)

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 your ANSWER BOOK.

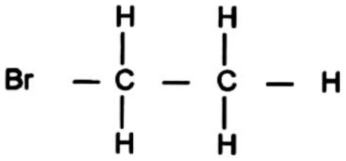
1.1 Which ONE of the following compounds has structural isomers?

A



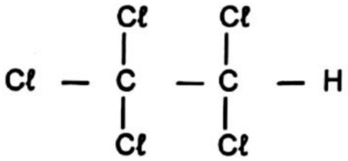
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ Cl & - & C & - & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

B



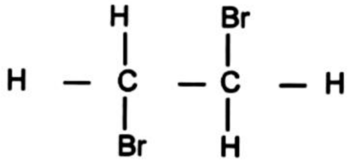
$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ Br & - & C & - & C & - & H \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

C



$$\begin{array}{ccccccc} & & Cl & & Cl & & \\ & & | & & | & & \\ Cl & - & C & - & C & - & H \\ & & | & & | & & \\ & & Cl & & Cl & & \end{array}$$

D



$$\begin{array}{ccccccc} & & H & & Br & & \\ & & | & & | & & \\ H & - & C & - & C & - & H \\ & & | & & | & & \\ & & Br & & H & & \end{array}$$

(2)

1.2 Consider the condensed structural formula:

$$CH_3COCH_3$$

Identify the name of the functional group in this formula.

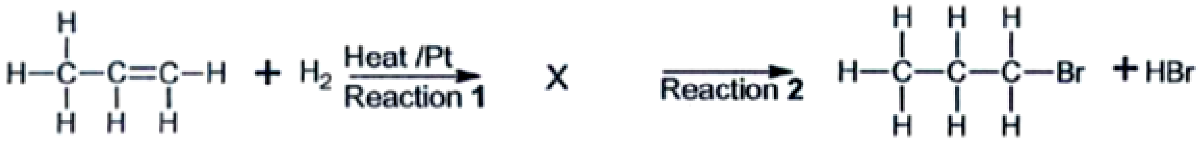
A Carboxylic acid

B Carboxyl group

C Ketone

D Carbonyl group (2)

1.3 Consider the Reactions **1** and **2** below. Compound **X** is an organic compound.



What type of reaction is Reaction **2**?

A Halogenation

B Hydrolysis

C Hydration

D Hydrohalogenation (2)

1.4 If $y = \frac{\Delta n}{\Delta t}$ applies to chemical reactions, where Δn = change is the number of moles and Δt = time interval, then **y** probably represents the …

A equilibrium constant.

B yield of products.

C heat of reaction.

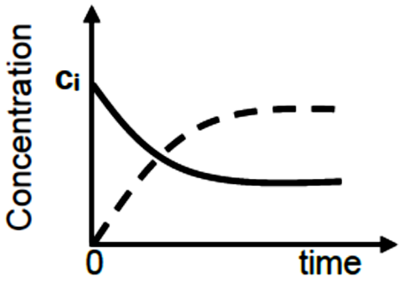
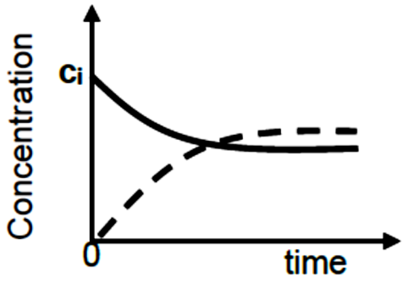
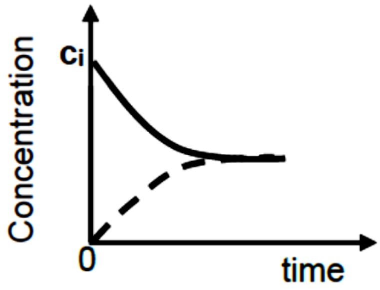
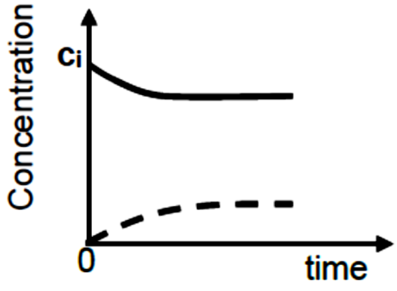
D rate of reaction. (2)

1.5 H_2S (g) decomposes according to the following balanced equation:

$$H_2S\ (g) \rightleftharpoons H_2\ (g) + S\ (s)$$

In each of four separate experiments, **A** to **D**, H_2S of initial concentration $\mathbf{c_i}$ is placed in identical empty flasks which are then sealed and heated. The graphs below display the results of the experiments **A** to **D**.

