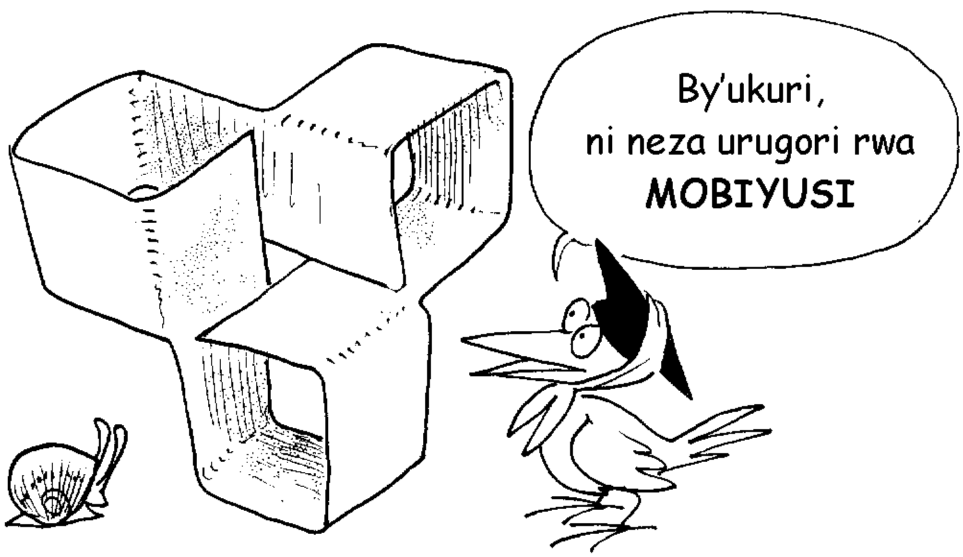
Ingyendo nshakisha z'Anselimi Lanturulu

TOPOLOJiKONi

Yohani-Petero Petit



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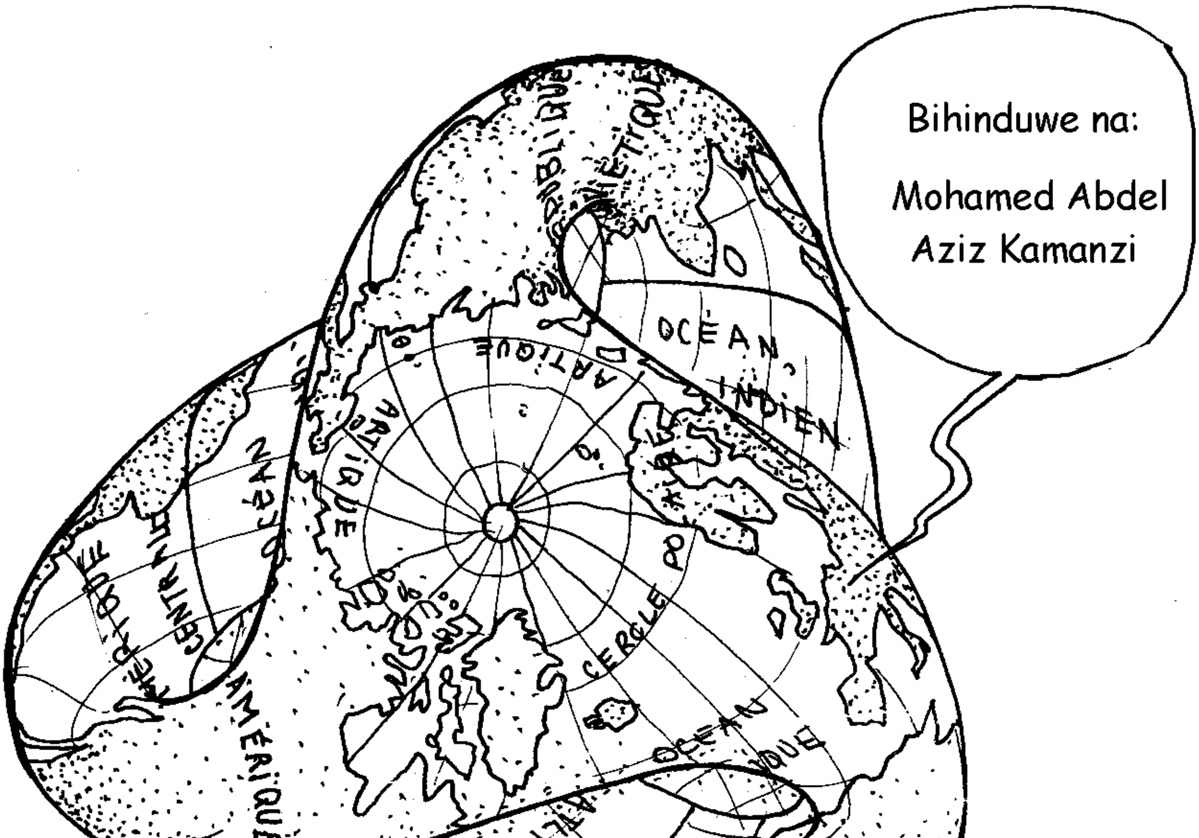
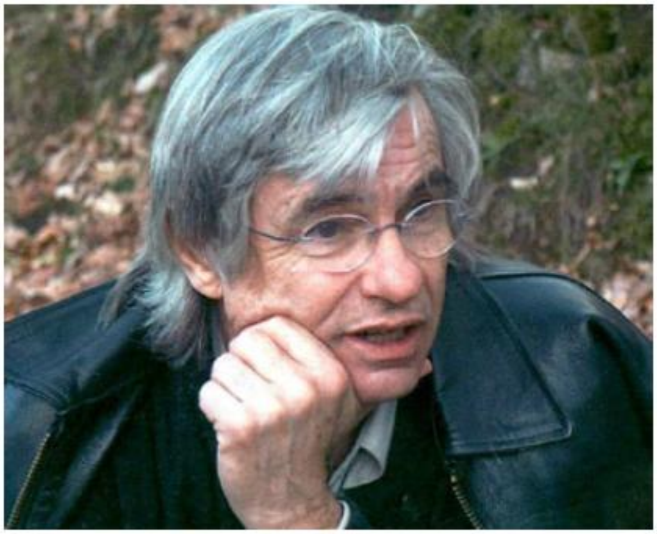

Bihinduwe na:
Mohamed Abdel
Aziz Kamanzi

Ubumenyi butagira Imipaka

Itegeko ryo mu 1901 rigenga amashyirahamwe



Jean-Pierre Petit, Perezida w'iri Shirahamwe

Uyu Jean-Pierre Petit, Peresida w'iri shyirahamwe ry'**Ubumenyi butagira Imipaka**, yahoze ari diregiteri w'ubushakashatsi mu kigo cy'inzobere cya CNRS, mu Bufaransa. Akaba kandi inzobere ihanitse muri Fizike y'inyenyeri (Asitorofizike); yahimbye uburyo bushyashya by'inyandiko bita: *Ibitabo by'amashusho by'ubumenyi.* "**Ubumenyi butagira Imipaka**" ni ishyirahamwe ryahimbwe mu 2005 n'abagabo babiri, Jean-Pierre Petit na mugenzi we Gilles d'Agostini. Iri shyirahamwe ryihaye intego yo gukwirakwiza kw'isi hose ubumenyi ku buntu harimwo n'ubumenyi bwa tekinike, ubukorikori n'ikoranabuhanga. Iri shyirahamwe ribeshejweho n'inkunga rihabwa. Izo nkunga nizo ziriha abantu bahindura inyandiko mu zindi ndimi. Buri nyandiko (igitabo cy'amashusho cy'ubumenyi) ihindurirwa mu rundi rurimi ku mafaranga angana n'amayero 150 (150 euros) kuva mu 2007 kugeza ubu. Iri shyirahamwe rinariha amafaranga ajyanye n'iyoherezwa ucishije muri banke ry'ayo mafaranga y'ihinduranya mu zindi ndimi. Abahinduranyi b'indimi bagiye bongera, buri munsi, umubare w'ibyo bitabo bisomwa hose k'ubuntu. (Nko kugeza mu 2007, hari hamaze kuboneka ibitabo magana abiri (200) bikurwa kuri interineti k'ubuntu kandi byanditse mu ndimi makumyabiri n'umunani (28) harimwo ikinyarwanda n'ururimi rwo muri Lawosi).

Biremewe ko iki gitabo gikopororwa cyangwa gifotorwa,cyose cyangwa igice; kinakoreshwa n'abarimu mu masomo ariko mu buryo butari ububyara inyungu z'amafaranga. Gishobora gushyirwa mu masomero y'uturere, y'amashuri cyangwa ya za kaminuza, cyanditse ku mpapuro cyangwa cya shyizwe mu miyoboro y'imbuga z'ikoranabuhanga zigose (intranet).

Uyu mwanditsi w'ibi bitabo yatangiye kwandika ibindi byo byoroshye kandi bigenewe abana bato (bari mu rugero rw'imyaka 12). Ibindi biriho bikorwa n'ibitabo by'amajwi avuga, bigenewe abatazi gusoma cyangwa abashaka kwiga urundi rurimi rutari urwo bakuriyemwo.

Iri shyirahamwe rishaka buri gihe abahinduranyi b'inyandiko bazishyira mu ndimi zabo zakavukire ariko bafite ubuhanga buhagije bwo gutanga inyandiko mpiduranyi nziza z'ibitabo basomye.

Ushatse kugira icyo ubaza cyangwa ugeza kuri iri shyirahamwe, wajya ku rubuga rwaryo ku interinete aha hakurikira: http://www.savoir-sans-frontieres.com

Iranga-konti mu Bufaranska → **Inyandiko ngaragaza mutungo muri (RIB)**

Ikigo	Umwanya wo kwakiriramwo amafaranga	Nimero ya konti	Urufunguzo rwa RIB
20041	01008	1822226V029	88

Aho ikorera: Banki ya Posita
Hagati y'Umujyi wa Marseille
13900 Marseille CEDEX 20
Mu Bufaransa

Mu bindi bihugu → **Ibanki Mpuzamahanga (International Bank) Nimero ya Konti (IBAN):**

IBAN
FR 16 20041 01008 1822226V029 88

→ **N' Inyandikobanga ya banki (BIC) :**

BIC
PSSTFRPPMAR

Amategeko agenga iri shyirahamwe agaragara ku rubuga rwa yo kuri interineti. Imibare ngaragaza mutungo nayo irahari kandi ihora ishyirwa ku gihe. Iri shyirahamwe nta mafaranga na make rikura ku nkunga rihawe uretse ayo kohereza, bicishijwe muri banki, ahemba abahinduranyi b'indimi ku buryo babona abagenewe yose.
Nta munyamuryango w'iri shyirahamwe n'umwe rihemba kuko bose ari abakoranabushake.
Abanyamuryango ubwabo nibo barihira amafaranga ishyirahamwe rikoresha ngo ribeho nk'ayo kwishyura no gukoresha urubuga rwa yo rwo kuri interineti kuko ayo atarihwa n'ishyirahamwe.
Bityo mugaragarizwa neza uko umutungo w'ishyirahamwe ukoreshwa kandi mukibonera ikizere ko, muri iyo "mirimo y'ubwitange mfashamuco", inkunga yose mutanga ikoreshwa neza mu kwishyura abahindura ibitabo mu zindi ndimi.
Dushyira ku rubuga rwa interineti buri kwezi, ugereranije, nk'ibitabo cumi bihinduwe mu zindi ndimi.

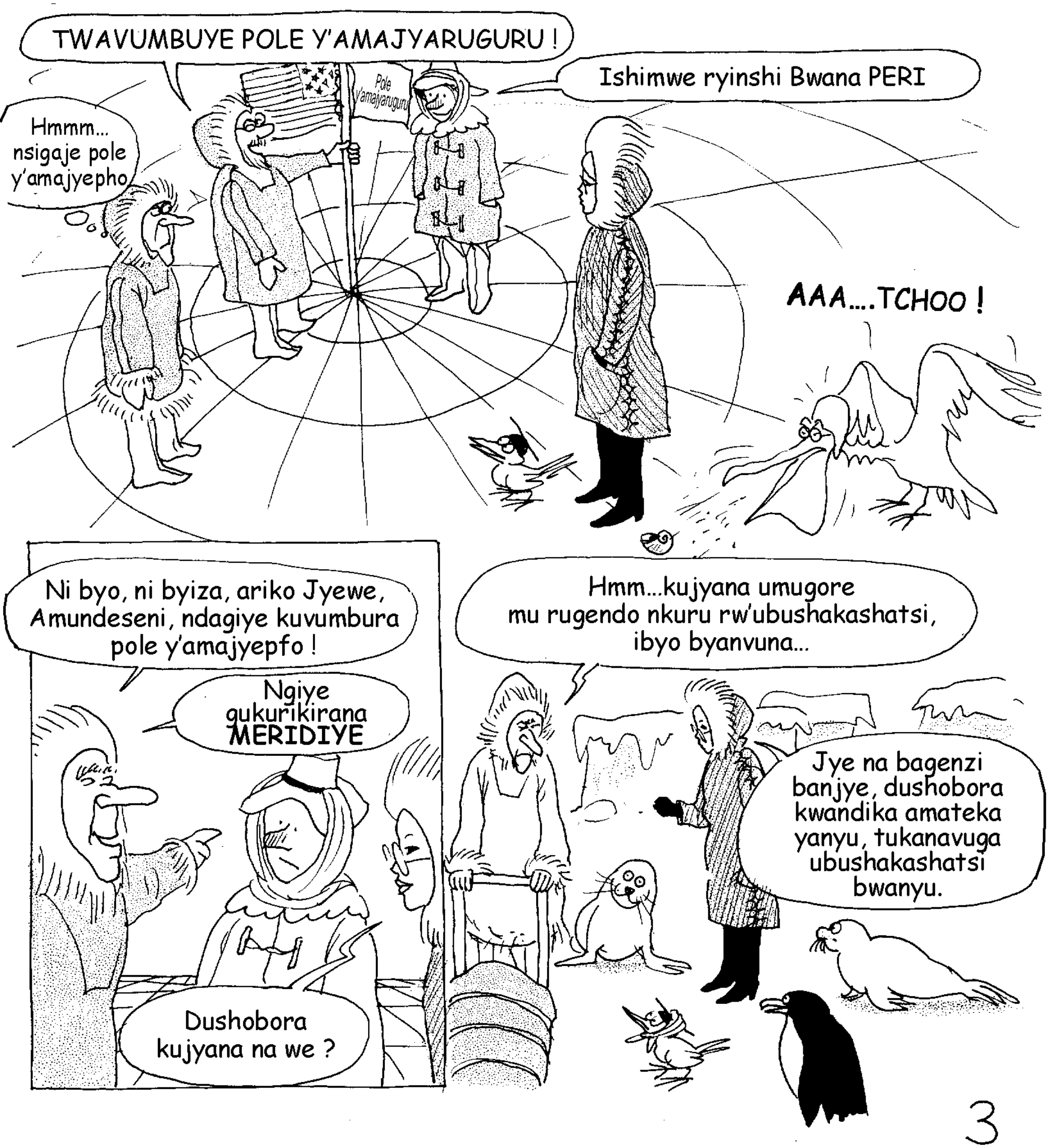
Ikitonderwa ku basomyi

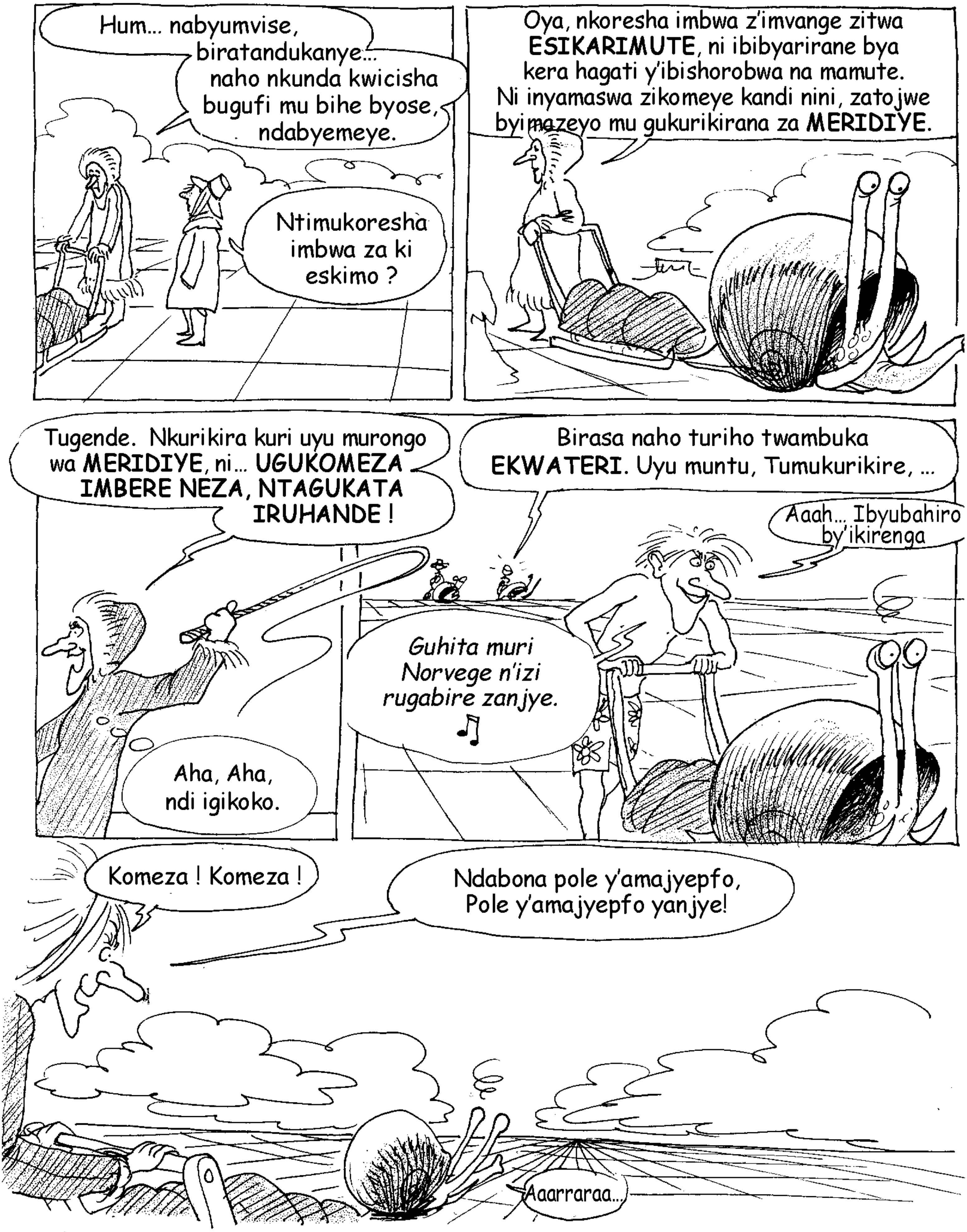
Byaba byiza mudasomye iyi alubomo :

- Nimugoroba mugiye kuryama
- Mumaze kurya ibiryo bitubutse kandi by'intungamubiri nyinshi
- Cyangwa igihe umangamanze mu mutwe, kuko bihita bibyunura.

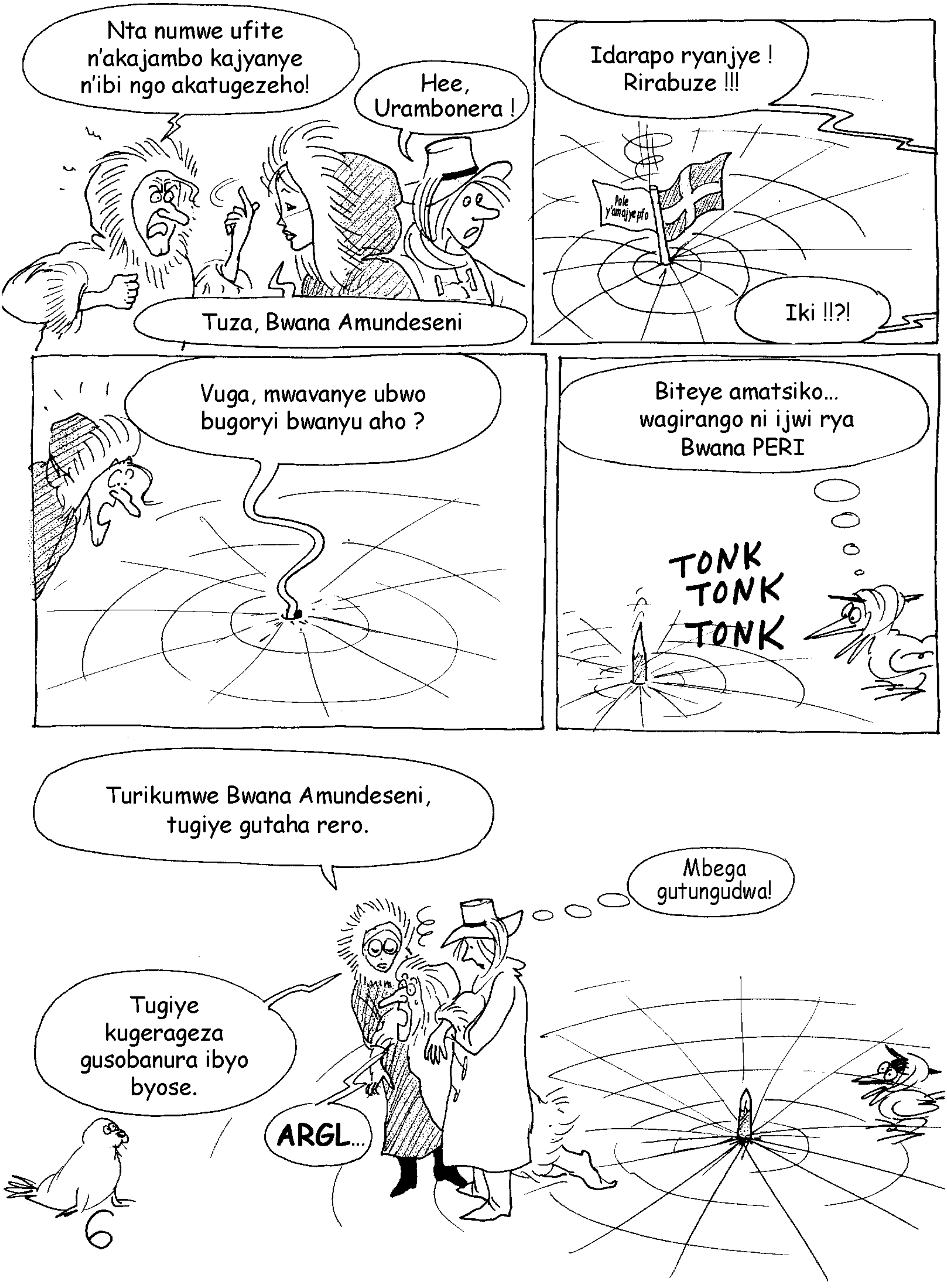
Umwanditsi.

