



Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Departement van Onderwys
Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

KEREITI YA 12

LOETSE 2024

FISIKALE SAENSESE P2 (KHEMISTIRI)

MATSHWAO: 150

NAKO: dihora tse 3

Pampiri ena e na le maqephe a 19, ho kenyelletsa le didatha shiti tse 4.

MELAO LE TLHAISO-LESEDING

1. Ngola LEBITSO le FANE ya hao ka botlalo dibakeng tse nepahetseng BUKENG YA HO ARABELA.
2. Pampiri ena e na le dipotso tse ROBONG. Arabela dipotso TSOHLE BUKENG YA HO ARABELA.
3. Qala potso KA NNGWE leqepheng LE LETJHA BUKENG YA HO ARABELA.
4. Nomora dikarabo ka nepo jwalo ka ha ho nomorilwe pampiring ena ya dipotso.
5. Siya mola O LE MONG dipakeng tsa dipotswana tse pedi, mohlala, dipakeng tsa POTSO ya 2.1 le POTSO ya 2.2.
6. O ka sebedisa khaletjhuleitha e sa prokeremuwang.
7. O ka sebedisa dihlobo tse nepahetseng tsa mathematikisi.
8. Bontsha difomulara TSOHLE le disabostitjhushene dikhaletjhuleisheneng TSOHLE.
9. QETELLONG atametsa dikarabo tsa hao ka ho bonyane dinomoro TSE PEDI tsa didesimale.
10. Fana ka tshehetso, dimanollo, le tse ding ka bokgutshwanyane moo ho hlokehang.
11. O eletswa ho sebedisa DIDATHA SHITI tse hokelletsweng.
12. Ngola ka makgethe le ka mongolo o balehang.

POTSO YA 1: DIPOTSO TSA KGETHO TSE FUWENG

Ho fanwe ka dikgetho tse fapaneng ele dikarabo tse ka kgonehang dipotsong tse latelang. Kgetha karabo o be o ngola feela tlhaku (A-D) pela dinomoro tsa dipotso (1.1 ho ya ho 1.10) BUKENG YA HO ARABELA, mohlala 1.11 E.

- 1.1 Ke efe E LE NNGWE ho tse latelang di-homologous series e nang le hydroxyl group e bonduweng ho athomo ya carbon e saturated?

A Ketones

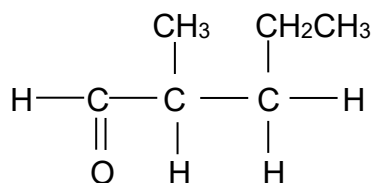
B Aldehydes

C Alcohols

D Esters

(2)

- 1.2 Shebisisa khompaonde e bontshitsweng ka tlase:



Lebitso le NEPAHETSENG la IUPAC la khompaonde e ka hodimo ke:

A 3-ethyl-2-methylpropanal

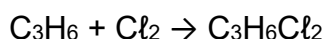
B 2-methyl-3-ethylpropanal

C 2-methylpentanal

D 4-methylpentanal

(2)

- 1.3 Shebisisa reekeshene:



Lebitso la reekeshene ke ...

A hydration

B halogenation

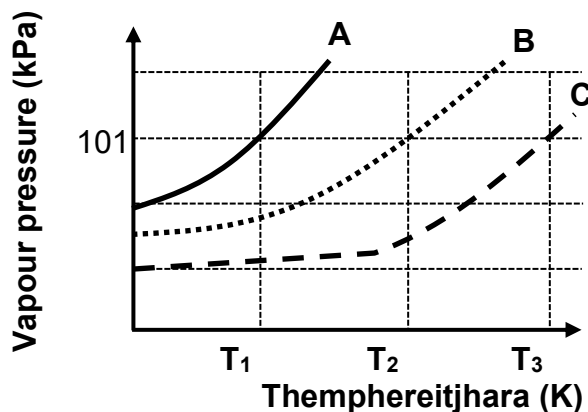
C hydrogenation

D hydrolysis

(2)

- 1.4 Shebisisa methinya ya vapour pressure against temperature ya di-CHAIN ISOMER tse THARO tlasa standard atmospheric pressure.

VAPOUR PRESSURE VERSUS TEMPERATURE



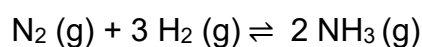
Shebisisa diteitemente mabapi le methinya e MERARO ya di-CHAIN ISOMER.

- I Khompaonde ya **A** e na le chain length e kgutshwane haholo.
- II Boiling poente ya khompaonde ya **B** ke T_2 .
- III Khompaonde ya **C** e ho gaseous phase ho T_2 .

Ke sefe seteitemente ho tse ka hodimo seo/tseo e leng nnete?

- A I le II feela
- B III feela
- C II le III feela
- D I le III feela (2)

- 1.5 Shebisisa synthesis reekeshene ya ammonia, NH_3 :

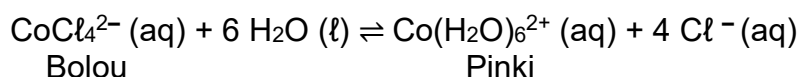


Reithi eo $\text{N}_2(\text{g})$ e sebedisitsweng nakong ya reekeshene ke $x \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$.

