HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2 - CHEMISTRY

TRIALS 2020
EXAMINER: J. KNOX-WHITEHEAD

TIME: 3 HRS
TOTAL 150

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

SECTION A

QUESTION 1: MULTIPLE CHOICE QUESTIONS

Four options are given 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 Which one of the following pairs of compounds are FUNCTIONAL isomers?

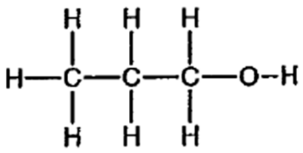
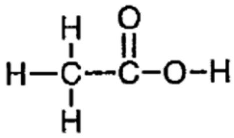
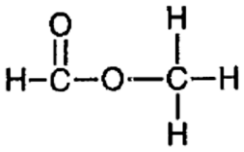
A Methanol and methanal

B Butane and 2-methylpropane

C Propan-1-ol and propan-2-ol

D Propanoic acid and methyl ethanoate (2)

1.2 The organic compounds shown in the table below have the same molar mass (60g.mol^{-1}).

Compound	Structural formula	Boiling point (°C)
X		97
Y		?
Z		32

Which ONE of the following is most likely to be the boiling point (in ˚C) of compound **Y**?

A 24

B 40

C 90

D 118 (2)

1.3 The complete combustion of propane is represented by the balanced equation below:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$$

30 cm^3 of propane is mixed with 200 cm^3 of oxygen and the mixture is ignited. What is the volume, in cm^3, of the CO_2 in the resulting gas mixture? (All the volumes are measured at the same temperature and pressure.)

A 230

B 140

C 120

D 90 (2)

1.4 Consider the four chemical samples below:

P

12 g zinc powder

Q

12 g zinc granules

R

1 dm^3 of 1 $mol{\cdot}dm^{-3}$ HCℓ solution

S

1 dm^3 of 2 $mol{\cdot}dm^{-3}$ HCℓ solution

A small balloon must be inflated with hydrogen gas. The balloon is attached to the top of one of the flasks into which zinc was added. To inflate the balloon as quickly as possible, which ONE of the combinations will be the most suitable?

A P and R

B P and S

C Q and P

D Q and S (2)

1.5 Consider the reaction represented by the following balanced equation:

$$A_2(g) + B_2(g) \rightarrow 2AB(g)$$

The activation energy for the forward reaction is 180 kJ and that of the reverse reaction is 200 kJ. The heat of reaction (ΔH) for the forward reaction is:

A -20 kJ

B +20kJ

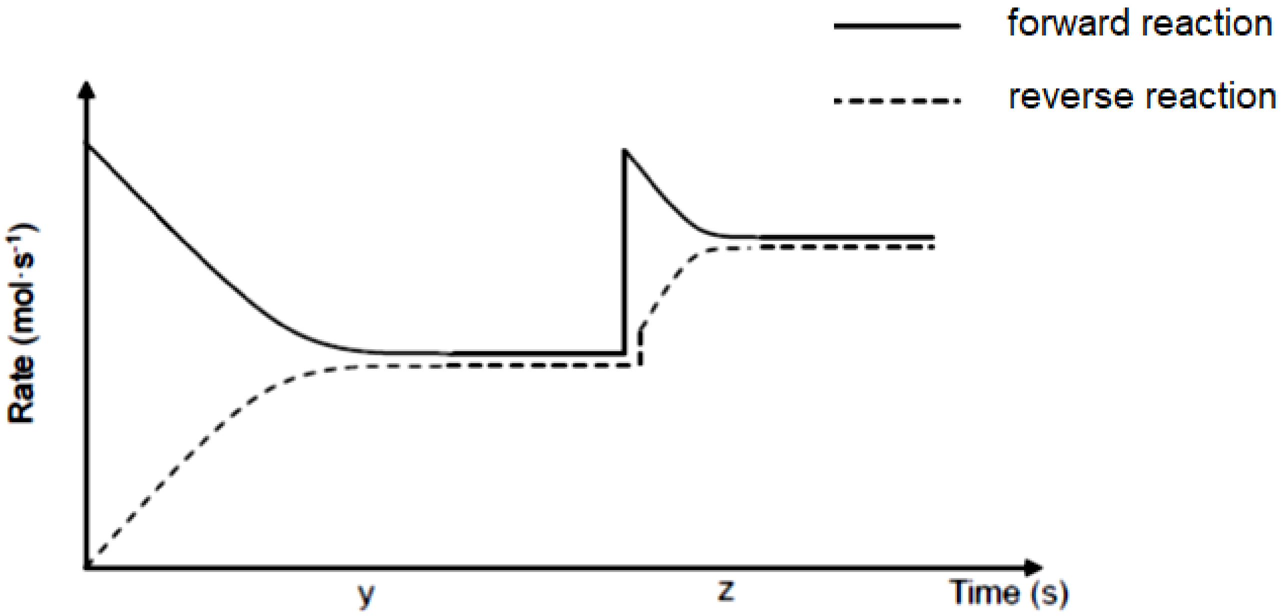
C -380 kJ

D +380kJ (2)