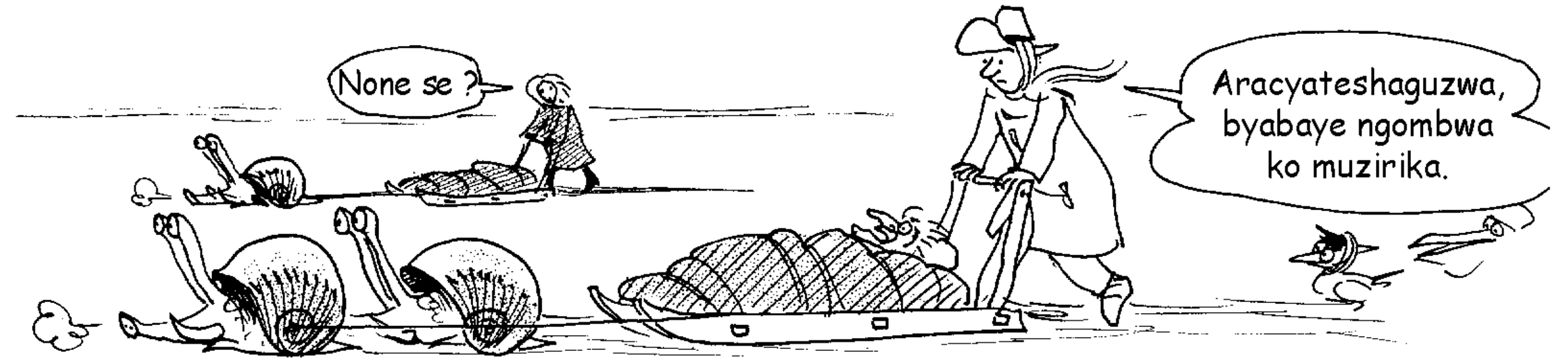
PALANETE iTAGiRA POLE Y'AMAJYEPFO




Hum... nabyumvise, biratandukanye... naho nkunda kwicisha bugufi mu bihe byose, ndabyemeye.
Ntimukoresha imbwa za ki eskimo ?
Oya, nkoresha imbwa z'imvange zitwa ESIKARIMUTE, ni ibibyarirane bya kera hagati y'ibishorobwa na mamute. Ni inyamaswa zikomeye kandi nini, zatojwe byimazeyo mu gukurikirana za MERIDIYE.
Tugende. Nkurikira kuri uyu murongo wa MERIDIYE, ni... UGUKOMEZA IMBERE NEZA, NTAGUKATA IRUHANDE !
Aha, Aha, ndi igikoko.
Birasa naho turiho twambuka EKWATERI. Uyu muntu, Tumukurikire, ...
Aaah... Ibyubahiro by'ikirenga
Guhita muri Norvege n'izi rugabire zanjye.
Komeza ! Komeza !
Ndabona pole y'amajyepfo, Pole y'amajyepfo yanjye!
Aaarraraa...

Ndi uwambere...
IBYUBAHIRO BY' IKIRENGA !
Ariko !? ibi ni ibiki ??
Iyi byenda kunsetsa ni bwoko ki ?
Eheee !?
Aho ra!
OROROROO !
KKRAK
Ngibyo ! Hari ufite icyo yongeraho ?
Pole y'amajyepfo

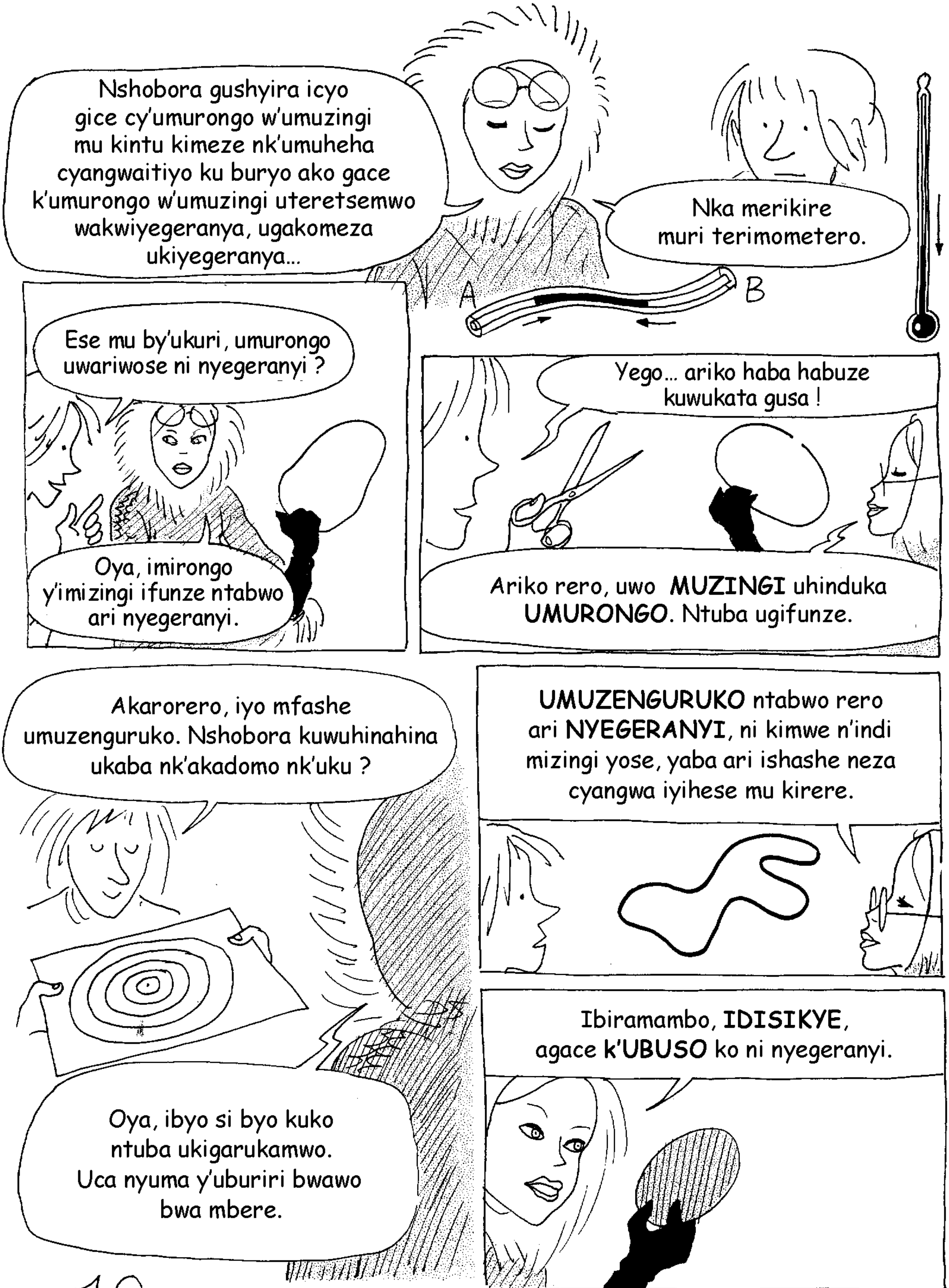

Nta numwe ufite n'akajambo kajyanye n'ibi ngo akatugezeho!
Hee, Urambonera !
Tuza, Bwana Amundeseni
Idarapo ryanjye ! Rirabuze !!!
Pole y'amajyepfo
Iki !!?!
Vuga, mwavanye ubwo bugoryi bwanyu aho ?
Biteye amatsiko... wagirango ni ijwi rya Bwana PERI
TONK TONK TONK
Turikumwe Bwana Amundeseni, tugiye gutaha rero.
Mbega gutungudwa!
Tugiye kugerageza gusobanura ibyo byose.
ARGL...



Esikarimute ziranyerera bucece kuri meridiye zikonje cyane.

(*) Umushumi uhotowe kujyeza hagati warangiza ukomekanya imitwe yombi, ugira uruhande rumwe.

Nimba dushaka gukura bwana Amundeseni muri buriya buzima bubabaje arimwo, tugomba mbere ya byose gusobanukirwa n'imiterere, n'iforoma y'iriya palanete idasanzwe. Tugerageze gukoresha amahame y'ibanze ya TOPOLOJI. Kubera ibyo tugiye guhambura ikintu icyaricyo cyose muri :
CELILE NYEGERANYI
Ikintu kitiyegeranya ni akadomo...
Ariko se, akadomo twagakoresha iki?
Ikintu cyose kigereranwa n'itsinda ry'utudomo, kigira umwanya kicaramo. Kizitwa inyegeranyi iyo gishobora kwiyegeranya muri iyo nzira kicayemwo, kuburyo kigaruka kikaba akadomo.
Urugero twafata ni kariya gace k'umurongo w'umuzingi. Ni IKINTU CY'URUHANDE RUMWE RW'IKIRERE.
B
A
Ah, yego. Aho akadomo runaka gahagaze kuri uriya murongo w'umuzingi hashobora gupimwa ukoresheje igipimo kimwe gusa : abusisi y'umuzingi, cyangwa uburebure bw'umugozi butandukanya ako kadomo n'akandi kafashwe nk'itangiriro.

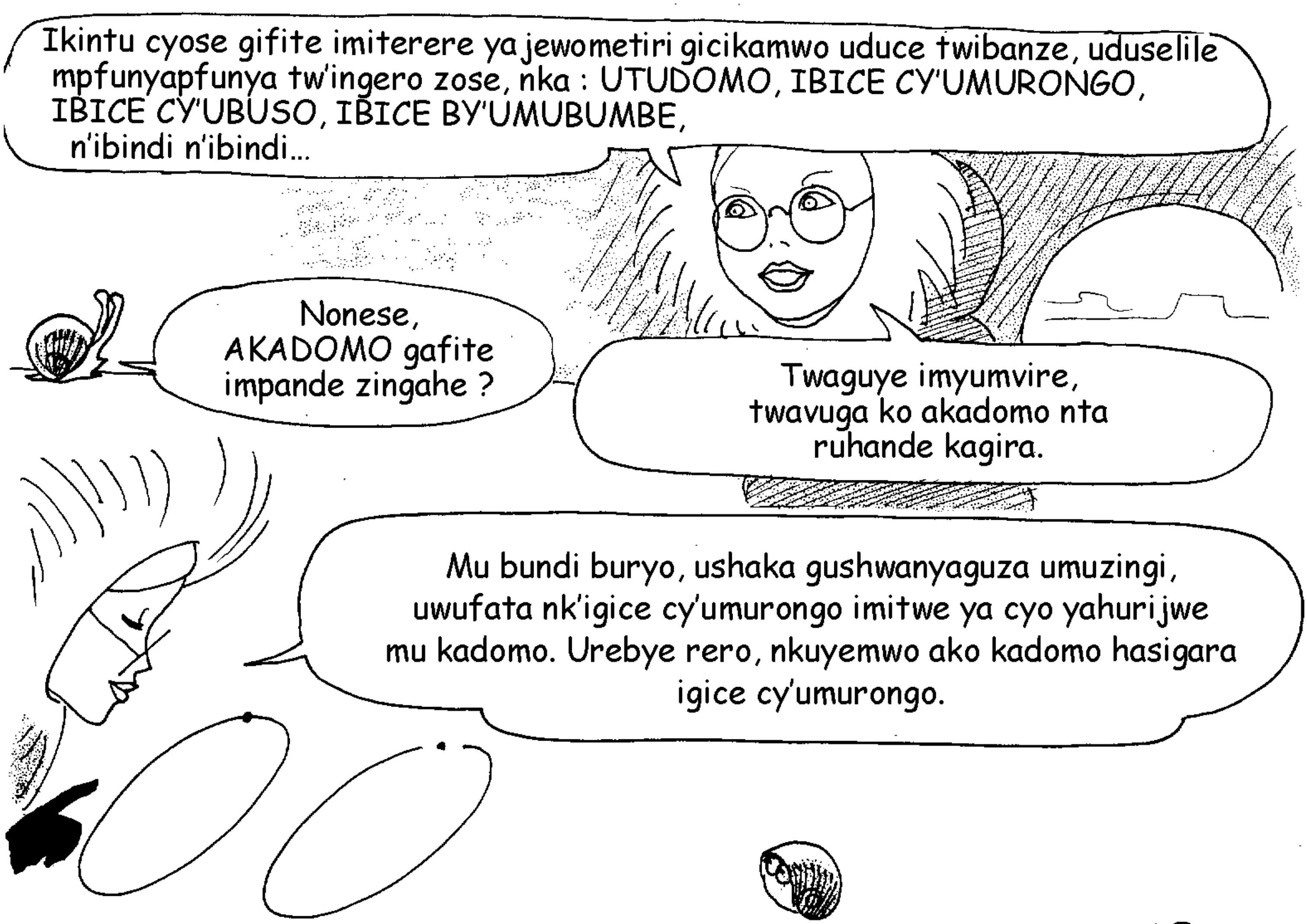


Nshobora gushyira icyo gice cy'umurongo w'umuzingi mu kintu kimeze nk'umuheha cyangwaitiyo ku buryo ako gace k'umurongo w'umuzingi uteretsemwo wakwiyegeranya, ugakomeza ukiyegeranya...
Nka merikire muri terimometero.
A
B
Ese mu by'ukuri, umurongo uwariwose ni nyegeranyi ?
Oya, imirongo y'imizingi ifunze ntabwo ari nyegeranyi.
Yego... ariko haba habuze kuwukata gusa !
Ariko rero, uwo MUZINGI uhinduka UMURONGO. Ntuba ugifunze.
Akarorero, iyo mfashe umuzenguruko. Nshobora kuwuhinahina ukaba nk'akadomo nk'uku ?
Oya, ibyo si byo kuko ntuba ukigarukamwo. Uca nyuma y'uburiri bwawo bwa mbere.
UMUZENGURUKO ntabwo rero ari NYEGERANYI, ni kimwe n'indi mizingi yose, yaba ari ishashe neza cyangwa iyihese mu kirere.
Ibiramambo, IDISIKYE, agace k'UBUSO ko ni nyegeranyi.

(*) Reba **JEOMETIRIKONI** icapiro BELINI

Ese haba hariho za volime zitari nyegeranyi ?
Yego pe, urugero ni « ingata-mubumbe ».
Yego biragaragara. Naho ntayikata nshobora kuyegeranya ikaba nk'umuzingi wa serikyeri.
Ni ukuvugako n' « ingata-buso » nayo itari nyegeranyi.
Mbwira, mu by'ukuri uri mu biki?
Kora ibikureba, di.
Sinziko mubibona ariko dufite umushakashatsi w'umukerarugendo w'intagondwa ku maboko yacu.
Mu by'ukuri muratekereza ko tuzikura hano kubera ko twakase umutsima mwo kane gusa ?
UBURAKARI NJYANABUTAKA bwe bufite inkomoko muri jewometiri. Yenda tunononsoye ibitekerezo nyubakiro niho twabona umuti uzamuvura.
Umubiri we wose urareze utegereje ivumburwa rya pole y'amajyepfo, icyo gitekerezo yaracyihebeye we ubwe no mu mibereho ye n'abandi.

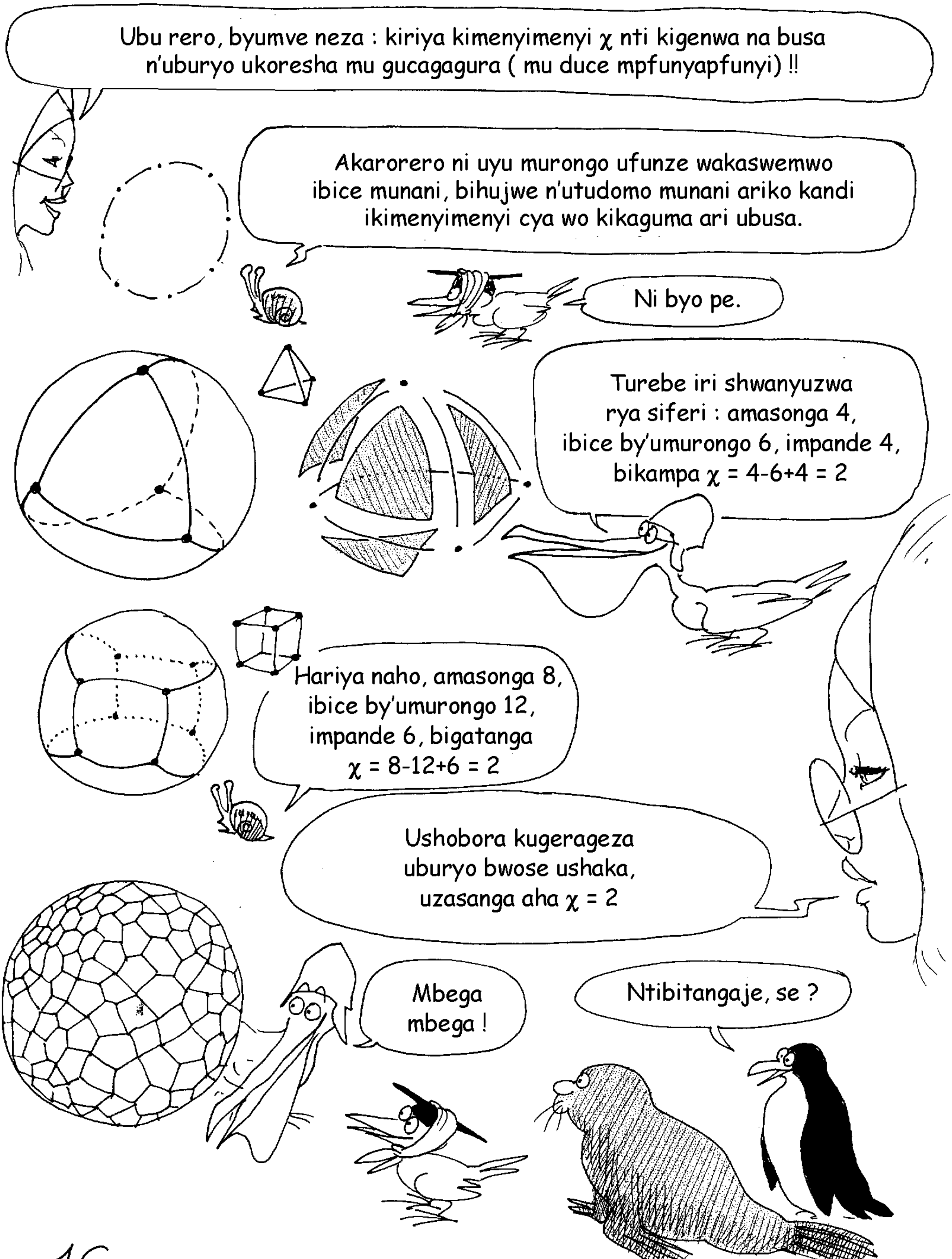
ICIKAGURIKA MU MA SELILE



I « SIFERI BUSO » S2 ishobora gukatwamwo ingofero ebyiri n'igice cy'umurongo gifungiye ku kadomo.
I « NGATA MUBUMBE » ? Turebe, nayishwanyaguza nkoresheje i disikye.
Naho i « NGATA-BUSO » ? Turebe, nayikatisha i serikyere nayo ubwayo ikatishijwe akadomo.
Iyo ngata yakaswe ihita yiyegeranya ikurikije i serikyeri:
Nayo kazashwanyuzwa ihita itanga igice cy'umurongo n'akadomo.
Dore ubundi buryo ukoresheje akadomo, uduce tubiri tw'umurongo n'ubuso bumwe ariko ibihimba byose bikaba ari nyegeranyi.
Yego, ariko se ibyo byose tuzabikoresha iki ?
Ku bigaragara bizadufasha gusobanukirwa uko isi iteye.
A

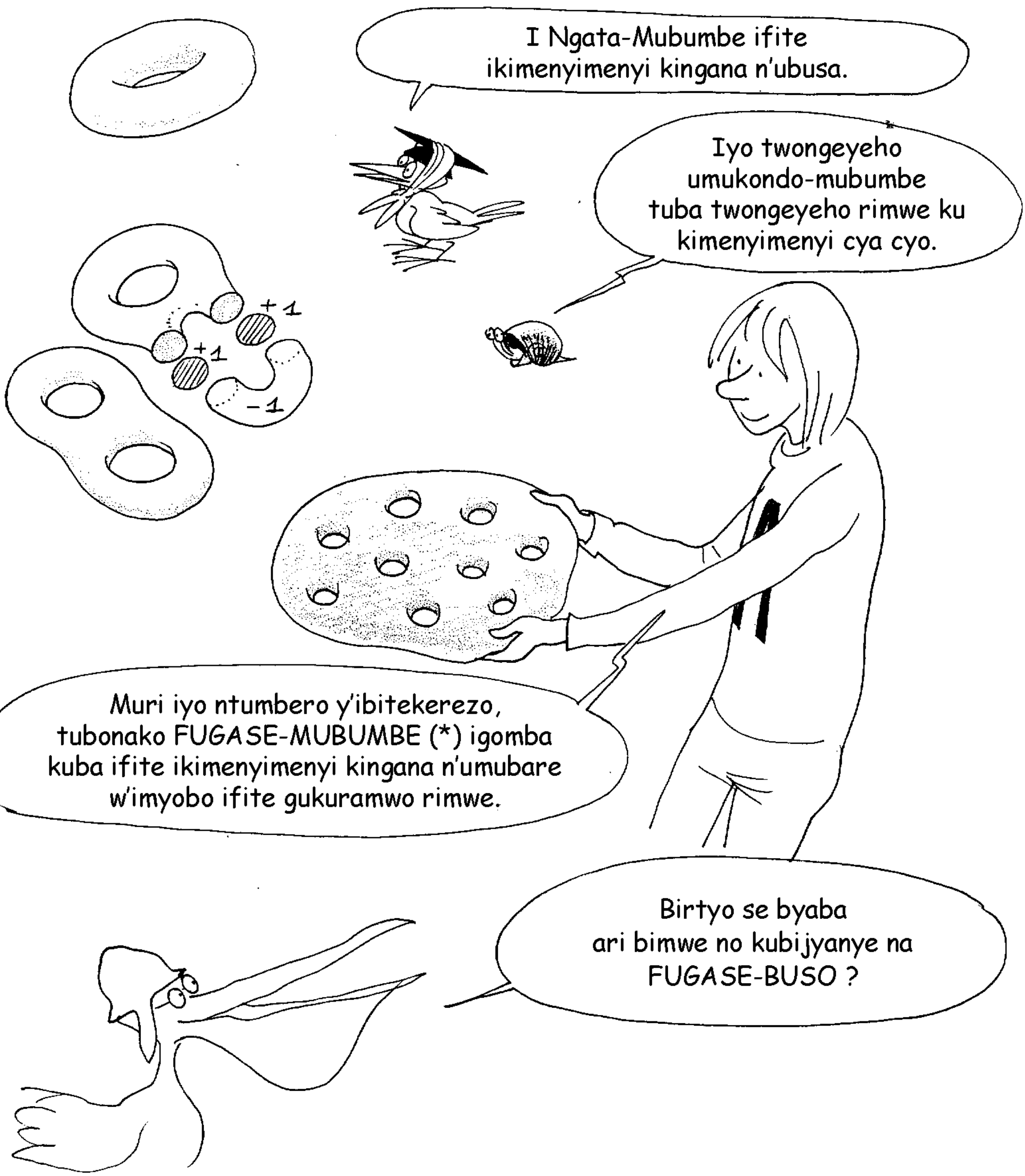
IKIMENYIMENYI CYA EWULERI-PUWANKARE

(*) Bihita byiramburira ako kanya k'umubare wa dimansiyo zisumbye eshatu (ni igiteranyo k'imibare igenda ihushanyije.)