Ke efe E LE NNGWE ho tse latelang eo reithi moo Ammonia, $\text{NH}_3(\text{g})$ e phorodutang ka $\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$ ka ho bapisa le $\text{N}_2(\text{g})$?

- A x
- B $2x$
- C $\frac{x}{2}$
- D $3x$ (2)

1.6 Shebisisa reekeshene e latelang e ho ekwiliboriamo:



Solushene ha jwale e **pinki**.

Khonsentereithete hydrochloric asiti (HCl) e ekeditswe ho ekwiliboriamo mikisetjhara.

Ke efe E LE NNGWE dikopanong tse latelang e hlalosing ka ho NEPAHALA tshusumetso eo keketso ya khonsentereithete hydrochloric asiti (HCl) e tla bang le yona ho ekwiliboriamo khonsetente, Kc le phetoho ya mmala wa solushene?

	Kc	PHETHOHO YA MMALA
A	Ha ho tshusumetso	Solushene e tjhenthja ho ba pinki haholo
B	Ha ho tshusumetso	Solushene e tjhenthja ho ba bolou
C	E a ata	Solushene e tjhenthja ho ba bolou
D	E a fokotseha	Solushene e tjhenthja ho ba pinki haholo

(2)

1.7 Ke efe E LE NNGWE ho disabosetense tse latelang e ka kgethwang e le Lowry-Brønsted asiti?



(2)

1.8 Shebisisa letswai, CH_3COONa .

Ke efe E LE NNGWE dikopanong tse latelang e hlalosing haeterolisisi reekeshene le pH ya letswai ka ho NEPAHALA?

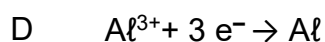
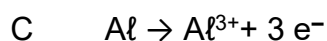
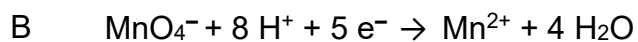
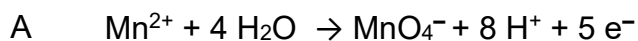
	HAETEROLISISI	pH
A	$\text{CH}_3\text{COO}^{-} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^{-}$	E kgolo ho 7
B	$\text{CH}_3\text{COO}^{-} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COOH} + \text{OH}^{-}$	E nyane ho 7
C	$\text{Na}^{+} + \text{H}_2\text{O} \rightleftharpoons \text{NaOH} + \text{H}_2\text{O}$	E kgolo ho 7
D	$\text{CH}_3\text{COO}^{-} + \text{Na}^{+} \rightleftharpoons \text{CH}_3\text{COONa}$	E lekana le 7

(2)

1.9 Shebisisa sele notheishene ya galvanic cell e ka tlase.

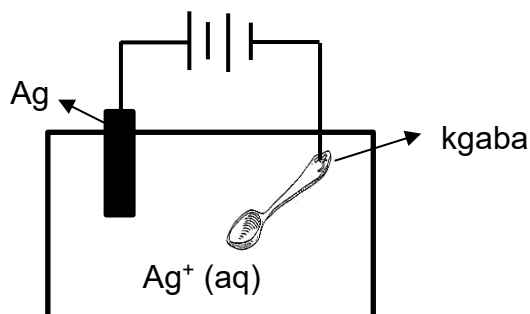


Ke efe E LE NNGWE ho tse latelang reekeshene e etsahalang ho cathode?

