



Province of the  
**EASTERN CAPE**  
EDUCATION



# **NATIONAL SENIOR CERTIFICATE**

**IBANGA 12**

**SEPTEMBER 2023**

**IFIZIKHALI SAYENSIZI P2  
(IKHEMISTRI)**

**AMANQAKU: 150**

**IXESHA: 3 iiyure**

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Eli phepha lemibuzo linamaphepha angama23 kuquka needatha  
shithi ezinamaphepha ama4.

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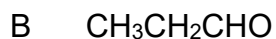
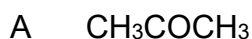
**IMIYALELO NOLWAZI**

1. Bhala igama nefani kwisithuba esifanelekileyo kwincwadi yokuphendulela.
2. Eli phepha liqulethe imibuzo ELITHOBA. Phendula yonke imibuzo KWINCWADI YOKUPHENDULELA.
3. Qala umbuzo NGAMNYE kwiphepha ELITSHA KWINCWADI YOKUPHENDULELA.
4. Nambarisha iimpendulo zakho ngokuthe ngqo ngalendlela imibuzo yakho enambarishwe ngayo kwi khweshini phezipha.
5. Shiya umgca OMNYE phakathi kwemibuzwana, umzekelo: UMBUZWANA 2.1 no MBUZWANA 2.2.
6. Uvumelekile ukusebenzisa ikhaltyhuleyitha engafakwanga lwazi.
7. Ungazisebenzisa izixhobo zeMathematika ezifanelekileyo.
8. Bonakalisa ZONKE iifomyula nee sabstityushini kwizibalo zakho ZONKE.
9. Shiya impendulo yakho YOKUGQIBELA yamanani kubuncinane bee desimali pleyisi EZIMBINI.
10. Xhasa okanye unike iingxoxwana apho zifuneka khona.
11. Uyacetyiswa ukuba usebenzise IIDATHA SHITHI ezikweli phepha.
12. Bhala cocekileyo nangokucacileyo.

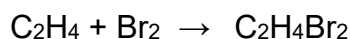
**UMBUZO 1: IMIBUZO ENEEMPENDULO EZIKHETHWAYO EZINIKIWEYO**

Iindlela ezahlukileyo zinikiwe njengeempendulo ezinokuchaneka kwimibuzo elandelayo. Khetha impendulo ze ubhale unobumba kuphela (A–D) ecaleni kweenombolo zemibuzo (1.1 ukuya ku1.10) KWINCWADI YOKUPHENDULELA, umzekelo: 1.11E.

1.1 Yeyiphi ENYE kwezilandelayo eneZONA intermolecular forces EZISTRONGO ?



1.2 Qwalasela irhiekshini engezantsi:



Luluphi UHLOBO lwerhiekshini oluboniswe yi-ikhweyizhini engentla?

A Hydration

B Halogenation

C Hydrogenation

D Hydrohalogenation (2)

1.3 Igama lefunctional group yeealdehyde ngu ...

A formyl.

B carbonyl.

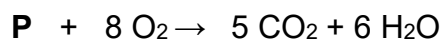
C hydroxyl.

D carboxyl. (2)

- 1.4 Ukhompawundi **Q** undergoes a cracking reaction ukuvelisa iorganic khompawundi **P** ne-ethene,  $C_2H_4$  njengoko kubonisiwe ngezantsi.



Ukhompawundi **P** uyaqhubeka esenzeka ikhombashini rhiexshini ngokwebhalansdi ikhweyizhini:



Igama le-IUPAC likakhompawundi **Q** ngu ...

A butane.

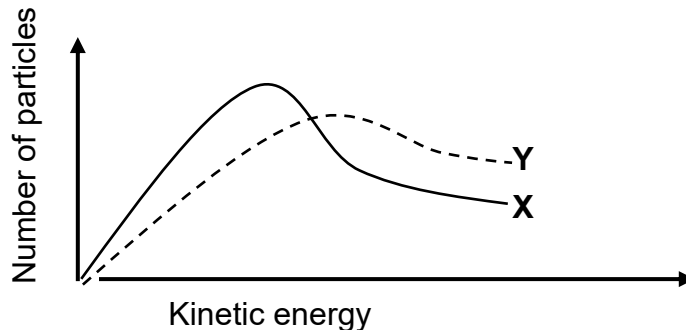
B pentane.

C hexane.

D heptane.

(2)

- 1.5 IMaxwell-Boltzmann distribhuyushini khevu **X** ibonisa inani le molecules against kinetic energy yerhiexshini ethile. Ukhevu **Y** ufunyenwe xa enye kwiirhiexshini khondishini itshintshiwe.



Yeyiphi ENYE kwiifektha ezilalandelayo etshintshiweyo ukufumana ukhevu **Y**?