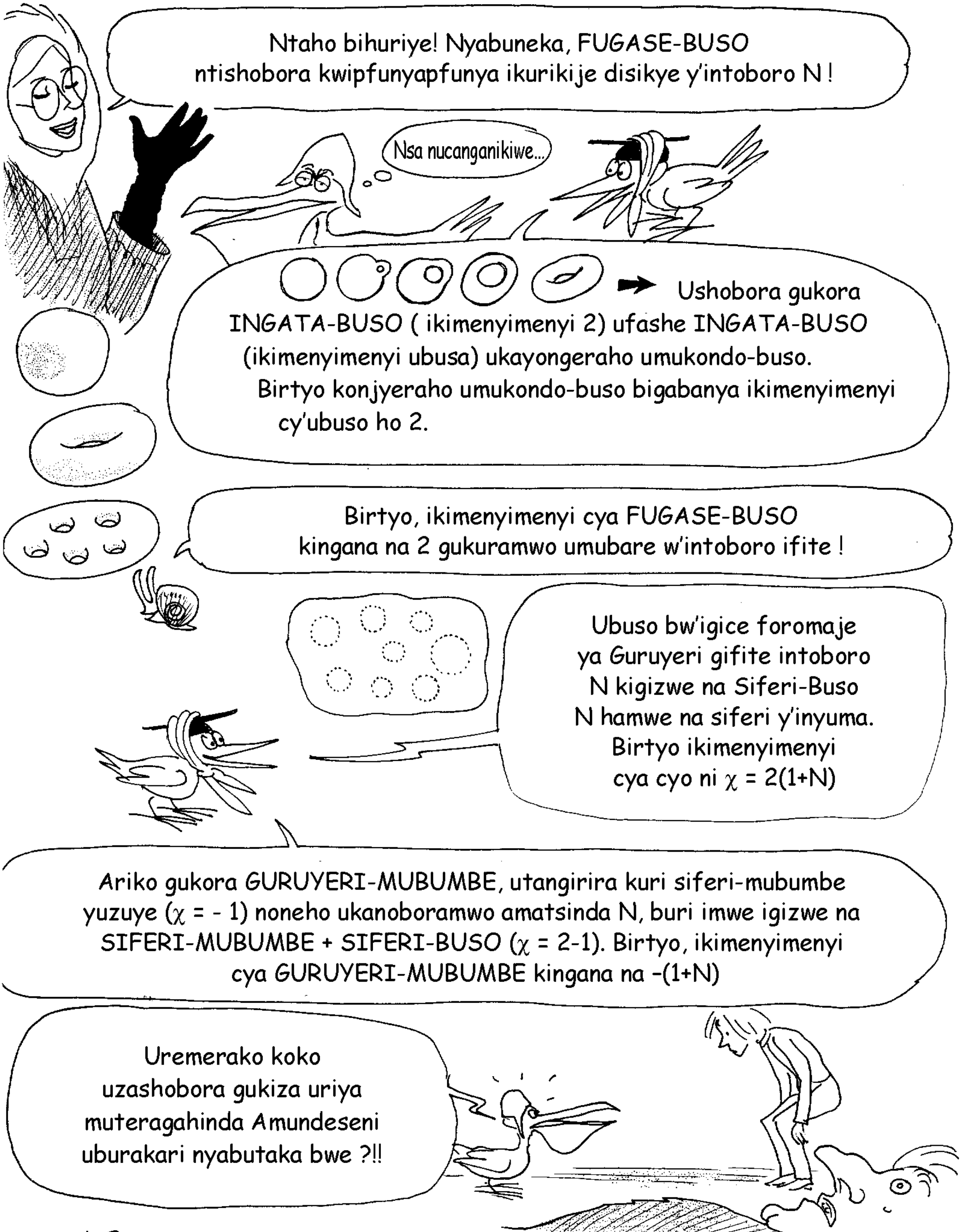

Ubu rero, byumve neza : kiriya kimenyimenyi χ nti kigenwa na busa n'uburyo ukoresha mu gucagagura (mu duce mpfunyapfunyi) !!
Akarorero ni uyu murongo ufunze wakaswemwo ibice munani, bihujwe n'utudomo munani ariko kandi ikimenyimenyi cya wo kikaguma ari ubusa.
Ni byo pe.
Turebe iri shwanyuzwa rya siferi : amasonga 4, ibice by'umurongo 6, impande 4, bikampa χ = 4-6+4 = 2
Hariya naho, amasonga 8, ibice by'umurongo 12, impande 6, bigatanga χ = 8-12+6 = 2
Ushobora kugerageza uburyo bwose ushaka, uzasanga aha χ = 2
Mbega mbega !
Ntibitangaje, se ?

Dore teworeme y'ingirakamaro : niba ikintu kigizwe n'iteranywa ry'ibintu bibiri, ikimenyimenyi cya cyo kingana n'igiteranyo k'izibyo bintu bibiri bikigize.

Ubuyobozi



(*) ubwoko bw'umukati wo mu majyepfo y'u Bufaransa.



Ntaho bihuriye! Nyabuneka, FUGASE-BUSO ntishobora kwipfunyapfunya ikurikije disikye y'intoboro N !
Nsa nucanganikiwe...
Ushobora gukora INGATA-BUSO (ikimenyimenyi 2) ufashe INGATA-BUSO (ikimenyimenyi ubusa) ukayongeraho umukondo-buso. Birtyo konjyeraho umukondo-buso bigabanya ikimenyimenyi cy'ubuso ho 2.
Birtyo, ikimenyimenyi cya FUGASE-BUSO kingana na 2 gukuramwo umubare w'intoboro ifite !
Ubuso bw'igice foromaje ya Guruyeri gifite intoboro N kigizwe na Siferi-Buso N hamwe na siferi y'inyuma. Birtyo ikimenyimenyi cya cyo ni χ = 2(1+N)
Ariko gukora GURUYERI-MUBUMBE, utangirira kuri siferi-mubumbe yuzuye (χ = - 1) noneho ukanoboramwo amatsinda N, buri imwe igizwe na SIFERI-MUBUMBE + SIFERI-BUSO (χ = 2-1). Birtyo, ikimenyimenyi cya GURUYERI-MUBUMBE kingana na –(1+N)
Uremerako koko uzashobora gukiza uriya muteragahinda Amundeseni uburakari nyabutaka bwe ?!!

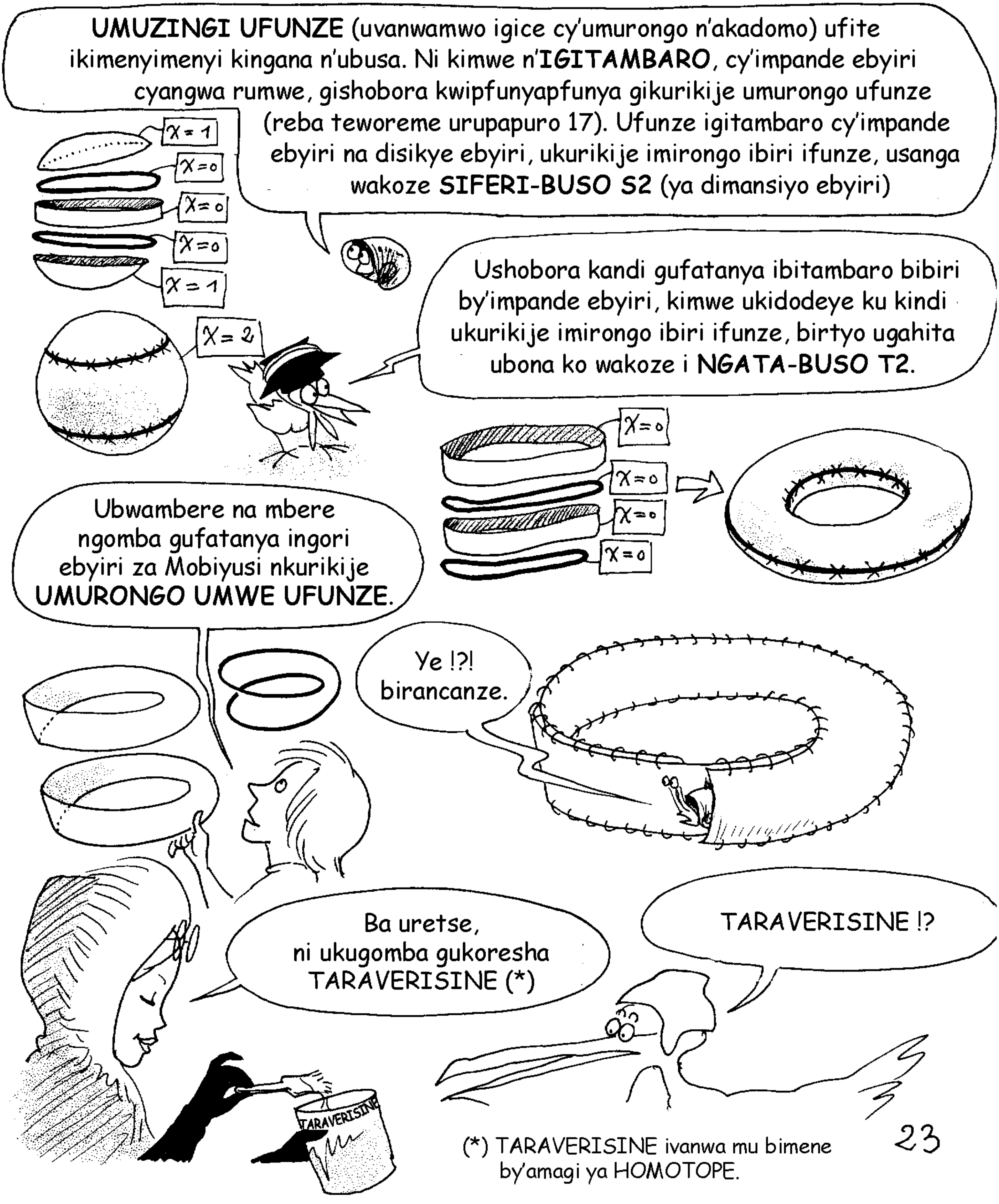
IYI SI TUBAMWO

(*) Reba **BIGI BANGE** na modeli za FIRIDIMANI kuri page 64.

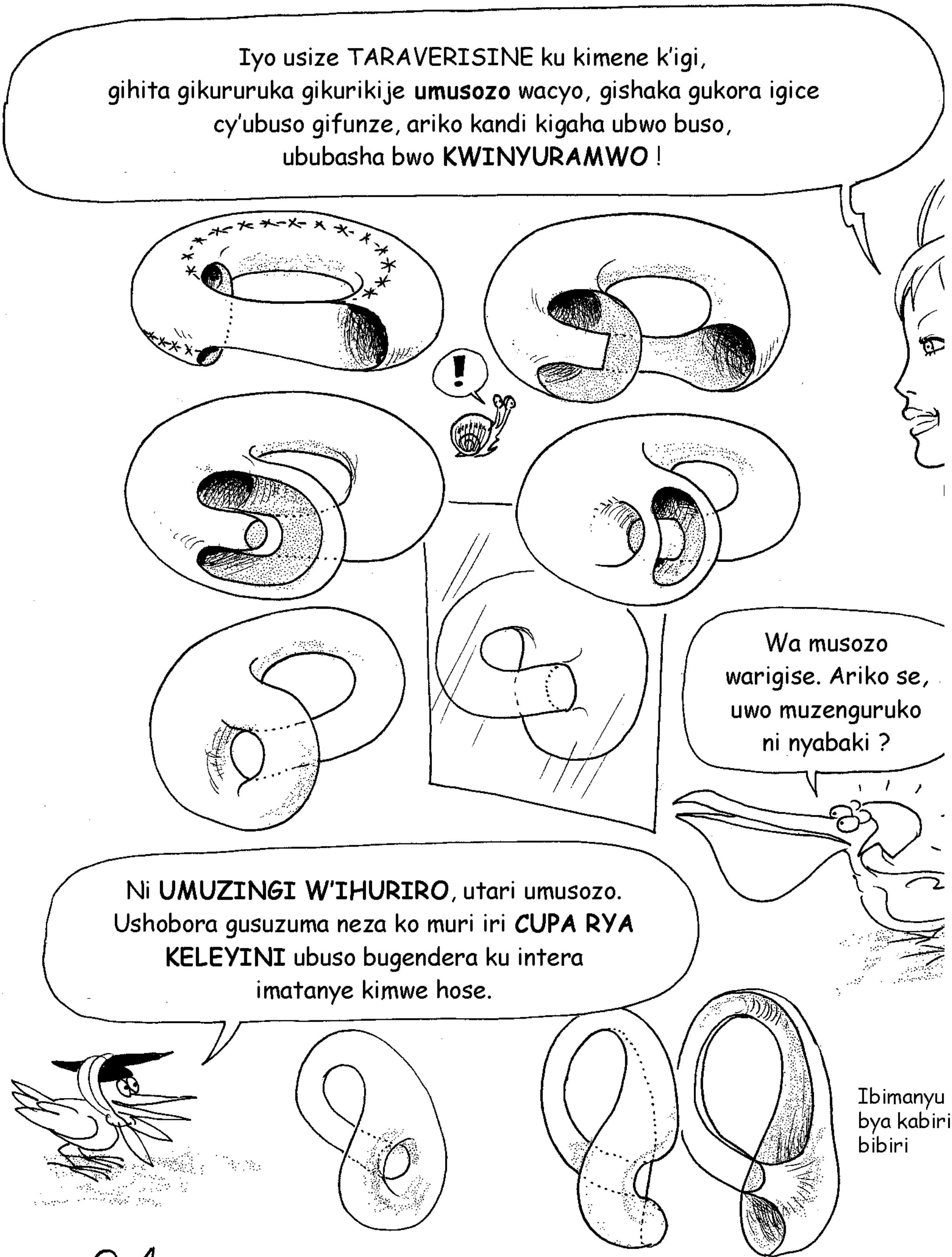
Rwose, iki kimenyimenyi cya Ewuleri-Puwankare cyatumye dushobora gushyira ku murongo muri iriya nzitane y'ibintu biteye bwa jewometiri.
Birtyo, kiriya gice cya silenderi gisa mu buryo bwa topoloji nk'idiskye ifite intoboro imwe, birtyo rero ikimenyimenyi cya yo kikaba ubusa.
Ariko se kiriya kintu ugitekerezaho iki ?
Ni URUGORI RWA MOBIYUSI, rufite uruhande rumwe gusa. Nk'uko nta waruha IMBERE cyangwa INYUMA, tuvuga yuko ari URUTAGANISHWA.
Mu by'ukuri, ingori zose zifite umubare UGABANYIKA NA KABIRI w'IBICE BY'UMUSINGI ni ingori za MOBIYUSI, ZITAGANISHWA. Ariko izo ngori ebyiri urebye neza ntizisa...

(*) Reba **JEWOMETIRIKONI** urupapuro rwa 59

UMUSOZO KU MUSOZO



(*) TARAVERISINE ivanwa mu bimene by'amagi ya HOMOTOPE.


Iyo usize TARAVERISINE ku kimene k'igi, gihita gikururuka gikurikije umusozo wacyo, gishaka gukora igice cy'ubuso gifunze, ariko kandi kigaha ubwo buso, ububasha bwo KWINYURAMWO !
!
Wa musozo warigise. Ariko se, uwo muzenguruko ni nyabaki ?
Ni UMUZINGI W'IHURIRO, utari umusozo. Ushobora gusuzuma neza ko muri iri CUPA RYA KELEYINI ubuso bugendera ku intera imatanye kimwe hose.
Ibimanyu bya kabiri bibiri

Ikimenyimenyi cya ryo kingana n'ubusa rikozwe n'ingori ebyiri za Mobiyusi (χ = 0) n'umurongo umwe ufunze (χ = 0). Ntawe bitorohera guhita abona rumwe muri izo ngori.
Birtyo pe, iyo ubonye urugori rwa Mobiyusi ku nyabuso, ni ukuvuga ko iyo nyabuso iba ifite uruhande rumwe.
Ahubwo se Tireziasi, nti twabona urugori rwa Mobiyusi kuri icyo gishishwa cy'igi cya we ?
Era.. !
Aha, mwe uko muri babiri nti mwongere !
Ariko ubundi, ni iki ni ubwoko bw'inyabuso yihariye...
Kugeza ubu, ubuso butinyuramwo, nka SIFERI, cyangwa INGATA, mw'iforoma yabwo isanzwe. Inyabuso zinyuramwo mu kirere cyacu bazita IBYIHINGUKEMWO.
Ama...ibyihingukemwo ?

UBUKWEDUKYE N'IBYIHINGUKEMWO

(*) ubukweduke ni ukwihindukiramwo bidasanzwe.

I
II
III
Ukoreshe je ubukwedukye busanzwe (nta mirongo ivunitse), mu KIBYATARARE, nshobora kuva ku musingi I nkajya ku muzingi III. Ibyo iyo bikorwa, ubuhindukire bwose bw'umwambi (360°) ntibuhinduka igihe cyo kunanara buri muzingi.
Iki ni HOMOTOPIYA IBONEYE ikorerwa mu KIBYATARARE. Igumana wa mubare w'inshuro z'ubuzenguruke bw'umwambi witseta ku muzingi.
Nakoresheje uburyo bwose ariko nananiwe guhindura uyu MUNANI mu MUZENGURUKO.
Ni ibisanzwe. Umwambi ntukora inshuro z'ubuzenguruke zimwe. Ku UMUNANI, igiteranyo aligeburikye cy'ubuzenguruke kingana n'ubusa.
Ufatiye kuri iryo tegeko ry'ubukwedure bw'imizingi ifunze (ubukomereze, ububonere), mu kinyabuso, hariho ibintu BISHOBOKA n'ibindi BIDASHOBOKA igihe cyose.
Ntibyoroshe !

Biterwa n'**IKIRERE** icyo kintu gishushanyijemwo. Dore, urugero, reba uyu muzingi. Kuri iki kibyatarare, nta buryo bwo kurigisa utu tudomo tubiri twa dubure.
IKIBYATARARE
Ariko kandi, kuri SIFERI :
Birtyo ibintu bimwe bigaragara nkaho bidashoboka mu **KIRERE CY'UBUSERUTSI** naka (aha ikibyatarare) biza gushoboka uhinduye icyo kirere, ugakorera mu kindi gifite topoloji inyuranye. Ubundi naho uhinduye n'ibindi birahinduka.
Mu kibyatarare, uyu muzingi urabohoka mu buryo bworoshye, ariko ntushobora kubikora iyo wawushushanyije ku ngata-buso
Ariko se rwose, Tireziyasi, muri **ESIPASE-GIHE** yacu, hariho ibintu BISHOBOKA cyangwa BIDASHOBOKA mu buryo budasubirwaho? Oya?
Agahinda...

Ese waba uzi, wowe, topoloji ya esipase-gihe yacu?
Eeeh...oya...
Tubayeho mu byigaragaza gusa... ariko kandi !
Utudomo huriro tw'umuzingi ufunze duterwa n'uburyo bwo kwerekana ibintu mu buso. Ishusho ya dimansiyo ebyiri ni igicapo gitumberejwe gusa ku kibwatarare.
Muri ibi byose hari mu by'ukuri ikintu kimwe gusa : UMUZINGI UFUNZE, IKIREMWA CYA DIMANSIYO IMWE
Muri esipase nyerekerwamwo ya dimansiyo 4, icupa rya KELEYINI ntiryinyuramwo !
Ariko rero, iyo duhinduye esipase nyerekerwamwo, BYOSE nshobora kubikora. Nk'akarorero, icupa rya Keleyini rishobora guhindukamwo siferi ?
Oya, hariho ibimenyimenyi BIDAHINDUKANA na ESIPASE NYEREKERWAMWO.

TOPOLOJi

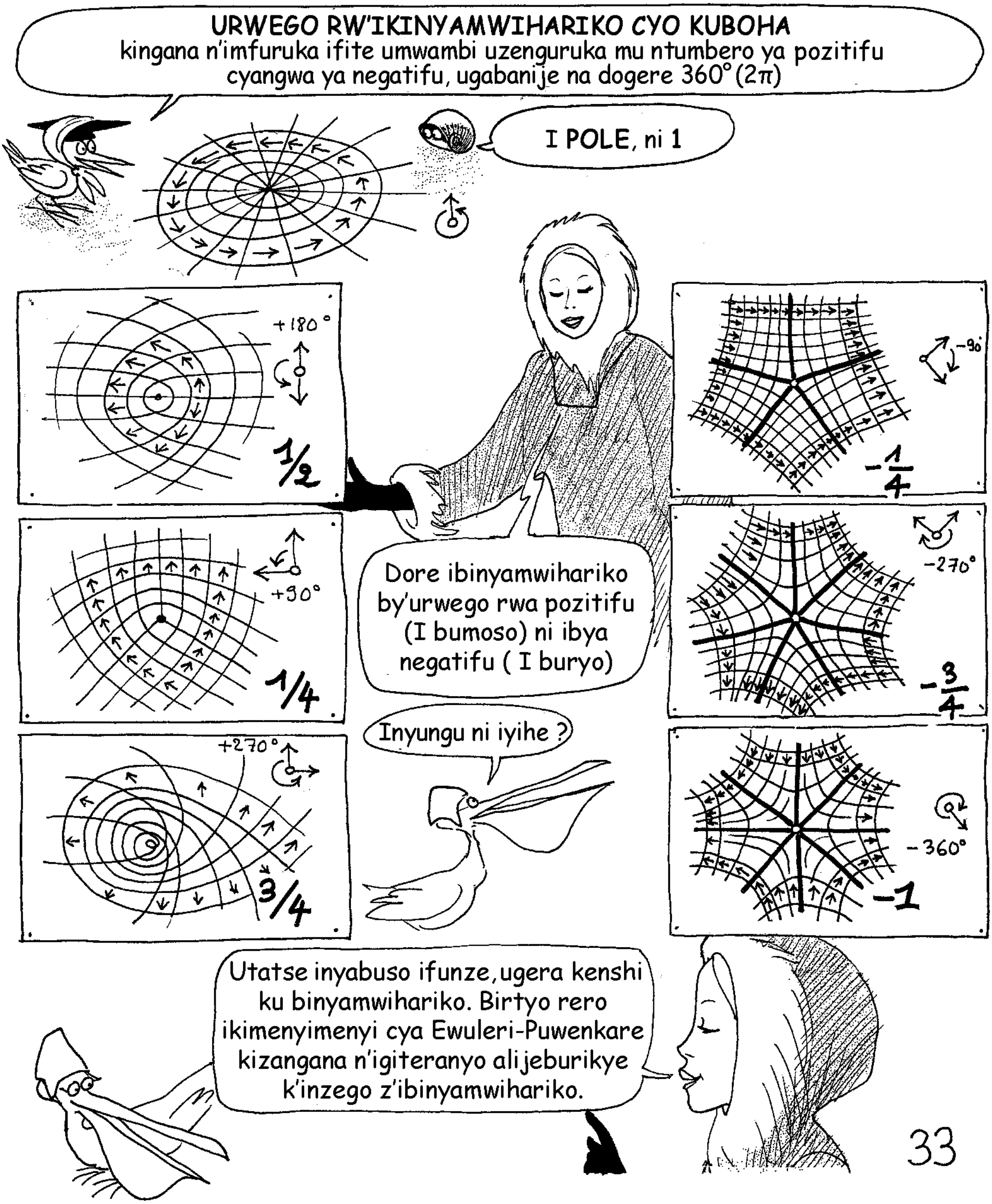
Akarorero : ikimenyimenyi cya Ewuleri-Puwenkare, icyerekeranyi, ubufunjye.
Ku bintu bya dimansiyo imwe, byose byasobanurwa birtya : UMUZINGI UGOMBA KUBA UFUNGUYE CYANGWA UFUNZE.
None se, Amundeseni ameze ate ?
Nta kuntu, nubu ni nka kwakundi...
UBURAKARI NYABUTAKA ? Jyewe ahubwo nkyekako byaba UBURAKARI NYAMITERERE.
Imiterere y'imyumvire y'ubwonko bwacu, IMITEKEREREZE yacu, uko tubona isi, bishingiye ku ndiba za jewometiri, zishobora gusaduka igihe icyaricyo cyose.
Nitudashobora kugarura imiterere nyayo na mikye mu mirebere mugenzi wacu afite y'ibintu bimwe na bimwe, hariho impungenge ko yakomeza gutsimbatarara yanga iyi si dukabakaba.