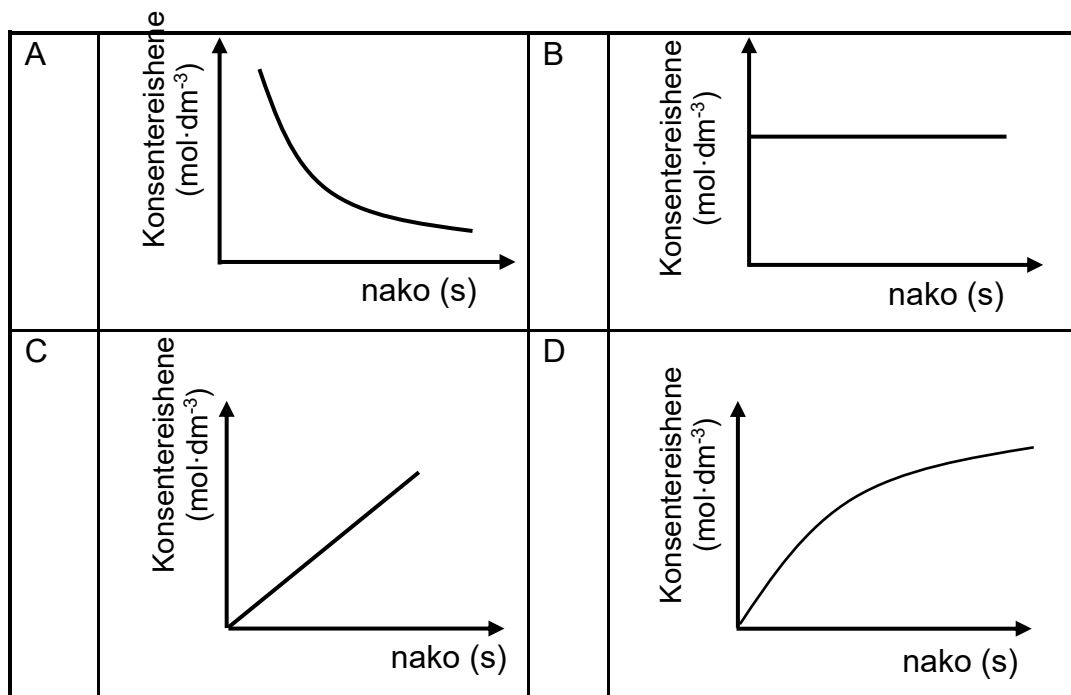


(2)

1.10 Kgaba e pleituwe ka silver (Ag) nakong ya porosese ya eleketerolaesese.



Ke efe E LE NNGWE ho tse latelang dikerafo e emetseng ka BOTLALO konsentereishene ya di-silver ion (Ag^+) ho eleketerolaete ka mora nako?



(2)
[20]

POTSO YA 2 (Qala leqepheng le letjha.)

Shebisisa diokanike khompaonde **A–E** tse ka tlase

A 3-methylbutanone	B C_3H_7Cl
C $ \begin{array}{ccccccc} & H & & H & & & \\ & & & & & & \\ H & - C & - & C & - & H \\ & & & & & & \\ & H & & H & & & \end{array} $	D $ \begin{array}{ccccccc} & H & & & & CH_3 & \\ & & & & & & \\ H & - C & - & C \equiv C & - & C & - H \\ & & & & & & \\ & H & & & & CH_2CH_3 & \end{array} $
E $ \begin{array}{ccccccc} & H & & H & & O & \\ & & & & & & \\ H & - C & - & C & - & C & - O - H \\ & & & & & & \\ & H & & H & & & \end{array} $	

2.1 Hlalosa *functional group*. (2)

2.2 Ngola TLHAKU ya khompaonde e:

2.2.1 Nang le carboxyl group (1)

2.2.2 Nang le general fomulara $C_nH_{2n}O$ (1)

2.2.3 Nang le empirical fomulara e leng CH_2 (1)

2.3 E tla bapiswa jwang molecular mass ya khompaonde ya **E** ho ya ethyl methanoate?

Kgetha ho E KGOLO HO NA LE, E NYANE HO NA LE kapa E LEKANA LE.

Fana ka lebaka la karabo. (3)

2.4 Ngola:

2.4.1 SETERAKETJHARALE FOMULARA sa **A**. (2)

2.4.2 Lebitso la IUPAC la khompaonde ya **E**. (2)

2.4.3 Lebitso la IUPAC la khompaonde ya **D**. (3)

2.5 Khompaonde ya **B** ke sekhondari haloalkane.

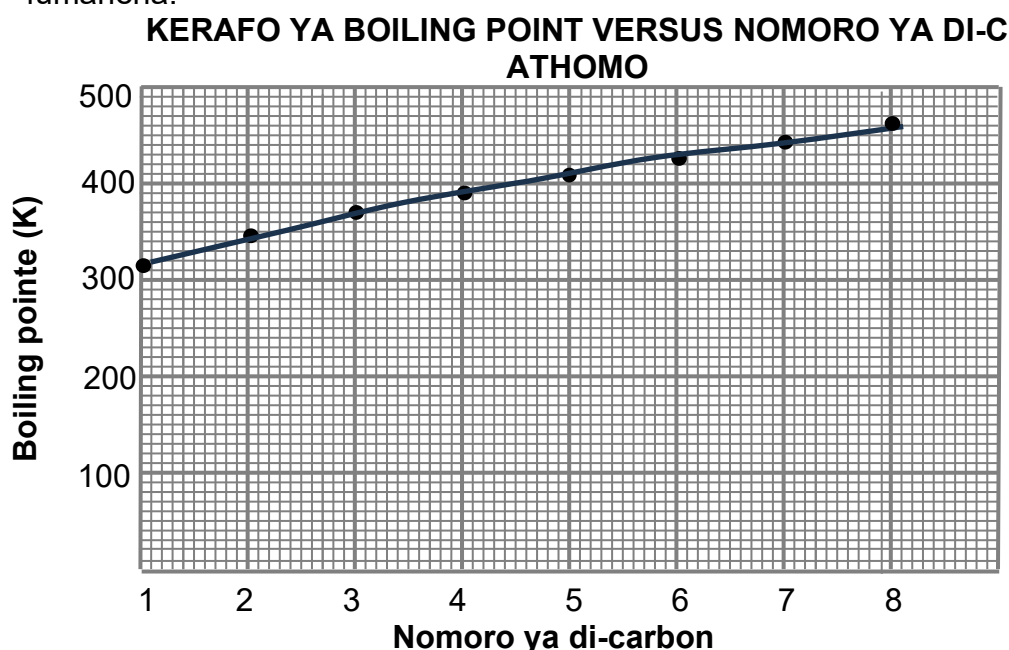
Teroya SETERAKETJHARALE FOMULARA sa khompaonde ya **B**. (2)

2.6 O sebedisa di-MOLECULAR FOMULARA, ngola ekweishene e balansitsweng ho khombaseshene e felletseng ya khompaonde ya **D**. (3)

[20]

POTSO YA 3 (Qala leqepheng le letjha.)

