

eiioaiodaoey aiiidfa Na, oai aieua e eiioaiodaoey yaeodifia, a -ai aieua eiioaiodaoey aeoioidfa NA, oai aieua eiioaiodaoey
 nifanoaaiiue (nk = pk), ii elaad dya eiadaaniuo naitenoa e ioee-ee. Iaiotiaei iodiodeu, -oi danhiiodaiiua auoa idioanhu yaeyp
 auniiea idienoiayo e iadaoiua iadaoiua. Iniafa aieiaiea iadaoei ia oi, -oi iaiadaaii n aaiadaoeae iad A «yaeodii-audea» idio
 daeiiaieaeae (naitaiiue yaeodii iadaoiueo ec ciuu idiaieiueo a aaeaiiop ciu). Ide iaeioidie onofiaeaeeeny daiiadaooda i
 iadaoiua iieoiidaiiee yaeyao ny odiaaiu Oadi, aadiyoiuou caiteiaey eioidiai ide daiiadaooda, ioee-ite to aanteiofai ioye,
 nenoiu, eaete au daciidaiie ia ie auua. Aey nifanoaaiiue iieoiidaiiee odiaaiu Oadi idioieo ii nadaaeia caidauaiiee ciu. A
 yaeodifia (e anaai iieoiidaiiee) caanu aaaa auua. Neaiaaadaeui, a yaeodifii iieoiidaiiee odiaaiu Oadi aieaei iadiae
 caidauaiiee ciu, ide-ai oai iaea, -ai aieua eiioaiodaoey aeoioidfa. Iaiotiaei iodiodeu, -oi iieii danhiiodaiiua caanu ioeian
 aey yaeodifii e a aaeaiioiee ciu aey auidi-ii iieoiidaiiee. Ia iadaoeea iau-ii eniuecopony auidiaaiiua iieoiidaiiee n ne
 3). {mospagebreak title=Iniaiaua iadaoiu iieoiidaiiee} A A A A A A A

INIIAIUA IADAIADU IEOIDAIIEIA Auua auee iaea danhiiodaii iaeioidua iadaoiu iieoiidaiiee, a oi -ene e naiue
 yaeodii iaiiueo iieoiidaiiee. Yoe iadaoiu -anoi eniuecopony ide ienae ioeiea aaeioae e oadaeoadenee iiaeo y
 iiaaeaiiueo iieoaeae ii iadaaeaeep anou eo niaaiyy iadaaeaiay neiou a iieoiidaiiee ide iadiyaeaiiueo yaeode-aneia
 aieuae eiadoeiiuou auidie (nifanoaaiiueo eiadoeiiuue aaeaiiofai yaeodifia), -ai naitaii yaeodifia. Iaeiaea cia-eoda
 iieoiidaiiee iai yaiia. Ionpa noaiaieony iyyoiu iadaoiu anoi auni-anoioiu yaiiaia, ecaioiaaiuo ec yaeodifii ad
 danhaiyey iieoaeae. Inieueo n iauuaieai daiiadaoode oaae-eaaony eiouneaiiueo eieaaiey adiiia edeioaeae-aneie da
 Aey edaiyey i-oeia iaeii caienou $I\% = I\%O(OO / O)3/2, (1.1)$ aaa $I\%O - iiaaeaiiueo iieoaeae ide ia-aeuie$

iieoiidaiiee iaduadeaia; ioee-ea caeep-aadny oiuei a aae-eiaa ieaadaeey noaiaie. Iiaaeaiiueo iieoaeae cadya a i
 aieueo iadiyaeaiiueo yaeode-aneia iiey (aieueo cia-aiyoe edeoe-aneie iadiyaeaiiueo Aed) iiaaeaiiueo oiiauuaadny ii q
 iieoaeae cadya ide A = Aed A (aey edaiyey n-oeia, iadiada, Aed= 2,5 eA / ni). Iiaaeaiiueo iieoaeae cadya nacya n adoa
 aaa $I\% = kO / q - oaietate iadaioeae, eioidue ide eiiiaoiie daiiadaoode iaeaeaeaii daaa 26 IA; k - iioiyiay Aieuiia; q - cad$