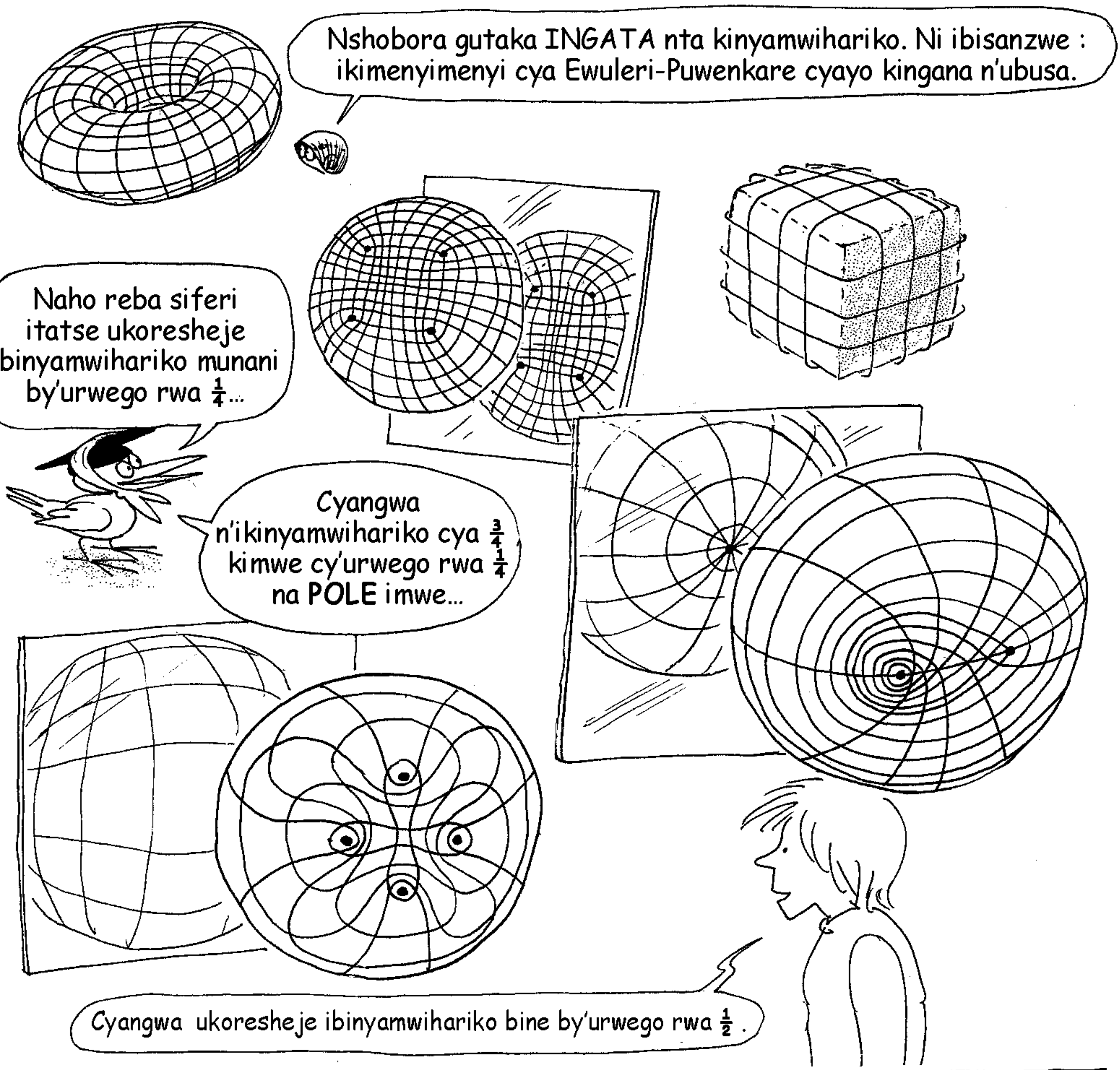
KUBOHA

Nashoboye kubona ubundi burtyo bwo kwerekana ubuso : KUBOHA
Akarorero, iki ni silenderi
Mfite ibibazo kubijyanye na siferi
Ni INGATA
ICUPA RYA KELEYINI
Ku bijyanye na SIFERI, ugomba gushyiramwo **POLE 2**
Ariko...simbyumva. Kubijyanye n'INGATA cyangwa icupa rya KELEYINI, sinzikeneye...
Ikimenyimenyi cya Ewuleri-Puwenkare kiguha umubare wa **POLE** zikenewe kugirango **UBOHE** ubuso bwawe. Ku bijyanye n'INGATA cyangwa icupa rya KELEYINI, ni zero. Ariko kubijyanye na siferi ni **2**.

(*) reba BIGI BANGE (Icapiro BELINI).

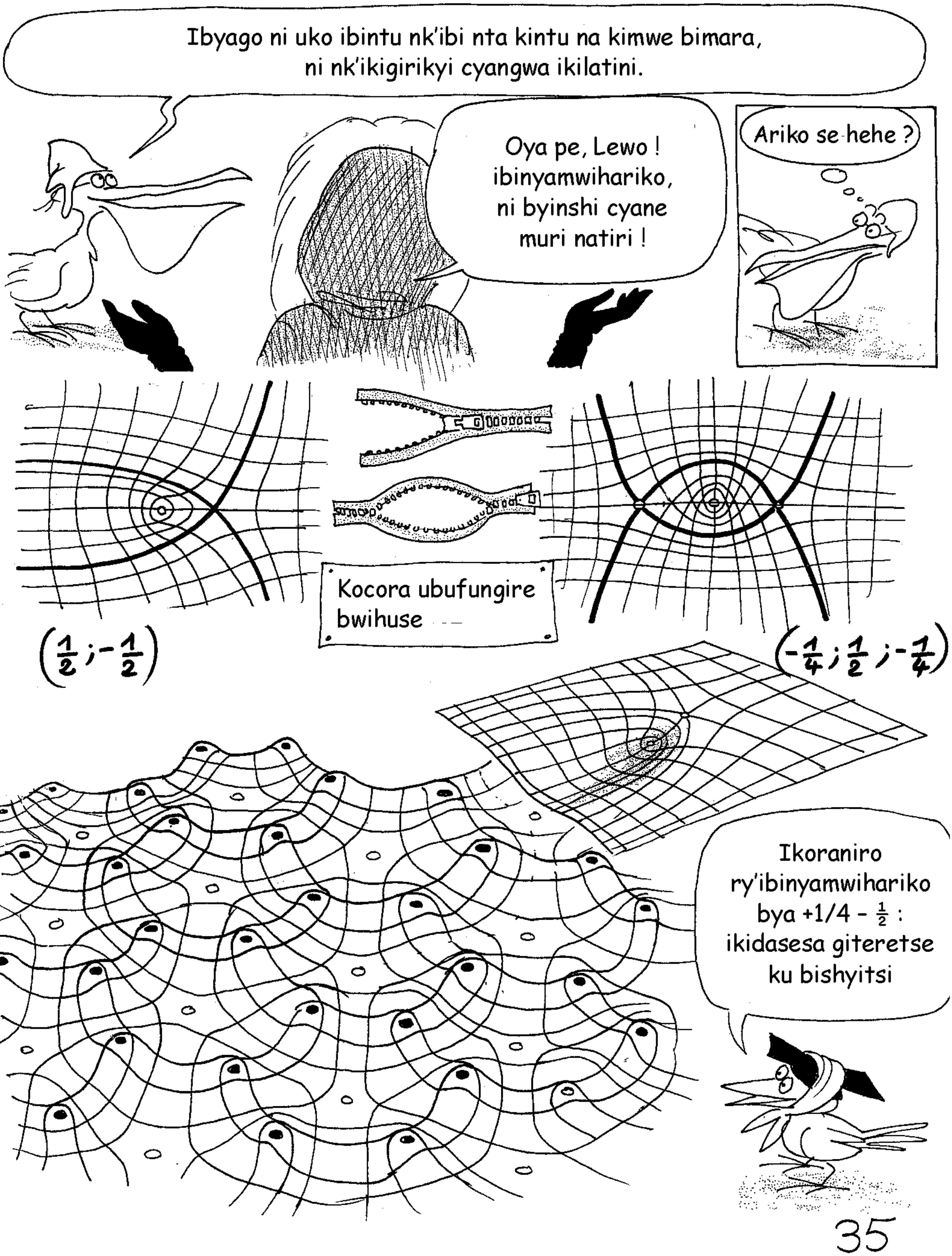
iBiNYAMWiHARiKO

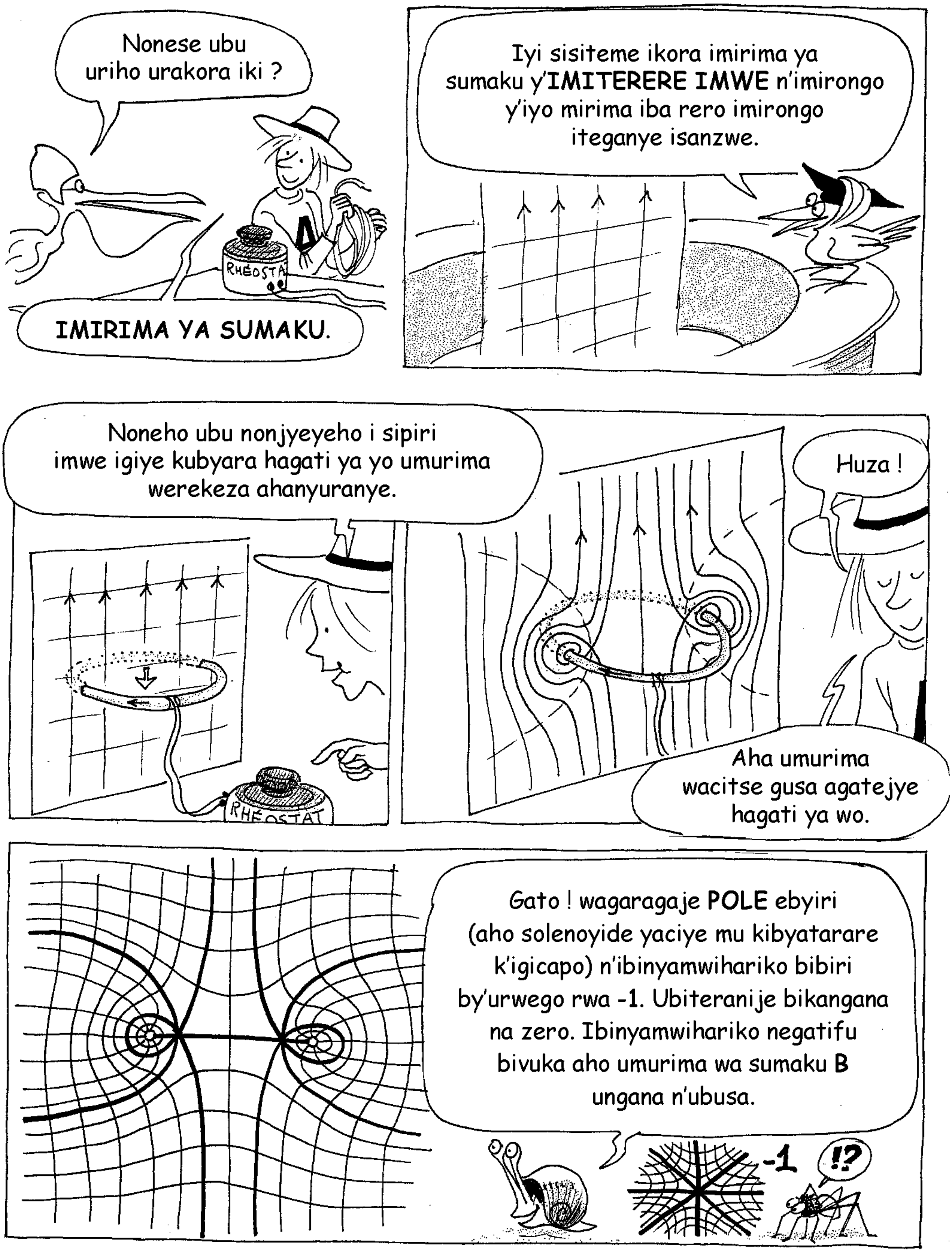




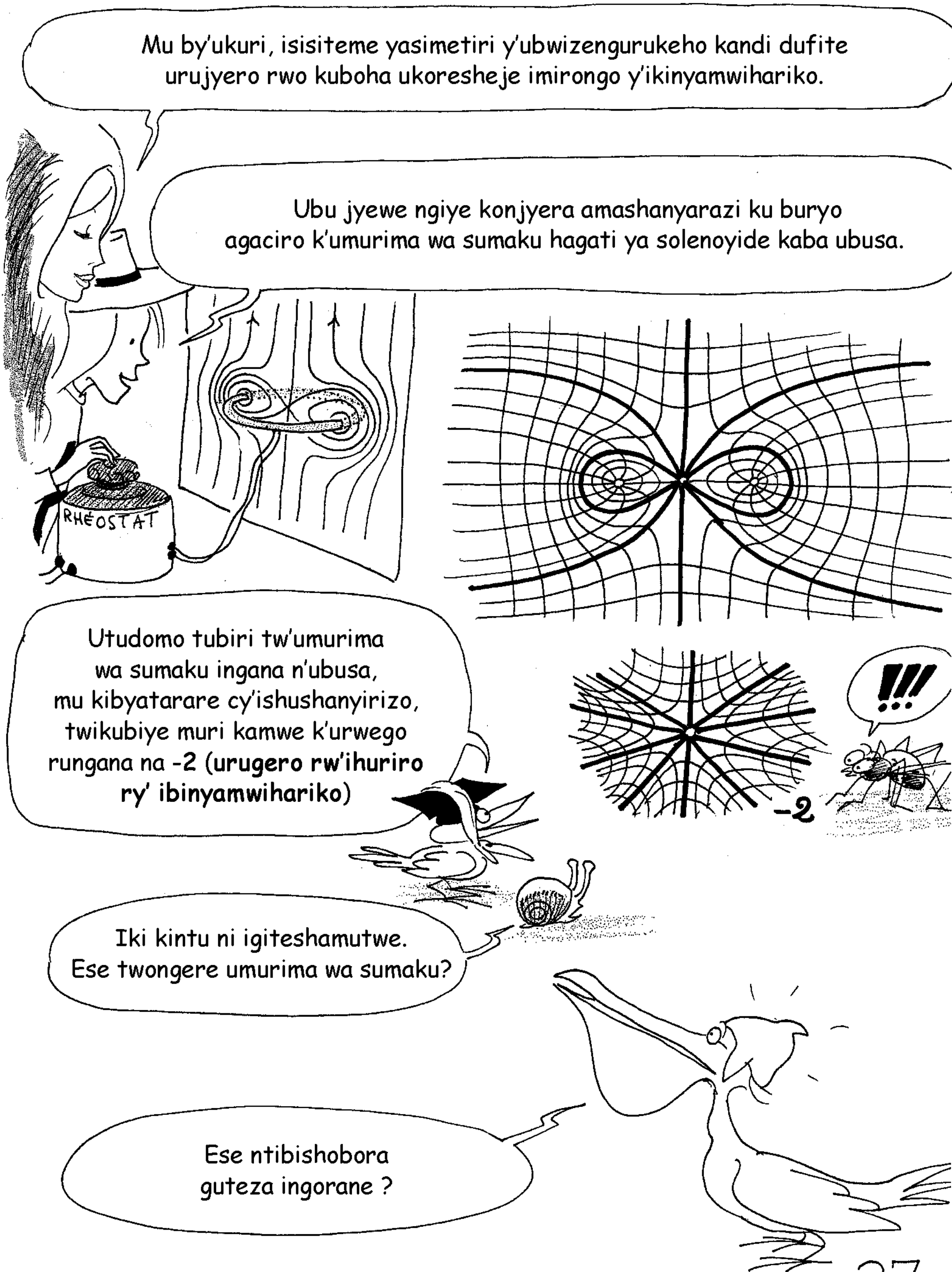
Uramenye :
Umusomyi uzaba yarasomye **UMWOBO W'UMUKARA** (icapiro BELINI), ipaje 14 kugeza kuri 36 azaba, ntagushidikanya, yarabonye imiterere imwe hagati y'ibishushanyo by'ibinyamwihariko by'ubutatsi n'ibiganisha, muri iki gitabo kuri za, POZIKONE, NEGAKONE n'ubuzingye. Ibi byigwa byose, bishingiye nka byose ku mfuruka, birafatanye cyane. UBUZINGYE BYOSE bw'inyabuso, bwerekaniwe muri esipase yacu ya dimansiyo eshatu, bungana neza n'ikimenyimenyi cya Ewuleri-Puwenkare, ukubye na dogere 360° (cyangwa na 2π).

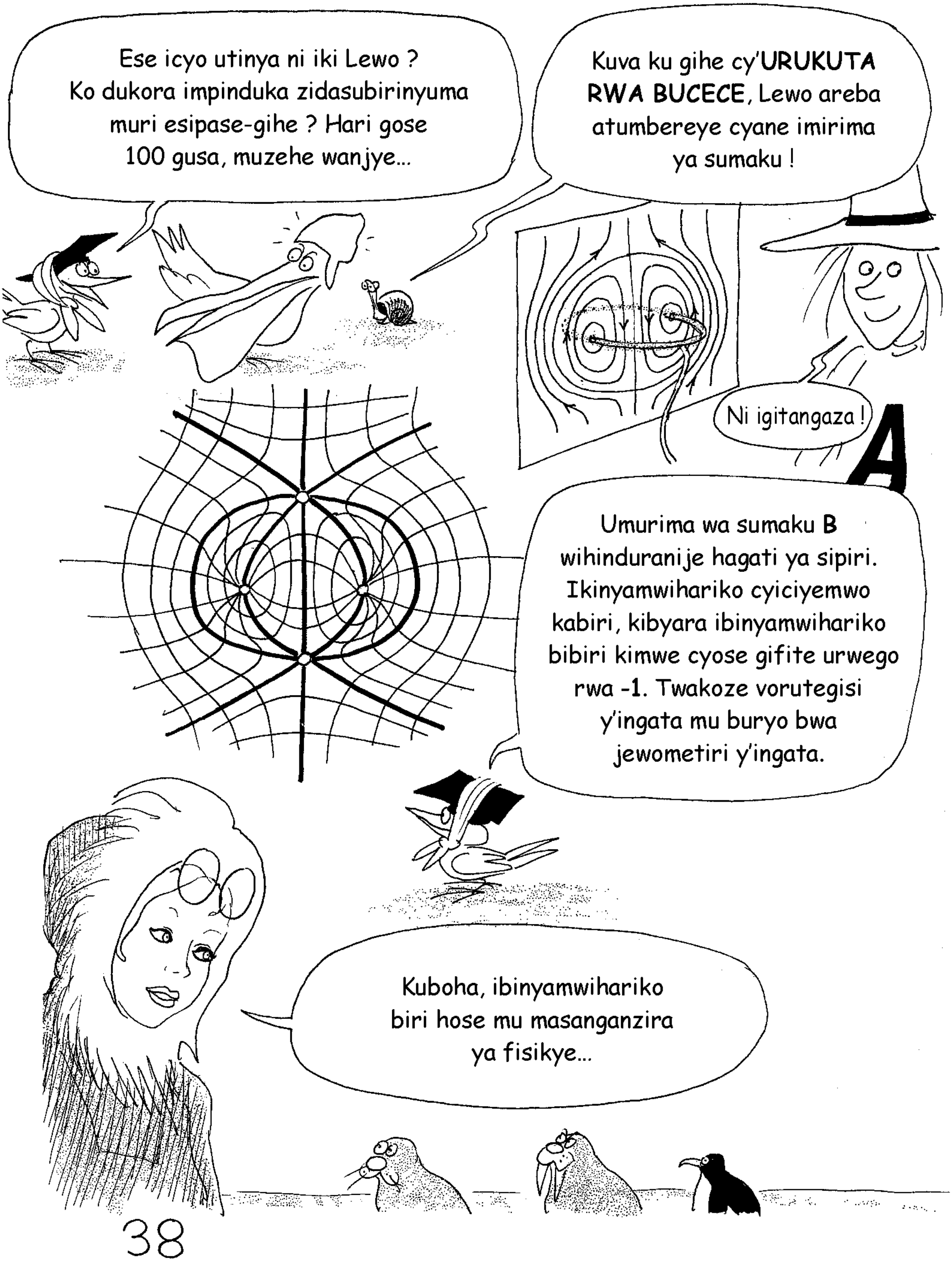
Ubuyobozi.

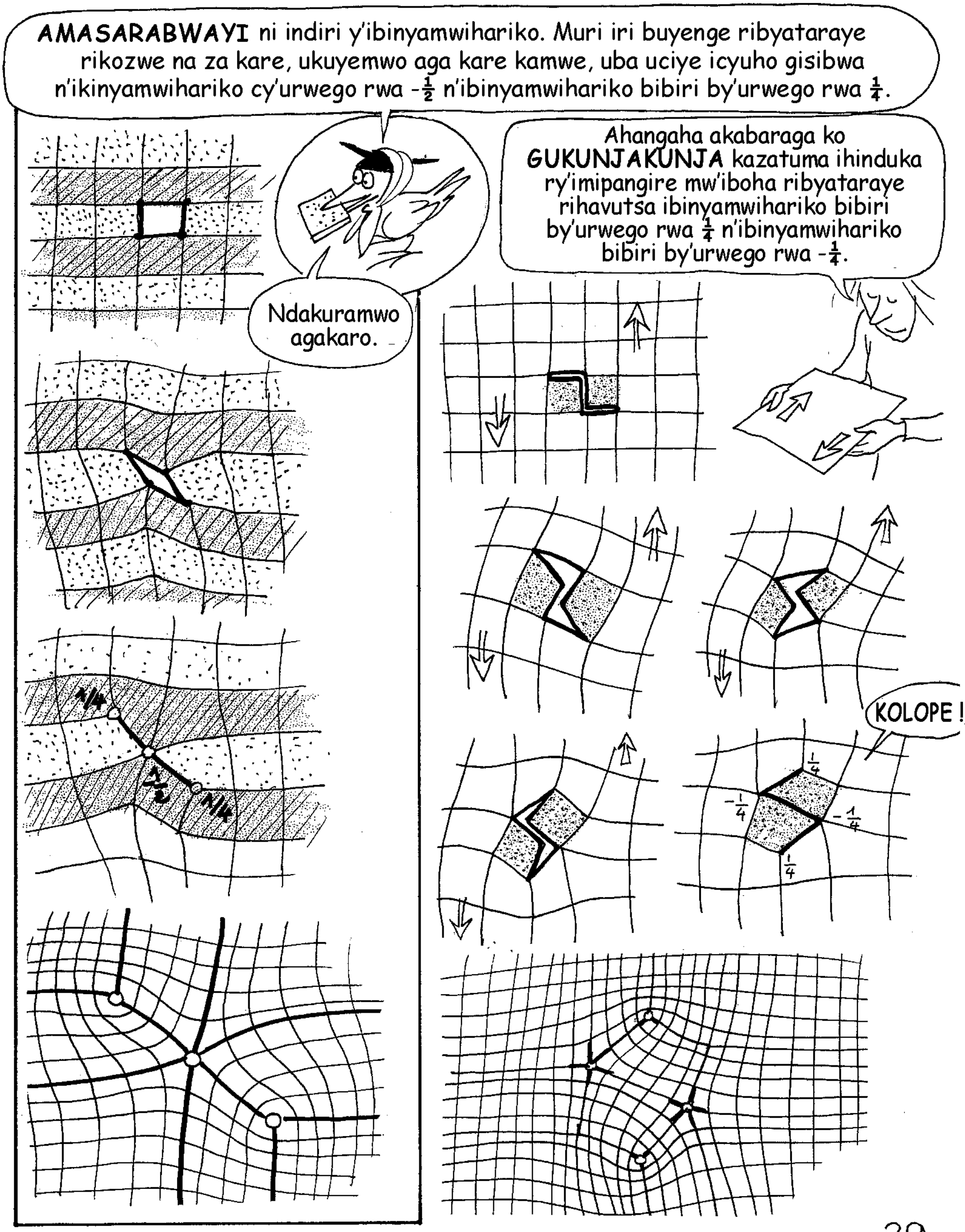

Ibyago ni uko ibintu nk'ibi nta kintu na kimwe bimara, ni nk'ikigirikyi cyangwa ikilatini.
Oya pe, Lewo ! ibinyamwihariko, ni byinshi cyane muri natiri !
Ariko se hehe ?
Kocora ubufungire bwihuse
(1/2 ; -1/2)
(-1/4 ; 1/2 ; -1/4)
Ikoraniro ry'ibinyamwihariko bya +1/4 – ½ : ikidasesa giteretse ku bishyitsi



Nonese ubu uriho urakora iki ?
RHÉOSTAT
IMIRIMA YA SUMAKU.
Iyi sisiteme ikora imirima ya sumaku y'IMITERERE IMWE n'imirongo y'iyo mirima iba rero imirongo iteganye isanzwe.
Noneho ubu nonjyeyeho i sipiri imwe igiye kubyara hagati ya yo umurima werekeza ahanyuranye.
RHÉOSTAT
Huza !
Aha umurima wacitse gusa agatejye hagati ya wo.
Gato ! wagaragaje POLE ebyiri (aho solenoyide yaciye mu kibyatarare k'igicapo) n'ibinyamwiharico bibiri by'urwego rwa -1. Ubiteranije bikangana na zero. Ibinyamwihariko negatifu bivuka aho umurima wa sumaku B ungana n'ubusa.
-1
!?