- 3.1 Kamano dipakeng tsa boiling point le nomoro ya di-carbon ho di-SETEREYITI TJHEINE PORAIMARI ALEKOHOLE e ya fuputswa. Mothinya o latelang o a fumaneha:



- 3.1.1 Hlalosa *boiling point*. (2)
- 3.1.2 Ke efe tshwano ya seteraketjharale ho dialekohele tse etsang phuputso e be le tokafatso? (1)
- 3.1.3 Ke efe van der Waals fose e ikarabelang ho bontsha thrende mothinyeng ona? (1)
- 3.1.4 Ngola lebitso la IUPAC ya alekohele e nang le boiling point e batlileng e lekana le 410 K. (2)

- 3.2 Phuputso e nngwe e entswe ho fumana tshusumetso ya phapano ya diseteraletjhara ho boiling pointe. Tafole e ka tlase e bontsa dikompaonde tse fapaneng le molar mass tsa tsona tse sebedisitsweng phuputsong ena.

KOMPAONDE		MOLAR MASS (g·mol ⁻¹)
A	Butanone	72
B	Butan-1-ol	74
C	Propanoic acid	74

- 3.2.1 Ke efe khompaonde ho **A**, **B** kapa **C** e tla ba le boiling pointe e hodimo? (1)
- 3.2.2 Hlalosa ka botlalo karabo ho POTSO ya 3.2.1. (5)

[12]

POTSO YA 4 (Qala leqepheng le letjha.)

4.1 Shebisisa diokanike reekeshene tse tharo, **I**, **II** le **III** ka tlase:

I	Pent-1-ene + HCl → Okanike khompaonde P (Meyija porodakete)
II	Okanike khompaonde P + NaOH → sekhondari alekohole Q + NaCl
III	Okanike khompaonde P + NaOH → Okanike khompaonde R + NaCl + H ₂ O (Meyija porodakete)

4.1.1 Na pent-1-ene e SATURATED kapa UNSATURATED? Fana ka lebaka la karabo. (2)

Ngola mofuta wa reekeshene o emetsweng ke:

4.1.2 Reekeshene ya **II** (1)

4.1.3 Reekeshene ya **III** (1)

Ngola:

4.1.4 SETERAKETJHARALE FOMULARA sa khompaonde ya **P**. (2)

4.1.5 Lebitso la IUPAC la khompaonde ya **Q**. (2)

4.1.6 Reekeshene ya **II** le **III** di hloka tshebediso ya beise e seterong.

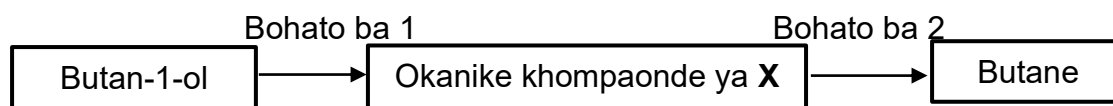
Ngola dikhondishene tse tla ikamahanya le reekeshene ya **II** ho feta reekeshene ya **III**. (2)

4.1.7 Pent-1-ene le okanike khompaonde ya **R** ke di-isomer.

Pent-1-ene le okanike khompaonde ya **R** ke mofuta ofe wa isomer?

Kgetha ho FUNCTIONAL, POSITIONAL le CHAIN. (2)

4.2 Tayakeramo ya neheletsano e ka tlase e bontsha phetolelo ya butan-1-ol hoba butane gas.



Dikhemikhale tse latelang di ya hlokeha:

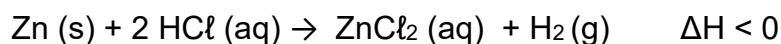
H ₂ SO ₄ e konsentereituweng	Pt	H ₂
--	----	----------------

Sebedisa DISETERAKETJHARALE FOMULARA TSE KONDENSUWENG, o ngole ekweishene e balansitseng o bontshe dikhemikhale tse sebedisitsweng bohato ka bong ho porephesisha butane gas ho tloha ho butan-1-ol.

(6)
[18]

POTSO YA 5 (Qala leqepheng le letjha.)

Reekeshene dipakeng tsa hydrochloric acid (HCl) E FETANG TEKANYO le zinc (Zn) e sebedisitswe ho fuputsa difeketha tse susumeletsang reekeshene reithe. Ekweishene e balansitseng ya reekeshene ena ke:



Diekeseperimente tse tharo di entswe mme fekhetha e le nngwe e tjhentjhuwe ekeseperimenteng ka nngwe.

