APPLIED
MATERIALS
AND TECHNOLOGY

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Lifting removal of cationic dye (methylene blue) from wastewater by improving Zr-MOFs via second metal Al coordination

Tj –n' GuGv n' Ç[6]/1Nı —nrwXj –xxuGkrm[67 8]1Yqj xkrw‘ j wp[9] jwmYqj xv rwRn ı[6]

[6]I qnv rl j uKwprwnn' rwp1‘ GYl qxxuxoS rwn–@S rwn' j u-1Kwn' pÇj wmI qnv rl j uKwprwnn' rwp1I ı ' –rw[wr°n' –r–ÇlGı —'–j uj
[7]Kw°r' x w nw–j –uJ nyj ' –v–nw–1Gyyumm S nml j uYl mwl n1[wr°n' –r–ÇxoQj ' kj uj 1Oj z
[8]Yl qxxuxoKwprwnn' rwp1Kmr–q–I x×j w[wr°n' –r–ÇlGı —'–j uj
[9]Yl qxxuxoI qnv rl j uKwprwnn' rwp1[wr°n' –r–ÇxoGmnuj mn1Gı —'–j uj

GHYZ I Z@S n–j –ux' pj wrl ój v n×x't – - S UL–. j 'n ónzı nw–uÇı –nmj – j m–x' knw—rw j m–x' y–rxw y' x l n—n– –x' nv x°n mÇn– ónxv n ı nw–y' x m l nmkÇ–qn –nÅ–nn rwm —'–Ç3Zx nj ÇlnÇn l x w–j –v rwj w—qj °n knl x v n j w rv yx' –j w–nw°r' x w nw–j –uy' x kunv 3 Uwn xo –qn–n mÇn– r– v n–qÇnwn ku n - S H j wm r—' nv x°j u ónxv ×j —n×j –n' r– j y' rx' r–Çknl j ı –n r—r– yn' –r–nw–j wm wx w mnp' j nj kun3S H r– ı –nm rw v j wÇ rwm —'–n– j u–qx ı pq r—qj – yx–nw–j –uqj ' v ɑ un nl —x w qı v j w j wm j zı j –l– urn j wml j w kn l x w–mm' nmj qj Ö)' mx ı –l qnv rl j u× qnw rw×j —n×j –n'3 n y' n–nw—ı nÇ–qx×– –qn yx–nw–j –uj yyul j –rx w–ox' nwqj wl nmox' v –xo [rU2; ; S UL–1 –ı l q j – [rU2; ; 1 [rU2; ; 265) Gu j wm [rU2; ; 285) Gu3 n–n ox' v – ×n' n y' nyj ' nm –x– ' nv x°n S H ónxv ×j —n×j –n' ı –rwp kj –l–q nÅyn' rv nw–3I qj ' j l –n' r–j –rxw x oj m–x' knw—×n' n j l l x v yu–qnm–ı l l n—ɑ uÇı –rwp Lx ı ' m' –'–j w–ox' v rwój ' nml a 2j Ç yx×mm' mr ' j l –rxwl H ı wj ı n' ttKv v n ttZnun' –ı ' ój l n j ' nj j wm –qn' v xp' j °rv n–'–l j wj uÇ–r– –nl qwrz ı n–3 Zx rw°n—rpj –n–nz ı ruk' n v j m–x' y–r°n knqj °rx ı ' 1Rj wpv ı r' j wmL' nı wmul q r–x–qn' v v xmnu–×n' n –n–nmj pj rw—qn nÅyn' rv nw–j –u nj –j –3 Hj –nm x w uwnj ' ' np' n—rx w l x' ' nuj –rx w l x n l mw—X7. 1 –qn L' nı wmul q v xmnu nm–l ' rknm –qn nz ı ruk' n v r–x–qn' v xo S UL4S H kn n' –qj w –qn Rj wpv ı r' v xmnu3 Uo j uı ox' v – xo [rU2; ; S UL1 [rU2; ; 265) Gu qj m –qn v j Årv ı v Rj wpv ı r' j m–x' y–rx w l j yj l r–Çj –9>37; v p4p3G t rwn–l– –ı–nÇnÅj v rwnmy–nı mx ' –2x' mn' l y–nı mx –nl x wmx' mn' j wmKux°rl q v xmnu–x–mn–n' v rwn×qrl q l x ı umnÅyuj rw–qn –x' y–rx wv nl qj wr–v 3' qrun–qn y–nı mx –nl x wmx' mn' j wmKux°rl q v xmnu–qx×nmj pxxm —×r–q–qn nÅyn' rv nw–j –unj –j –l–qn l x' ' nuj –rx w l x n l mw–xo–qn y–nı mx –nl x wm2x' mn' v xmnu×j – –qn qrpqn—3 n–n' n–ı u—rwml j –n–qj –j –m–x' y–rx wxoS H r–l x w–'–xunmkÇj l qnv r–x' y–rx wv nl qj wr–v 3Lı ' –qn' l rw–'–j yj ' –l–un mr ı –rx w×j –ı –ur–nm–x–mn–l ' rkn –qn j m–x' y–rx wv nl qj wr–v j wmmn–n'v rwn–qn' j –n2rv r–rwp —ny–rw–qn j m–x' y–rx wy' x l n—3

QnÇ×x' m–@S n–j –uU' pj wrl L' j v n×x't – - S UL–. lnÇn1v n–qÇnwn ku n1yxuu –j w—' nv x°j ulj m–x' y–rxw