Mu by'ukuri, isisiteme yasimetiri y'ubwizengurukeho kandi dufite urujyero rwo kuboha ukoresheje imirongo y'ikinyamwihariko.
Ubu jyewe ngiye konjyera amashanyarazi ku buryo agaciro k'umurima wa sumaku hagati ya solenoyide kaba ubusa.
RHÉOSTAT
Utudomo tubiri tw'umurima wa sumaku ingana n'ubusa, mu kibyatarare cy'ishushanyirizo, twikubiye muri kamwe k'urwego rungana na -2 (**urugero rw'ihuriro ry' ibinyamwihariko**)
-2
!!!
Iki kintu ni igiteshamutwe. Ese twongere umurima wa sumaku?
Ese ntibishobora guteza ingorane ?


Ese icyo utinya ni iki Lewo ? Ko dukora impinduka zidasubirinyuma muri esipase-gihe ? Hari gose 100 gusa, muzehe wanjye...
Kuva ku gihe cy'URUKUTA RWA BUCECE, Lewo areba atumbereye cyane imirima ya sumaku !
Ni igitangaza !
A
Umurima wa sumaku B wihinduranije hagati ya sipiri. Ikinyamwihariko cyiciyemwo kabiri, kibyara ibinyamwihariko bibiri kimwe cyose gifite urwego rwa -1. Twakoze vorutegisi y'ingata mu buryo bwa jewometiri y'ingata.
Kuboha, ibinyamwihariko biri hose mu masanganzira ya fisikye...


AMASARABWAYI ni indiri y'ibinyamwihariko. Muri iri buyenge ribyataraye rikozwe na za kare, ukuyemwo aga kare kamwe, uba uciye icyuho gisibwa n'ikinyamwihariko cy'urwego rwa -1/2 n'ibinyamwihariko bibiri by'urwego rwa 1/4.
Ndakuramwo agakaro.
Ahangaha akabaraga ko GUKUNJAKUNJA kazatuma ihinduka ry'imipangire mw'iboha ribyataraye rihavutsa ibinyamwihariko bibiri by'urwego rwa 1/4 n'ibinyamwihariko bibiri by'urwego rwa -1/4.
KOLOPE !
1/4
-1/4
-1/4
1/4

(*) **KUBOHA** birebana n'ibintu bya dimansiyo 2.
KOMEKANYA bihwanye n'ibyo ariko kuri dimansiyo z'umubare wo hejuru.

Ibikurikira byose bigiye gusobanurwa dukoresheje **INKURIKIRANE Z' IBISHUSHANYO BISOMWA** bigaragazwa n'inyuguti A,B,C na D.

Ubuyobozi

A

IHINDURANYA RY'URUGORI RWA MOBIYUSI MU NYABUSO YA BOYI

INYABUSO BWA BOYI

B

NKUKO : UMUZINGI-MUSOZO N'ITSINDA RY'IHWANIRO MU BWARYO

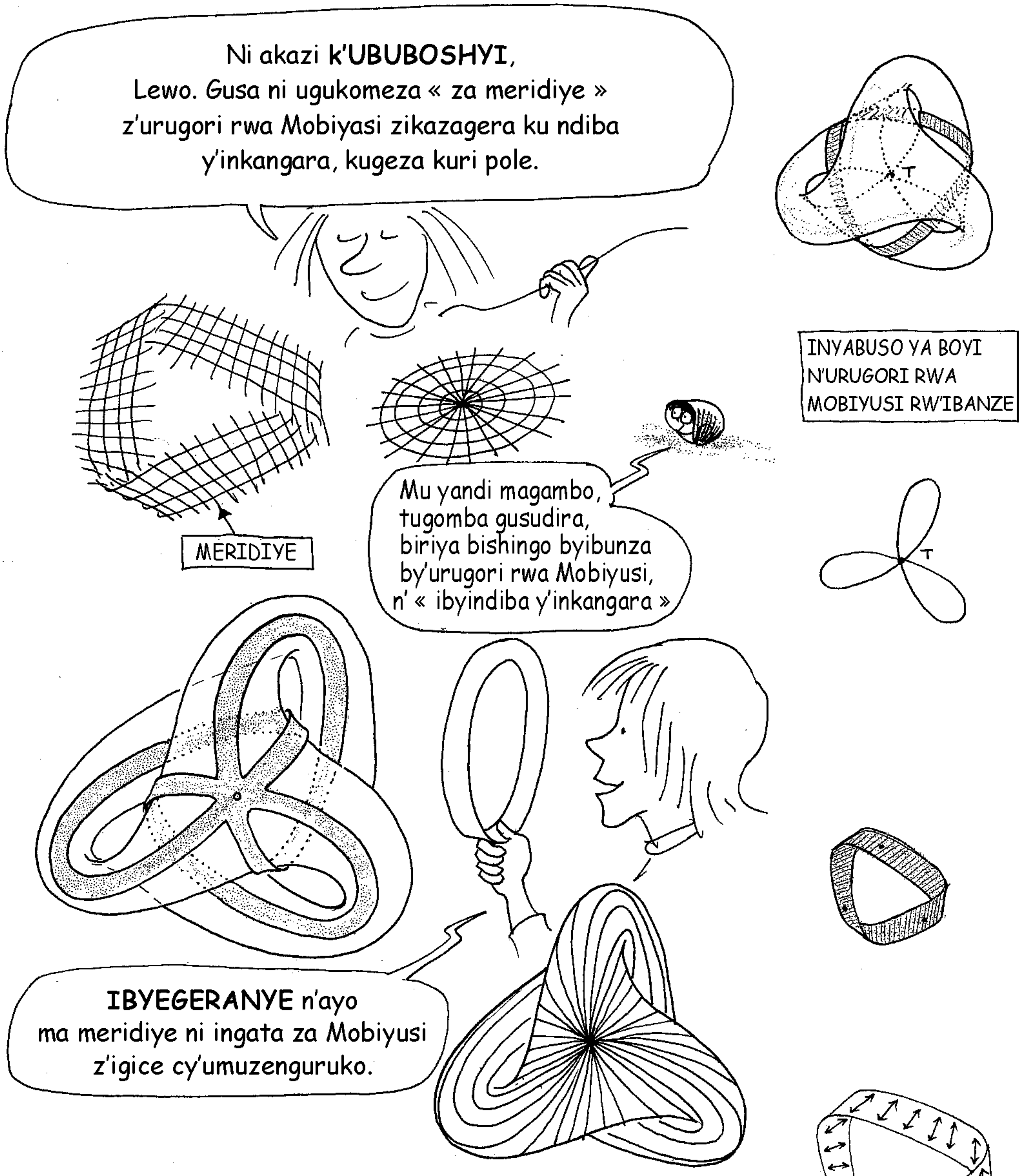
C

GUSHYIRA MW'IHWANIRO RY'UTUDOMO NDWANYAPODALE

D

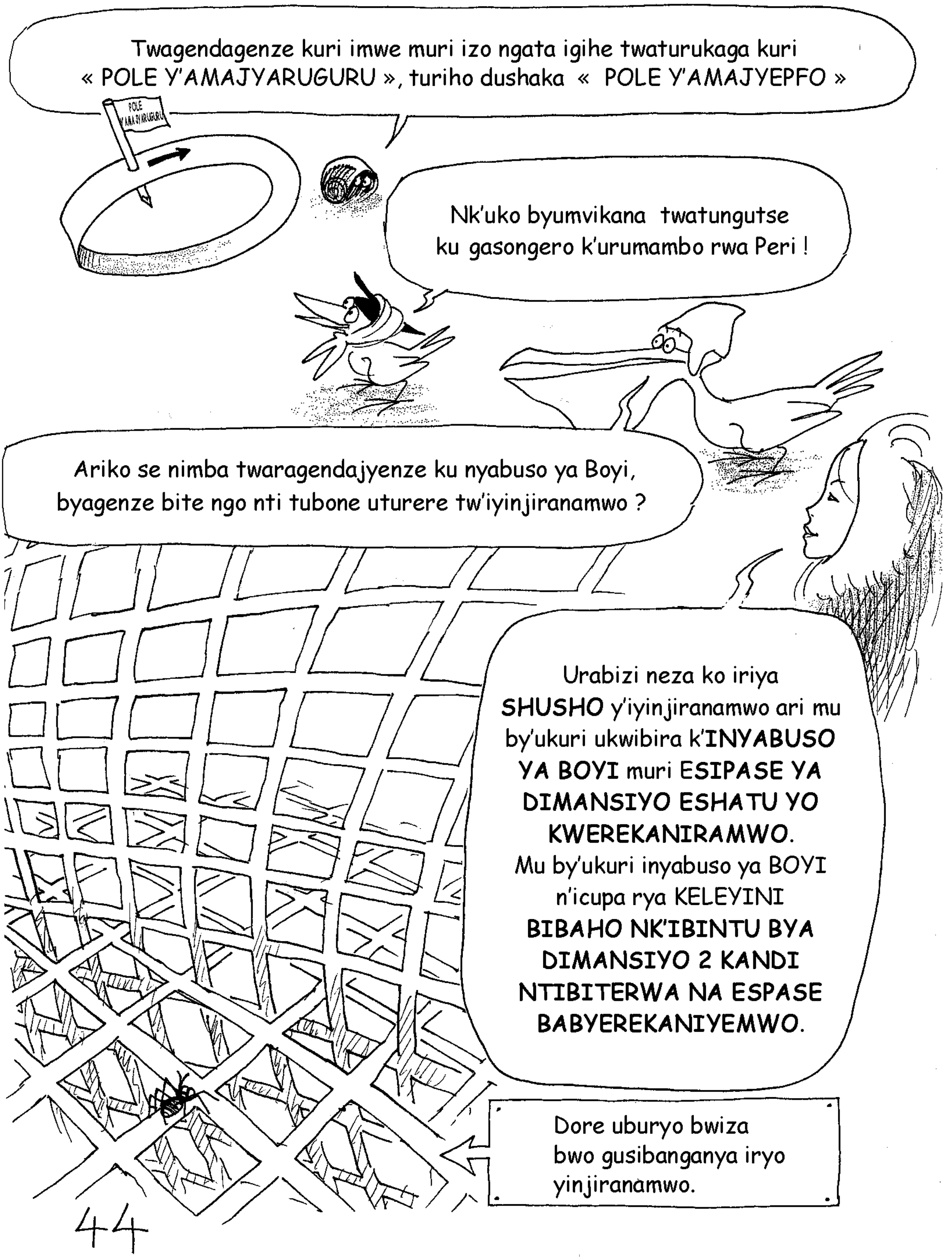
IKIGARAGARA NK'ICURIKWA RY'IGIHE

Urugori rwa Mobiyusi rufite ikimenyimenyi kingana n'ubusa. Nk'akarorero, nshobora kurudoderaho idiskye isanzwe nkurikije umuzingi ufunze, ufite nawo ikimenyimenyi kingana n'ubusa...
χ=1
χ=0
χ=0
Uwo mwenda mushya uzaba ufite ikimenyimenyi kingana na rimwe, kandi waba ari inyabuso ifunze y'inyaruhande rumwe. Ariko se, aho kudoda, kuki tutakoresha ubugeni bwa TARAVERISINE ?
TARAVERISINE
Amateka y'urugori rwa Mobiyusi rwihinduramwo inyabuso ya **BOYI** wabirebera ku nkurikirane z'ibishushanyo **A** na **B**. Reba igishushanyo cya nyuma:
A
. POLE
Ibande yi « inyakwateri »
A
Dore ama « **PARALELE** » y'inyabuso ya **BOYI**. Kandi ni injyanambere y'**UMUSOZO** w'urugori rwa Mobiyusi ruhura n'igice **A**
Paralele zisetsa...

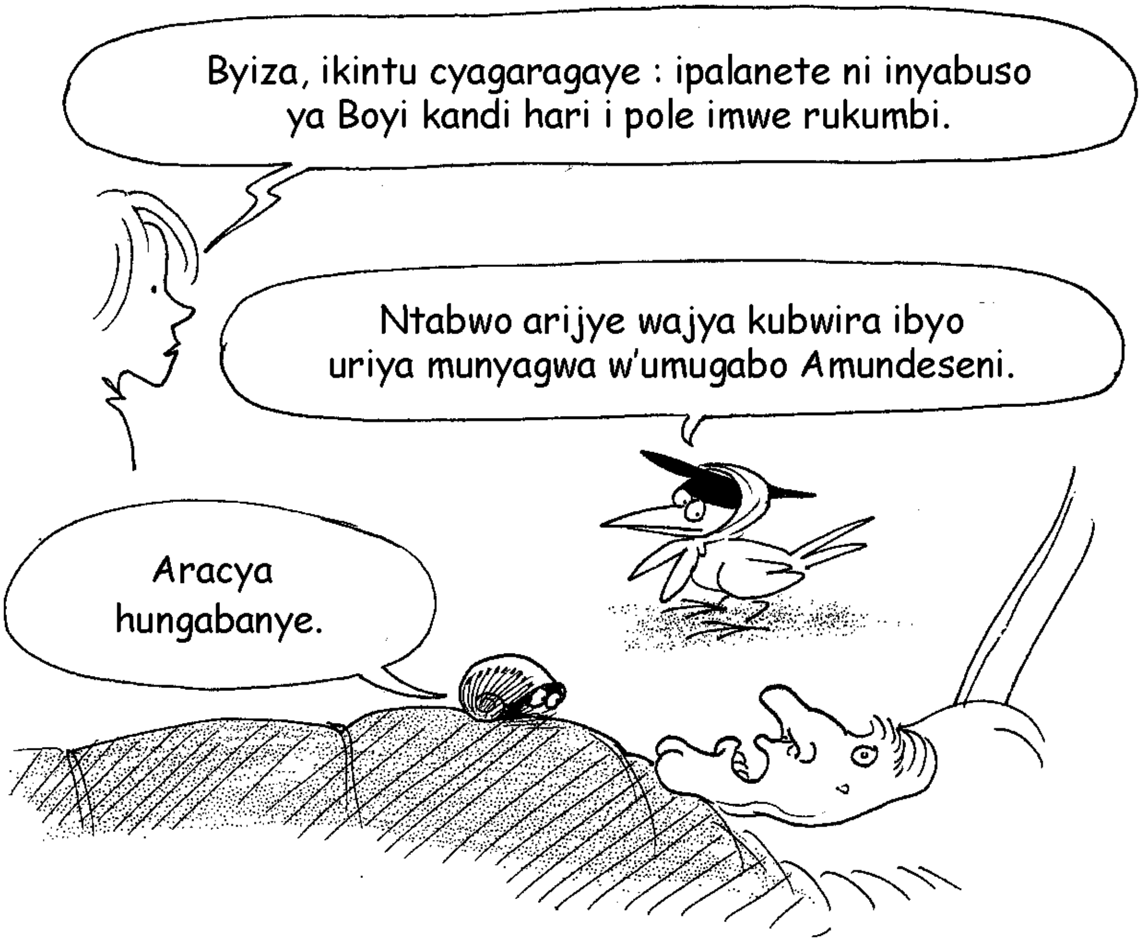


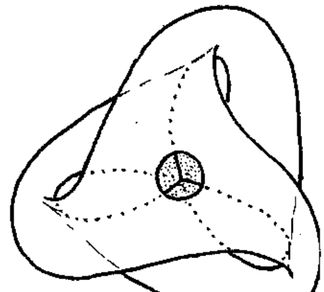
Umudeli wa mbere w'inyabuso ya Boyi hamwe n'igiteranyo « meridiye » + « paraleli », watekerejwe bwa mbere n'umwanditsi w'iki gitabo naho igishushanyo cya byo cyakozwe nyuma yaho n'umutatsi w'umubaji Maksi Soze kandi kiragaragara mu cyumba cy'Ingoro y'Ubuvumbuziy'i Parisi mu Bufaransa.

Ubuyobozi

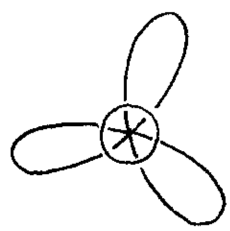


Twagendagenze kuri imwe muri izo ngata igihe twaturukaga kuri « POLE Y'AMAJYARUGURU », turiho dushaka « POLE Y'AMAJYEPFO »
POLE Y'AMAJYARUGURU
Nk'uko byumvikana twatungutse ku gasongero k'urumambo rwa Peri !
Ariko se nimba twaragendajyenze ku nyabuso ya Boyi, byagenze bite ngo nti tubone uturere tw'iyinjiranamwo ?
Urabizi neza ko iriya SHUSHO y'iyinjiranamwo ari mu by'ukuri ukwibira k'INYABUSO YA BOYI muri ESIPASE YA DIMANSIYO ESHATU YO KWEREKANIRAMWO. Mu by'ukuri inyabuso ya BOYI n'icupa rya KELEYINI BIBAHO NK'IBINTU BYA DIMANSIYO 2 KANDI NTIBITERWA NA ESPASE BABYEREKANIYEMWO.
Dore uburyo bwiza bwo gusibanganya iryo yinjiranamwo.

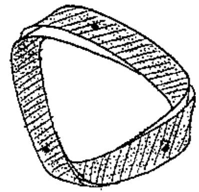


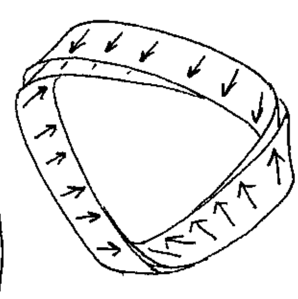


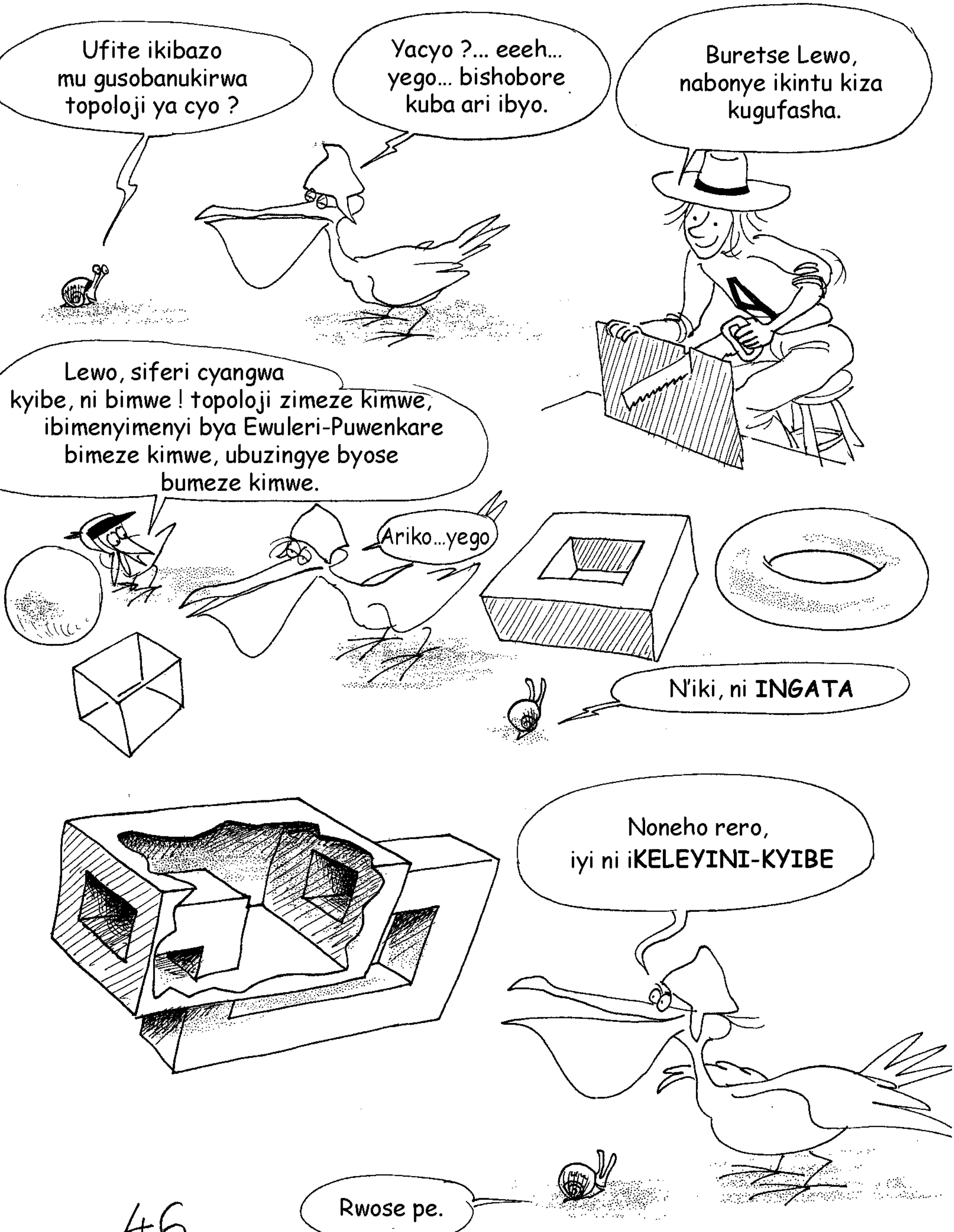
INGATA YA MOBIYUSI Y'UMUSOZO WA SERIKYERE