 aaeiui iadaoiu iieoiidaiiee yaeyao ny adaiy aeciie I,, Daee-apo iaiiadaaiaaiop daeiiaieaeep e daeiiaieaeep -adac eia
 auiieaiiueo ia iniaa adnaiea aaeey e iaeioiduo adoaed iieoiidaiiee, iaiiadaaiaaiay daeiiaieaeep iiaeo eadao aaeaiop
 aaeaiop die eadao daeiiaieaeep -adac eiaoee (den. 1.5). Eiaoeae iacuuaadny aeoiiee yadaae-aneie odiaie, daniea
 edeioaeae-aneie daeae iieoiidaiiee. Daaui anaiaa nouaioaop e iaeae aadaeoiua odiaie (odiaie ioeeiaiey), eioidua
 Daeiaieaeep -adac eiaoee idenoiad a aaa yoaia: nia-aea yaeodii iadaoiueo ec ciuu idiaieiueo ia odiaaii eiaoee, a ca
 daeiiaieaeep e nifanoaaii iaiua I,, Iyyoiu iaeua adaiia aeciie naitenoaaii iieoedeneae, aaa aadaeod danieiaai ia ana
 iauaiA neo-aa aaeaeia iieoaeae cadya a iieoiidaiiee iadonetaai aaoiy oee-aneie idioanhai: aeodoeae e adaeoi
 iieoaeae cadyaia. Adaeoi iacuuaadny iadaaeaiia iadaiaiea iieoaeae cadya ia aaeioaeai yaeode-aneia iiey. Ca adaeo
 danhiyiea, ia eioidii eiioaiodaoey iieoaeae oiiauueony a a (~ 2,7) dac. Aeodoeaiiop aeio iaeii iadaaeoou eae A L = a*SD
 iieoiidaiiee. {mospagebreak title=Idiaieiueo iieoiidaiiee} A A A A A A A

IDIADAIIEIUNOU IEOIDAIIEIA Iineueo a iieoiidaiiee eiadny aaa oia iiaaeaiuo iieoaeae cadya, oaeuiay idiaieiueo
 Inieueo aey nifanoaaii iieoiidaiiee ia nifanoaeypuea daaiiia-ii, iaeii caienou: $I\% = qni (I\%n + I\%p)$. Ioiadei, -oi eiio
 iieueo Iµq, o adiaiey iaiua, -ai o edaiyey, ni, o adiaiey aieua (ieaeoeoaeui ia ode iidyaea), -ai o edaiyey. Aiaie-ii
 iauae aey epaii nioiyey iieoiidaiiee n-oeia. Anee aiiidaiy idiaiu aeoeaeidiaeaiu, oi n iaeii caiaieou ia ii. Oaeuiay idiaie
 (1.3) e (1.4) iicaiyao naeao aaeiue iaeoe-aneie auia: ide daaiie eiioaiodaoe idiaie yaeodifii iieoiidaiiee aaaa
 idiaieiueo iieoiidaiiee, iadiada yaeodifii. Oae eae ide daiiadaoode aanteiofai ioye a iieoiidaiiee ionoioaop naitai
 neo-aa yaeodii n aiiiduo odiaie (aiiidie ciu) iadaoiayo a ciu idiaieiueo (ni. den.1.3), -oi nifanoaioaop aicdaieep n a
 ecaoi-iua aaeaioua yaeodii, idiyoi iacuuaadny daiiadaoode aeoeaeae taed. Yoa daiiadaoode iadaaeayao ny oei idiaie
 yaeodifia iadaony iaeoe-aneie iioiyiee. Yoi nifanoaioaop $qn = const$ a oiioea (1.3). Neaiaaadaeui, oiaiu ecaiaiea idiaie
 idiaieaadao ia idiaiee, oi idiaieiueo iieoiidaiiee daci adnaoae. Caanu daiiadaoode noaiaieony oae ainoai-ite aey iadaa
 yaeayony oedeia caidauaiiee ciu. xai oeda caidauaiy cia, oai aieua ted. Oae, anee aey edaiyey ted a% 330 UN, oi aey a
 ted. Aanteiofai aieueieoi iieoiidaiiee oioedieno yaeodifiee e eniuecopony a yoi aeiaiaia daiiadaoode (iau-ii aaeae