A YiPresha

B YiTempritsha

C YiKhonsentreyshini

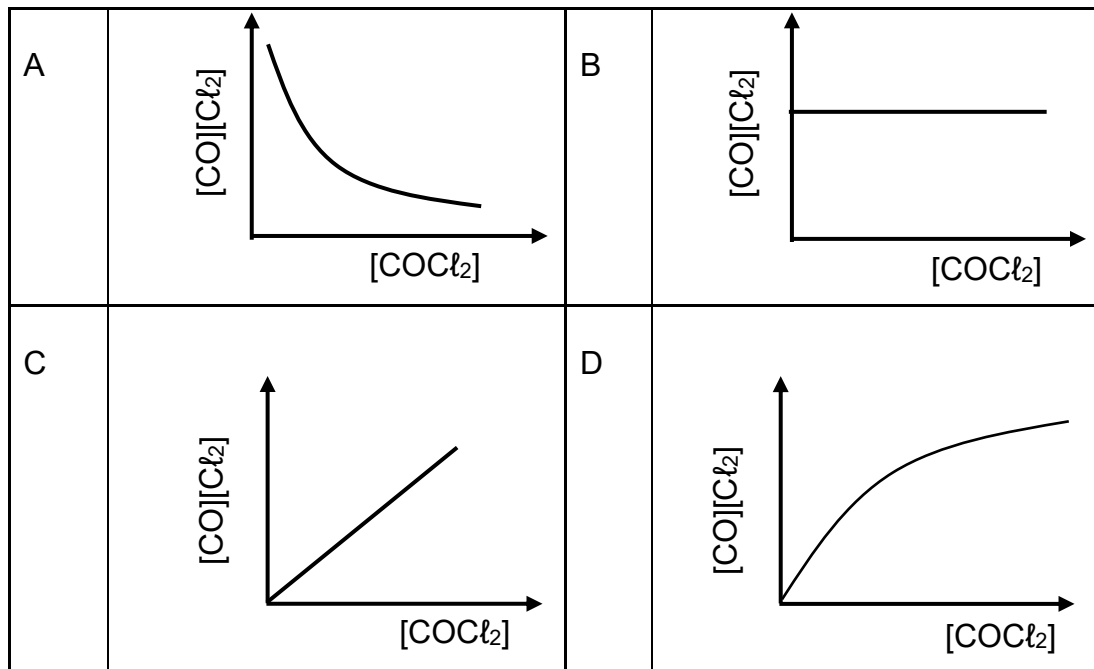
D Kukufakwa kwekhathalisti

(2)

1.6 Idikhompozishini rhiexshini elandelayo ivunyelwe ifikelele kwiekhwilibriyam:



Yeyiphi ENYE kwiigrafu ezilandelayo  $[\text{CO}][\text{Cl}_2]$  vesazi  $[\text{COCl}_2]$  ECHAN EKILEYO kwiekhwilibriyam?



(2)

1.7 Yeyiphi ENYE kwiisalt ezingezantsi enokuveliswa ngerhiexshini yestrong bheyisi neweak asidi?

A  $\text{Na}_2\text{SO}_4$

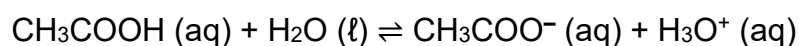
B  $\text{NH}_4\text{Cl}$

C  $\text{NaCl}$

D  $\text{KHCO}_3$

(2)

- 1.8 Irhiekshini emelwe yi-ikhweyizhini engezantsi ifikekelela kwiekhwilibriyam:



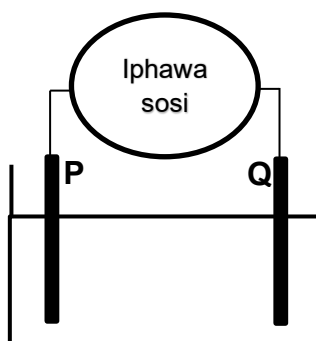
Amaqabaza ambalwa ekhonsentreyithedi solushini ye  $\text{CH}_3\text{COONa (aq)}$  agalelwe kwiekhwilibriyam mixture.

Yeyiphi ENYE kwezilandelayo ngokubhekiselele kwipH ne ekhwilibriyam pozishini ECHANEKILEYO xa irhiekshinini isondela kwiekhwilibriyam entsha?

	pH	iEkhwilibriyam pozishini ishiftela ngase:
A	Iyanda	Khohlo
B	Iyancipha	Kunene
C	Iyanda	Kunene
D	Iyancipha	Khohlo

(2)

- 1.9 Idayagram eyenziwe yalula engezantsi imele ielectrolytic seli esetyenziswe kwiphuyurifikheyishini yekopa (Cu).



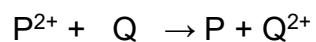
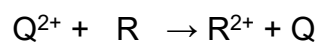
UElektrowudi **P** iyiCATHODE yeseli.

Yeyiphi ENYE kwindibanisela ezilandelayo echanekileyo ngokubhekisele kuelektrowudi **P**?

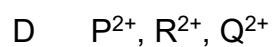
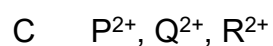
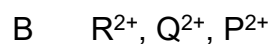
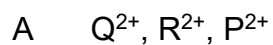
	Irhiekshini eyenzeka kuelektrowudi P	ITteminali akonekthwe kuyo uelektrowudi P
A	Oksideyshini	Phozithivi
B	Oksideyshini	Negethivi
C	Ridakshini	Phosithivi
D	Ridakshini	Negethivi

(2)

1.10 Qwalasela ihayiphothethikhali sponteniyasi riekshini elandelayo:



Yeyiphi ENYE kuluhlu olulandelayo iioxidising agent zikwioda yeincreasing strength?