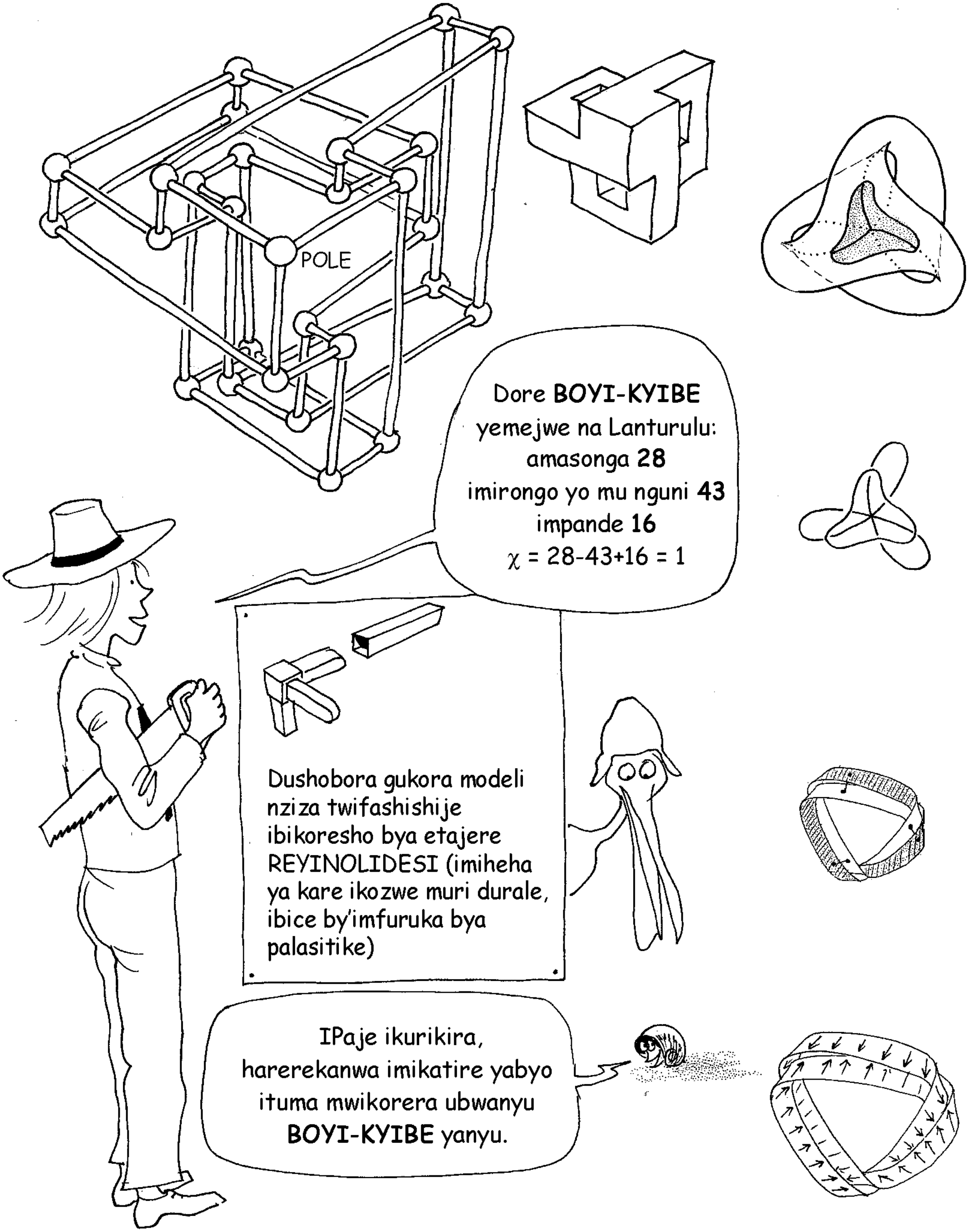


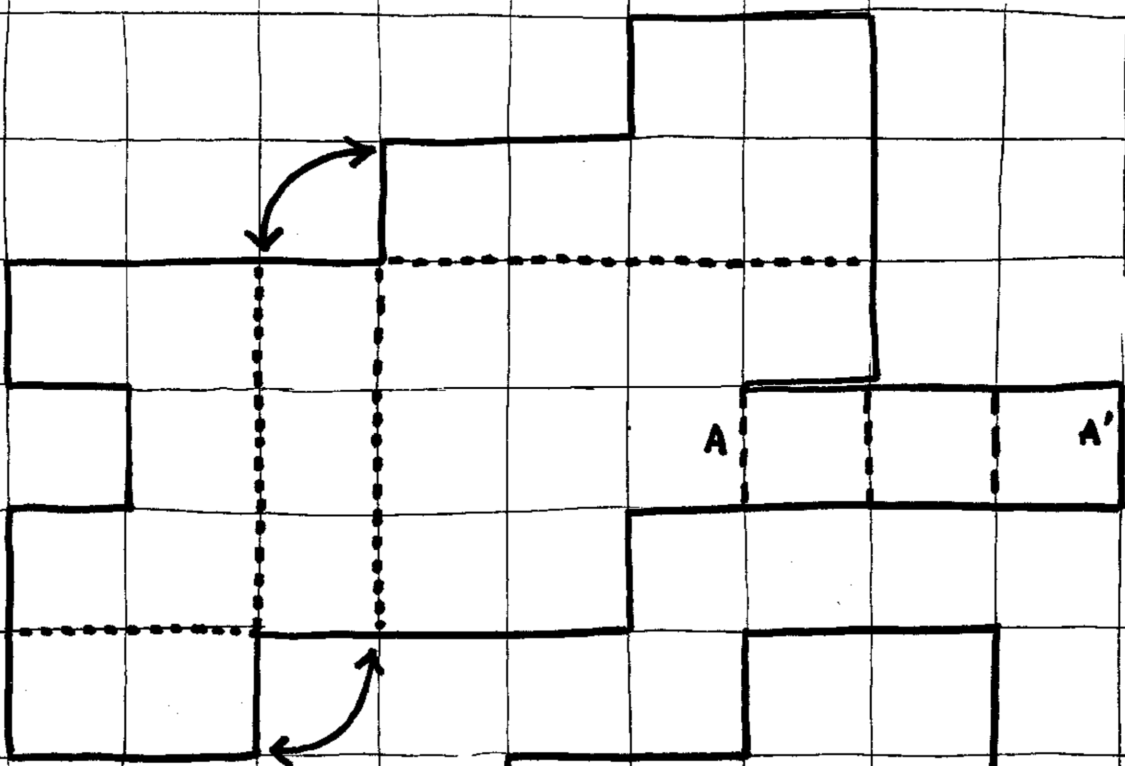
BOYi-KYiBE

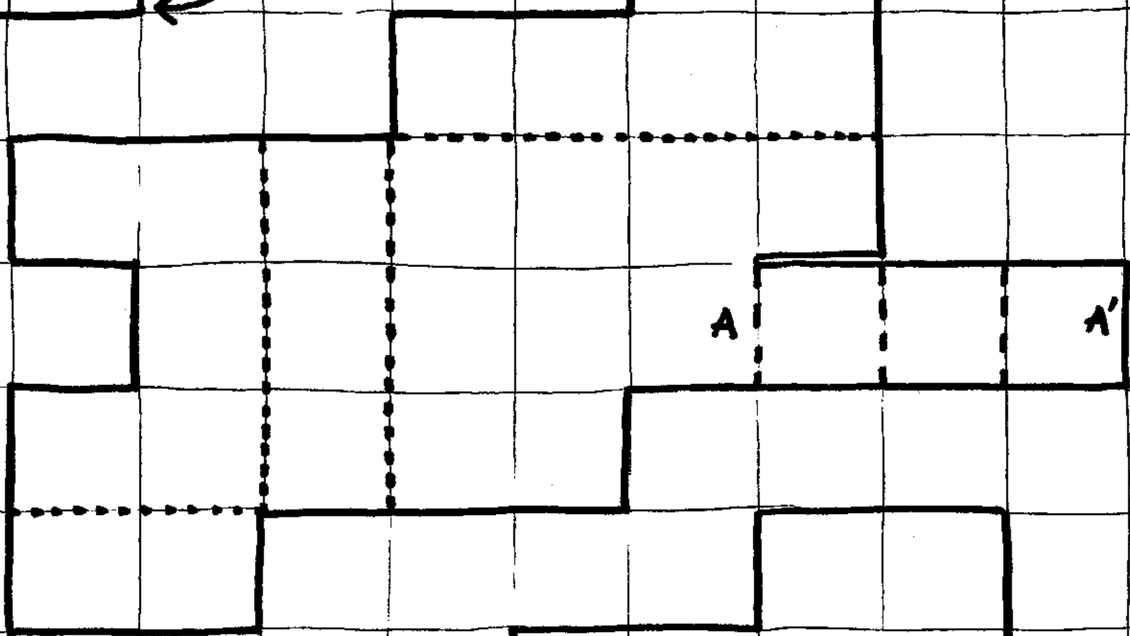


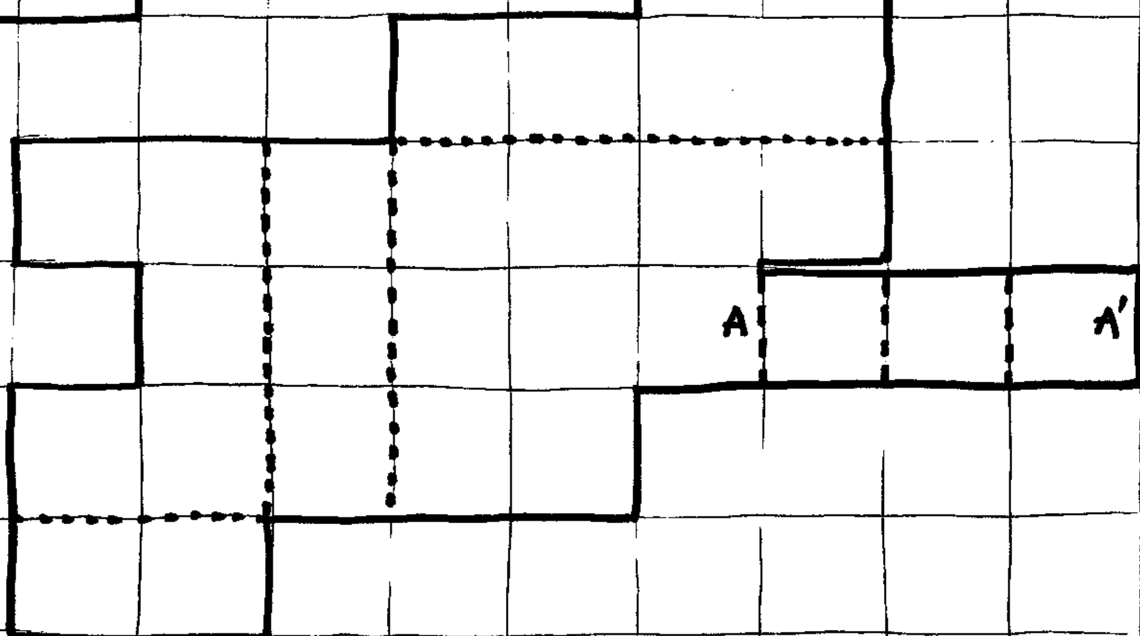


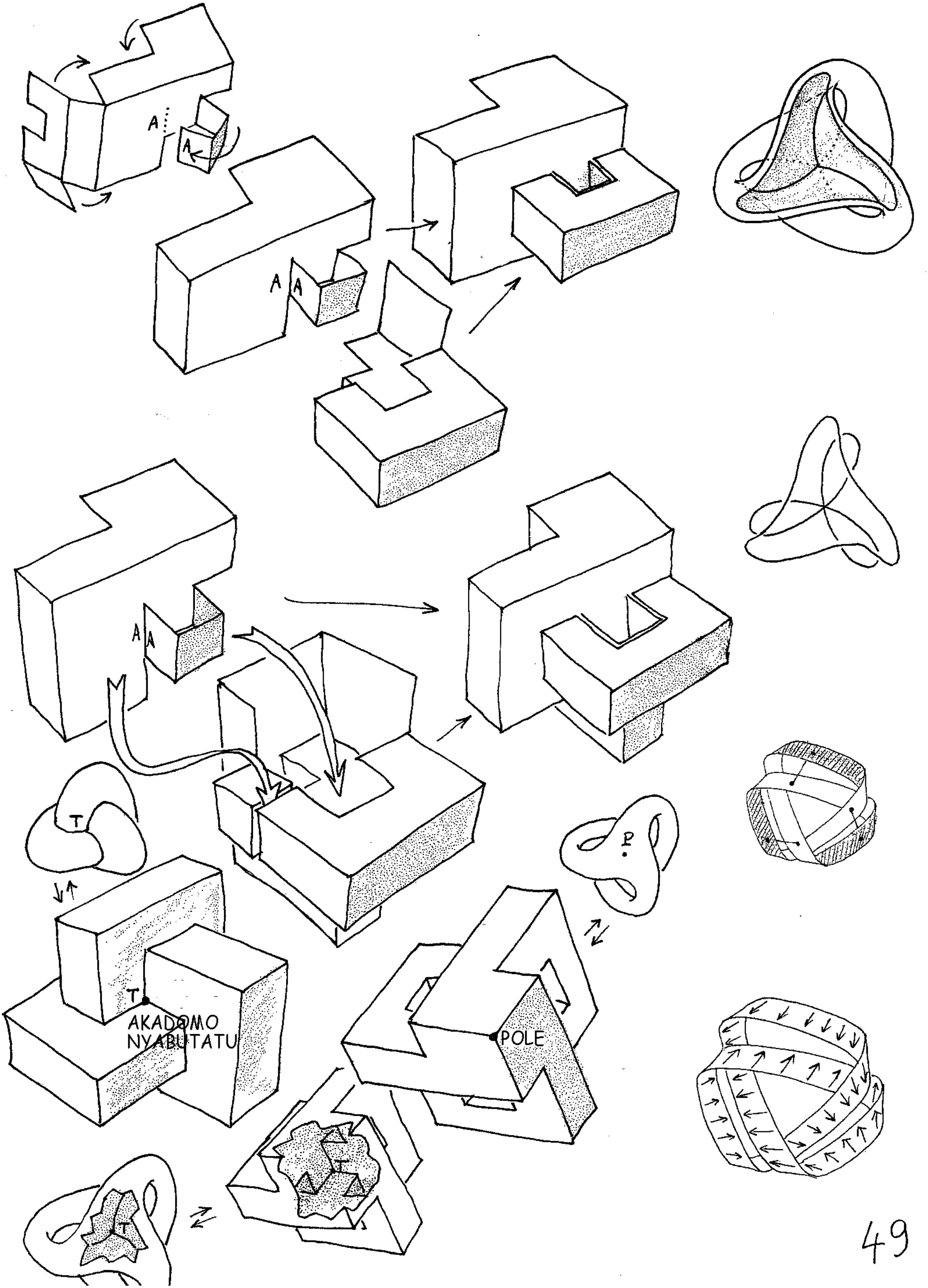

Ufite ikibazo mu gusobanukirwa topoloji ya cyo ?
Yacyo ?... eeeh... yego... bishobore kuba ari ibyo.
Buretse Lewo, nabonye ikintu kiza kugufasha.
Lewo, siferi cyangwa kyibe, ni bimwe ! topoloji zimeze kimwe, ibimenyimenyi bya Ewuleri-Puwenkare bimeze kimwe, ubuzingye byose bumeze kimwe.
Ariko...yego
N'iki, ni INGATA
Noneho rero, iyi ni iKELEYINI-KYIBE
Rwose pe.


POLE
Dore **BOYI-KYIBE** yemejwe na Lanturulu: amasonga **28** imirongo yo mu nguni **43** impande **16** χ = 28-43+16 = 1
Dushobora gukora modeli nziza twifashishije ibikoresho bya etajere REYINOLIDESI (imiheha ya kare ikozwe muri durale, ibice by'imfuruka bya palasitike)
IPaje ikurikira, harerekanwa imikatire yabyo ituma mwikorera ubwanyu **BOYI-KYIBE** yanyu.


A
A'


A
A'


A
A'


A
A
A
A
A
A
T
T
AKADOMO
NYABUTATU
POLE
P
T

GUFUNiKA

Noneho rero, niwo musozo w'inkuru ?
Oya, hari igaruka ryabyo ritunguranye...
Urwambiko rw'inyuma n'imbere rw'ikintu cy'uruhande rumwe, KITAGANISHWA, bitanga IKINTU KIMPANDE EBYIRI, KIGANISHWA kandi gifite ikimenyimenyi cyikubye bibiri.
Ese ibyo bikuru ni bwoko ki ?

Biroroshye, fata urugori rwa Mobiyusi, urusige irangi ku ruhande rwarwo RUMWE RUKUMBI, nurangiza usokororemwo urwo rugori

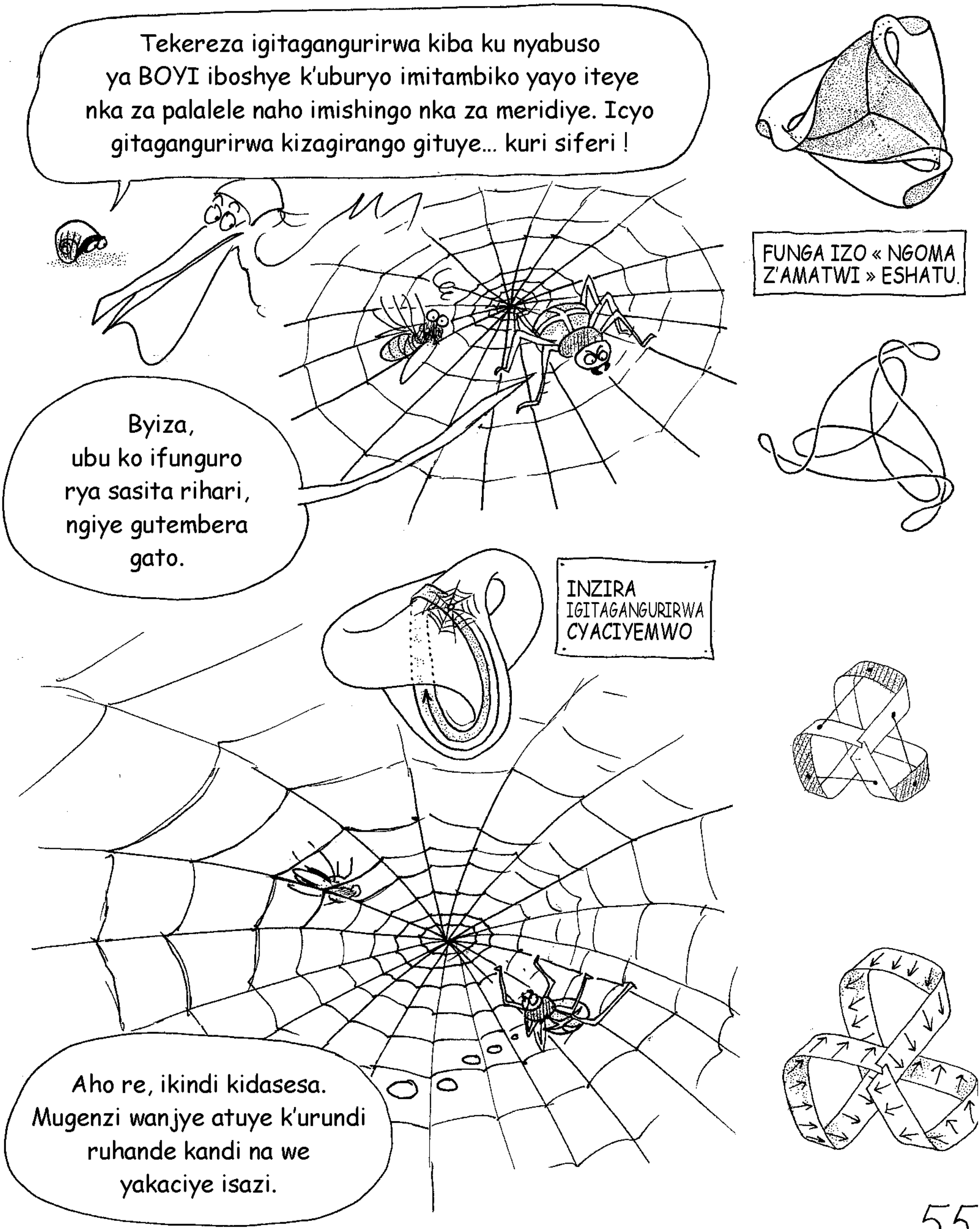
... k'uburyo usa n'usigarana irangi gusa !

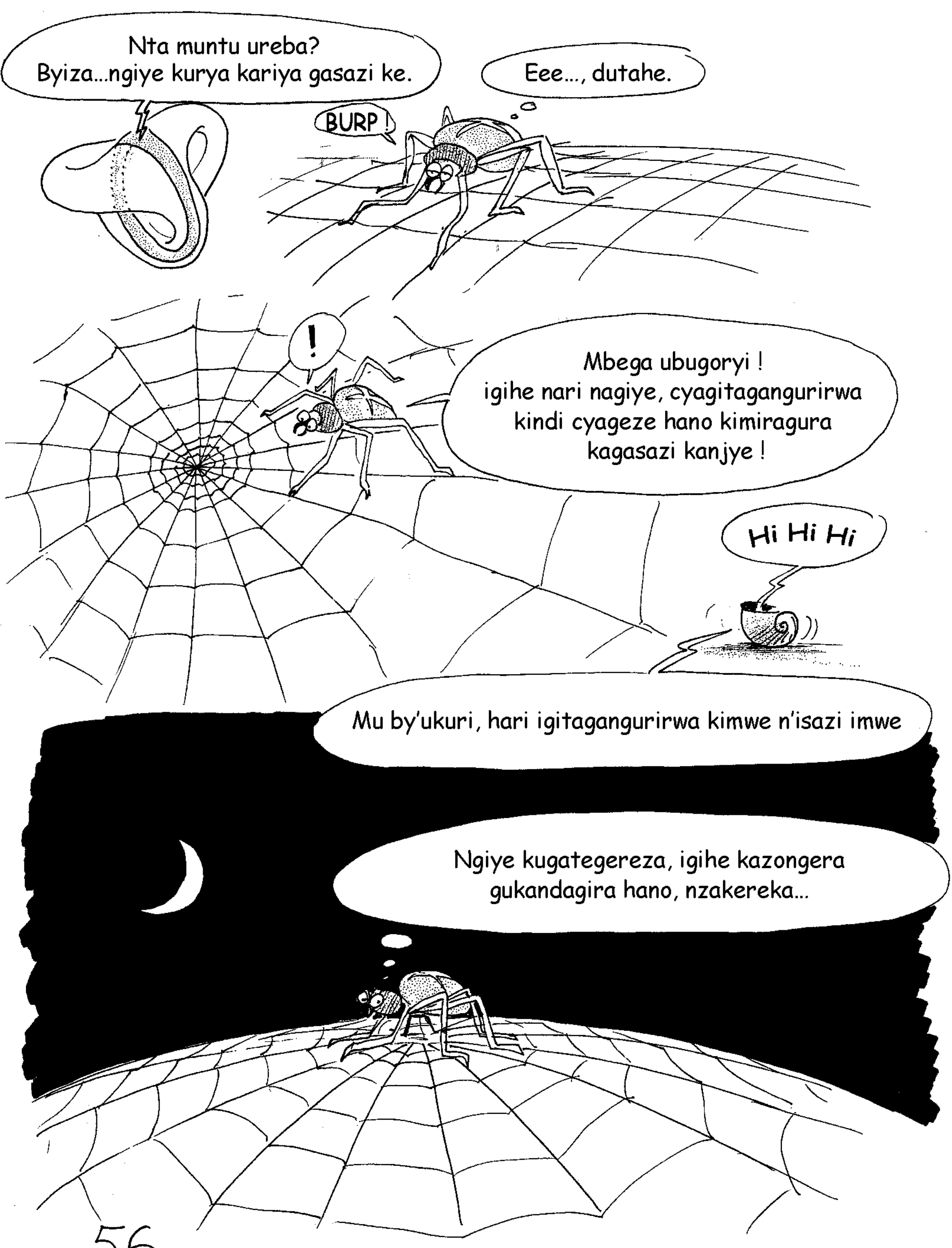
Iyo bande nshyashya, yifungiye ubwayo kuri yo, ifite impande ebyiri, kuko rumwe rwahuraga n'urugori rwa Mobiyasi. Ubundi kandi ushobora kwitegereza neza igice cy'amashusho **C** :
igice cy'umurongo
igice cy'umurongo
igice cy'umurongo
Ikimenyimenyi cya cyo n'icyurugori rwa Mobiyasi byose binga n'ubusa.
Buretse ndebe...iyo nsize irangi... i **CUPA RYA KELEYINI** k'**URUHANDE RWARYO RUMWE** narangiza ngasokororamwo iryo cupa ariko ndahungabanije iryo rangi, mbona ikinyabuso **GIFUNZE, GITUNGANYE NEZA**, cy'**IMPANDE EBYIRI** kandi gifite ikimenyimenyi cya Ewuleri-Puwenkare kingana na **2 x 0** = zero.
Ni ukuvuga ikihingukemwo cy'ingata