Which experiment has the largest K_c value?

A		B	
C		D	

(2)

1.6 The expression for the equilibrium constant, Kc, for a hypothetical reaction is given as follows:

$$K_c = \frac{[R]\ [S]^2}{[P]^3}$$

Which ONE of the following balanced equations represents the hypothetical reaction?

A $3P(s) \rightleftharpoons R(g) + 2S(g)$

B $3P(\ell) \rightleftharpoons R(aq) + 2\,S(aq)$

C $3P(aq) + Q(s) \rightleftharpoons R(g) + S_2(g)$

D $3P(aq) + Q(s) \rightleftharpoons R(aq) + 2S(g)$ (2)

1.7 When powdered lime is added into an acidic solution, the pH of the solution changes from 4 to 6.
What is the corresponding change in the hydrogen ion concentration, $[H^+]$?

A increases by a factor of 2

B decreases by a factor of 2

C increases by a factor of 100

D decreases by a factor of 100 (2)

1.8 Which of the following solutions, each of concentration 0,1 mol.dm^{-3}, has the highest pH?

A $HNO_3(aq)$

B $NH_4C\ell(aq)$

C $Na_2CO_3(aq)$

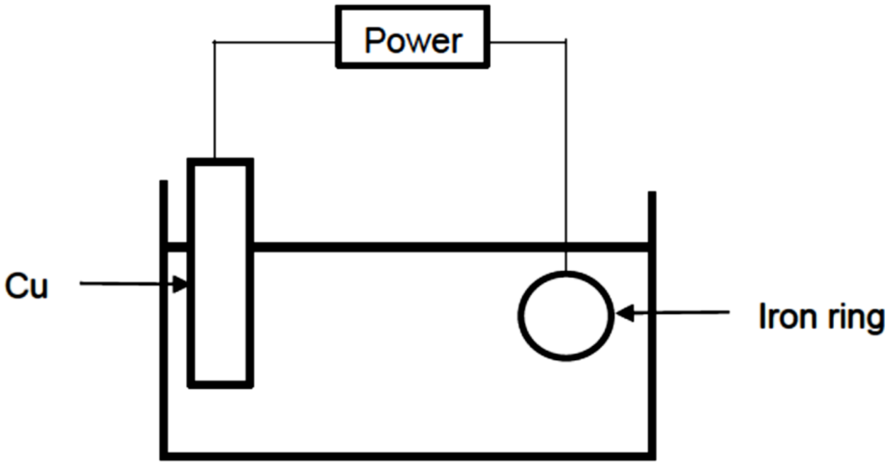
D $CH_3COOH(aq)$ (2)

1.9 Which of the following correctly gives the direction, as well as the medium, in which electrons move in a galvanic cell?

	DIRECTION	**MEDIUM**
A	cathode to anode	salt bridge
B	anode to cathode	external wire
C	cathode to anode	external wire
D	anode to cathode	salt bridge

(2)