(2)  
[20]

**UMBUZO 2 (Qala kwiphepha elitsha.)**

2.1 Qwalasela iioganikhi khompawundi **A** ukuya ku**F** ezingezantsi.

<b>A</b>	2-methylpent-2-ene	<b>B</b>	$(\text{CH}_3)_3\text{COH}$
<b>C</b>	2,3-dimethylpentanoic acid	<b>D</b>	$  \begin{array}{c}  \text{CH}_2\text{CH}_3 \qquad \qquad \text{CH}_3 \\    \qquad \qquad \qquad   \\  \text{H} - \text{C} - \text{C} \equiv \text{C} - \text{C} - \text{H} \\    \qquad \qquad \qquad   \\  \text{H} \qquad \qquad \qquad \text{H}  \end{array}  $
<b>E</b>	$  \begin{array}{c}  \text{H} \quad \text{H} \quad \text{O} \\    \quad   \quad    \\  \text{H} - \text{C} - \text{C} - \text{C} \\    \quad   \quad \diagdown \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $	<b>F</b>	$\text{CH}_3\text{CH}_2\text{Br}$

2.1 Bhala UNOBUMBA wekhompawundi ...

2.1.1 Eyi alkyne (1)

2.1.2 Eyi haloalkane (1)

2.1.3 Enejenerali fomyula  $\text{C}_n\text{H}_{2n+2}\text{O}$  (1)

2.2 Ingaba ukhompawundi **A** uSATSHUREYITHEDI okanye u-ANSATSHUREYITHEDI?

Nika isizathu sempendulo. (2)

2.3 Bhala:

2.3.1 ISitraktsharali fomuyula sikakhompawundi **C**. (2)

2.3.2 Igama le IUPAC likakhompawundi **D**. (2)

2.4 Ingaba ukhompawundi **B** yiPRAYIMARI, SEKONDARI OKANYE THESHIYARI alkhoholi?

Nika isizathu sempendulo. (2)

2.5 Bhala igama le IUPAC leCHAIN isomer ka khompawundi **B**. (2)

2.6 Ukhompawundi **E** une functional isomer.

2.6.1 Zintoni lifunctional isomer? (2)

2.6.2 Bhala iKHONDENSIDI STRAKTSHRALI fomyula sefunctional isomer kakhompawundi **E**. (2)

[17]



**UMBUZO 3 (Qala kwiphepha elitsha.)**

likhompawundi **A** ukuya ku**C** zisetyenziswe uku investigeyitha ifektha einfluence ibhoyilingi poyinti zeeorganikhi khompawundi. itheyibhile engezantsi ibonisa iziphumo ezifunyenweyo.

	<b>Khompawundi</b>	<b>Bhoyilingi poyinti(°C)</b>
<b>A</b>	Propan-1-ol	97
<b>B</b>	Butan-1-ol	117,7
<b>C</b>	Pentan-1-ol	138

3.1 Chaza igama *ubhoyilingi poyinti*. (2)

3.2 Ngale investigeyishini, bhala:

3.2.1 i-Indipendenti variyebli (1)

3.2.2 Ikhontrolldi variyebli (1)

3.3 Chaza i-intermolecular fosi ephembelela le threndi ibonakalayo kwiibhoyilingi poyinti. (1)

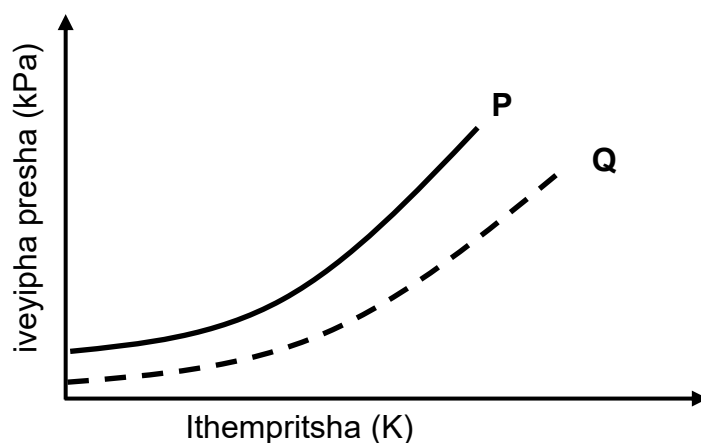
3.4 libhoyilingi poyinti zeealkhoholi ezintathu ezibranched zinikiwe ngezantsi:

108 °C	129 °C	149 °C
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Yeyiphi ENYE kwezi thempritsha zintathu enokuba yibhoyilingi ka2-methylbutag-1-oli? (1)

3.5 Cacisa ngokupheleleyo impendulo kuMBUZO 3.4. (4)

- 3.6 iigrafu ezingezantsi zibonisa irhileyshinishiphu phakathi kweveyipha presha ne thempritsha kapropani-1-oli nopropanali.