1.6 The hypothetical compound AX3(g) decomposes in a closed container according to the following balanced equation:

$$2AX_3(g) \leftrightharpoons 2AX_2(g) + X_2(g)$$

Equilibrium is reached at temperature **T_1** after **y** seconds as shown in the graph below. The temperature is increased after **z** seconds, as shown in the graph.



Which ONE of the following combinations is CORRECT?

	The forward reaction is:	Kc at temperature T₁ is:
A	Endothermic	Smaller than Kc at **T_2**
B	Endothermic	Equal to Kc at **T_2**
C	Exothermic	Smaller than Kc at **T_2**
D	Exothermic	Larger than Kc at **T_2**

1.7 A beaker contains a 0,01 mol.dm^{-3} HCℓ solution. A spoonful of a soluble salt, X, is added to the solution and the pH of the solution increases.

Which ONE of the following can be salt X?

A KNO_3

B $(NH_4)_2SO_4$

C CH_3COONa

D Na_2SO_4 (2)

1.8 Which ONE is the conjugate acid of $HC_2O_4^-$?

A $C_2O_2^{\ 2-}$

B OH^-

C $H_2C_2O_4$

D $H_2C_2O_4^-$ (2)

1.9 A standard zinc / copper cell is set up with a salt bridge containing a concentrated potassium nitrate (KNO_3) solution. The electrolytes are zinc sulphate ($ZnSO_4$) and copper sulphate ($CuSO_4$). After the reaction has been allowed to continue for an extended period of time, the salt bridge was found to contain …

A K^+ and NO_3^- ions

B K^+, NO_3^- and $SO_4^{\ 2-}$ ions

C K^+, NO_3^- and $Zn^{\ 2+}$ ions

D K^+, NO_3^-, $SO_4^{\ 2-}$ and $Zn^{\ 2+}$ ions (2)

1.10 Which ONE of the following statements about the process of extraction of aluminium in an electrolytic cell is TRUE?

A Carbon dioxide is released at the anode.

B Aluminium forms at the anode.

C The oxygen formed at the anode reacts with the aluminium.

D Carbon dioxide gas is released at the cathode. (2)

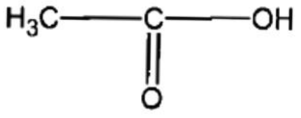
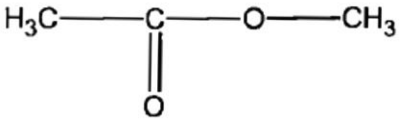
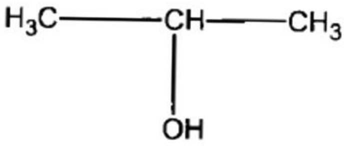
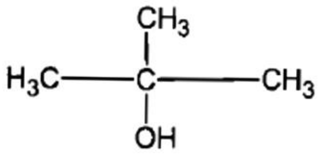
[20]

SECTION B

QUESTION 2

2.1 Define the term *functional group* of organic compounds. (2)

2.2 Consider the condensed structural formulae of the organic compounds below:

A	$H_3C-CH=CH_2$	B	H_3C-CH_2-OH
C	 $H_3C-\underset{\underset{O}{\|}}{C}-OH$	D	 $H_3C-\underset{\underset{O}{\|}}{C}-O-CH_3$
E	 $H_3C-\underset{\underset{OH}{\vert}}{CH}-CH_3$	F	 $H_3C-\underset{\underset{OH}{\vert}}{\overset{\overset{CH_3}{\vert}}{C}}-CH_3$

Write down the letter that represents a substance that: {a letter can be used more than once}

2.2.1 is an unsaturated compound. (1)

2.2.2 will react with a halogen by means of an addition reaction. (1)

2.2.3 can be used for the preparation of methyl ethanoate. (1)

2.2.4 is a primary alcohol. (1)

2.2.5 when produced, needs sulphuric acid as a catalyst. (1)

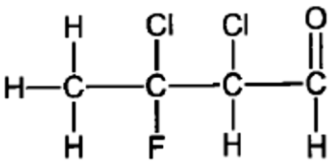
2.3.1 Draw the structural formula of 2,4-dimethylhexan-3-one. (3)