1.10 The electrolytic cell below is used during the electroplating of an iron ring with copper.



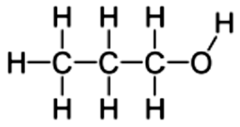
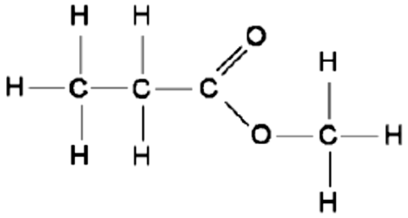
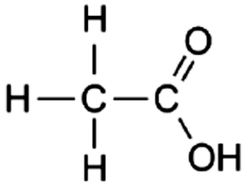
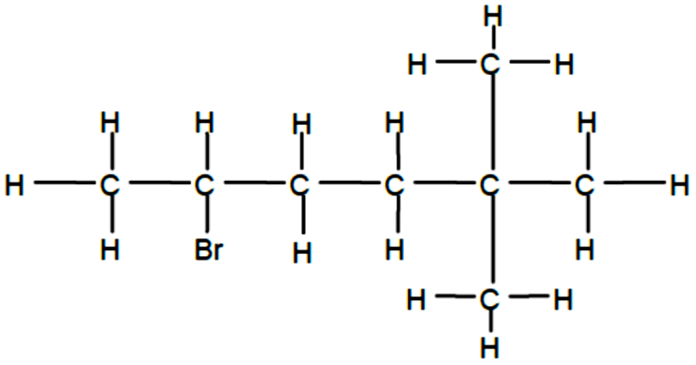
Which ONE of the following combinations is CORRECT about the ions in the electrolyte when the cell is operating?

	Concentration	**Positive ions**
A	Remain constant	Cu^{2+}
B	Remain constant	Fe^{2+}
C	Increases	Fe^{3+}
D	Increases	Cu^{2+}

(2)
[20]

SECTION B: QUESTION 2

The letters **A** to **G** in the table below represent seven organic compounds. Study the table and answer the questions that follow.

A		**B**		**C**	
D	$CH_3CHOHCH_3$	**E**	2,4-dimethylpent-1-ene	**F**	2-methylpropan-2-ol
G					

2.1 Consider compound **B**. Write down the:

2.1.1 Homologous series to which compound **B** belongs (1)

2.1.2 IUPAC name of compound **B** (2)

2.1.3 Homologous series to which the *functional isomer* of compound **B** would belong. (1)

2.2 An alcohol and an organic acid are heated in the presence of concentrated sulphuric acid to form compound B. Write down the:

2.2.1 role of the concentrated sulphuric acid in this reaction (1)

2.2.2 name of the organic acid used to prepare compound **B** (1)

2.3 From the table above, consider compound **C**. Write down the:

2.3.1 definition for the term *functional group*. (2)

2.3.2 name of the functional group of compound **C**. (1)

2.3.3 molecular formula of compound **C**. (1)

2.4 In the table above, compounds **A**, **D** and **F** are all alcohols.

2.4.1 Compounds **A** and **D** are structural isomers. As what type of isomer would they be classified? (1)

2.4.2 Write down the letter of the compound which is a *secondary alcohol*. (1)

2.4.3 Draw the structural formula for compound **F**. (2)

2.5 Write down the:

2.5.1 IUPAC name of compound **G**. (2)

2.5.2 Structural formula of compound **E**. (2)

[18]

QUESTION 3

3.1 **X** and **Y** are two saturated hydrocarbons with the same molecular formula. Both **X** and **Y** have 4 carbons each. **X** has a lower melting point than **Y**.

3.1.1 Define *melting point*. (2)

3.1.2 Fully explain why there is a difference in the melting points of these two compounds. (3)

3.1.3 Write down the STRUCTURAL FORMULA for compound **X**. (2)

3.1.4 Which substance, **X** or **Y**, would be expected to have a LOWER vapour pressure? (1)

3.2 In an experiment the boiling points of an alcohol is compared to that of a carboxylic acid. The boiling point of pentan-1-ol is found to be 138°C.

3.2.1 Write down the IUPAC name of the carboxylic acid that must be used in this experiment to ensure that the comparison is fair. Give a reason for the answer. (2)

3.2.2 Write down the *dependent variable* for this investigation. (1)

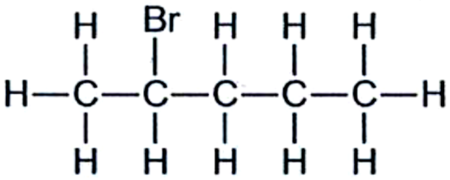
3.2.3 Will the boiling point of the carboxylic acid be LESS THAN, EQUAL TO, or GREATER THAN 138°C? (1)

3.2.4 Fully explain the answer to QUESTION 3.2.3. (3)

[15]