Volume e tshwanang ya hydrochloric acid le boima bo tshwanang ba di-zinc granule disebedisitswe ekeseperimenteng ka nngwe. Ekeseperimenteng ka nngwe hydrochloric acid e kupetsa zinc ka botlalo.

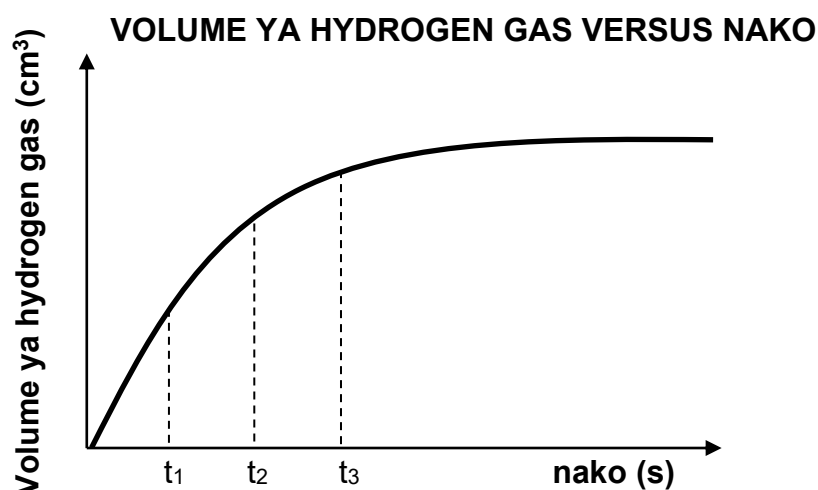
Tafole e ka tlase e bontsha di-reaction condition.

EKESEPERIMENTE	KONSENTEREISHENE YA HCl (mol·dm ⁻³)	Cu (s) E TENG
1	0,5	Tjhe
2	0,8	Tjhe
3	0,5	E

5.1 Hlalosa *reaction rate*. (2)

5.2 Ngola investigative question ka ho bapisa diekeseperimente 1 le 2. (2)

5.3 Mothinya, o sa teroywang ho ya ka scale, o fumanwe bakeng sa volume ya hydrogen gas, H₂ (g) e porojusitsweng ka mora nako e itseng ho ekeseperimente 1.



5.3.1 Reithi eo hydrogen gas porojisitsweng pakeng tsa t_1 – t_2 e ka bapiswa jwang le ya t_2 – t_3 ?

Ngola feela KA HODIMO HO, KA TLASE HO kapa E LEKANA LE. (1)

5.3.2 Teroya hape kerafo BUKENG YA HO ARABELA. Leibela mothinya ka ho hlaka e le **A**.

Seteng ya di-axis e le nngwe, etsa seketjhe sa mothinya o tla fumaneha ho ekeseperimente ya **3**. Leibela mothinya ona e le **B**. (2)

5.4 Reekeshene ho ekeseperimente ya **1** e nka 58 s ho fihlela e felella le average reaction rate eo hydrogen gas, H_2 e porojusitsweng ka yona ke $8,39 \text{ cm}^3 \cdot \text{s}^{-1}$.

Khaletjhuleitha initial mass ya zinc e sebedisitsweng ekeseperimenteng ka nngwe.

Molar volume ya hydrogen gas (H_2) ho 25°C ke $24\,000 \text{ cm}^3 \cdot \text{mol}^{-1}$.

Jwale ekeseperimente ya **4** e khondakethwa ka ho nyolla themphereitjhara ya reekeshene mikisetjhara ho ekeseperimente ya **1**. (5)

5.5 Ho tjhentjha hona ho ama reekeshene reithi jwang?

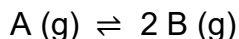
Kgetha ho e a NYOLOHA, THEOHA kapa DULA E TSHWANA. (1)

5.6 Hlalosa karabo ya POTSO ya 5.5 ka ho ikamanya le collision theory.

[16]

POTSO YA 6 (Qala leqepheng le letjha.)

6.1 Shebisisa hayephothethikale reekeshene e latelang e ho ekwiliboriamo:



Datha e tafoleng e latelang e bontsha diekwiliboriamo tsa A (g) le B (g) dithemphereitjhareng tse fapaneng:

Thempheritjhara (°C)	A (mol·dm ⁻³)	B (mol·dm ⁻³)
200	0,0125	0,843
300	0,171	0,764

6.1.1 Hlalosa Le Chaterlier's principle. (2)

6.1.2 Na FOWADE kapa REVESE reekeshene e feivuwe ho 200 °C?

Fana ka lebaka la karabo. (2)

Ekwiliboriamo konsentereishene ya **A** ho 200 °C e tla afeketuwa jwang ke tse latelang:

Kgetha ho e a NYOLOHA, THEOHA kapa HA HO TSHUSUMETSO

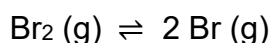
6.1.3 Pressure e a nyoloha. (1)

6.1.4 Ho eketswa ha khathalisiti e loketseng. (1)

6.1.5 Na fowade reekeshene e EXOTHERMIC kapa ENDOTHERMIC? (1)

6.1.6 Sebedisa Le Chatelier's principle o itshetlehile ka datha e tafoleng ho hlalosa karabo ya POTSO ya 6.1.5. (3)

6.2 Qalong 1,05 moles tsa Bromine (Br₂) di kwalletswe setshelong se senang letho. Reekeshene e latelang e etsahala ho 1 600 °C.