 eioidie aai idiaieiueo oiiauuaadny n oiioi daiiadaoode. {mospagebreak title=Nioeodea e iniaiaua naitenoa p-n iadaoia} A A

NONOEOODA E INIAIUA NAIENOAA d-n IADAIIA Idaeaa anaai, danhiioede aaa iadaoa iieoiidaiiee n yaeodifii e au
 iaiiaaeaiua iodeoadaeuiua eiu. Ia den. 1.6, a audee iaiia-aii caeaeie A «iepnA», a iodeoadaeuiua eiu - caeaeie A «ieionA», a
 Aiaie-ii iaiia-aiyey cadyaia a auidi-ii iieoiidaiiee a yaeodifii iieoiidaiiee yaeodifii iaiia-aii caeaeie A «ieionA», a ii
 a 2 dac -aua, -ai a yaeodifii. Oiaiu idaaioaei, -oi danhiiodaiiua iaie aaa iadaoa yaeypony idioi iaeayoyie aeiaie ede
 iaiidie, - ec iaeanoe d a iaeano n. Anoda-aynu ia adaiiea d e i iaeanoae, audee e yaeodii daeiiaieeop. Neaiaaadaeui,
 Ni noiidii iaeanoe iaeapony iieoaeaeuiua cadya aiiidfa, a ni noiidii iaeanoe d-iodeoadaeuiua cadya aeoioidfa. Iaeano
 iaeanoep, eia y aaeo daci niaaiiop eiioaiodaoep iiaaeaiuo iieoaeae cadya. Eiaaa yoo iaeano iacuuaop caiduii neiay y
 iaeiaieia. Inieueo a danhiioeaaaii iaie neo-aa NA = 2NA (iaieiaode-iue iadaoia), idiyaeaiiueo iaeanoae danieiaiey q
 nifanoai-eeaaony a neaiaaeedifii (auniioii) neiia. A daeuiuo d-i iadaoiaa eiioaiodaoe aiiidfa e aeoioidfa ioee-ai
 neaiaaeedifii -ane. Oedeia iaaiiaaii neiay (i-iaeano) a daaiiaaii nioiyiee IO (ni. den. 1.6, a) yaeyao ny aaeiui iadaoia
 ieaai ia ciu yadaae-aneie aeadaia d-i iadaoiaa, ecaiaaiie ia den. 1.7 (aaa IµF - odiaaiu Oadi). Ioiioeaeuiue aadu
 aey anaai iauua iieoiidaiiee e danieiaa a caidauaiiee cia. Inieueo a iieoiidaiiee i-oeia odiaaiu Oadi niaua aad oio
 daciadaaiiua ciu yaeodifii yadaae. Neaiaaadaeui, a iaaiiaaii neiia aeadaia yadaae-aneiee ciu enedeaeayony. Caiadei, -
 aaduaadi, idaiyioaadao idioaeaeep yaeodifii ec iaeanoe d-oeia a iaeano i-oeia e auidie a iadaoii iadaaeaeie. Aieaa nodia
 eiiiaieeadao idioan aaeodoe iieoaeae cadya, a daciueoada -aai oie -adac d-i iadaoia ia idioaeada. Aiaeeceody den. 1.7,
 aaduaada ITO oiaaii audeaeo a aeieoao iadiyaeA-ley - aieuoao. Aiaieui neuiia aeeyiea ia aae-eieo ITO iacuuaao oedeA
 - 0,7 A. Oedeia d-i iadaoiaa ai iiaii iadaaeayao ny aae-eiee ITO. Yoi oiioe aeai ec iauae oiioeue aey IO ide Na e°a° Na:
 nifanoaioaop. Aae-eiea IO iau-ii nifanoaeyao aanyoua aiee eae aeieoie iediA-iaoda. Ec (1.5) neaioa, -oi aey nicaiey o
 daaiuo eiioaiodaoey idiaie IO aaaa aieua o d-i iadaoia n aieuei ITO e, neaiaaadaeui, n aieuae Iµq. Oaei iadaaii, o e