QUESTION 4

4.1 Consider the following organic reactions **I** to **IV** shown below:

I	**A** + HBr $\longrightarrow$  **B**
II	**B** + concentrated NaOH → **C** (main product) + NaBr + **D**
III	$\mathbf{A} + \mathbf{D} \xrightarrow[H_3PO_4]{\text{Dilute}} \mathbf{E}$
IV	$C_5H_{12} \xrightarrow[\text{high pressure}]{600\ °C} C_3H_6 + \mathbf{F}$

Write down the:

4.1.1 NAME of each reaction **I** to **IV** shown above. (4)

4.1.2 The IUPAC name of compound **B**. (2)

4.1.3 Homologous series to which compound **C** belongs. (1)

4.1.4 FORMULA of the INORGANIC product **D** of reaction **II**. (1)

4.1.5 Give ONE additional reaction condition for reaction **II**. (1)

4.1.6 STRUCTURAL FORMULA of compound **E**. (2)

4.1.7 NAME of compound **F**. (1)

4.2 When impure methane, CH_4, undergoes a combustion reaction with excess oxygen in the air, 68,88 g CO_2 is produced. The percentage purity of the methane is 60%.

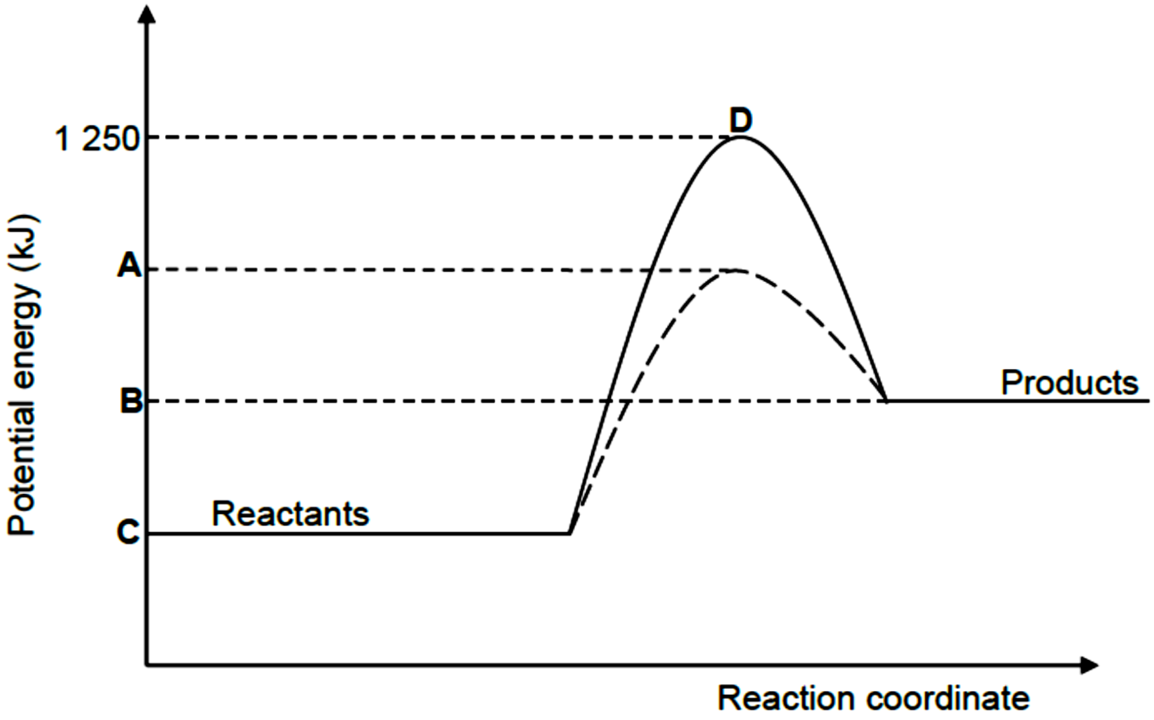
4.2.1 Write a balanced equation to represent this reaction. (3)

4.2.2 Calculate the mass of impure methane that was burned in the reaction. (5)

[20]

QUESTION 5

5.1 The graph below shows an energy diagram for a chemical reaction:



5.1.1 Define the term *activation energy* in words. (2)

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

The following information about the graph is given:

- The activation energy *without a catalyst* is **800 kJ**.
- The activation energy *with a catalyst* is 490 kJ.
- The energy released in the formation of products in the uncatalysed reaction is **520 kJ**.