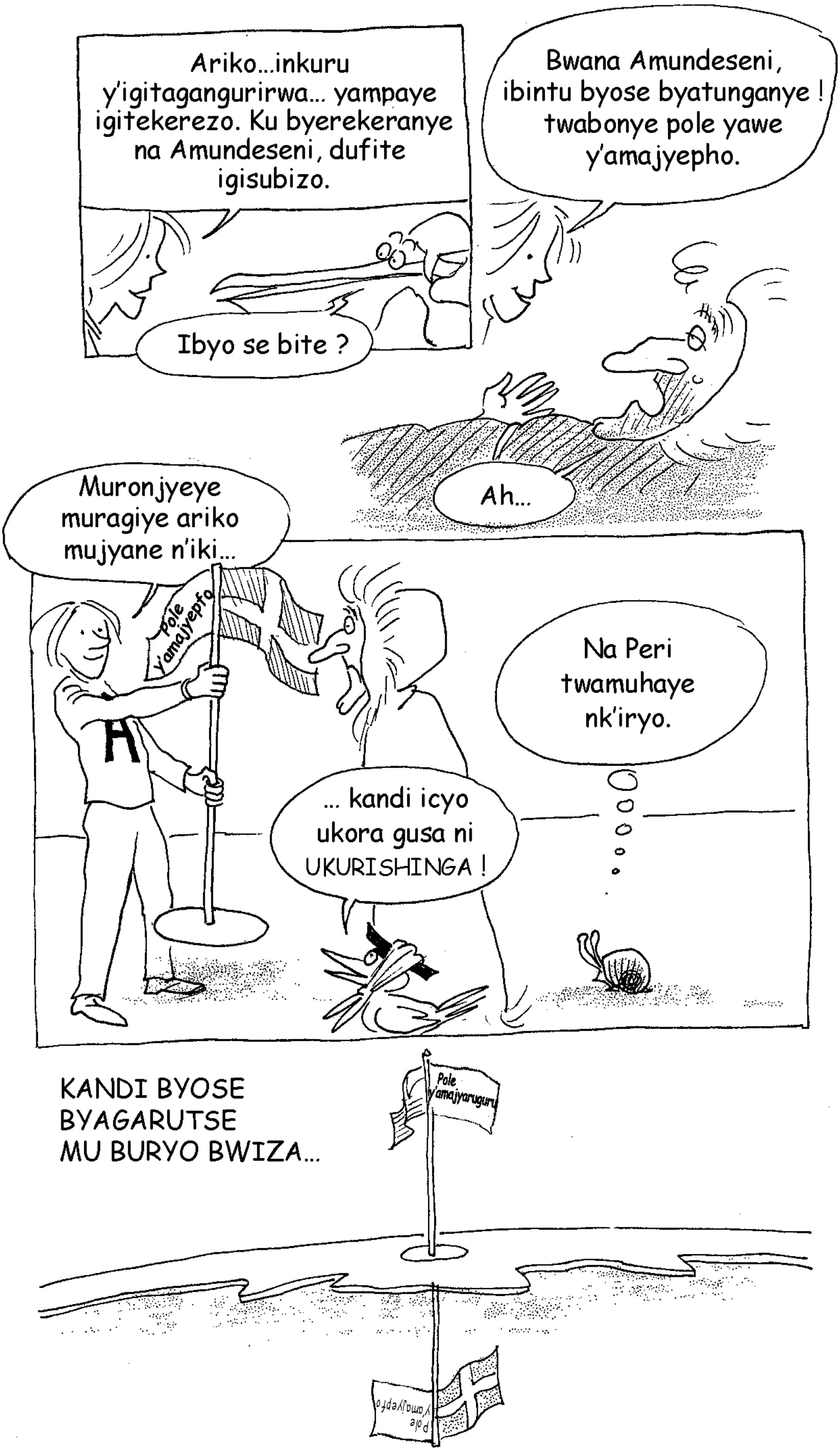
Tireziyasi, urihe ?
Hano !
Nkomeje ntyo, ngafata inyabuso ya Boyi, nkayisiga irangi hanyuma ngasokororamwo iyo BOYI kuburyo iryo rangi rigumana iforoma yaryo nk'uko ryasizwe, nasigarana inyabuso IFUNZE, ITUNGANYE NEZA, Y'IMPANDE 2 kandi ifite ikimenyimenyi cya Ewuleri-Puwenkare kingana na 2 x 1 = 2...
...ni ukuvuga IKIHINGUKEMWO CYA SIFERI

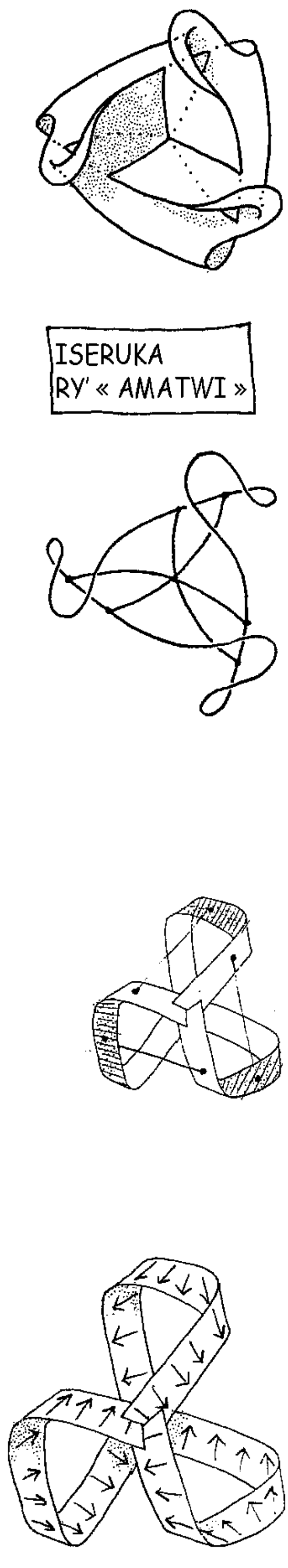
Ese, MU BY'UKURI, nshobora « kwigizayo » iyi nyarwa ya siferi nkanayihinduramwo siferi « isanzwe » ?
Ukoresheje UBUJENI BWA TARAVERISINE, nta kibazo kandi bikorwa kimwe kubijyanye n'INGATA.
Dukore duhereye inyuma. Reka dufateko nshaka « guhinduranya » i siferi utayizinze !
INYURANAMWO RY'IMIYOBORO RYARANGIYE.
RETERESISOLE
Ni ukugomba gukoresha RETERESISOLE

Dutangire duhuza buri kadomo ka siferi na ANTIPODE YAYO dukoresheje imigozi yanyujijwe muri RETERESISOLE.
Iyo migozi iriyegeranya kuburyo uburebure byayo buba ubusa, ariko kandi ubuso bya siferi buguma ari bumwe, budahinduka. Bityo tuzana buri kadomo mw'IHWANIRO na NDWANYAPODALE ya ko.
Ariko ibyo muzabibona mu yindi alubomu, yajyenewe IHINDURANYA RYA SIFERI. Hagati aho, ikurikirana ry'amashusho ya filime C yerekana uko EKWATERI ya SIFERI yikunja, igahinduka EKWATERI ya BOYI. Ku bigaragara, pole y'amajyaruguru iraza ikiyomeka kuri pole y'amajyepfo.
Ubuyobozi
Meridiye na paralele zose za siferi ziraza zimwe zikorosa izindi.

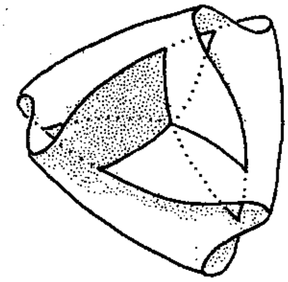

Tekereza igitagangurirwa kiba ku nyabuso ya BOYI iboshye k'uburyo imitambiko yayo iteye nka za palalele naho imishingo nka za meridiye. Icyo gitagangurirwa kizagirango gituye... kuri siferi !
FUNGA IZO « NGOMA Z'AMATWI » ESHATU.
Byiza, ubu ko ifunguro rya sasita rihari, ngiye gutembera gato.
INZIRA IGITAGANGURIRWA CYACIYEMWO
Aho re, ikindi kidasesa. Mugenzi wanjye atuye k'urundi ruhande kandi na we yakaciye isazi.

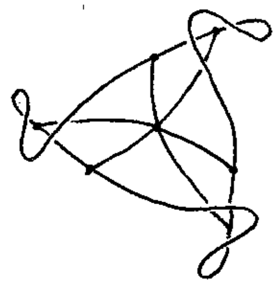

Nta muntu ureba?
Byiza...ngiye kurya kariya gasazi ke.
Eee..., dutahe.
BURP !
!
Mbega ubugoryi !
igihe nari nagiye, cyagitagangurirwa
kindi cyageze hano kimiragura
kagasazi kanjye !
Hi Hi Hi
Mu by'ukuri, hari igitagangurirwa kimwe n'isazi imwe
Ngiye kugategereza, igihe kazongera
gukandagira hano, nzakereka...


Ariko...inkuru y'igitagangurirwa... yampaye igitekerezo. Ku byerekeranye na Amundeseni, dufite igisubizo.
Ibyo se bite ?
Bwana Amundeseni, ibintu byose byatunganye ! twabonye pole yawe y'amajyepho.
Ah...
Muronjyeye muragiye ariko mujyane n'iki...
Pole y'amajyepfo
Na Peri twamuhaye nk'iryo.
... kandi icyo ukora gusa ni UKURISHINGA !
KANDI BYOSE BYAGARUTSE MU BURYO BWIZA...
Pole y'amajyaruguru

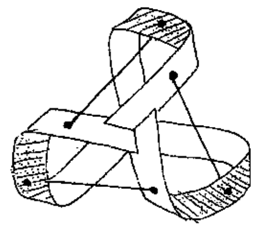

ISERUKA RY' « AMATWI »

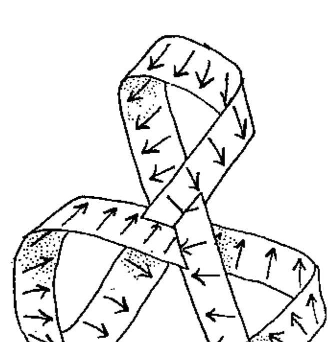
Mbega umunsi mwiza !
Ibi byari biyabavugishije.
Bwana Amundeseni, ifoto y'amateka.
Ni mumvire aho mugende, ndashaka kuba jyenyine kuri iyi foto y'amateka.
POLE Y'AMAJYEPFO
Muri siyanse, ni nk'ahandi hose. Rimwe na rimwe, biba byiza kudacukumbura cyane...
... buri pole, mu mwanya wa yo ; icyo gihe n'inka zizaragirwa neza...
Kandi noneho, iyo ducukura, munsi ya pole y'amajyaruguru, yenda twari kuzagera ku bintu bitunguranye.
Kandi hari kuboneka abo bibabaza, igendere.



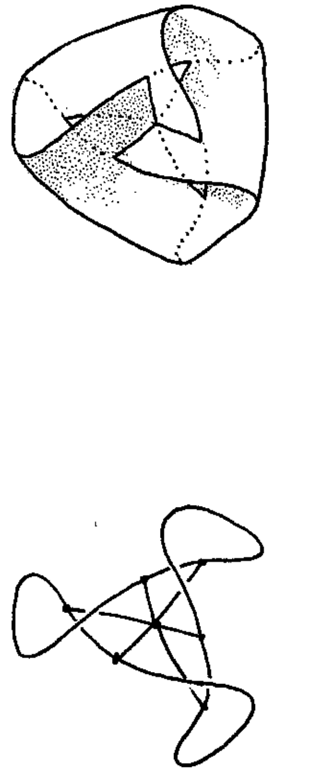


I STADE Y'INDORERWAMU

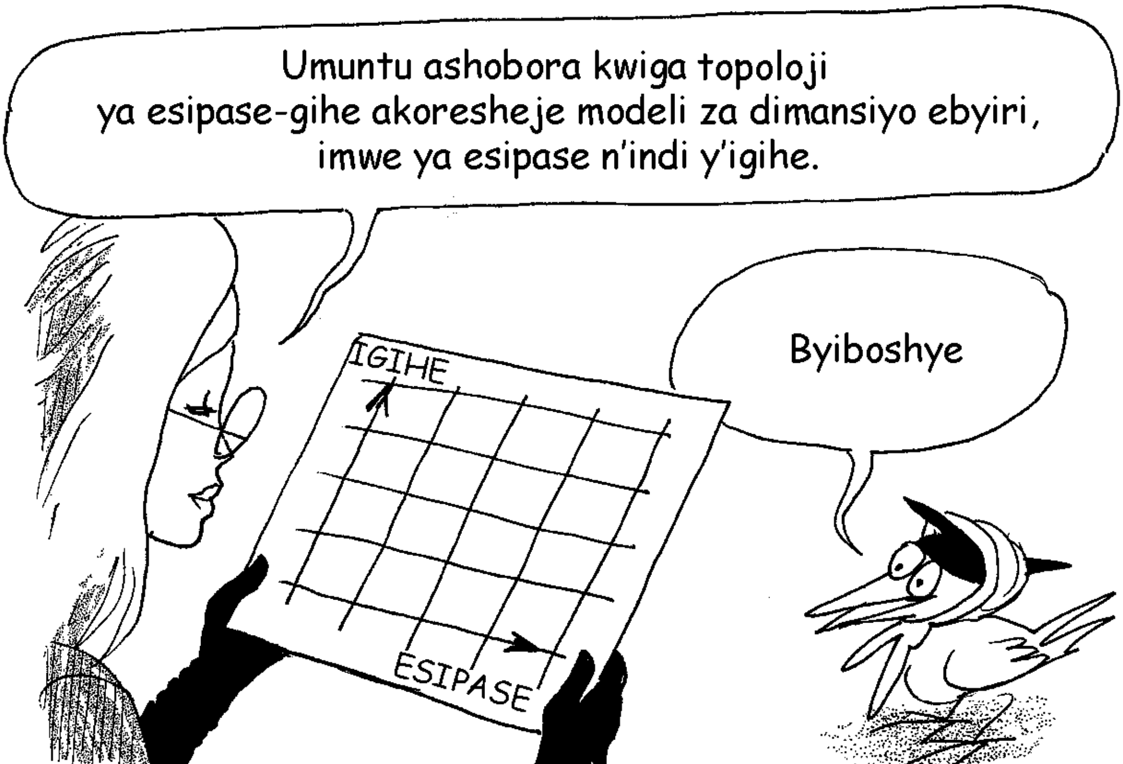




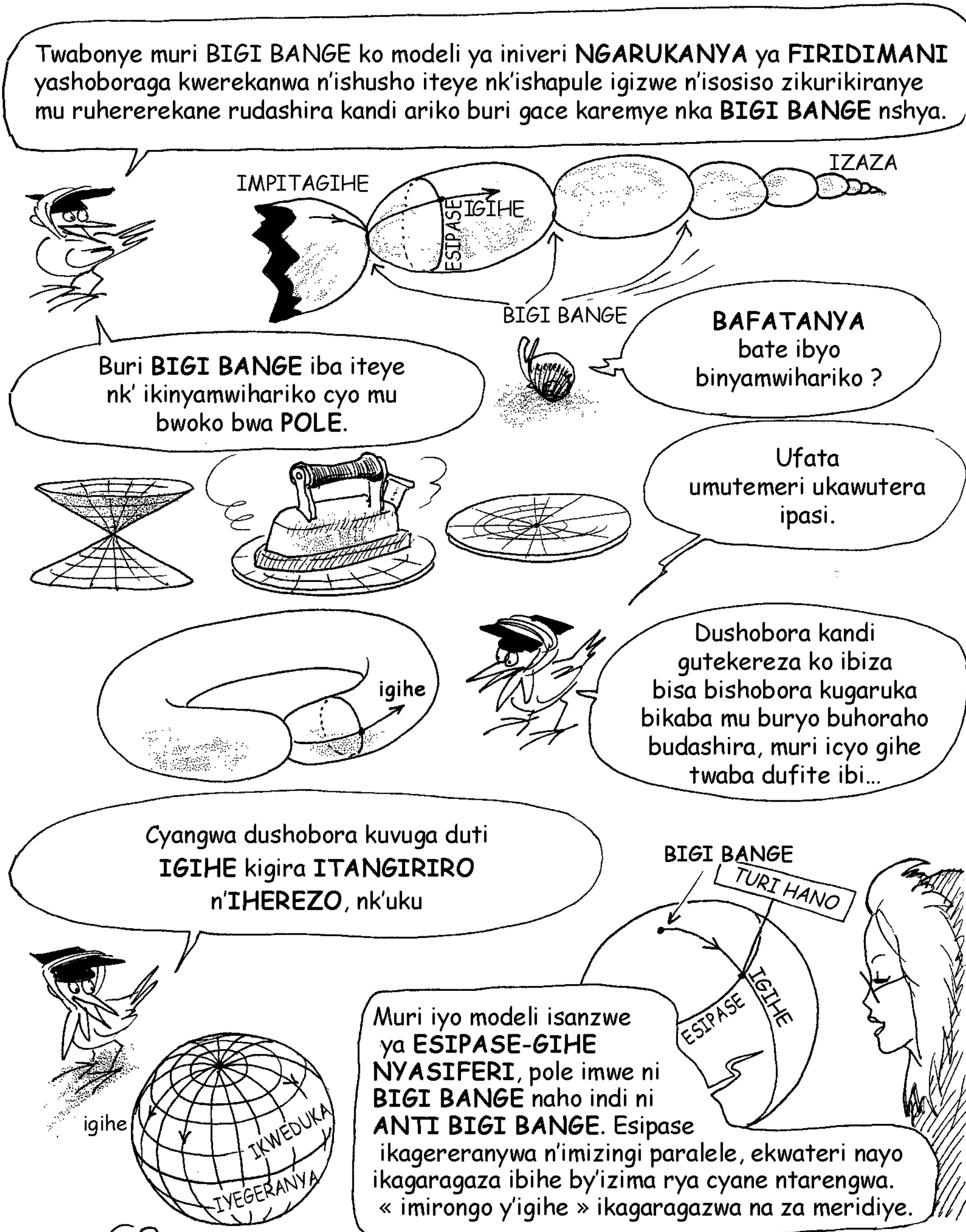
(*) MUSHOBORA KANDI GUKORA INDORERWAMU NK'IZO MU MACUPA YA KELEYINI ASHAJE MUTORAGUYE HIRYA NO HINO.



ESiPASE-GiHE YASAZE



(*) IGERAGEZWA NTIRYIGEZE RIKORWA


Twabonye muri BIGI BANGE ko modeli ya iniveri NGARUKANYA ya FIRIDIMANI yashoboraga kwerekanwa n'ishusho iteye nk'ishapule igizwe n'isosiso zikurikiranye mu ruhererekane rudashira kandi ariko buri gace karemye nka BIGI BANGE nshya.
IMPITAGIHE
ESIPASE
IGIHE
IZAZA
BIGI BANGE
Buri BIGI BANGE iba iteye nk' ikinyamwihariko cyo mu bwoko bwa POLE.
BAFATANYA bate ibyo binyamwihariko ?
Ufata umutemeri ukawutera ipasi.
igihe
Dushobora kandi gutekereza ko ibiza bisa bishobora kugaruka bikaba mu buryo buhoraho budashira, muri icyo gihe twaba dufite ibi...
Cyangwa dushobora kuvuga duti IGIHE kigira ITANGIRIRO n'IHEREZO, nk'uku
BIGI BANGE
TURI HANO
ESIPASE
IGIHE
igihe
IKWEDUKA
IYEGERANYA
Muri iyo modeli isanzwe ya ESIPASE-GIHE NYASIFERI, pole imwe ni BIGI BANGE naho indi ni ANTI BIGI BANGE. Esipase ikagereranywa n'imizingi paralele, ekwateri nayo ikagaragaza ibihe by'izima rya cyane ntarengwa. « imirongo y'igihe » ikagaragazwa na za meridiye.

Kugirango umuntu ananare izo meridiye z'igihe, iyo **MILONGO YA INIVERI**, ntacyaruta **IKORONOGARAFE** nziza.
IKORWA RY'AKADOMO NYABUTATU
Dushobora kujyana n'imwe muri ziriya mashine. Ibyo ntibyambabaza byo kujya kureba iyo esipase-gihe.
Ese Lewo na Tireziase bagiye he?
Hamwe na Tireziyasi, twakoze agatendo gahebuje !
Twafashe utudomo twose tw'iyi esipase-gihe tuduhuza na **ndwanyapodale** dukoresheje imigozi...