1. INTRODUCTION

J n–yr–n–px°n' wv nw–'–npı uj –rxw–lnw–ı ' rwp nw°r' x wv nw2 –j –ul x v yuj wl n ×r–q–n–j –ku r–qnm–n'v – x o×j —n×j –n' ' nunj –n j wm l qnv rl j u qj wmurwp r– mr l ı u—d6f3 Zx nj Çl mÇn l x w–j –v rwj w— qj °n knl x v n x wn xo –qn v x —rv yx' –j w—nw°r' x wv nw–j –uy' x kunv – rw–qn ×x' um3K ı nw–×r–q–x' pj wrl mÇn– mr–l j ' mmm rw–x– wj –ı ' j u×j –n'l x ı ' –n– nwnj wpn' u°rwp l ' nj –ı ' n– j wm–qn nw°r' x wv nw–knl j ı –n xo–qnr' –x–Ål r–Çj wm l j ' l rwx pnwrl n nl —d7f3 Gv j mmr–n–wl mÇn l x w–nw–rw×j –n' y' n°nw— –ı wupq— ynwn–'–j –n–w ×qrl q mml ' nj –n– yuj w— yqx–x–Çv–qn–r–d6f3

Yrpwr l j w—j v x ı w—xo mÇn– j 'n nv yux Çnm rw j ×mm 'j wpn xo rwm —'–n– rw°x ú nm rw y' x m l rwp yj yn' 1 –nÅ–nn l unj –qn' 1 yqj ' v j l nı –l–1 oxxml l x–v n–l–1 y' rw—y' x m l —1 r' x w2–nnu y' x m l —1 l x t n1 yn–'–x unı v 1 yn—l–mn–1 yj rw—1 –x ú nw—1 ×xxm2y' n–n' °rwp l qnv rl j u-3 Lı ' –qn' 1 –qnr' v j w ı qj l –ı ' rwp yuj w—l x w–ı v n uj 'pn °xu v n– xo×j –n' –qj — rw –ı ' w pnwn' j –n–uj 'pn °xu v n– xo×j —n×j –n' d8f3 Guv x —6555555 mÇn– j wm yrpv nw—qj °n knnw –j –kı uj –nm –x– nÅr—1 l x w–r—rwp xo<555 t rwm–xol qnv rl j u—'–l –ı ' n–1–qj –j ' n ı –nm –x– y' x m l n < 65: –x–wwn– yn' Çnj ' ×x' um×mn d92=f3 n v j sx' r–Çxo –qn–n mÇn– j 'n ' n–r–j –w—x– krxmnp' j nj –rxw j wm xÅnj –rxw y' x l n—n– d>f3 Gkx ı —65tt6:) xo –qn mÇn– r– mr–l qj ' pnmrw–x– –qn n ı nw—m ' rwp –qn mÇnrwp y' x l n— d6516 6f3 Xnl nw–uÇl –ı –nm– qj °n ' nyx' –nm –qj –j ' x ı wm 67) xo –Çw–qn–l– mÇn– j 'n ×j —nm–q–x ı pq l x ux ı ' rwp y' x l n—n– j wm xyn' j –rxw– d67fA 75) xo ux—— mÇn– nw–n' rwm —'–nj u ×j —n×j –n' – d68169f3

J Çn– l j w kn m°rnnm rw–x– –×x v j rw p' x ı y–l j wrxwrl -j l rnnl . j wm l j –rxwl -kj –l . l x ux ı ' mÇn–3 S n–qÇnwn ku n -S H r– j kj –l mÇn –qj —r– j oxl ı – xo –qr– —ı–nÇ3 Gu–qx ı pq S H r– ı –nm rw –xv n v nml j u j yyul j –rxw–l r—r– j u-x ×rnnuÇ ı –nm rw l x ux ı ' rwp yj yn' 1 mÇnm l x xw–1×xxu–l l x j –rwp ox' yj yn' –x–l t –l n–l–3 x ı pq S H r– wx—'–xwpuÇ qj Ö)' mx ı –l r— qj – –xv n qj ' v ɑ un nl —3 Gl ı –n–nÅyx–ı ' n –x–S H×ruul j ı –n rwl ' nj –nmqnj '–'–j –nl °xv r–rwp1–qx l t 1Nnrw Ökx nÇox' v j –rxw l lGjwx–r–1 sj ı wml n1 zı j n'ryunprj j wm –r—ı n wnl ' x–r– rw qı v j w–d6: f3

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Kw° r' x w v nw-j-u Ç l r—r– n—nw-rj-u -x- ' nv x° n mÇn– ó x v rwm —'-rj u × j —n×j -n' k n l j ı -n x o -q n r' -x-Å d r-Ç j w m q ı p q °r-rk n r-Ç d<1 6; 26=f 3 I x w-n z ı n w-u Ç l -q n' n r– j l x w-r w ı x ı – ı ' p n w—w n n m -x- n w-ı ' n -q n ' n v x° j u -q n-n y x u u -j-w— ó x v rwm —'-rj u n ı n w— j w m -x- l x v y u Ç × r-q- p x° n' w v n w— u n p r-u j -r x w d6>f 3 S j w Ç -n l q w z ı n– q j ° n k n n w j n v y-r n m -x- m-l x u ı ' rwm —'-rj u m-l q j ' p n -q j — r w° x ú n l q n v r l j u l k r x u x p r l j u j w m y q Ç-r l j u ' n v x° j u v n-q x m-A q x × n° n ' l v x—j ' n ı w-ı l l n—o u k n l j ı -n x o -q n r' u v r-j-r x w- j w m n r-j n° j w-j-p n– d75f 3