Calculate the value of each of the following:

5.1.3 **C**, as shown on the graph (2)

5.1.4 Δ**H** (2)

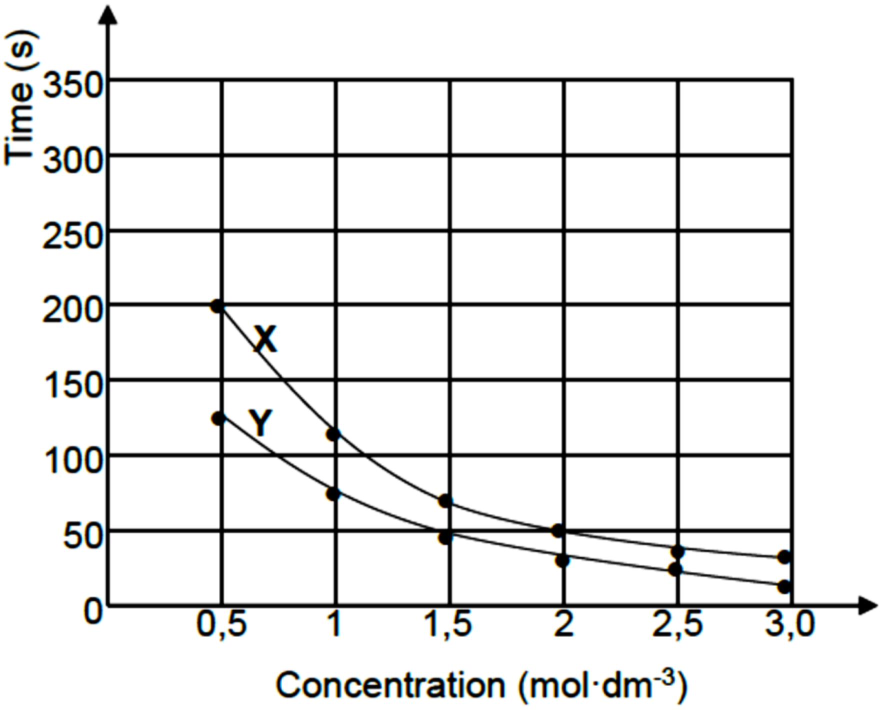
5.2 A grade 12 class carried out an experiment to determine the rate of reaction between zinc metal and EXCESS hydrochloric acid. The reaction which takes place is represented by the following equation:

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

Group **A** reacted zinc **granules** with 3 mol.dm^{-3} HCℓ and measured the time taken to collect 100 cm^3 of H_2 gas. They repeated the experiment a number of times, changing the concentration of the acid to 2,5 mol.dm^{-3}; 2 mol.dm^{-3}; 1,5 mol.dm^{-3} and 0,5 mol.dm^{-3}.

Group **B** performed the same experiments but used the same mass of **powdered** zinc each time.

Excess HCℓ was used in all the experiments. The results obtained are shown in the graphs (**X** and **Y**) below:



5.2.1 Write down the *dependent variable* for this experiment. (1)

5.2.2 Which graph (**X** or **Y**) was obtained from the results of group **A**? (1)

5.2.3 Use the collision theory and the graph to explain the answer to QUESTION 5.2.2. (3)

5.2.4 Calculate the mass of zinc needed to produce 100 cm^3 of $H_2(g)$ at 25°C. Assume the molar gas volume is 24,04 dm^3 at 25°C. (4)

[17]

QUESTION 6

10 g of hydrogen gas and 355 g of chlorine gas are heated together in a sealed 500 cm^3 container. A chemical equilibrium I reached at 450°C. The balanced equation for the reaction is:

$$H_2(g) + C\ell_2(g) \rightleftharpoons 2HC\ell(g)$$

The equilibrium constant for this reaction at 450°C is 64.

6.1 Calculate the mass of chlorine gas present at equilibrium. (9)

The reaction is now carried out at a lower temperature. It is found that the K_c value increases.

6.2 Is the heat of reaction (∆H) POSITIVE or NEGATIVE for the forward reaction? Use Le Chatelier's principle to explain the answer. (4)

The pressure of the container is now increased by decreasing the volume of the container, without affecting the temperature further.