2.3.2 Write down the homologous series to which the molecule in QUESTION 2.3.1 belongs. (1)

2.4.1 Draw the structural formula of methyl propanoate. (2)

2.4.2 Write down TWO reaction conditions needed for the preparation of an ester. (2)

2.5 Write down the correct IUPAC name of the following compound:



$H-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{F}{|}}{\overset{\overset{Cl}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{Cl}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{O}{\|}}{C}}$

(3)

[18]

QUESTION 3

The vapour pressure of straight-chain alkanes and straight-chain alcohols, together with their molecular masses, are given in the table below. (Compounds **A**, **B**, **C** and **D**)

	COMPOUNDS	**VAPOUR PRESSURE (kPa)**	**MOLECULAR MASS ($g\cdot mol^{-1}$)**
A	Propane	853,16	44
B	Butane	112	58
C	Propan-1-ol	2,4	60
D	Butan-1-ol	0,1	74

3.1 Define the term *vapour pressure*. (2)

3.2 The vapour pressure of compound **C** and **D** are compared. Write down the:

3.2.1 Independent variable (1)

3.2.2 Dependent variable (1)

3.3 Explain the difference between the vapour pressure of the alkane and the alcohol, each having FOUR carbon atoms per molecule, by referring to the TYPE of intermolecular forces in each compound. (3)

3.4 Compound **B** has an isomer.

3.4.1 Write down the structural formula of this isomer. (2)

3.4.2 Give the IUPAC name of the isomer in QUESTION 3.4.1. (2)

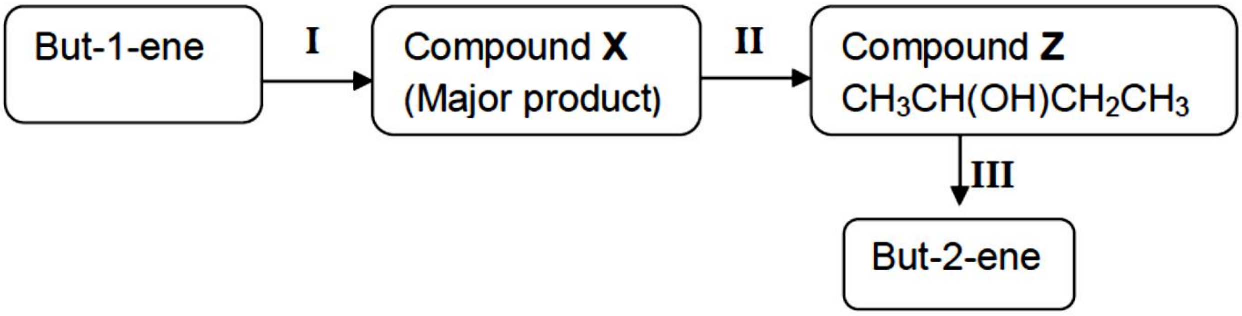
3.4.3 State what type of isomer this is. Choose from CHAIN, POSITIONAL or FUNCTIONAL isomer. (1)

3.5 Which ONE of compounds A to D has the highest boiling point. Explain your answer. (2)

[14]

QUESTION 4

The flow diagram below shows the steps that a learner follows to convert but-1-ene to but-2-ene. **I**, **II** and **III** represent different types of reactions.



4.1 Compound **X** is formed when but-1-ene reacts with HCℓ (g).

Write down:

4.1.1 TWO reaction conditions for this reaction (2)

4.1.2 The IUPAC name of compound **X** (2)

4.2 Name the type of reactions represented by:

4.2.1 **I** (1)

4.2.2 **II** (1)

4.2.3 **III** (1)

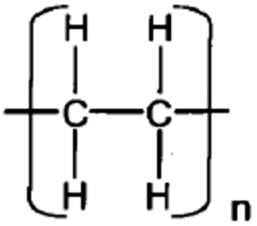
4.3 Compound **Z** is converted to but-2-ene in the presence of concentrated sulphuric acid in a warm water bath.