G m-x ' y-r x w r– j × n u2t w x × w j w m q j ° x ı ' r-n- -n l q w z ı n k n l j ı -n x o r— o n j -r k r u r-Ç l -n v y u l r-Ç j w m n l m w l Ç r w -q n ' n v x° j u x o -ı l q l x w-j-v r w j w—d76f 3S j w Ç j m-x ' k n w—q j ° n k n n w n v y u x Ç n m -x- '-n j —r w m —'-rj u × j —n×j -n' l x w-j-r w r w p m Ç n 3 n Ç r w l u m n j l-°j -r n m l j ' k x w m n' r° n m ó x v m r n ' n w— -x ı ' l n– x o ' j × v j -n'-rj u- d77288f 1 j p ' r l ı u-'-j u -x u m × j —n- d89 29<f 1 k r x -x ' k n w—d6<16=19=2; 5f 1 Ô n x u-r n- d; 62; ; f 1 r w m —'-rj u -x u m × j —n– d6: 1 ; <2<9f 1 w j -+'-j u l u j Ç v r w n ' j u- d<: 2=8f 1 ' n-r w- d=92=<f 1 v n-j-u x Å m n– d==1 =>f 1 v n-j-u x ' p j w r l ó j v n × x ' t – - S UL–. d71>52>8f 3

G l-°j -r n m l j ' k x w ó x v °j ' r x ı – -x ı ' l n– q j – k n n w -q n v x—r w° n—r p j -r n m j m-x ' k n w—r w u j k x ' j -x'-m– j w m v x—+-r n m k Ç r w m —'-r n– -x- ' n v x° n k j -r l m Ç n– ó x v -q n r' × j —n×j -n'– d=<1>92><f 3N x × n° n ' l r—l x —q j – u v r-r n m r—l x v v n ' l r j u ı -n j – j -x ' k n w-3G– j ' n-ı u-l-v j w Ç—+-r n m – q j ° n k n n w ı w m ' -j-t n w r w -q n u j —r n m l j m -x- r n m w-r e Ç j l x—2n n l-°j -n -x ' k n w-d>=f 3

S UL d>>265; f 1 x ' q Ç k ' r m r w x ' p j w r l j w m x ' p j w r l ó j v n × x ' t d65<f 1 r– j 76—l n w+-' Ç v j -n'-r j u × r-q- -+w n j k u n x y-r x w-l x ' p j w r l o w l-r x w j u r-Ç l x y n w v n-j-u -r-n– r w r—-t n u n-x w l u j ' p n 2-r Ô m y x ' n–l q r p q -ı ' q j l n j ' n j – -6555 -x- 655555 v 74p. j – × n u u j – q r p q -q n ' v j u l × j -n'-1 l q n v r l j u l j ' l q r-n l -+'-j u j w m v n l q j w r l j u –j-k r u r-Ç d7165=f 3O-r– j l u j —x o ı u'-j 2q r p q y x ' x ı – v j -n'-r j u l x w-'-+l -r m × r-q- -n l x w n j ' Ç k ı r u m r w p ı w r— - YH[–. d65>f j w m -Ç w-q n-r-n m k Ç ' n-r l-ı u j ' l q n v r—'-Ç d6651666f -q j —l x w w n l —q n r w x ' p j w r l y j ' —× r-q- -q n v n-j-u r x w-x- -q n x ' p j w r l y j ' —× r-q- y x u Ç-x y r l l j ' k x Å Ç j -r n p ' x ı y -x- o x ' v °n ' -r l-n– j w m u r w t n ' – × r-q- —'-x w p k x w m- d667f 3

n °j ' m-Ç x o p n x v n-'-Ç l -r Ô n j w m o w l-r x w j u r-Ç x o -q n l x w—r-+-n w— x o S UL– q j – n w j k u n m -l m w-r —— j ' x ı w m -q n × x ' u m -x- -Ç w-q n-r-n v x ' n -q j w =916=: S UL —'-+l -+'-n– d657f 3 m' °j ' m-Ç j w m v ı u-r y u l r-Ç l j – × n u u j – y n ' v j w n w— y x ' x-r-Ç l v j t n -q n v q j ° x ı ' j k u n v j -n'-r j u- r w v j w Ç j y y u l j -r x w-l -ı l q j – I U7 l j y-+'-n l q Ç m ' x p n w j w m v n-q j w n —x'-j p n l -n w-x ' –l y q x-x-l j -j-u Ç-r–l m ı p m u° n ' Ç l l j -j-u Ç-r– j y y u l j -r x w- j w m -q n j m-x ' y-°n ' n v x° j u x o l x w-j-v r w j w— ó x v j z ı n x ı – -x u -r x w-d>5166726 6<f 3