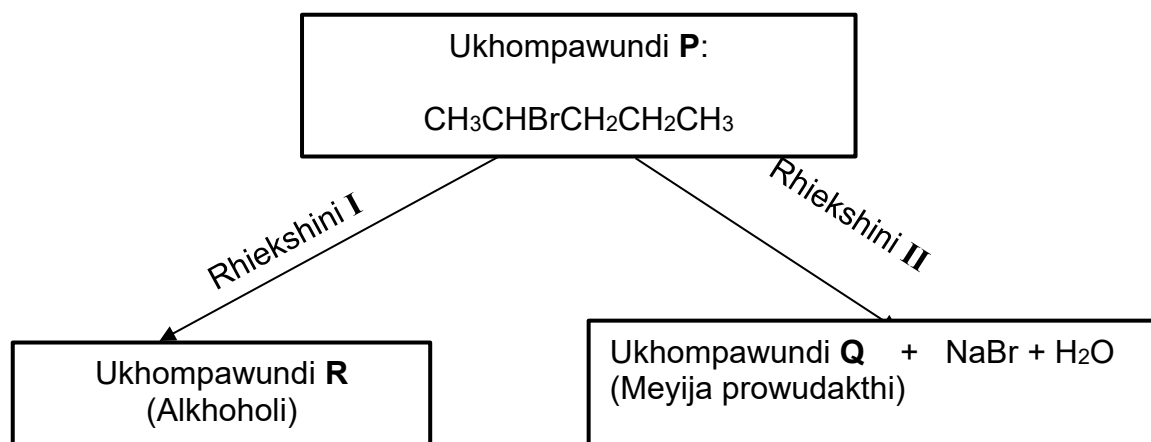


- 3.6.1 Chaza igama veyipha presha. (2)
- 3.6.2 Yeyiphi ikhevu, uP okanye uQ, ebonisa igrafu kapropani-1-oli? (1)
- 3.6.3 Cacisa impendulo kuMBUZO 3.6.2 ngokubhekisele kwi TAYIPHU. yee-intermolecular fosi. (4)

[17]

**UMBUZO 4 (Qala kwiphepha elitsha.)**

- 4.1 Iflowu dayagram engezantsi ibonisa ukhompawundi **P** ukuba angatshintshwa njani abe ziogani khi khompawundi **Q** no**R**.



Ngorhiekshini **I** bhala:

4.1.1 Igama lohlobo lwesabstityushini rhiekshini (1)

4.1.2 Igama le-IUPAC likakhompawundi R. (2)

Ngorhiekshini **II** bhala:

4.1.3 Irhiekshini khondishini ibenye ngaphandle kweheat. (1)

4.1.4 ISitraktsharali fomyula sikakhompawundi **Q**. (2)

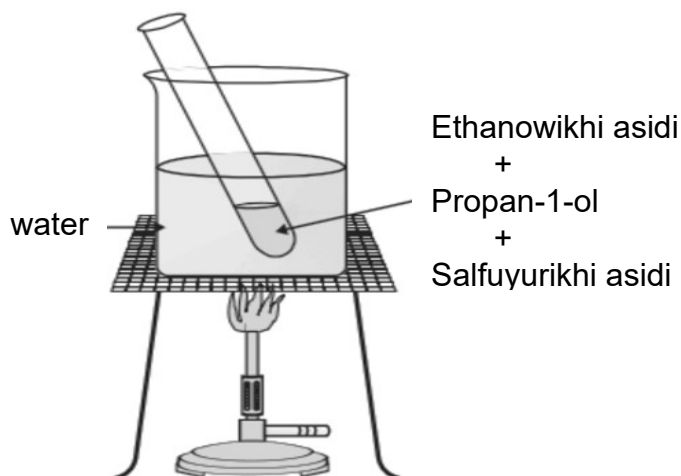
Ukhompawundi R angaguqulelwa kuKhompawundi **Q**.

Ngenguqulelo kakhompawundi **R** ukuya kukhompawundi **Q** bhala i:

4.1.5 Fomyula okanye igama leinorganic reagent efunekayo. (1)

4.1.6 Uhlobo lwerhiekshini . (1)

- 4.2 Imiktsha ye-ethanowikhi asidi ( $\text{CH}_3\text{COOH}$ ) nepropan-1-ol ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ ) ihithishiwe kukho ikhonsentreyithedi sulfuyurikhi asidi ( $\text{H}_2\text{SO}_4$ ) kwiwater bath njengoko kubonisiwe ngezantsi.

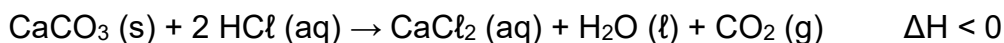


- 4.2.1 Bhala igama le rhiexhshini eyenzekayo. (1)
- 4.2.2 Nika isizathu sokuhithisha irhiexhshini mikstsha kwiwater bath. (1)
- 4.2.3 Bhala istraktsharali fomyula negama le-IUPAC seprowudakthi eyenzekileyo. (4)
- [14]**

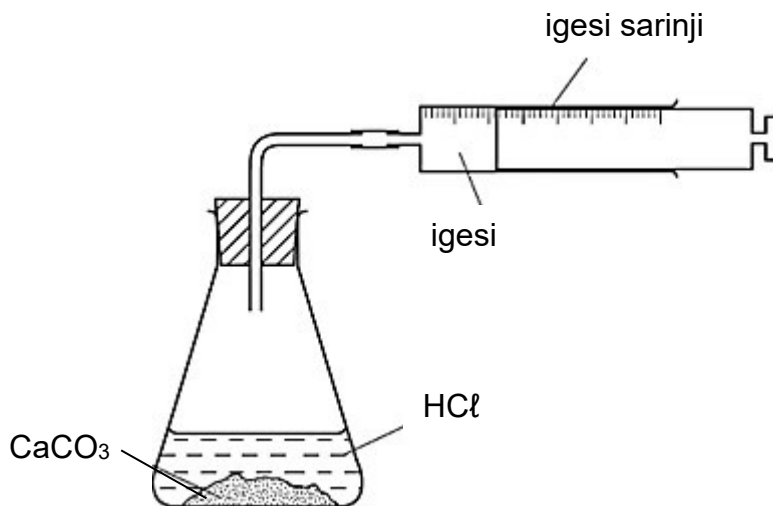
**UMBUZO 5 (Qala kwiphepha elitsha.)**

Iqela labafundi li-investigeyitha ireleyinishphu phakathi kwerhiekshini rheyithi nekhonsentreyishini. Basebenzise irhiekshini phakathi kwek calcium carbonate phawuda  $\text{CaCO}_3$  (s) ne EXCESSi hydrochloric acid solution  $\text{HCl}$  (aq), ku  $25^\circ\text{C}$ .