4.3.1 Is compound **Z** a PRIMARY, SECONDARY or TERTIARY alcohol? (1)

4.3.2 Why is compound **Z** heated in a water bath? (1)

4.4 Explain the difference between *addition polymerisation* and *condensation polymerisation.* (4)

4.5 Consider the structural formula of a part of a polymer as shown below:



4.5.1 Write down the IUPAC name of this polymer. (1)

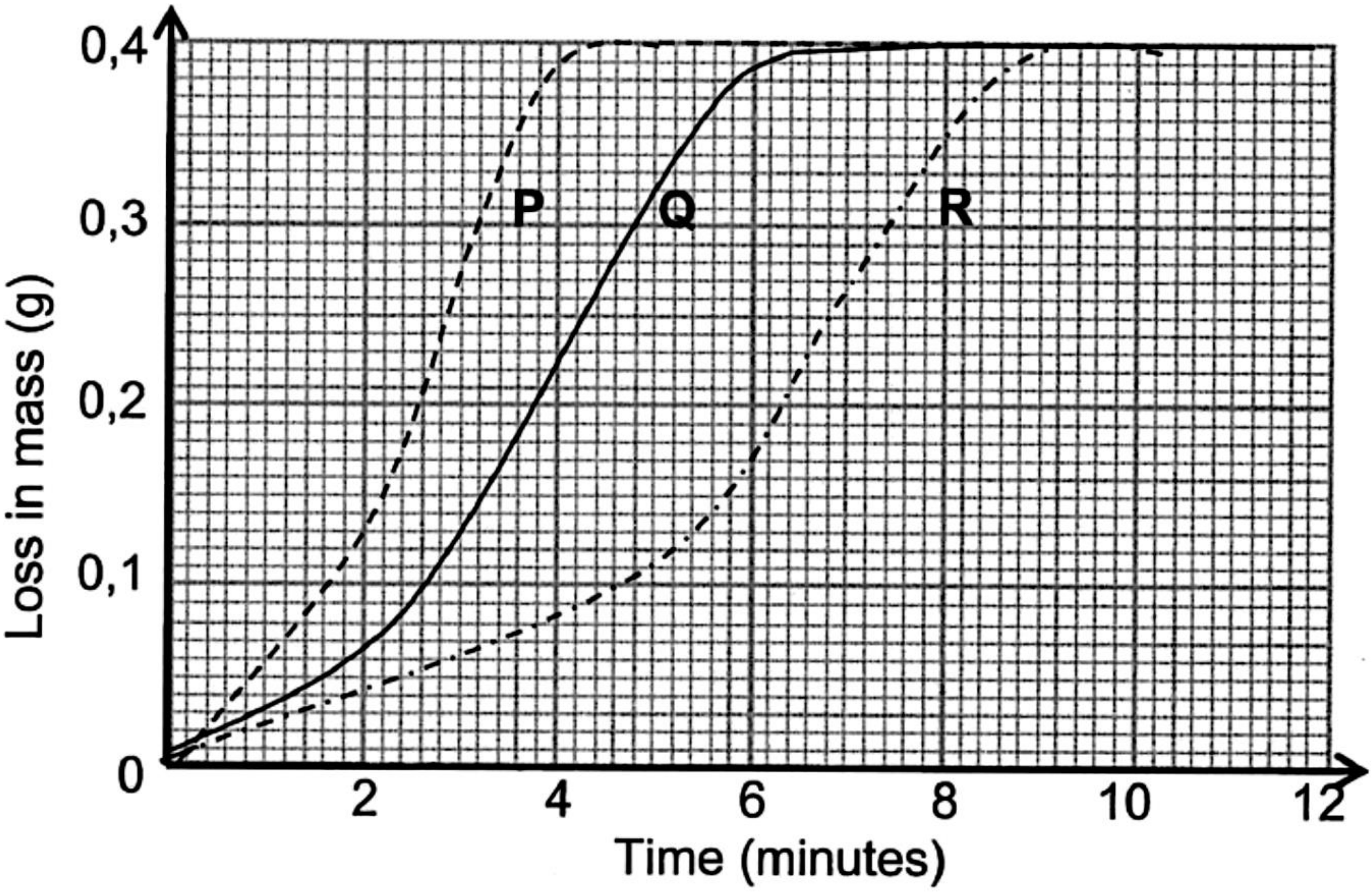
4.5.2 Name one product that is made from this polymer. (1)

4.5.3 Give the MOLECULAR formula of the monomer used to prepare this polymer (1)

[16]

QUESTION 5

Pieces of marble ($CaCO_3$) with a mass of 1,05 g are placed in a flask and covered with 10 cm^3 of a 2 $mol.dm^{-3}$ hydrochloric acid solution at 20°C. The flask is weighed every two minutes to determine the loss in mass due to the production of carbon dioxide. Line graph **Q** is plotted from these results.



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

5.2 Write down a balanced equation for the reaction between the marble and hydrochloric acid. (3)

Use graph Q to answer the following questions.