n x k s n l-°n x o -q n y ' n-n w—-+-n Ç r– -x- m n-l ' r k n -q n -Ç w-q n-r-n-j w m l q j ' j l -n'-r-j -r x w x o -r w p u n 2v n-j-u c ' 2S UL-[rU 2; ; . j w m k r v n-j-u c ' 2S UL– -[rU 2; ; 265) Gu j w m [rU2; ; 2 85) Gu 1 j w m n Å j v r w n -q n r' y x -n w-r j -u j – -x ' k n w—-x- ' n v x° n S H l j l j -r x w l k j -r l n Ç n 1 r w × j —n×j -n' 3 n t r w n-r l— j w m n z ı n r u k ' n v x o -q n j m-x ' y-r x w y ' x l n—× n ' n n m -x- t r w n-r l— v x m n u- j w m n z ı n r u k ' n v -q n x ' n-r l-j u v x m n u-3 L ı ' -q n ' 1 -q n v n l q j w r-v -q j —u r v r— -q n ' j -n- x o -x ' y-r x w ' n j l-r x w × j – r w° n—r p j -n m ı -r w p j w r w-'-+j y j ' -r l-u n m r ı -r x w v n-q x m -x- r v y ' x° n ı w m ' —j-w m r w p x o -q n n Ç w j v r l – r w -q n j m-x ' y-r x w y ' x l n—3

2. METHODOLOGY

736 YÇw-qn-r–j wmj l-°j -rxw

Guu l qnv rl j u- × n ' n -ı yyumm kÇ Yrpv j 2Gum ' rl q -G ı —'-j u j . × r-q x ı –o ' -q n ' y ı ' r l j -r x w-3

G -l j u m m2 ı y y ' x l n m ' n x o j y ' n° r x ı -u Ç ' n y x ' -n m v n-q x m d: >f x o -Çw-q n-r-n w p c ' 2S UL × j – -ı l l n—o u Ç ı w m ' -j-t n w l ı -r w p j v x m r n m ' j -r x x o c ' I u, (ÐÐ I (Ð S L -737<v v x u c ' I u, 1 737<v v x u 6192k n w Ô n w n m l j ' k x Å Ç u r l j l m m d HJ I f. 3

n j k x ° n v n w-r x w n m l q n v r l j u- × n ' n v r Å n m × r-q- l x w-r w ı x ı – j p r-j -r x w × r-q- 95: 38=v v x u T1 T2m v n-q Ç u o x ' v j v m n -J S L. -x ú x-q n ' v j u Ç3 n ' n-ı u-r w p v r Å+-' n × j – y u j l n m r w j w j ı -x-l u j ° n j —8>8 Q o x ' 6 m3 n y ' x m l —c ' 2S UL × j – u-n'-n m l m ' m m j w m r v v n ' -n m r w l q u x ' x o x ' v o x ' : m3 G n ' j l-°j -r x w kÇ l q u x ' x o x ' v × j – l x v y u n-n m l -q n -x u m × j – u-n'-n m j w m m ' m m ı -r w p °j l ı ı v j w m q n j -n m j —9; 8 Q o x ' 9=q 3

n o x u x × r w p v n-q x m × j – ı -n m -x- -Çw-q n-r-n [rU2; ; 2 65) Gu3 Z n ' n y q-q j u l j l m m -636 p1>=) AYrpv j 2Gum ' rl q. j w m J S L -<8 v R1>>) AYrpv j 2Gum ' rl q. × n ' n v r Å n m -x p n-q n ' j w m —r'-n m ı w-r u-q n j l m m r—x ú n m3 ' r-q r w 65 v r w x o -q n l u n j ' -x u -r x w o x ' v r w p 1 c ' I u9 -63 pAYrpv j 2Gum ' rl q1>>) . × j – j m m m m -x- -q n -x u -r x w × r-q- l x w-r w ı n m —r'-r w p o x ' j w x -q n ' : v r w3Gu-TU8. 83>N7U-536: p. × j – -q n w j m m m l j u x w p × r-q- 7 v R x o N7U1-x- -q n v r Å+-' n j w m —r'-n m o x ' j w x -q n ' 6: v r w3 n -x u -r x w × j – -'-j w-o n ' ' n m -x- j 67: 2v R Z n x w2r w n m j ı -x-l u j ° n1 × q r l q × j – -r p q-u Ç -n j u n m j w m -q n w y u j l n m r w j y ' n q n j -n m x ° n w j –687 I o x ' 79q3 n × q r-n-y x × m n ' y ' x m l — x o [rU2; ; 265) Gu × j – l x u n l -n m ı -r w p j l n w-'-r o p n v j l q r w n j w m × j -q n m r w J S L -q ' n n -r v n-3 n ' n-ı u j -r w-y ' x m l –× j – m ' m m r w j w x ° n w j w m j l-°j -n m kÇ r v v n ' -r w p r—r w j k-x u -n- v n-q j w x u-655) AYrpv j 2Gum ' rl q. o x ' : m3 H n o x ' n ı -r w p -q n S UL j – j w j m-x ' k n w-l r—× j – u-n'-n m l m ' m m j w m q n j -n m r w °j l ı ı v j –9<8 Q x ° n ' w r p q-3