6.3 How would the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The concentration of $HC\ell$ (1)

6.3.2 The K_c value (1)

[15]

QUESTION 7

7.1 The equations below show the reactions occurring in hydrochloric acid and ethanoic acid solutions. Both acids have a concentration of 1 mol.dm^{-3} an are kept at a temperature of 25°C.

I: $HC\ell\,(aq) + H_2O\,(\ell) \rightleftharpoons C\ell^-\,(aq) + H_3O^+\,(aq)$ $K_a = 1{,}3 \times 10^6$

II: $CH_3COOH\,(aq) + H_2O\,(\ell) \rightleftharpoons CH_3COO^-\,(aq) + H_3O^+\,(aq)$ $K_a = 1{,}8 \times 10^{-5}$

7.1.1 Define the term *strong acid*. (2)

7.1.2 Which solution, I or II, will have the lower pH value? Explain your answer. (3)

7.2 10 cm^3 of a 1 mol.dm^{-3} sodium hydroxide (NaOH) solution is diluted with water until its pH is 13.

7.2.1 Calculate the number of moles of NaOH in the 10 cm^3 of the initial solution.(3)

7.2.2 Calculate the volume of the diluted solution in dm^3. (5)

All of the diluted sodium hydroxide solution is poured into a burette. During a titration, 12 cm^3 of oxalic acid of concentration 0,09 $mol.dm^{-3}$ is exactly neutralised by a certain volume of the diluted sodium hydroxide solution.

The balanced equation for the reaction is:

$$2\ NaOH\ (aq) + H_2C_2O_4\ (aq) \rightarrow Na_2C_2O_4\ (aq) + 2\ H_2O\ (\ell)$$

7.2.3 Calculate the volume of the diluted sodium hydroxide that is left in the burette after the titration. (5)

7.3 A few crystals of sodium carbonate (Na_2CO_3) are added to water in a test tube.

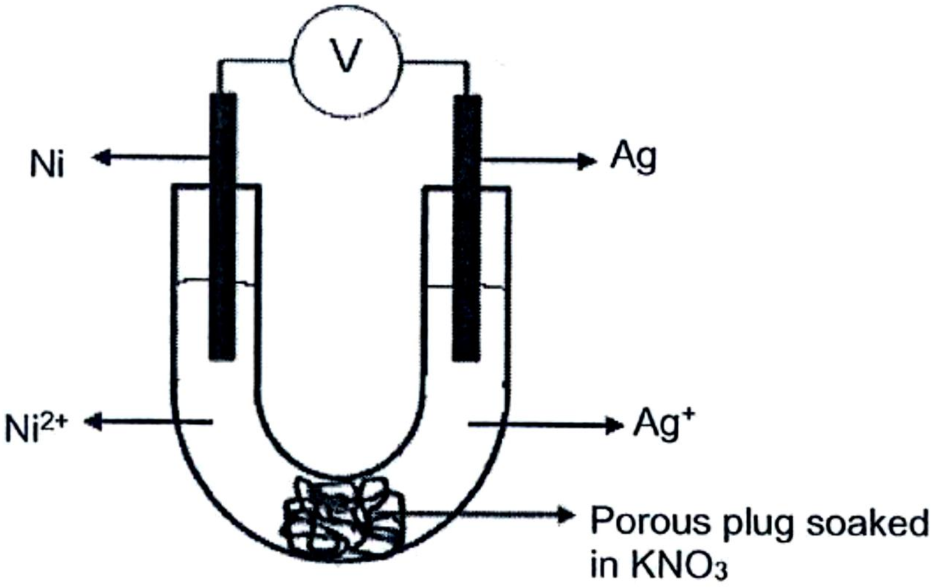
7.3.1 Is the solution in the test tube ACIDIC, BASIC or NEUTRAL? (1)

7.3.2 Use a balanced ionic equation to explain the answer to QUESTION 7.3.1. (3)

[22]

QUESTION 8

The diagram below represents a galvanic cell.