5.3 What mass of carbon dioxide gas is formed after 8 minutes? (1)

5.4 During which ONE of the following time intervals is the reaction rate the highest? Choose from the following and briefly explain your choice.

0-2 minutes
2-4 minutes
6-8 minutes
8-10 minutes

. (2)

5.5.1 After how many minutes has half of the $CaCO_3$ reacted? (1)

5.5.2 Calculate the average reaction rate in $g.min^{-1}$ up to this point. (3)

5.6 Predict what will happen to the rate of the reaction in each of the following cases; (Choose from INCREASES, DECREASES or REMAINS THE SAME)

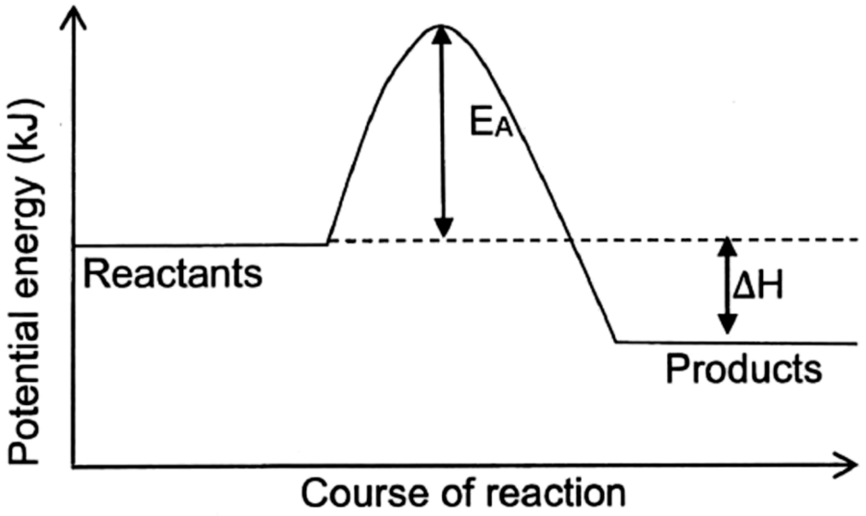
5.6.1 The marble pieces are replaced by marble powder (1)

5.6.2 20 cm^3 of a 2 $mol.dm^{-3}$ hydrochloric acid solution is used (1)

The experiment is now repeated with a 1.5 $mol.dm^{-3}$ hydrochloric acid solution. The reaction runs to completion.

5.7 Which graph, **P** or **R**, is obtained from this experiment? (1)

5.8 A potential energy diagram is drawn for the above reaction.



5.8.1 Is this reaction exothermic or endothermic? (1)

5.8.2 How will the heat of reaction change if the concentration of the hydrochloric acid is decreased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

5.8.3 A suitable catalyst is added to the reaction. WHICH quantity on the graph will change? (1)

[18]

QUESTION 6

6.1 State *Le Chatelier's principle*. (2)

6.2 Potassium chromate (K_2CrO_4) is dissolved in water. In solution, the chromate ions (CrO_4^{2-}) reach equilibrium with the dichromate ions ($Cr_2O_7^{2-}$) according to the following balanced equation:

$$\underset{\text{yellow}}{2\ CrO_4^{2-}(aq)} + 2\ H^+(aq) \rightleftharpoons \underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(\ell)$$

6.2.1 A reagent is now added to the orange solution. Which reagent, NaOH(aq) or HNO_3(aq), will result in a colour change from orange to yellow? (1)

6.2.2 Which ion, CrO_4^{2-}(aq) or $Cr_2O_7^{2-}$(aq), will be present in higher concentration at a low pH? (1)

When the temperature is gradually increased, it is observed that the colour of the solution changes to yellow.

6.2.3 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? (1)

6.2.4 Explain the answer in QUESTION 6.2.3 by referring to Le Chatelier's principle. (2)

6.3 Carbon dioxide reacts with carbon in a closed system to produce carbon monoxide (CO), according to the following balanced equation:

$$CO_2(g) + C(s) \rightleftharpoons 2\ CO(g)$$

6.3.1 Explain the term *closed system*. (2)

Initially an unknown amount of carbon dioxide is exposed to hot carbon at 800°C in a sealed 2 dm^3 container. The equilibrium constant, K_c, for the reaction is 14. At equilibrium it is found that 224 g carbon monoxide is present.