Z x -Çw-q n-r-n [rU2; ; 285) Gu l c ' I u, -63 p. × j – v r Å n m × r-q- -n ' -n y q-q j u l j l m m -638 p. r w J S L -; 537 v R. 3 G n ' v r Å r w p o x ' 6: v r w1Gu-TU8. 83>N7U-539: p. × j – j m m n m j w m -q n w : v R x o N7U × j – j m m n m -x- -q n v r Å+-' n3 n -x u -r x w × j – v r Å n m o x ' j y y ' x Å r v j -r u Ç 85 v r w3O-× j – -q n w v x ° n m -x- j 67: 2v R Z n x w2r w n m j ı -x-l u j ° n1 × q r l q × j – -r p q-u Ç -n j u n m j w m -q n w y u j l n m r w j y ' n q n j -n m x ° n w j –6: < I o x ' 6m3 n × q r-n- y x × m n ' y ' x m l —x o [rU2; ; 265) Gu × j – l x u n l -n m ı -r w p j l n w-'-r o p n v j l q r w n j w m × j -q n m r w J S L -q ' n n -r v n-3 n ' n-ı u j -r w-y ' x m l —× j – m ' m m r w j w x ° n w j w m j l-°j -n m kÇ r v v n ' -r w p r w j k-x u -n-v n-q j w x u-655) AYrpv j 2Gum ' rl q. o x ' : m3 H n o x ' n ı -r w p -q n S UL j – j w j m-x ' k n w-l r—× j – u-n'-n m l m ' m m j w m q n j -n m r w j °j l ı ı v j –9<8 Q x ° n ' w r p q-3

737 I q j ' j l -n'-r-j -r x w

n ' v x p ' j ° r v n-'-l j w j u Ç-r– - ZMG. x o -q n -r w p u n 2v n-j-u j w m k r v n-j-u c ' 2S UL– × j – m x w n ı -r w p j ZMG r w-'-+v n w— -ZMG4J Y I 6 YZGXn -Ç—n v AS n u n ' 2Z x u n m x. 3 Gu u S UL -j v y u n– × n ' n y u j l n m r w l ' ı l r k u n– j w m -'-j w-o n ' ' n m -x- -q n v j 2 l q r w n j w m q n j -n m j -j- ' j -n-x o: Q4v r w ı w-r u 66<8 Q × q n w -q n j r ' p j – x × ' j -n-x × j – v j r w-j-r w n m j –65 v R4v r w3

n —j-k r u r-Ç x o -q n o w l-r x w j u p ' x ı y– x w -q n x ' p j w r l u r w t n ' – × n ' n j —n—n m ı -r w p Lx ı ' m ' -'-j w-o x ' v r w o j ' n m -y n l-'-x -l x y Ç -LZOXA Y y n l-'-+v 655 LZ2OX -y n l-'-x v n-n'-1 Vn ' t r w K u v n ' . 3 G -l j w w r w p y ' x l n— × j – ı w m n ' -j-t n w kÇ j w j n w ı j -n m -x-j-u ' n n l-j-w l n -n l q w z ı n -x- x k-j-r w -q n LZOX

–ynl–'–j 'jwpn; 55 –x–9555lv ¯6×r–q–j 'n–xu –xwxo9lv ¯63

Zx lqnlt –qn rw–np'r–Ç xo–qn S UL —'–l–t–'n1a2jÇ yx×mn' mr 'jl–xw yj n'w–×n'n xk–j–rwnm ı–rwp jwa2jÇ mr 'jl–xv n–n' -J = Gm^jwln1 H ı t n' Ga Y. ×r–q– I ı Q 'jmj–xw - C 63 95; .1jll nun'j–rwp °xuj–pn 95 t] jwm lı''nw–95v G3

T 7 jm–x'y–xw4mn–x'y–xw r–x–qn'v – ×n'n yn'ox'v nm ı–rwp j Wijw–j–l q'xv n rw–'–t v nw—- Gı –x–x'k26.1 jwm –nÅ–t 'juy'xyn'–m–xo–qn c'2S UL–×n'n nm–n'v rwnml–ı lqj–yx'n –rÖ'lyx'n °xu v n jwm–ı 'qjln j'nj3 Guu S UL– ×n'n y'nyj'nmkÇqnj–jwm°jlıı ox' 6 mknox'n uxjmrwp –x– –qn v jlqrwn–x–mn–n'v rwn–qnr' jm–x'y–xwy'xyn'–m–3

738 Gm–x'y–xwV'xln—

Gw jzınxı – —xlt –xu –xw xoS U -6555yyv . ×j–y'nyj'nmkÇmr–xu'rwp S H-I 6; N6=I uT 8Y1v xunlıuj' ×nrpq—86>3=: p3v xu^6AYrpv j2Gum'rlq. rwmnxwr–nm×j–n'3Gzınxı – –xu –xw–×r–q–mr n'nw–lxwlnw–'j–xw–xoS H-: tt655yyv . ×n'n y'nyj'nmkÇ–ı lln–r°n mu–xw xo–qn –xlt –xu –xw ×r–q–×j–n'1jwmS Hlxwlnw–'j–xw–×n'n mn–n'v rwnmı–rwp jk–x'kjwln j—;;=wv ×j°nunwp–q– xo–qn –xu –xw j n' xk–j–rwrwp –qn [ ] –ynl–'–j xo–qn –xu –xw ×r–q– j –ynl–'–xyqx–xv n–n' -[ ] –ynl–'–xyqx–xv n–n'. 3G ljuk'j–xw lı''°n×j–xk–j–rwnmóxv –ynl–'–j xo–qn –j–wnj'm–xu –xw–-: tt655yyv . 3V'rx' –x–jm–x'y–xwl–qn jm–x'knw—×n'n m'mm x°n'wrpq—rw j °jlıı v j—8<8 Q3 Yn°n'ju puj— lxw–j–rwn'–×n'n lunj wnmlm'mmjwm unm–x–75v R×r–q–S Hxomr n'nw— lxwlnw–'j–xw–'jwprwpóxv : –x–: 5yyv 3Lxux×rwp –qr–ljw nÅjl–j–v xıw–xojwS UL jm–x'knw—75v p. ×j–yı –rwnjlq puj— lxw–j–rwn'3