Ibhalandsi i-ikhwezhini yale rhiekshini ngu:



Iapharathasi esetyenzisiweyo iboniswe ngezantsi.



Itheyibhile engezantsi ibonisa iirhiekshini khondishini zeEksperimenti **1 no2**.

UEKSPERIMENTI	IKHONSENTREYISHINI YE $\text{HCl}$ ( $\text{mol}\cdot\text{dm}^{-3}$ )	IVOLYUM YE $\text{HCl}$ ( $\text{cm}^3$ )	IXESHA ELITHATHWE YIRHIEKSHINI UKUFIKA ESIPHELWENI (minutes)
<b>1</b>	0,9	50	5,28
<b>2</b>	1,2	50	Y

- 5.1 Chaza igama *rhiekshini rheyithi*. (2)
- 5.2 Chaza iapharathasi efunekayo kwi-investigeyishini engaboniswa kwisiketshi esingentla. (1)
- 5.3 Nika isizathu kutheni ithempitsha yerhiekshini mikstsha ingahlali injalo ngelixesha lerhiekshini (1)
- 5.4 Ingaba ixesha Y kueksperimenti **2** lizakuba LIDE okanye LIFUTSHANE kunemizuzu emi5,28? (1)
- 5.5 Cacisa impendulo kuMBUZO 5.4 ngokubhekisele kwicollision theory. (2)
- 5.6 Kueksperimenti **1**, i250  $\text{cm}^3$  **ngqo** ye  $\text{CO}_2$  iveliswe kwimizuzu emi5,28.

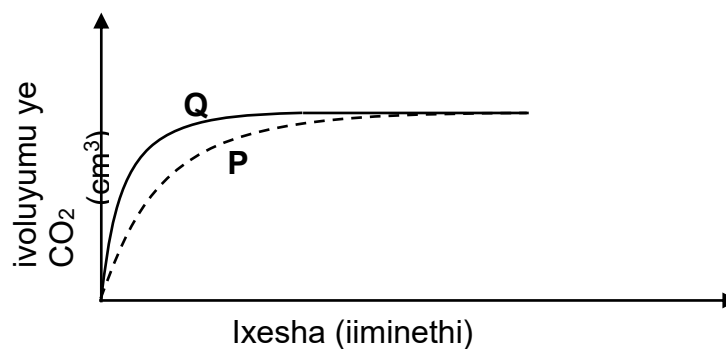
5.6.1 Khaltyhuleyitha iavaeyiji rheyithi yemveliso yeCO<sub>2</sub> kwi cm<sup>3</sup>·min<sup>-1</sup> (3)

Kancinci emva kokuba irhiekshini kueksperiment 1 iphelile, iflaskhi itywinwe ngokuqinileyo kwaze kwafunyaniswa ukuba i100 cm<sup>3</sup> yeCO<sub>2</sub> iphumile kwiflaskhi.

5.6.2 Khaltyhuleyitha imesi yeCO<sub>2</sub> eshiyeke kwiflaskhi emva kokuba iflaskhi itywinwe. Thatha ngokuba imolar voluyum yeCO<sub>2</sub> ku25 °C ngu25 000 cm<sup>3</sup>·mol<sup>-1</sup>. (4)

5.7 Kueksperimenti 3 abafundi ngoku bagalela u50 cm<sup>3</sup> we EXESS ethanoic acid (C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>) solushini onekhonsentreyishini engu 0,9 mol·dm<sup>-3</sup> kuCaCO<sub>3</sub> phawda ku25 °C baze bathelekisa iziphumo nezo zika eksperimenti 1.

Igrafu yevoluyum yeCO<sub>2</sub> kunye nexesha yee-eksperimenti ezimbini ibonakalisiwe ngezantsi.



5.7.1 Yeyiphi igrafu uP okanye uQ emele iziphumo zika eksperimenti 3? (1)

5.7.2 Cacisa impendulo kuMBUZO 5.7.1. (2)

5.7.3 Ingathelekiswa njani i-amawunti yeCaCO<sub>3</sub> esetyenziswe ku eksperimenti 1 kwiamawunti yeCaCO<sub>3</sub> esetyenziswe kueksperimenti 3?

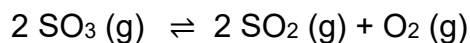
Khetha kuINGAPHEZULU KO, INGAPHANTSI KO okanye ILINGANA NO.

Nika isizathu sempendulo. (2)

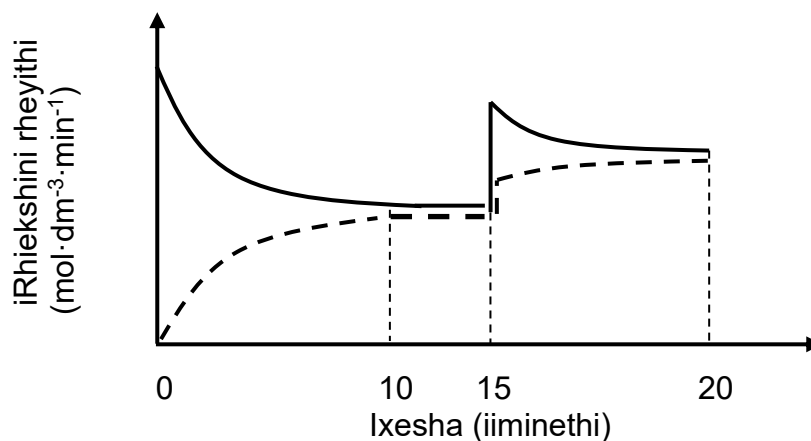
[19]

**UMBUZO 6 (Qala kwiphepha elitsha.)**

- 6.1 iSulphur trioxide ( $\text{SO}_3$ ) gesi i-injekthelwe kwikhonteyina engenanto yaze yatywinwa. Irhiekshini elandelayo yenzeka phakathi kwikhonteyina:



Igrafu engezantsi ibonisa linguqu kwiirhiekshini rheyithi nexesha kwi20 yeeminethi yokuqala.