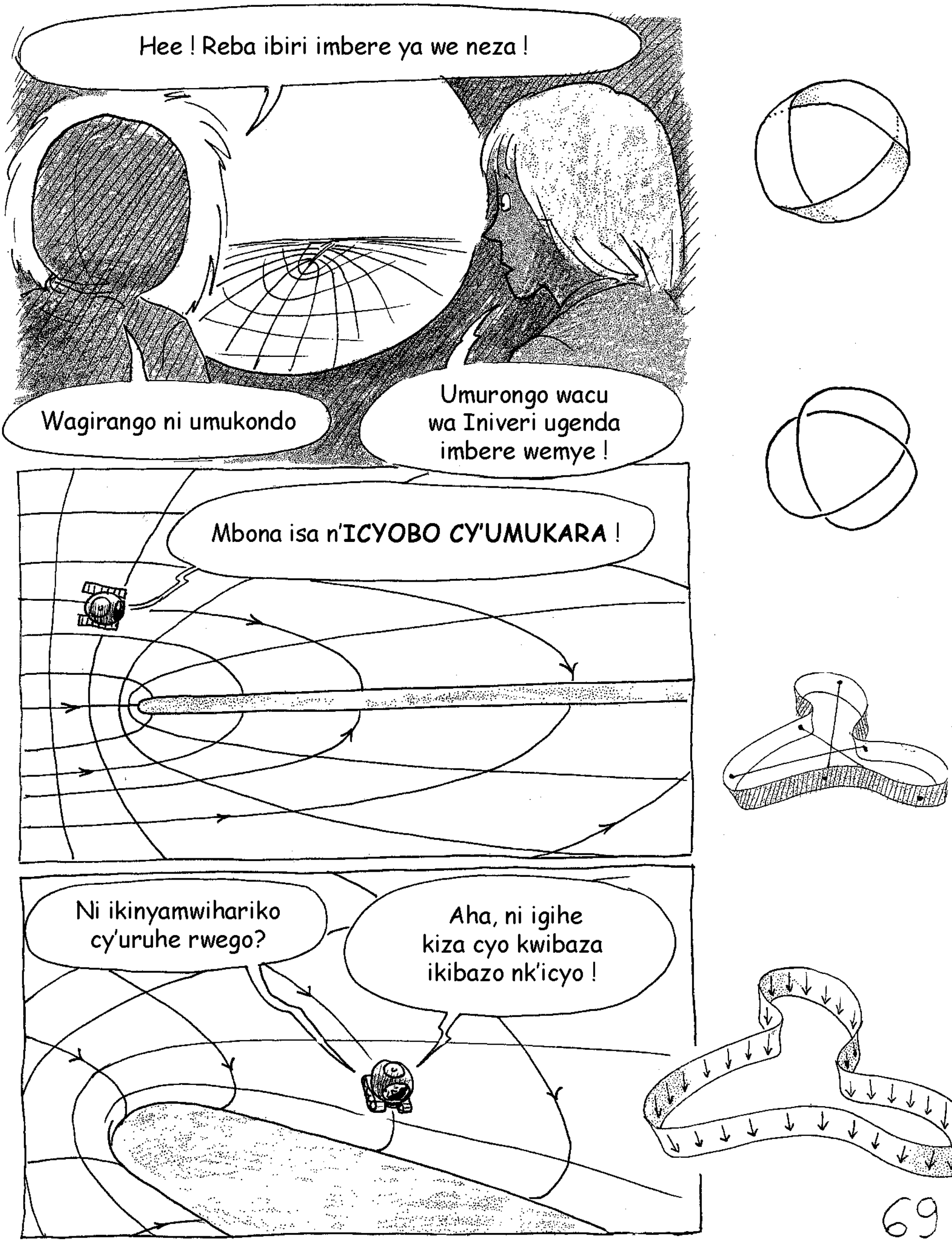
(*) byakozwe na HOYILE na SAKAROVE

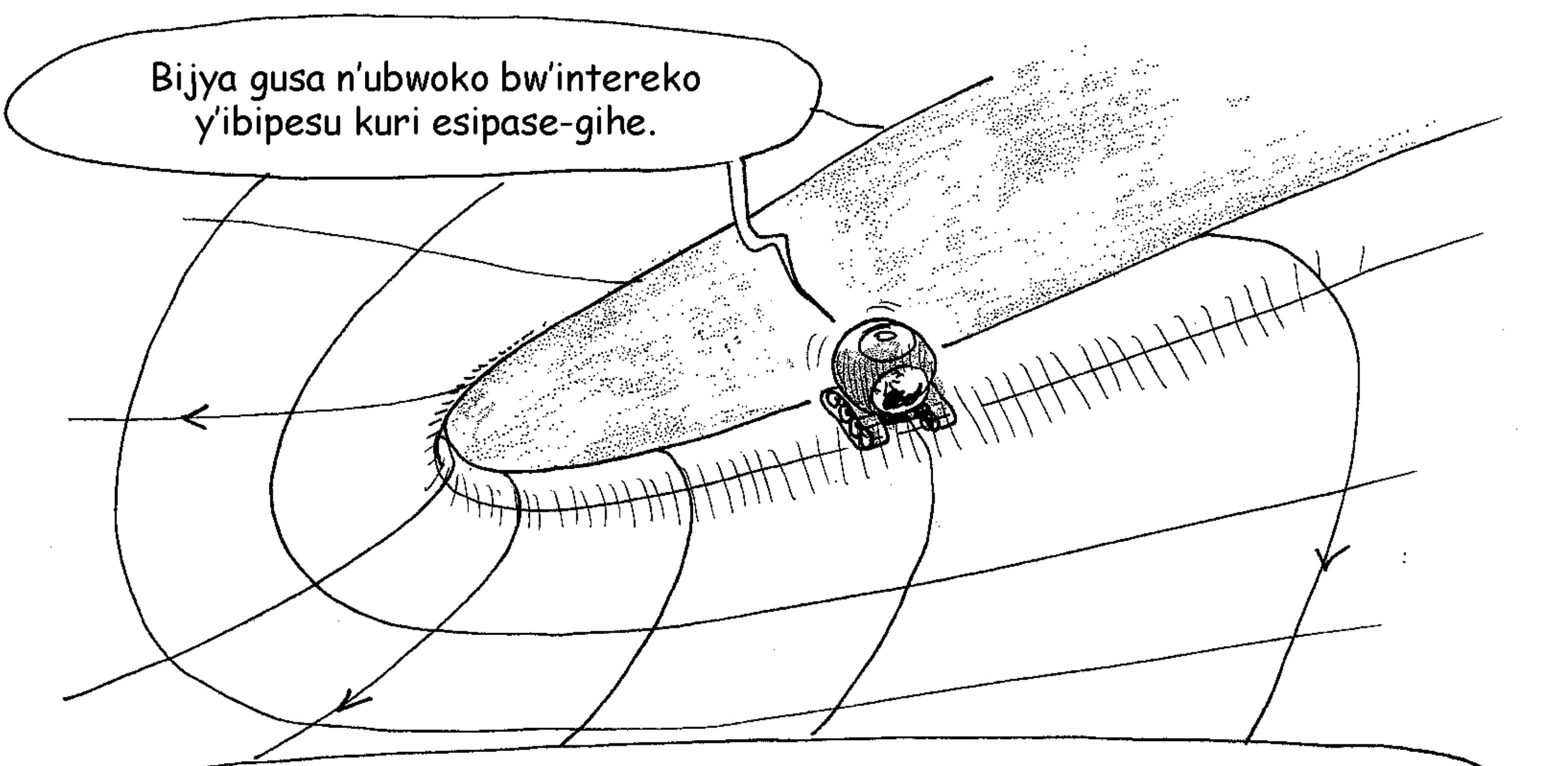
Ariko iyo fenomene y'ihwaniro izakora kuburyo intara za esipase-gihe, ziteganye na ndwanyapode za zo zizisanga mw'IHANGANA MU BIHE n'izo ndwanyapode.
Ntibishoboka !
Habe na gato ! urugero, fata intara iri mu nkyengero za eqwateri y'iyi esipase-gihe nyasiferi ihwanye n'ibihe by'irambuka ntarengwa. Muyibona neza cyane yiyegyeranya kuri yo yonyine muri filime D
IMYAMBI Y'IGIHE yishyira mw'IHANGANA.
Urashaka kuvuga ko icyari kuba IMPITAGIHE kuri bamwe cyakwitwa IBIHE BIZAZA ku BARI KU NDWANYAPODALE za bo ?
GULP...

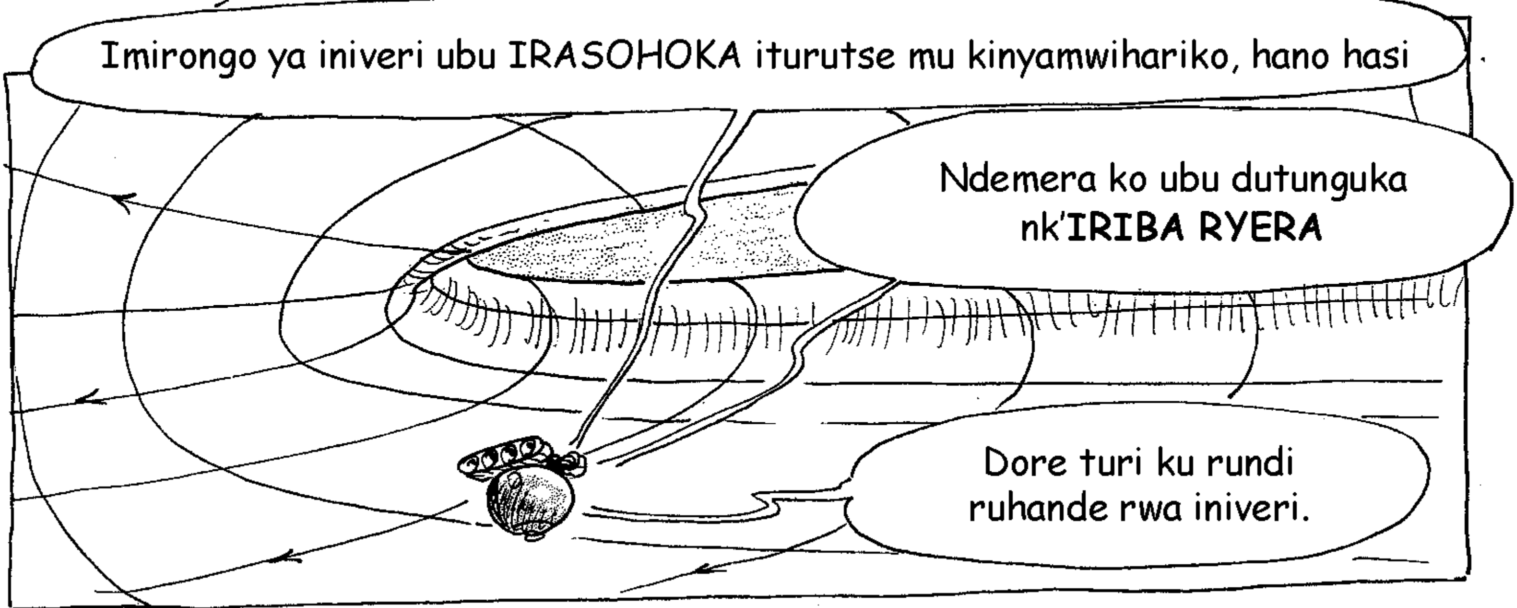
Nshuti yanjye Lewo, mwakoze akazi keza
Murashaka kuvuga yuko ibi bishobora gushyira iniveri mu kwivuguruza ndashyigikirwa ?
Ubwoko bw'amayobera nyakuri
Igihe UBUGENI BWA RETERESISOLE buzaba bwa koze, Iniveri izashobora kwireba iturutse kure inyuma ya yo kandi tuzabona igihe gisubira inyuma n'ingoga.
Mu bigaragara, Tireziyasi yaciye he ?
Reka twizamukire muri koronosikafe. Dushobora kugerageza tukamuhamagara.
Itangazo ryo gushakashaka ?
A

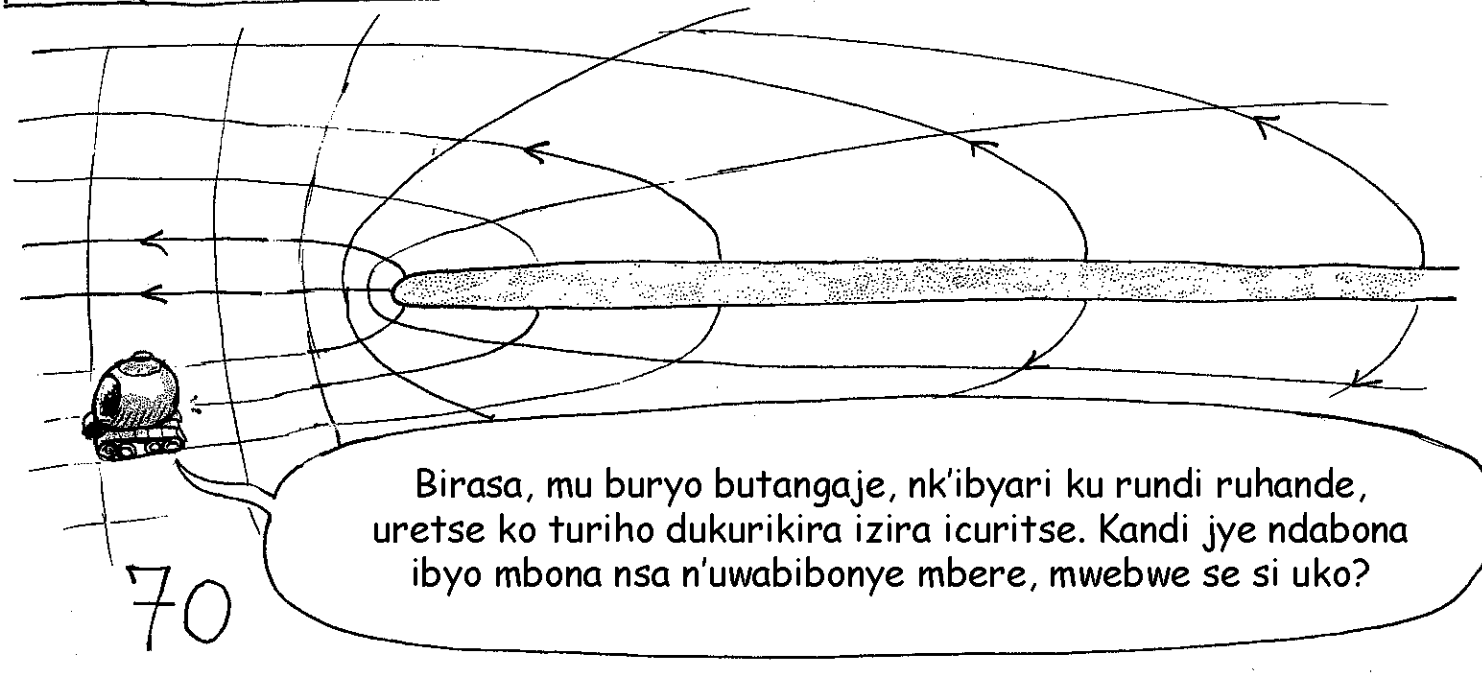
(*) Reba **BIGI BANGE** (Icapiro BELINE)

Tireziyasi! Wari waragiye he ?
KOLONKE !
Nari naragiye kunanura amaguru.
Hee, KORONOSIKAFE ! Yatangiye kugenda...
Iyo mutaba mwakubise urugi cyane nk'uko, nk'uko !
Gihagarara gite, iki kintu ?
Urabizi neza ko kidahagarara !
None se iyoborwa ite ?
Wowe n'ibitekerezo bya we !!
Aha !
Ntawuyobora KORONOSIKAFE. Ni yo ibayobora. Kandi ikurikira UMURONGO WA INIVERI, ni ibyo, nta kindi...


Hee ! Reba ibiri imbere ya we neza !
Wagirango ni umukondo
Umurongo wacu wa Iniveri ugenda imbere wemye !
Mbona isa n'ICYOBO CY'UMUKARA !
Ni ikinyamwihariko cy'uruhe rwego?
Aha, ni igihe kiza cyo kwibaza ikibazo nk'icyo !


Bijya gusa n'ubwoko bw'intereko y'ibipesu kuri esipase-gihe.


Imirongo ya iniveri ubu IRASOHOKA iturutse mu kinyamwihariko, hano hasi
Ndemera ko ubu dutunguka nk'IRIBA RYERA
Dore turi ku rundi ruhande rwa iniveri.


Birasa, mu buryo butangaje, nk'ibyari ku rundi ruhande, uretse ko turiho dukurikira izira icuritse. Kandi jye ndabona ibyo mbona nsa n'uwabibonye mbere, mwebwe se si uko?

(*) IMITERERE IMWE ISHOBORA KUBAHO MURI DIMANSIYO YA 4.

UMWiHARiKO W'UBUMENYi

BOYI, umunyeshuri wa Hiberi,. yavumbuye iyo nyabuso imwitirirwa mu 1902. Iyerekanwa ryizwe neza rya mbere rya yo ryakozwe mu 1981 na Jerome SURIYO (umuhungu w'umuhanga mu mibare J.M. SURIYO) afatanije n'uyu mwanditsi. Uburyo bakoresheje ni ubwa gikorikori butiranya meridiye y'iyo nyabuso na za elibuse zihita zipimwa. Akadomo kajyendajyenda gatangwa na :

$$\begin{cases} x = X_1 \cos\mu - Z_1 \sin\alpha \sin\mu \\ y = X_1 \sin\mu + Z_1 \sin\alpha \cos\mu \\ z = Z_1 \cos\alpha \end{cases}$$

Ukoresheje :

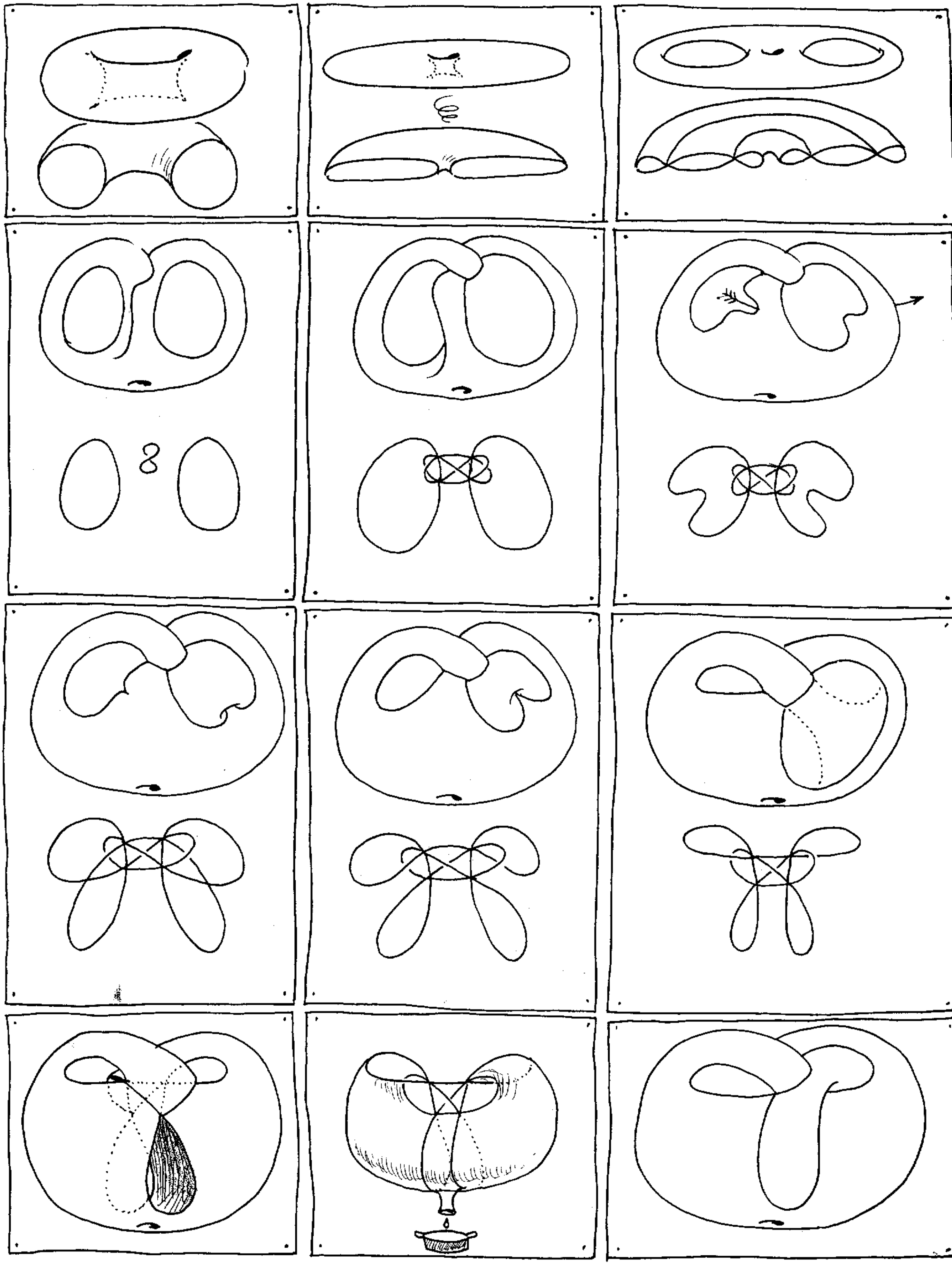
$$\begin{cases} X_1 = \dfrac{A^2 - B^2}{\sqrt{A^2+B^2}} + A\cos\theta - B\sin\theta \\ Z_1 = \sqrt{A^2+B^2} + A\cos\theta + B\sin\theta \end{cases}$$

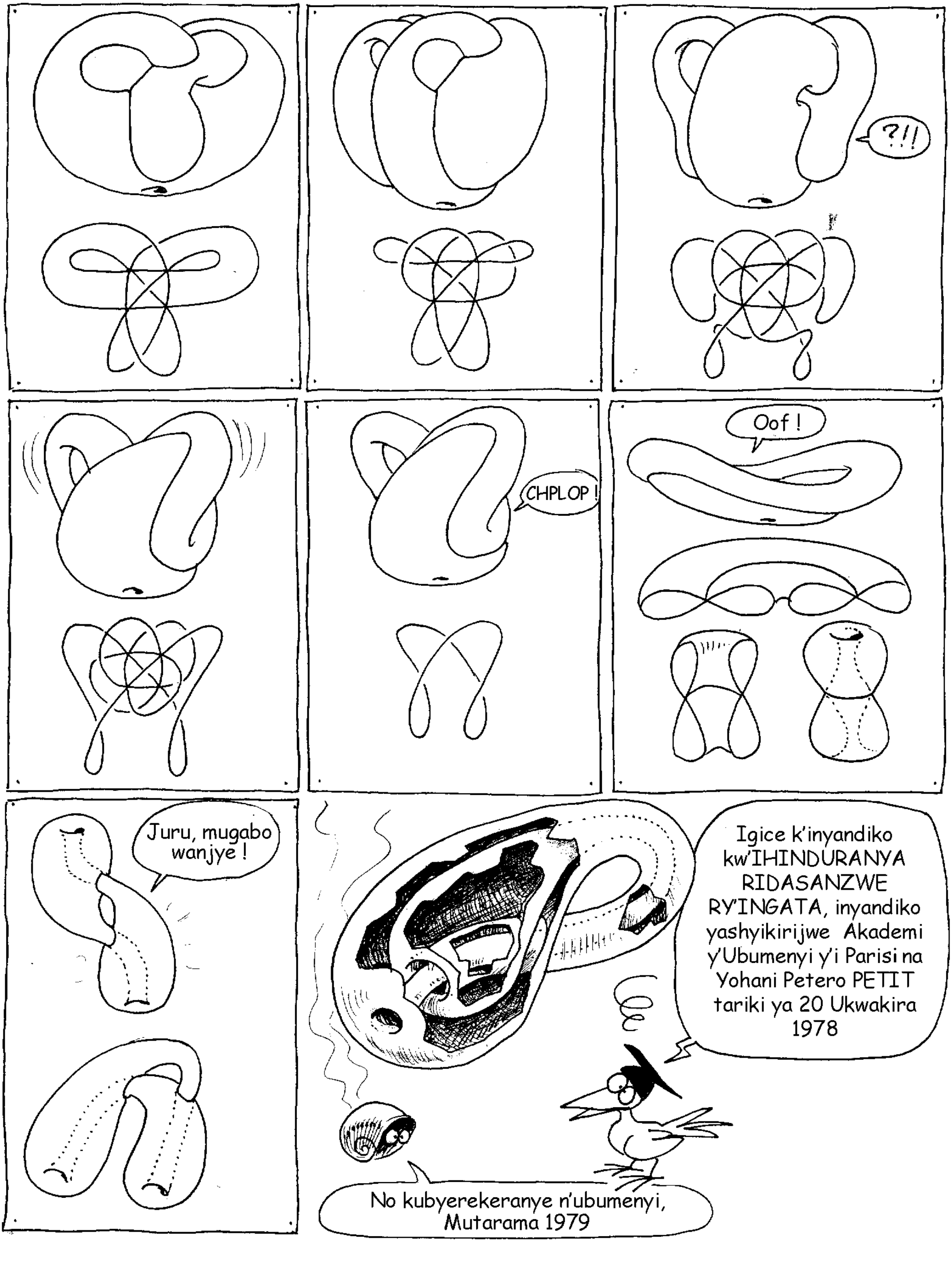
$$\alpha = \frac{\pi}{8}\sin 3\mu \qquad \begin{cases} A(\mu) = 10 + 1{,}41\sin(6\mu - \pi/3) + 1{,}98\sin(3\mu - \pi/6) \\ B(\mu) = 10 + 1{,}41\sin(6\mu - \pi/3) - 1{,}98\sin(3\mu - \pi/6) \end{cases}$$

Meridiye : umuzingi μ = ikidahinduka ; θ ifata igipimo kuva kuri 0 kugeza kuri 2π, μ ifata igipimo kuva kuri 0 kugeza kuri π.

Porogaramu yo muri BAZIKE ikurikira itanga inzira yakurikijwe ku mpapuro za mbere zibanze:

```
1  REM  TRACE MERIDIENS DE LA SURFACE DE BOY
3  HOME : TEXT
50 PI = 3.141592:P3 = PI / 3:P6 = PI / 8:P8 = PI / 8
60  HGR : HCOLOR= 3
90  FOR MU = 0 TO PI STEP 0.1
95 P = P + 1
100 D = 34 + 4.794 *  SIN (6 * MU - P3)
110 E = 6.732 *  SIN (3 * MU - P6)
120 A = D + E:B = D - E
130 SA =  SIN (P8 *  SIN (3 * MU))
140 C2 =  SQR (A * A + B * B):C3 = (4 * D * E) / C2
160 CM =  COS (MU):SM =  SIN (MU)
180  FOR TE = 0 TO 6.288 STEP .06
190 TC = A *  COS (TE):TS = B *  SIN (TE)
200 X1 = C3 + TC - TS
210 Z1 = C2 + TC + TS
250  REM  VOICI LES 3 COORDONNEES
300 X = X1 * CM - Z1 * SA * SM
310 Y = X1 * SM + Z1 * SA * CM
350  REM  PROGRAMME DE DESSIN
360  HPLOT 130 + X,80 + Y
400  NEXT TE: NEXT MU
```




?!!
CHPLOP !
Oof !
Juru, mugabo wanjye !
Igice k'inyandiko kw'IHINDURANYA RIDASANZWE RY'INGATA, inyandiko yashyikirijwe Akademi y'Ubumenyi y'i Parisi na Yohani Petero PETIT tariki ya 20 Ukwakira 1978
No kubyerekeranye n'ubumenyi, Mutarama 1979