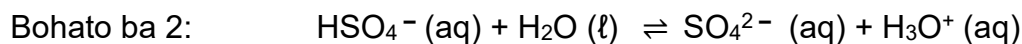
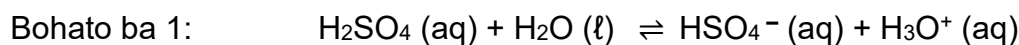
Konsentereishene ya Bromine (Br₂) ke 2,074 mol·dm⁻³ ho ekwiliboriamo. Ekwiliboriamo khonsetente, K_c ke 6,34 x 10⁻⁴ ho 1 600 °C

Khaletjhuleitha volume ya setshelo. (7)

[17]

POTSO YA 7 (Qala leqepheng le letjha.)

7.1 Sulphuric acid, H_2SO_4 ke asiti e matla e ayonaisang ka mehato e mmedi jwalo ka ha ho bontshitswe diekweisheneng tse ka tlase:



7.1.1 Hlalosa se bolelwang ka *strong acid*. (2)

7.1.2 Fana ka lebaka le etsang hore sulphuric acid e nkuwe e le diprotic acid. (1)

7.1.3 Ngola khonjageithe beisi ya H_3O^+ . (1)

7.1.4 Ngola FOMULARA ya sabosetense e sebetsang jwalo ka ampholyte nakong ya ionisation ya sulphuric acid. (2)

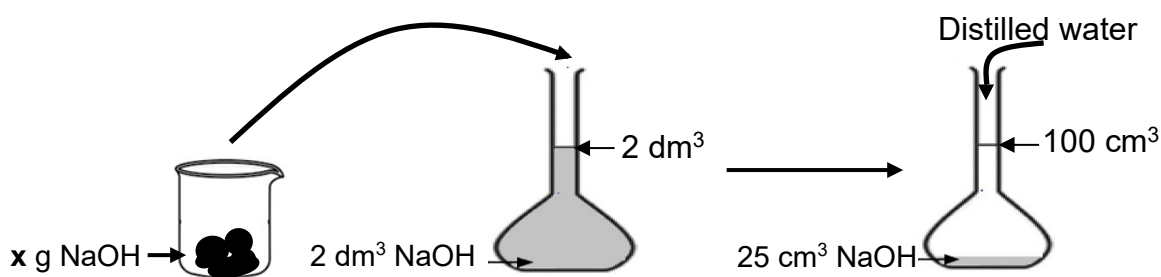
Sulphuric acid e na le konsentereishene ya $0,1 \text{ mol} \cdot \text{dm}^{-3}$.

7.1.5 Khaletjhuleitha pH velu ka mora ho phethela ha ionisation. (4)

7.2 1,2 g ya anhydrous oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) e disolefa ho etsa solushene ya 50 cm^3 .

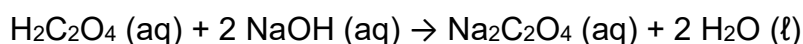
7.2.1 Khaletjhuleitha konsentereishene ya oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$. (3)

Baithuti ba disolefa $x \text{ g}$ ya sodium hydroxide, NaOH ho etsa solushene ya 2 dm^3 ya sodium hydroxide, $\text{NaOH} (\text{aq})$. Ba teranseferela solushene e leng 25 cm^3 ya sodium hydroxide, NaOH ho volumetric folaseke mme ba eketsa distilled water ho etsa solushene ya 100 cm^3 e **daeluthuweng**.



Ba thaethereitha $43,8 \text{ cm}^3$ ya **diluted** sodium hydroxide, NaOH solushene kgahlanong le 25 cm^3 oxalic acid, $\text{H}_2\text{C}_2\text{O}_4$ tse entsweng ho POTSO 7.2.1 ho fihlela endpoint.

Ekweishene e balansitseng ke:

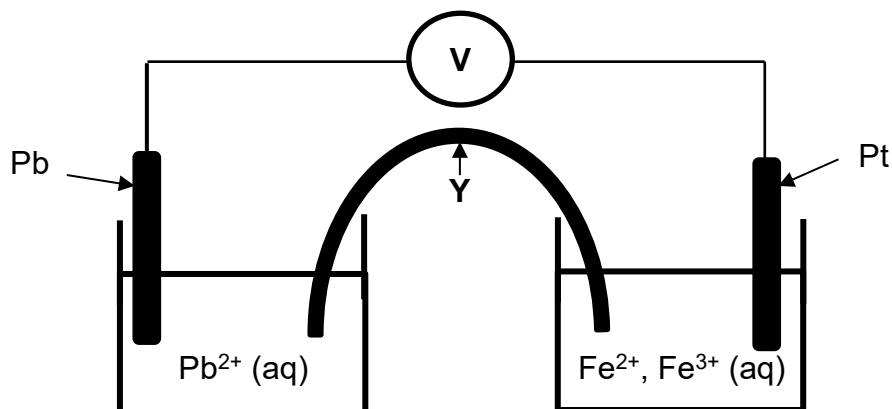


7.2.2 Khaletjhuleitha mass, $x \text{ g}$ ya sodium hydroxide e ileng ya sebediswa ho etsa solushene ya 2 dm^3 .

(7)
[20]

POTSO YA 8 (Qala leqepheng le letjha.)