n nÇn –xu –xw– lxw–j–rwrwp –qn jm–x'knw—×n'n v rÅnm×nuukÇj v jpwn–l –r–'n' jwmv jrw–j–rwnmox' : v rw–x–79q j—7>=Q3 n –j v yun– ox' jwjuÇ–r– ×n'n lxunl–nm kÇ –Çrwpn un–' j—mr n'nw— –j v yuwp rw–n–'°ju-3 G [ ] –ynl–'–xv n–n' ×j–ı –nm–x–rw°n—rpj –n–qn nÇn lxw–rw–rw–qn –ı yn'wj–j–w-3

739 Gm–x'y–xwY–ı–nÇ

n jm–x'y–xw v nlqjwr–v jwm'j–n–xomr ı–rxw×n'n n—rv j–nm ı–rwp –q'nn trwn–l– v xmnu@j'n y–nı mx –nlxwm2 x'mn' d66>f1 y–nı mx '—2x'mn' d675f jwm rw–'–j y j'–l–un mr ı–rxw v xmnu- d676f3 Gm–x'y–xw knqj°rxı'– ×n'n –rv ı uj–nm ı–rwp –qn Rjwpv ı r' d677f jwmL'nı wmulq d678f jm–x'y–xwr–x–qn'v –3

739.6 Qrwn–l– Y–ı–nÇ

Hj–l–q jm–x'y–xw uj kx'j–x'Ç–nl qwrzı n–×n'n ı–nm–x–mn–rpw –qn nÅyn'rv nw—3 Guu y'jl–l–ju trwn–l— nÅyn'rv nw— ×n'n lxwml–nm kÇ y'nyj'rwp –qn –ynlr nm rwr–j–u lxwlnw–'j–xw– -: tt: 5v p4R. jwmjmnrwp j y'nm–n'v rwnm mx–n xo–qn jm–x'knw–rw–x–j mn wr–n–°xu v nxoS H–xu –xw j—'xxv –xv yn'j–ı–'n3 Gpr–j–xw ×j– yn'ox'v nm ×r–q– j v jpwn–l– –r–'n' v jlqrwn j—755'yv –x– xy–rv r–n v j— –'j w–on' jwm lxw–j–l —×r–q– –qn rw–n'–qjlrju j'nj ox' j y'nmn–n'v rwnm –rv n rw–n'°ju3 S H lxwlnw–'j–xw ×j– v nj–ı 'nmı–rwp –qn–ı yn'wj–j–w–j–nj lqy'nmn–n'v rwnm–rv n rw–n'°ju–rwpj [ ] –ynl–'–x–lxyÇv jlqrwn3

n jv xıw–xoS Hjm–x'knmxw–x– [rU2; ; 1[rU2; ; 2 65) Gu jwm [rU2; ; 288) Gu S UL– j—jwÇ –rv n ×j–ljulıuj–nmı–rwp Kzıj–xw6 d679f3Nx×n°n'1–qn yn'lnw–j–pn 'nv x°juxoS H×j–lxv yı–nmkÇKzıj–xw7 d67: f3

$$q_t = (C_0 - C_t)\frac{V}{m} \qquad -6.$$

$$R\% = \frac{(C_0 - C_t)}{C_0} X100 \qquad -7.$$

‘ qn'n@

z— @qnjv xıw–xoS Hjm–x'knmyn' ı wr–×nrpq–xoS ULj— jwÇ–rv n—v p4p.

I 5 @rwr–j–ulxwlnw–'j–xwxo–qn S H–xu –xwj—rv n Ö'lx -v p4R.

I _ @qnlxwlnw–'j–xwxoS H–xu –xwj—rv n—v p4R.

] @°xuv n xo–qn S H–xu –xw rw–qn kj–l–q jm–x'y–xw y'xln—-R.

X) @yn'lnw–j–pn'nv x°juxoS H

v @8 ULvj—ı–nmrw–qnjm–x'y–xwkj–l–qy'xln—-p. 3

- V–nı mx '—2x'mn' v xmnu

n S UL 'nv x°juxoS Hóxv –rv ı uj–nm×j—n×j–n' ljwkn 'ny'n–nw–nmkÇj urwnj' y–nı mx '—2x'mn' v xmnuxo jm–x'y–xwd675167; f nÅy'n—nmknux×@

$$ln(q_e - q_t) = ln(q_e) - k_1 t \qquad -8.$$

‘ qn'n@

zn @qnjv xıw–xoS Hjm–x'knmyn' ı wr–×nrpq–xoS ULj— nzı ruk'n v -v p4p.

z—@qnjv xıw–xoS Hjm–x'knmyn' ı wr–×nrpq–xoS ULj— jwÇ–rv n—v p4p.

t6 @y–nı mx '—2x'mn' 'j–n–lxw–j–w—v rw^t6.