- 6.1.1 Bhala intsingiselo yedouble arrow " $\rightleftharpoons$ " kwi-ikhweyizhini. (1)

- 6.1.2 Yintoni eboniswa yihorizontali sekshini kwigrafu phakathi ko  $t = 10$  yeeminethi no  $t = 15$  yeemineuthi (1)

Kut = 15 yeeminethi ithempitsha yerhiekshini mikstsha kwi khonteyina iye yatshintshwa.

- 6.1.3 Ingaba ikhonteyina iye YABANDISWA okanye YENZIWA SHUSHU ku  $t = 15$  yeeminethi? (1)

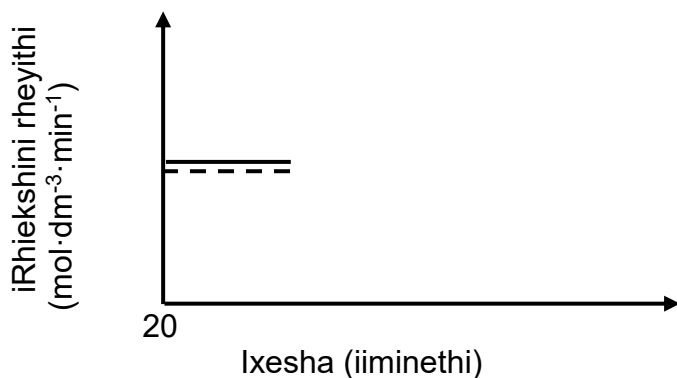
- 6.1.4 Ingaba iforwardi rhiekshini IEKZOTHEMIKHI okanye iENDOTHEMIKHI? (1)

- 6.1.5 Cacisa impendulo **kuMBUZO** 6.1.4 ngokubhekisele kuLe Chatelier's prinsipuli. (2)

Emva kwe20 yeeminethi ipresha ngaphakathi kwirhiekhshini yandisiwe ngokuthoba ivoluyumu kwithempitsha engatshintshiyo.

- 6.1.6 Zoba kwakhona igrafu ingezantsi uze ubonise impembelelo yokwandisa ipresha kwirhiekhshini rheyithi kude kube kwenzeke iikhwilibriyam entsha..

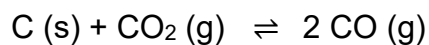
### IGRAPH YERATE VERSUS TIME



(2)

- 6.2 Ikhabhoni (C) nekhabhoni dayioksayidi ( $\text{CO}_2$ ) zixutyelwe kwikhonteyina engenanto engu2 dm<sup>3</sup>.

likhweyizhini elandelayo ebhalansiweyo ibonisa irhiekhshini efikelela kwi ekhwilibriyam kwikhonteyina ku7 00 °C.



Kwiekhwilibriyam, kufumaniseke okokuba ikhonsentreyishini ye $\text{CO}_2$  ngu0,05 mol.dm<sup>-3</sup> kwaye u0,4 weemowuli zeC (s) zikhona. iekhwilibriyam khonstenti yale rhiekhshini ku700 °C ngu0,05.

Khaltyhuleyitha ipesenteyiji yekhabhoni erhiekhthileyo.

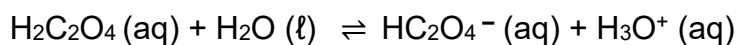
(8)

**[16]**



**UMBUZO 7 (Qala kwiphepha elitsha.)**

- 7.1 Qwalasela layonizeyshini 'yeoxalic acid  $\text{H}_2\text{C}_2\text{O}_4$  (aq), eboniswe yibhalansidi ikhweyizhini elandelayo.



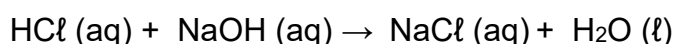
Ikhonsentreyishini yesabsitensi NGANYE efunyanwa ku  $0,1 \text{ mol} \cdot \text{dm}^{-3}$  solushini ye  $\text{H}_2\text{C}_2\text{O}_4$  kwiekhwilibriyam inikwe kwitheybhile engezantsi:

iiSabstensi	$\text{H}_2\text{C}_2\text{O}_4$	$\text{HC}_2\text{O}_4^-$	$\text{H}_3\text{O}^+$
Ikhonsentreyishini ( $\text{mol} \cdot \text{dm}^{-3}$ )	0,046	0,054	0,054

- 7.1.1 Chaza iasidi ngokwethiyori kaLowry-Brønsted. (2)
- 7.1.2 Bhala Ifomyula yebheyisi kwirhiekshini engentla ngaphandle ko  $\text{H}_2\text{O}$ . (1)
- 7.1.3 Ingaba ioxalic acid yiasidi eSTRONG okanye eWEAK? (1)
- 7.1.4 Cacisa impendulo **kuMBUZO** 7.1.3 ngokubhekisele kwidatha ekwitheybhile. (2)
- 7.2 Ikhonsentreyithedi sodium hydroxide solution,  $\text{NaOH}(\text{aq})$ , idayiluthwe ngewater kwisinye eshumini seorijinali khonsentreyishini yayo.