Standard electrochemical cell e hokahantswe jwalo ka ha ho bontshitswe ka tlase.



8.1 Hlalosa phethoho ya eneji e etsahalang seleng ena. (2)

8.2 Khomponente ya **Y** e nnetefatsa hore sele e felletse.

Hlalosa mosebetsi e le nngwe o mong wa khomponente ya **Y**. (1)

8.3 Ngola hafo-reekeshene ya retakeshene. (2)

8.4 Khaletjhuleitha initial emf ya sele ena. (4)

8.5 E tla ameha jwang reading ya voltmeter, haeba:

Kgetha ho E A ATA, E A FOKOTSEHA kapa E DULA E TSHWANA

8.5.1 Initial konsentereishene ya Pb^{2+} e a nyollwa. (1)

8.5.2 Safeise ereya ya Pt eleketerote e a nyollwa. (1)

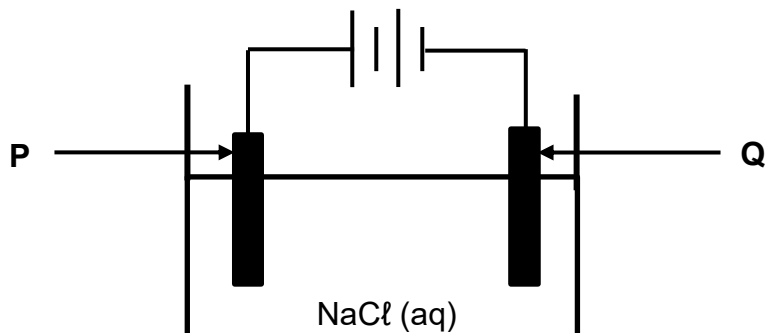
8.5.3 Hafo-sele ya $\text{Pb} | \text{Pb}^{2+}$ e tjhentjhwa ka ya $\text{Zn} | \text{Zn}^{2+}$. (1)

8.6 Hlalosa karabo ya POTSO ya 8.5.3 ka ho ipapisa ka relative strength ya direjusing agent. (2)

[14]

POTSO YA 9 (Qala leqepheng le letjha.)

Marothodi a mmalwa a phenolphthalein a ekeditswe ho solushene ya sodium chloride (NaCl) e konsenteretuweng. Solushene e dula e le khalalese. Di-carbon eleketerote tsa **P** le **Q** tse hokahantsweng leshaleng ditipilwe solusheneng jwalo ka ha ho bontshitswe ka tlase.



- 9.1 Hlalosa *electrolysis*. (2)
- 9.2 Ngola lebitso la khomponente e bontshang hore sele e ka hodimo ke electrolytic cell. (1)
- 9.3 Ngola LEBITSO kapa FOMULARA la/ya kgase e porojuswang ho eleketerote ya **Q**. (1)
- 9.4 Ngola hafo-reekeshene e etsahalang ho eleketerote ya **P**. (2)
- 9.5 Phenolphthalein e KHALALESE ho solushene e asitiki e be PINKI ho solushene e alekhalaene.
- Ngola mmala wa solushene ka ho eleketerote ya **Q** le fomulara ya sabosetense e ikarabellang mmaleng oo. (2)
- 9.6 Electrolytic cell e hokahanyeditswe tlhwekiso ya copper (Cu) ore e nang le di-impurity tsa zinc (Zn) le platinum (Pt). Ka mora ho felella ha tlhwekiso ya copper e impure, $1,38 \times 10^{-2}$ mol tsa dieleketerone di teranseferuwe. Initial mass ya cathode ke 2 g.
- 9.6.1 Ke efe methale, ntle le copper, e tla okesetaesa?
- Kgetha ho Zinc kapa Platinum. (1)
- 9.6.2 Khaletjhuleitha mass ya cathode ka mora tlhwekiso. (4)
- [13]**

MATSHWAO KAOFELA: 150

**NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT**

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**DATHA YA FISIKALE SAENSESE KEREITI YA 12 PAMPIRI YA 2
(KHEMISITIRI)**

TABLE 1: PHYSICAL CONSTANTS/TAFOLE YA 1: DIFISIKALE KONSETENTE

LEBITSO/NAME	LETSHWAO/SYMBOL	BOLENG/VALUE
Standard pressure <i>Standard pressure</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molar gas volume ho STP</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standard themphereitjhara</i>	T^θ	273 K
Charge on electron <i>Tlhatjhe ya eleketerone</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro's khonsetente</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/TAFOLE YA 2: DIFOMULARA