6.3.2 How will the equilibrium concentration of the product compare to that of the reactants? Choose from LARGER THAN, SMALLER THAN or EQUAL TO. Give a reason for your answer. (No calculation is required.) (2)

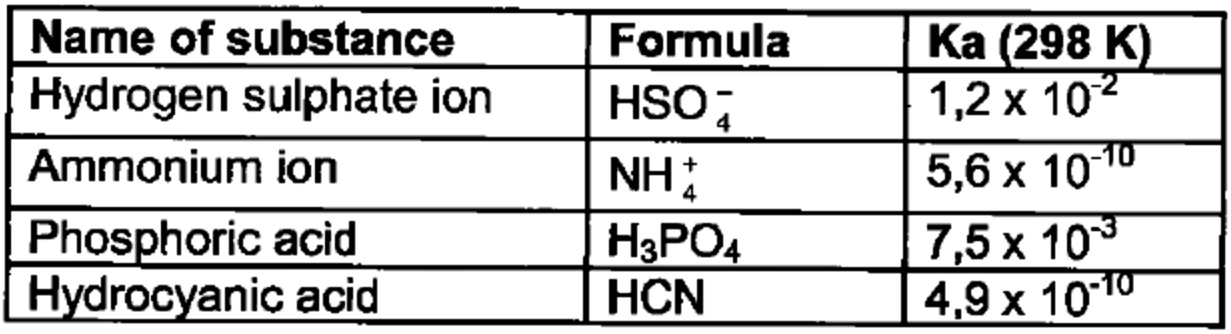
6.3.3 Calculate the initial amount (in moles) of CO_2(g) present. (9)

6.3.4 If more carbon is added at a constant temperature, how will this affect the yield of CO(g) at equilibrium? Choose from INCREASES, DECREASES, or REMAINS THE SAME. (1)

[21]

QUESTION 7

7.1 The dissociation constant of some substances is given below:



Name of substance	Formula	Ka (298 K)
Hydrogen sulphate ion	HSO_4^-	$1{,}2 \times 10^{-2}$
Ammonium ion	NH_4^+	$5{,}6 \times 10^{-10}$
Phosphoric acid	H_3PO_4	$7{,}5 \times 10^{-3}$
Hydrocyanic acid	HCN	$4{,}9 \times 10^{-10}$

7.1.1 Write down the FORMULA of the substance that has the highest tendency to dissociate. (1)

7.1.2 Write down the FORMULA of the conjugate base of hydrocyanic acid. (1)

7.2 7,6 g of impure commercial washing soda ($Na_2CO_3{\cdot}10H_2O$)is dissolved in water. The solution is diluted to 500 cm^3 in a measuring flask. 25 cm^3 of this solution is titrated with a standard HCℓ solution of concentration 0,1 mol.dm^{-3}.

$$Na_2CO_3{\cdot}10H_2O \;+\; HC\ell \;\rightarrow\; NaC\ell \;+\; H_2O \;+\; CO_2$$

7.2.1 Define a *weak base*. (2)

7.2.2 Rewrite and balance the chemical equation for the above reaction. (2)

7.2.3 Three indicators are available to indicate the equivalence point of this titration.

- Methyl orange
- Bromothymol blue
- Phenolphthalein

Choose from the list of indicators the ONE which will be most suitable for this titration. (1)

7.2.4 Give a reason for the answer to QUESTION 7.2.2 (2)

7.2.5 What colour change will be observed during the titration of the base with the acid. (1)

7.2.6 Calculate the mass of pure $Na_2CO_3{\cdot}10H_2O$ in commercial washing soda if 24,8 cm^3 of the HCℓ solution was needed to reach the equivalence point in the titration. (5)