$35 \text{ cm}^3$  **ngqo** yedayiluthi solushini ye sodiyam hayidroksayidi imikswe ne  $25 \text{ cm}^3$  yehydrochloric acid solution,  $\text{HCl} (\text{aq})$  enekhonsentreyishini engu  $0,1 \text{ mol} \cdot \text{dm}^{-3}$  eflaskhini.

Inyutralizeyshini rhiekshini yenzeka kwifaskhi ngokwebhalansidi ikhweyizhini:



- 7.2.1 Khaltyhuleyitha i-inishiyali number yeemowuli ze  $\text{HCl}$  eflaskhini. (3)

ipH yesolushini yokugqibela ngu 12.

Khaltyhuleyitha i CONSENTREYISHINI ye/yee:

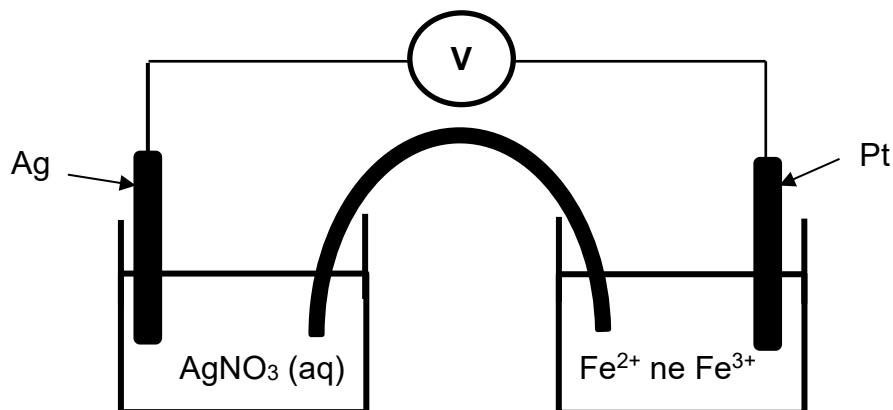
- 7.2.2 Hayidroksayidi ayoni kwisolushini yokugqibela. (4)

- 7.2.3 Khonsentreyithedi sodiyam hayidroksayidi. (6)

**[19]**

**UMBUZO 8 (Qala kwiphepha elitsha.)**

Igalvanic seli isetwe kwimeko eziqingqiweyo (Kwiistandadi Khondishini). Enye ihafu-seli inesiliva pleyiti, Ag, kwi akhwiyasi solushini ye  $\text{AgNO}_3$ , ngelixa enye ihafu-seli ine inert platinam pleyiti kwiakhwiyasi solushini ene  $\text{Fe}^{2+}$  ne  $\text{Fe}^{3+}$ , njengoko kubonisiwe kwisimplifayidi dayagram engezantsi.

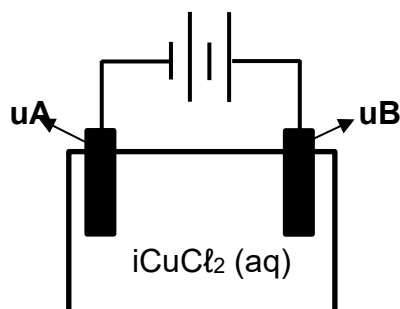


- 8.1 Bhala iirhiekhshini khondishini ezenzeka kule seli xa isebenza (2)
- 8.2 Kule galvanikhi seli, bhala:
- 8.2.1 iOksideyishini hafu-rhiekhshini (2)
- 8.2.2 Iseli noteyishini (3)
- 8.2.3 izitandadi khondishini ezibini ze  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$  hafu-seli. (2)
- 8.3 Khaltyhuleyitha i-inishiyali emf yale seli. (4)
- 8.4 Kuyakwenzeka ntoni kwiemf ebaliweyocalculated kuMBUZO 8.3, ukuba isolution ye  $\text{NaCl}$  ibizakusetyenziswa mjenge solithi bridge kwiseli phantsi kwee standadi khondishini? (1)
- Bhala kuphela IYANDA, IYANCIPHA okanye IHLALA INJALO (1)
- 8.5 Cacisa impendulo kuMBUZO 8.4. (2)

**[16]**

**UMBUZO 9 (Qala kwiphepha elitsha.)**

Ielectrolytic seli eboniswe ngezantsi isetynziswa kwielectrolysis ye  $\text{CuCl}_2$  solushini.



uA noB ziikhabhoni electrowudi

9.1 Chaza igama uelectrolysis. (2)

9.2 Ingaba iprosesi ye elektrolisisi IEKZOTHEMIKH okanye iENDOTHEMIKHI? (1)

9.3 Bhala ihafu-rhiekshini eyenzeka kuelektrowudi B.

i0,369 g yeCu idiphozithelwe kwikhathowudi kwi27 yeeminethi (2)