$n = \frac{m}{M} \text{ or/kapa}$ $n = \frac{N}{N_A} \text{ or/kapa}$ $n = \frac{V}{V_m}$	$c = \frac{n}{V} \text{ or/kapa}$ $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$ $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at /ho } 298\text{K}$
$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} / E^\theta_{\text{sele}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}}$ $E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}} / E^\theta_{\text{sele}} = E^\theta_{\text{retakeshene}} - E^\theta_{\text{okeseteishene}}$ $E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}} / E^\theta_{\text{sele}} = E^\theta_{\text{kemedi e okesetaesang}} - E^\theta_{\text{kemedi e rejusang}}$		
$q = I\Delta t$ $n = \frac{Q}{e}$ or/kapa $n = \frac{Q}{q_e}$		

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/TAFOLE YA 3: TAFOLE TA PHERIOTIKI YA DIELEMENTE

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)
KEY/ SESUPO																	
Nomoro ya athomiki Atomic number																	
1 H 1																	2 He 4
3 Li 7	4 Be 9																
11 Na 23	12 Mg 24																
19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63,5	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	36 Kr 84
37 Rb 86	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 92	42 Mo 96	43 Tc 98	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	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	81 Tl 204	82 Pb 207	83 Bi 209	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89 Ac															
			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm 147	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 231	92 U 238	93 Np 237	94 Pu 244	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 262	

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: DISETANDADE RETAKESHENE PHOTHENSHIALE

Increasing oxidising ability/Kgoneho ya okesetaeseng e eketsehang

Half-reactions/Hafo-reekeshene		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
$Cl_2(g) + 2e^-$	$\rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^-$	$\rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons Hg(l)$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons Al$	- 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/Kgoneho ya rejusing e eketsehang

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: DISETANDADE RETAKESHENE PHOTHENSHIALE

Increasing oxidising ability/Kgoneho ya okesetaeseng e eketsehang

Half-reactions/Hafo-reekeshene			E^{θ} (V)
$\text{Li}^+ + \text{e}^-$	\rightleftharpoons	Li	-3,05
$\text{K}^+ + \text{e}^-$	\rightleftharpoons	K	-2,93
$\text{Cs}^+ + \text{e}^-$	\rightleftharpoons	Cs	-2,92
$\text{Ba}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ba	-2,90
$\text{Sr}^{2+} + 2\text{e}^-$	\rightleftharpoons	Sr	-2,89
$\text{Ca}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ca	-2,87
$\text{Na}^+ + \text{e}^-$	\rightleftharpoons	Na	-2,71
$\text{Mg}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mg	-2,36
$\text{Al}^{3+} + 3\text{e}^-$	\rightleftharpoons	Al	-1,66
$\text{Mn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mn	-1,18
$\text{Cr}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cr	-0,91
$2\text{H}_2\text{O} + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Zn	-0,76
$\text{Cr}^{3+} + 3\text{e}^-$	\rightleftharpoons	Cr	-0,74
$\text{Fe}^{2+} + 2\text{e}^-$	\rightleftharpoons	Fe	-0,44
$\text{Cr}^{3+} + \text{e}^-$	\rightleftharpoons	Cr^{2+}	-0,41
$\text{Cd}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cd	-0,40
$\text{Co}^{2+} + 2\text{e}^-$	\rightleftharpoons	Co	-0,28
$\text{Ni}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ni	-0,27
$\text{Sn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Sn	-0,14
$\text{Pb}^{2+} + 2\text{e}^-$	\rightleftharpoons	Pb	-0,13
$\text{Fe}^{3+} + 3\text{e}^-$	\rightleftharpoons	Fe	-0,06
$2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^-$	\rightleftharpoons	Sn^{2+}	+0,15
$\text{Cu}^{2+} + \text{e}^-$	\rightleftharpoons	Cu^+	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cu	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	\rightleftharpoons	4OH^-	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^-$	\rightleftharpoons	$\text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + \text{e}^-$	\rightleftharpoons	Cu	+0,52
$\text{I}_2 + 2\text{e}^-$	\rightleftharpoons	2I^-	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	H_2O_2	+0,68
$\text{Fe}^{3+} + \text{e}^-$	\rightleftharpoons	Fe^{2+}	+0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^-$	\rightleftharpoons	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^-$	\rightleftharpoons	Ag	+0,80
$\text{Hg}^{2+} + 2\text{e}^-$	\rightleftharpoons	$\text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^-$	\rightleftharpoons	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2\text{e}^-$	\rightleftharpoons	2Br^-	+1,07
$\text{Pt}^{2+} + 2\text{e}^-$	\rightleftharpoons	Pt	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$	\rightleftharpoons	$2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^-$	\rightleftharpoons	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^-$	\rightleftharpoons	2Cl^-	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$	\rightleftharpoons	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^-$	\rightleftharpoons	Co^{2+}	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^-$	\rightleftharpoons	2F^-	+2,87

Increasing reducing ability/Khoneho ya reusing e eketsehang