8.1 State TWO standard conditions under which this cell functions. (2)

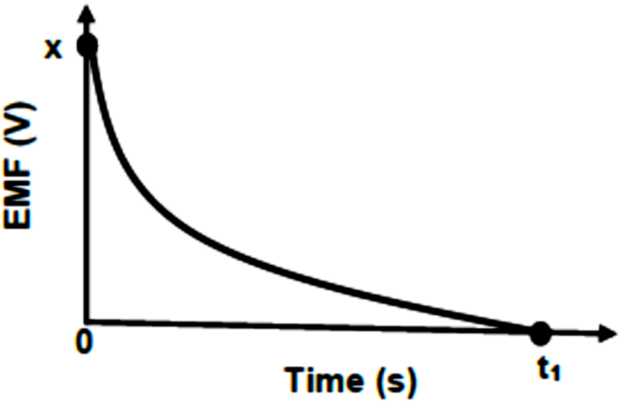
8.2 Write down ONE function of the porous plug. (1)

8.3 In which direction do electrons flow in the external circuit?
Write down only **from Ni to Ag** or **from Ag to Ni**. (1)

8.4 Write down the balanced equation for the overall (net) reaction for this cell. (3)

8.5 If 0,4 moles of electrons flow to the cathode, what will be the decrease in mass of the anode be? (3)

8.6 The graph below shows the EMF of this cell against time.



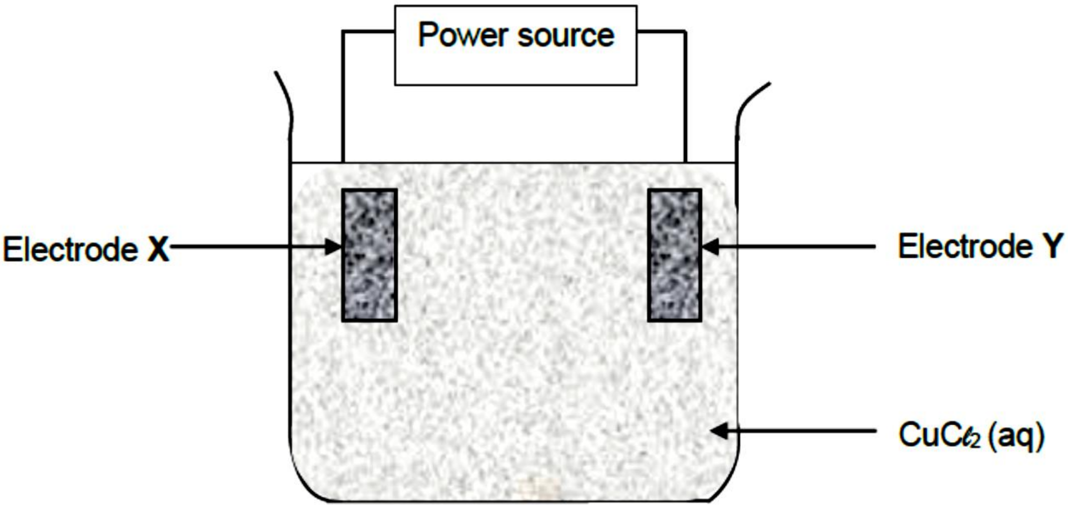
8.6.1 Calculate the value of **x** on the graph. (4)

8.6.2 What has happened to the reaction in the cell at time $\mathbf{t_1}$? (1)

[15]

QUESTION 9

The diagram below represents an electrochemical cell that is used for the refining of copper.



One of the electrodes consists of *pure copper* and the other of *impure copper*.

9.1 When the cell is allowed to operate, it is found that the mass of electrode **X** increases over time.

9.1.1 Define the term *electrolyte*. (2)

9.1.2 Is electrode **X** the CATHODE or ANODE of the cell? (1)

9.1.3 Write down a half-reaction to justify the answer to QUESTION 9.1.2 above. (2)

9.2 State whether electrode **Y** is connected to the POSITIVE or NEGATIVE terminal of the power source. (1)

9.3 Refer to the *relative strength of oxidising agents* to explain why zinc in the impure copper will not be deposited on the pure copper electrode. (2)

9.4 Electrodes **X** and **Y** are now replaced with graphite (carbon) electrodes.
State what will be observed at electrode **Y** (now graphite). (1)

[9]