èñííèýçíááíèè ìíááððííñòù èðáííèááúð ð-í ìáðáðíáíá ìíèðùáááðñý çàùèðííè ìèáíèíè SiO2. Ýòí ìíèðùèè, ñ ìáííè ñòíðííù, ìðàèèè-áñè ñ-áò ìáðáçíááíèý èáíáèà (í-áíù òííèíáí ñèíý) ñ-ðèíà á ìðèííááððííñòííè íáèáñòè ð-ðèíà, ìíÁ-èðùòíè ìèáíèíè SiO2. Ìòíáðèì, -ðí èáíáè ìá ááí ááèè-èÁ-íó è áèèýðò ìííáèà ðàèòíðù, áñá æá ìíæíí ñ-èòáòù, -ðí ìí áíçðáñòáèð ìðè òíáíùðáíèè ðèðèíù çáíðáùáííè çííù ìíèð èðáííèááúð. {mospagebreak title=Ìðíáíè p-n ìáðáðíáíá}Á Á Á Á Á Á Á
 ÌÐÍÁÍÉ ð-ñ ÌÁÐÁÓÍÁÁ Éæè ìòíá-áèíñù áùðá, ìðè ðááí-èò ááèè-èíáð ìáðáðííù ìáíðýæáíèè ÌO ìáááÁ-èèè. Ìáíáèí ìðè ìðááùðáíèè ýáèáíèà ðáçèíáí óááèè-áíèý ìáðáðííáí òíèà ìðè áíÁ-ñðèæáíèè ìáðáðííù ìáíðýæáíèáí ìíðáááèáííáí èðèèè-áñèíáí çíá-áíèý. Áñá ðá ìáíðýæáíííðè ýáèèððè-áñèíáí ìíèý á çáííðííí ñèíá ð-í ìáðáðíáá, à ðáíÁ-èíáúá - ñ óááèè-áíèáí ðáññáèááííè ìíííñòè è ñííðááðñò. ìíááððííñòííè. Áèà ÁÁÓ ýáèèððè-áñèíáí ìðíáíý ìðááñòááèáí ìá ðèñ. 1.13. Ìíííáíá áíáðíáá ìðèè-èà ðáçííáèáííñòáè ýáèèððè-áñè ìáú-íí áíçíèèááð ìíèááíè ìðíáíè. Á ìíííáá ìíèááíáí ìðíáíý ìíáóò èáæáðù ìáñèíèùèí ýòáèèðíá. Õáè, ìíá ááèñòáèáí áíèùòíè ìáíðýæáíííí ýòáèèðíí, ìíðáááÁ-èýðùèì ðáçáèèèè ìíèááíáí ìðíáíý, ñòáííáèòñý òóííáèùííè. Ýéáèèððè-áñèèè ìðíáíè, áíçíèèáðùèè ìíá ááèñòáèáí ý èááèíííè ìðíáíè, ìáðáíèçí èíòíðíáí çáèèð-ááòñý á èááèííí ðáçíííæáíèè ìíñèòáèáè çáðýáá á ñèèùííí ýáèèððè-áñèíí ìíèá ìíá ááèñòáè ìðíáááá, ìíáóò ìðè ñòíèèííááíèè ñ ðáðáðèíè èðèñòáèèèà ðáçíðááòù ááèáíòíð ñáýçù. Á ðáçèùèòáðá ðíæáááòñý ìíáý ìáðá Á«ýéá ìíñèòáèè çáðýáá òííáèè ìðèíáðáñòè áùñíèð ñèíðííòù, ìáÁ-íáðíáèíð ìðè óááðííè èííèçáèèè, ìóòù è áðáíý èð ðáçáííá áíèæíù áúç èñííèýçòðùèò ñèááíèááèðíááííùá ìíèóÁ-ìðíáíáíèèè. Á ìáèáñòè ð-í ìáðáðíáá, áùñòóíáðùáè ìá ìíááððííñòù, ìáú-íí èíááò ìáñòí çíá-è ðáçèùèòáðá ýòíáí ìá ìíááððííñòè ð-í ìáðáðíáá ìðíèñòíáèò ýéáèèððè-áñèèè ìðíáíè ìðè ìáÁ-ìðýæáíèè, ìáíùðáí, -áí á ìáúáíá. Ýòí ýáè Á ìáèíòíðùò ñèó-áýò ðáíùðá, -áí áíçíèèíáð ýéáèèððè-áñèèè ìðíáíè, ìíæáð ìðíèçèèèè òáíèíáíè. Á ìðèíðèíá ñóúáñòáðá ìáñèíèùèí ð áíçíèèáðùèè çà ñ-áò áíèùòíáí Ì. Ýòíò ìðíáíè áíçíèèááð á òáò ñèó-áýò, èíááá ìá ìáñííá-èáááòñý ìáíáðíáèííèè ìáíá òáíèá ìò ð-í ìá òíè. Ìíñèíèùèó Ìí ááèèè, òí ááæá ìðè ìááíèùèòè ìáðáðííùò ìáíðýæáíèýò (ìáíùèòè ìáíðýæáíèý ýéáèèððè-áÁ-ñèíáí ìðíáíý) áúááèýáòñ. Õáèáý áçáèííáýçù ìðèáíáèò è ðáçèííó óááèè-áíèð òíèà, ò. á. è ìðíáíð ð-í ìáðáðíáá. ìá ðèñ. 1.14 ìðèááááíá òèííáý ìáðáðíáý áá áèèçèíè è òèð. Çáíáðèì, -ðí áñèè ÌO áúðíñ áèáííáðý ýéáèèððè-áñèííó ìðíáíð, òí ìíñèá ýòíáí ìíæáð ìáñòóíèòù òáíèíáíè ìðíáíè. Ñíí ò-áñòíè ñ ìðèòáðáèùíí ñííðíèèáèáíèáí. Ìáíáðíáèíí ìíá-áðèíóòù, -ðí òáíèíáíè ìðíáíè ýáèýáòñý èðáèíá ìáæáèáÁ-ðáèùííí ýáèáíèá òíèííáðáíè-èááðùáá ñííðíèèáèáíèá. Á Á Á Á Á Á Á Á Á Á Á Á