7.2.7 Calculate the percentage purity of the Na_2CO_3 in the original mass of commercial washing soda. (3)

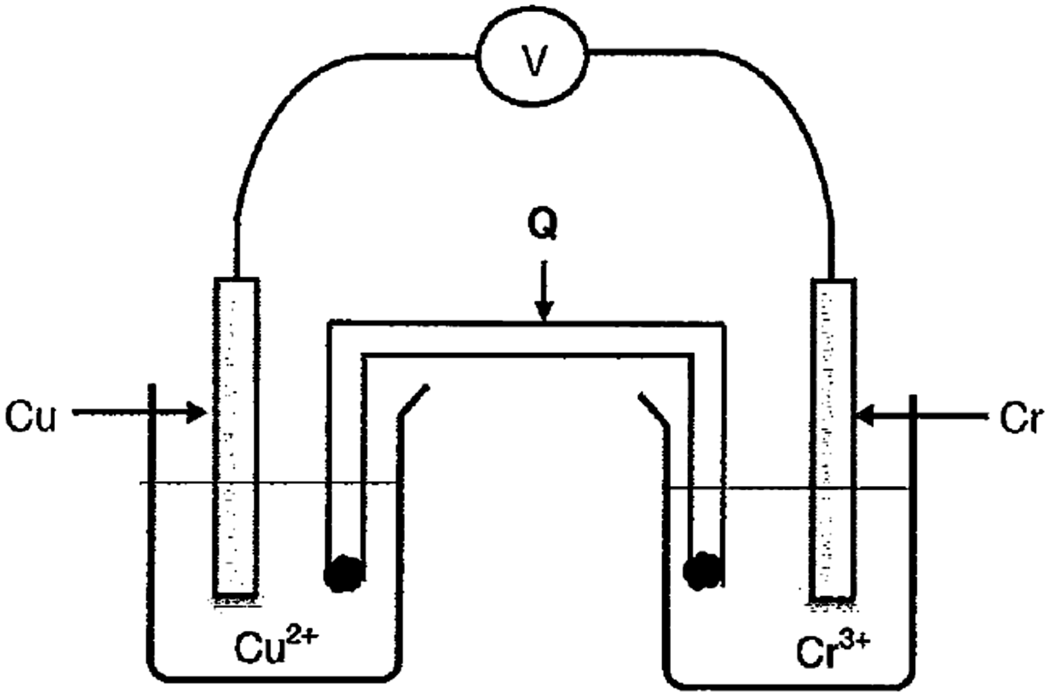
[18]

QUESTION 8

8.1 An iron nail, which has been thoroughly cleaned, is placed in a beaker containing a 1 $mol.dm^{-3}$ copper (II) sulphate solution. The beaker is allowed to stand overnight. The next morning it is observed that a reddish brown precipitate formed on the iron nail.

By referring to the relative strength of reducing agents, explain why a reddish brown precipitate formed on the iron nail. (3)

8.2 A galvanic cell is set up under standard conditions as shown in the simplified diagram below:



8.2.1 State ONE function of the component labelled **Q**. (1)

8.2.2 Which electrode (Cu or Cr) is the cathode of this cell? (1)

8.2.3 Write down the overall (net) balanced cell reaction that takes place in this cell. (3)

8.2.4 Calculate the initial emf of this cell. (4)

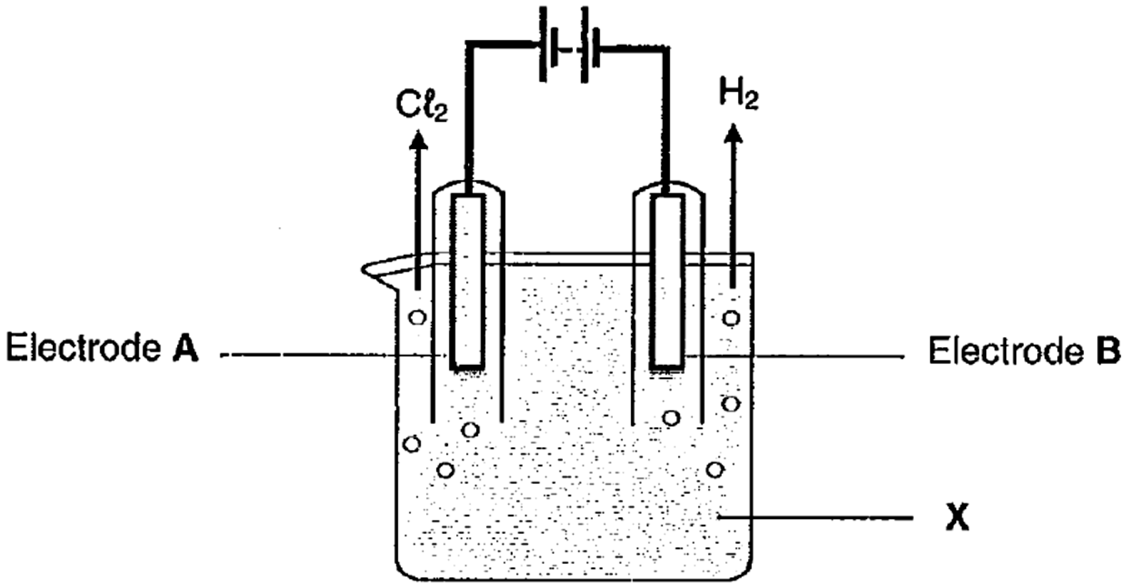
8.2.5 A similar cell is now set up using 2 $mol.dm^{-3}$ $Cu^{2+}(aq)$. All other conditions stay the same. How will the initial emf of this cell compare to that calculated in QUESTION 8.2.4? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

8.2.6 How will the initial reading on the voltmeter change as the cell reaction approaches equilibrium? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[14]