9.4 Khaltyuleyitha ielektrikhali kharenti esetyenziswe kule prosesi. (7)  
[12]

**TOTAL: 150**

**IDATHA YEFIZIKHALI SAYENSIZI IBANGA 12**  
**IPHEPHA 2 (IKHEMISTRI)**

**THEYIBHILE 1: IIKHONSTENTI ZEFIZIKHALI SAYENSIZI**

IGAMA	ISIMBOLI	IVELIYU
IStandadi presha	$p^\theta$	$1,013 \times 10^5 \text{ Pa}$
IMolar gas volume ku STP	$V_m$	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
IStandadi thempritsha	$T^\theta$	$273 \text{ K}$
Itshaji kwi elektroni	$e$	$-1,6 \times 10^{-19} \text{ C}$
I-Avogadro's constant	$N_A$	$6,02 \times 10^{23} \text{ mol}^{-1}$

**THEYIBHILE 2: IIFOMYULA**

$n = \frac{m}{M} \text{ or/of}$ $n = \frac{N}{N_A} \text{ or/of}$ $n = \frac{V}{V_m}$	$c = \frac{n}{V} \text{ or/of } c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$ $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at /by 298K
$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} / E^\theta_{\text{seli}} = E^\theta_{\text{khathowudi}} - E^\theta_{\text{anowdi}}$ $E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}} / E^\theta_{\text{sel}} = E^\theta_{\text{rHidaksie}} - E^\theta_{\text{oksidisie}}$ $E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}} / E^\theta_{\text{sel}} = E^\theta_{\text{oksideermiddel}} - E^\theta_{\text{reduseermiddel}}$		

### THEYIBHILE 3: PHIRIYODIKHI THEYIBHILE YEE-ELEMENTI

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)
<p><b>KEY/ SLEUTEL</b></p> <p><i>Atoomgetal</i> Atomic number</p> <p><i>Elektronegatiwiteit</i> Electronegativity</p> <p><i>Simbool</i> Symbol</p> <p><i>Benaderde relatiewe atoommassa</i> Approximate relative atomic mass</p>																	
1 H 1,008								29 Cu 63,5									2 He 4,003
3 Li 6,941	4 Be 9,012											5 B 10,81	6 C 12,01	7 N 14,01	8 O 16,00	9 F 18,99	10 Ne 20,18
11 Na 22,99	12 Mg 24,31											13 Al 26,98	14 Si 28,09	15 P 30,97	16 S 32,07	17 Cl 35,45	18 Ar 39,95
19 K 39,10	20 Ca 40,08	21 Sc 44,96	22 Ti 47,88	23 V 50,94	24 Cr 51,99	25 Mn 54,94	26 Fe 55,85	27 Co 58,93	28 Ni 58,69	29 Cu 63,55	30 Zn 65,38	31 Ga 69,72	32 Ge 72,64	33 As 74,92	34 Se 78,96	35 Br 79,90	36 Kr 83,80
37 Rb 85,47	38 Sr 87,62	39 Y 88,91	40 Zr 91,22	41 Nb 92,91	42 Mo 95,94	43 Tc 98,91	44 Ru 101,07	45 Rh 102,91	46 Pd 106,42	47 Ag 107,87	48 Cd 112,41	49 In 114,82	50 Sn 118,71	51 Sb 121,76	52 Te 127,60	53 I 126,91	54 Xe 131,29
55 Cs 132,91	56 Ba 137,33	57 La 138,91	72 Hf 178,49	73 Ta 180,95	74 W 183,84	75 Re 186,21	76 Os 190,23	77 Ir 192,22	78 Pt 195,08	79 Au 196,97	80 Hg 200,59	81 Tl 204,38	82 Pb 207,2	83 Bi 208,98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89 Ac															
			58 Ce 140,12	59 Pr 140,91	60 Nd 144,24	61 Pm	62 Sm 150,36	63 Eu 151,96	64 Gd 157,25	65 Tb 158,93	66 Dy 162,50	67 Ho 164,93	68 Er 167,26	69 Tm 168,93	70 Yb 173,05	71 Lu 174,97	
			90 Th 232,04	91 Pa 231,04	92 U 238,03	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	



## ITHEYIBHILE 4A: YESTANDADI RHIDAKSHINI POTENSHIYALI

Ukwenyuka kwe oxidising ability

Hafu-rhiekshini			$E^{\theta}$ (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
<b><math>2H^+ + 2e^-</math></b>	<b><math>\rightleftharpoons</math></b>	<b><math>H_2(g)</math></b>	<b>0,00</b>
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	$Fe$	- 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

Ukwenyuka kwe reducing ability

## ITHEYIBHILE 4B: YESTANDADI RHIDAKSHINI POTENSHIYALI

Ukonyuka kwe oxidising ability

Hafu-rhiekshini			$E^{\theta}$ (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
$\text{Cr}^{3+} + \text{e}^-$	$\rightleftharpoons$	$\text{Cr}^{2+}$	-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
$\text{Sn}^{4+} + 2\text{e}^-$	$\rightleftharpoons$	$\text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^-$	$\rightleftharpoons$	$\text{Cu}^+$	+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
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$	$\rightleftharpoons$	$4\text{OH}^-$	+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
$\text{I}_2 + 2\text{e}^-$	$\rightleftharpoons$	$2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	$\rightleftharpoons$	$\text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^-$	$\rightleftharpoons$	$\text{Fe}^{2+}$	+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
$\text{Br}_2(\ell) + 2\text{e}^-$	$\rightleftharpoons$	$2\text{Br}^-$	+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
$\text{Cl}_2(\text{g}) + 2\text{e}^-$	$\rightleftharpoons$	$2\text{Cl}^-$	+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
$\text{Co}^{3+} + \text{e}^-$	$\rightleftharpoons$	$\text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^-$	$\rightleftharpoons$	$2\text{F}^-$	+2,87

Ukwenyuka kwe reducing ability.