— @rv n-v rw. 3

n urwnj' 'nuj–xw–qry kn–×nnw°ju n–xouw–z n tt z ⊥ jwm— ljwkn yux nmj–j —'j rpq–urwn1óxv ×qıl q z n jwmt 6 ljwkn ox ı wmnj–nuÇóxv –qn rw–n'–lny–j–wm–uxyn1'n–ynl–r°nuÇ3

- V–nı mx –nlxwm2x'mn' v xmnu

n –x'y–xw trwn–l– xo–qn S UL4S H–Ç–rv v jÇju–x kn mn–l'rknmkÇj urwnj'r–nmox'v xo–qn y–nı mx –nlxwm2x'mn' v xmnu d66>f1 kj–nm xw jm–x'y–xw nzı ruk'n v ljyjlr–Ç nÅy'n—nmrw–qn oxux×rwp ox'v @

$$\frac{t}{q_t} = \frac{1}{k_2 \quad q_e^2} + \frac{1}{q_e} t \qquad -9.$$

‘ qn'n@

zn @qnjv xıw–xoS Hjm–x'knmyn' ı wr–×nrpq–xoS ULj— nzı ruk'n v -v p4p.

z—@qnjv xıw–xoS Hjm–x'knmyn' ı wr–×nrpq–xoS ULj— jwÇ–rv n—v p4p.

— @rv n-v rw.

t7 @y–nı mx –nlxwm2x'mn' 'j–n–lxw–j–w—p4v pv rw. 3

n °jun–xo--4z ⊥ j'n urwnj'uÇlx''nuj–nm×r–q– –ljwm–qn yux—xo--4z ⊥ jpjrw———qxı um kn j —'j rpq—urwn3 n mn–n'v rwj–xwxozn jwmt 7 ljwkn mxwn óxv –qn –uxyn jwm rw–n'–lny–l'–n–ynl–r°nuÇ3

- Kux°rlq trwn–l– v xmnu

n Kux°rlq nzıj–xw r– pnwn'juÇı–nm ox' lqnv r–x'y–xw jyyuljxw–jwmljwkn×'r nwj–oxux×–@

$$\left(\frac{dq_t}{dt}\right) = \alpha\, Exp(-\beta q_t) \qquad -:.$$

‘ qn'n@

z—@qnjv xıw–xoS Hjm-x'knmyn' ıwr–×nrpq–xoS ULj— jwÇ-rv n—v p4p.

@ lxw–jw–'ny'n–nw-rwp -qnrwr-rj-u'j -n-xojm-x'y-rxw

@ xw–jw–m 'rwpjwÇxwnnÅyn'rv nw—

— @rv n-v rw. 3

Oj-yynj'– -qj—qnrwr-rj-ujm-x'y-rxw'j -nj—qn knprwwrwp xo lxwjl—rv n r– wx–lxw-'xunmkÇnÅyxwnw-rj-uuj× knljı–n ×qnwz_jyy'xjlqn–Ön'x1mz_4m_nzıju– d67<f3Ov-np'j-rwp Kzıj-rxw: kÇj–ıvrwpz_C5j—C51-qn'n-ıu-×rukn@

$$q_t = \left(\frac{1}{\beta}\right)\ln(1+\alpha.\beta t) \qquad -;.$$

Oo –D61-qn–rv yunox'v xoKzıj-rxw:3 ljwknnÅy'n—nm j–oxux×-@

$$q_t = \left(\frac{1}{\beta}\right)\ln(\alpha.\beta) + \left(\frac{1}{\beta}\right)\ln(t) \qquad -<.$$

Ovj yux–xo-qn—'j-rpq-2arwnnzıj-rxwxoz_j–j ow-rxwxouw --.1-qn-uxynjwmrw-r-lny–×rukn-64 . jwm-64 . uw- .1 'n-ynl-r°nuÇ3

Kzıj-rxw < ljw ojlrur-j-n -qn mn-r-'vrwj-rxw xo -qn jyyul jkrur-Çxo-qn Kux°lq trwn-rl- nzıj-rxwxwS UL4S H -Ç-rv –d67=f3

- Ov-'j-yj'-rl-unmr ı-rxwv xmnu

n rw-'j-yj'-rl-unmr ı-rxwttkj-nmv xmnur–lxv v xwuÇ ı-nm-x-n—qnv nlqjwr–v xojm-x'y-rxwxoyxuu-jw—xw-x-j-x'knw-3- r–v xmnur–nv yux-Çnm-x-rmnw-roÇ-qnjm-x'y-rxw v nlqjwr–v xoS Hxw-x-S UL1jwmljwkn×'r nwj–oxux×-@

$$q_t = k_p t^{1/2} + C \qquad -=.$$

‘ qn'n@

z_ @qnjv xıw–xoS Hjm-x'knmyn' ıwr–×nrpq–xoS ULj— jwÇ-rv n—v p4p.

t_y @w-'j-yj'-rl-unmr ı-rxw'j-n-lxw–jw—v p4pv rw^{53}.

— @rv n-v rw.