Total 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
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	$6{,}02 \times 10^{23}\ mol^{-1}$

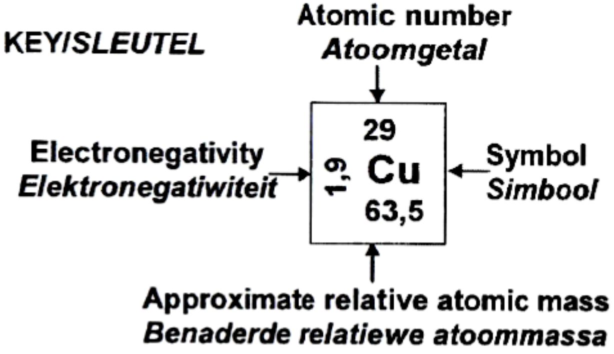
TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

NSC – Grade 12

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*



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

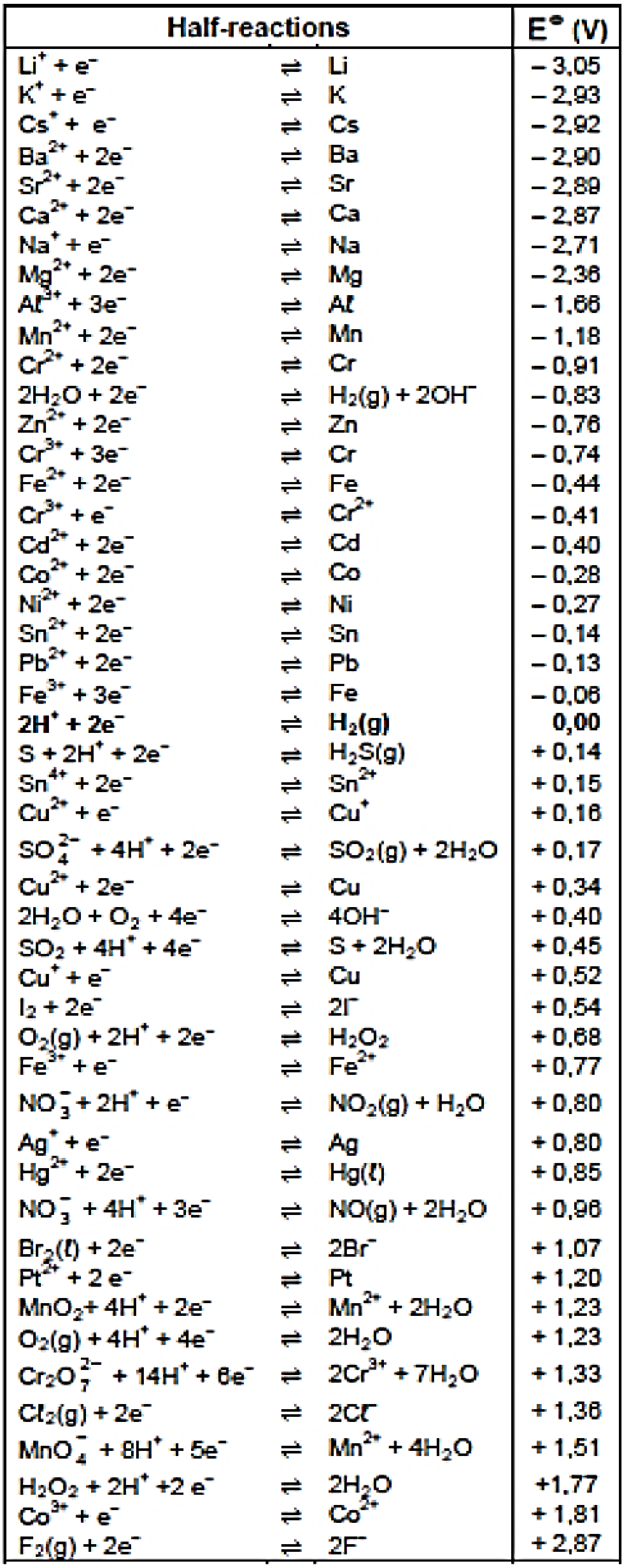
Increasing oxidising ability

Half-reactions			E° (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 reducing ability/

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability



Half-reactions			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 reducing ability