QUESTION 9

A simplified diagram of an electrochemical cell, used for the production of chlorine gas, is shown below:



9.1 Define the term *electrolyte*. (2)

9.2 Write down the NAME of electrolyte **X**. (1)

9.3 Write down the half-reaction which takes place at the positive electrode. (2)

9.4 Which electrode, **A** or **B**, is the ANODE? Give a reason for the answer. (2)

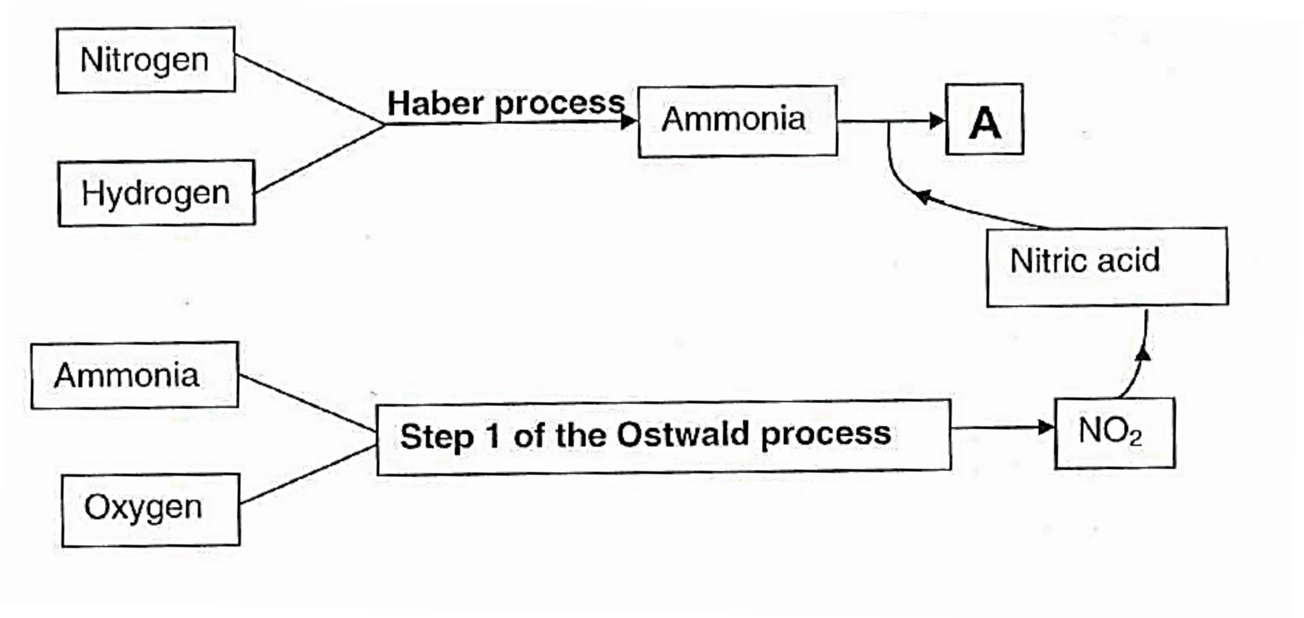
9.5 Litmus added to the electrolyte turns blue around electrode B. Explain this observation with the aid of the relevant half-reaction. (3)

9.6 Give a reason why platinum can be used as electrodes. (1)

[11]

QUESTION 10

10.1 The flow diagram below represents the processes used to manufacture fertiliser **A**. Both the Haber and the Ostwald processes are part of the total process.



10.1.1 Write down the name of a suitable catalyst used in the Haber process. (1)

10.1.2 Write down the FORMULA of the compound represented by **A**. (1)

10.1.3 Write down a balanced chemical equation for **STEP 1 of the Ostwald process**. (3)

10.2 You want to start a vegetable garden in your community. You obtain the following bags of fertilisers as described below:

X: 4:6:9 (43)

Y: 15:3:3 (51)

10.2.1 From fertilisers **X** and **Y**, choose a fertiliser most suitable for growth of tomatoes. (1)

10.2.2 Give a reason for the answer to QUESTION 10.2.1. (1)

10.2.3 Calculate the mass of potassium in a 20 kg bag of fertiliser **Y**. (3)

[10]

TOTAL 150

CAPS

INFORMATION FOR PHYSICAL SCIENCES GR 12
PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

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

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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)
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**

TABLE 4A: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability

Half-reactions			E° (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/

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

Half-reactions			E° (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	$-0,06$
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	$\mathbf{0,00}$
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	$+0,14$
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	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 ↑