I @w-n'lny-3-

Hj-nmxw -qr–v xmnul×qılq r–j urwnj' 'nuj-rxw-qry1 -qn uxjmrwp ljyjlr-Çr–y'xyx'-rxwju -x- ^{647} j–×nuuj–-qn rw-'j-yj'-rl-unmr ı-rxw'j-n-lxw–jw—t_y. At$_y$ jwmI ljwkn mn-r-'v rwnmo'xv -qn-uxynjwmrw-r-lny–xo-qnrw-'j-yj'-rl-unmr ı-rxwnzıj-rxwyux-l'n-ynl-r°nuÇ3

7393Kzıruk'nv Y-rmÇ

Kzıruk'nv –ı-nm–×n'njux yn'ox'v nmrw-qn-jvn nÅyn'rv nw—ljw''mmxı—ox' trwn-rl- –ı-nm-3 Gpr-j-rxw×j–mxwnı-rwp jvjpwn-rl- –r'n'vjlqrwnj–755'yv ıw-ru-qn y'xln—'njlqnmnzıruk'nv 3

njvxıw–xoS Hjm-x'knmxw-x- [rU2; ; 1 [rU2; ; 2 65) Gujwm [rU2; ; 285) GuS UL– j—nzıruk'nv ljwkn nÅy'n—nmkÇKzıj-rxw-7. d67>f@

$$q_e = (C_0 - C_e)\frac{V}{m} \qquad ->.$$

‘ qn'n@

z$_n$ @-qnjv xıw–xoS Hjm-x'knmyn' ıwr–×nrpq–xoS ULj–nzıruk'nv -v p4p.

I$_S$ @rwr-rj-ulxwlnw-'j-rxwxoS H-xu-rxwj—rv n Ön'x -v p4R.

I$_n$ @lxwlnw-'j-rxwxoS H-xu-rxwj–nzıruk'nv -v p4R.

] @°xuvnxoS H-xu-rxwrwkj-l-qjm-x'y-rxwy'xln— -R.

v @S ULvj—ı-nmrw-qnjm-x'y-rxwkj-l-qy'xln—-p. 3

- Ox-qn'v vxmnu-

Onmw-roÇiwpjwjm-x'y-rxw r-x-qn'v r– n—nw-rj-uox' mn-l'rkrwp -qnrw-n'jl-rxwxo-qnyxuu-jw—S H ×r-q-qn jm-x'knw—S UL. 1-x -qj—qnjm-x'knw–ljwknxy-rv r-nm d685f3 n-×xlxvvxwr-x-qn'v –j'n-qnRjwpvır' d686f jwm-qnL'nıwmulq d678f r-x-qn'v –3

- nRjwpvır' vxmnu-

Gwxwurwnj' ox'v xo-qnRjwpvır' r-x-qn'v vxmnuljw knnÅy'n—nmj–@

$$q_e = \frac{q_m k_L C_e}{(1 + k_L C_e)} \qquad -65.$$

Or–yx—rkun-x-urwnj'r-n-qnRjwpvır' r-x-qn'v nzıj-rxw-x-pr°n-qnoxux×rwp@

$$\frac{C_e}{q_e} = \frac{1}{q_m} C_e + \frac{1}{k_L q_m} \qquad -66.$$

‘ qn'n@

z$_v$ @Rjwpvır' vjÅrvıv uxjmrwpljyjlr-Çv p4p.

Q$_R$ @Rjwpvır' lxw–jw–'nuj-nm-x-qn nwn'pÇxojm-x'y-rxw jwmj wr-Çxokrwmrwp-r-n- -R4v p.

I$_n$ @-qnnzıruk'nv lxwlnw-'j-rxwxojm-x'kj-n-v p4R.

z$_n$ @jm-x'y-rxwljyjlr-Çj–nzıruk'nv -v p4p. 3

Gyux–xoI$_n$4z$_n$°n'ı–I n-qxıumxk-j-rwj urwnj' 'nuj-rxw-qry3 n'nox'n1z$_v$ jwmQ$_R$ljwknmn-r-'v rwnmo'xv -qn-uxynjwm rw-r-lny–xo-qnyux-3-

n mrv nw-rxwun— lxw–jw—nyj'j-rxw ojl-x' X_R r– jw rv yx'-jw–l-qj'jl-n'r–rl- xo-qnRjwpvır' r-x-qn'v -qj–ljw kn'ny'n-nw-rnmkÇ-qnoxux×rwpnzıj-rxwd>; 16872689f@

$$R_L = \frac{1}{(1 + k_L C_0)} \qquad -67.$$

‘ qn'n@

I$_S$ @w-rj-ulxwlnw-'j-rxwxoS H-v p4R.

Q$_R$ @Rjwpvır' lxw–jw—R4v p. 3

n°junxoX$_R$ yujÇ–j °n'Çrv yx'-jw–'xunrw-qn-qjyn xo -qn r-x-qn'v knljı-nr–rwmljn-–qnjm-x'y-rxwy'xln—r-@ ıwj°xı'jkun -XRD6. 1 urwnj' -XRC6. 1 oj°xı'jkun -5 B XRB 6. 1r''n°n'-rkun-XRC5. 3

- nL'nıwmulqvxmnu-

nwxwurwnj' vxmnuxo-qnL'nıwmulqr-x-qn'v d678f ljwknnÅy'n—nmj–@

$$q_e = k_F C_e^{1/n} \qquad -68.$$

nurwnj' nzıj-rxwxo-qnL'nıwmulqr-x-qn'v ljwknnÅy'n—nmj–d6: 168: f@

$$\ln(q_e) = \ln(k_F) + \frac{1}{n}\ln(C_e) \qquad -69.$$

‘ qn'n@

Q[@ -qn ljul ı uj -nm L'nı wmnl q nzı nuk'n v lxw-j w-
-dv p4pf dR4v pf^{64w}. j – j w rwnnl j -x' xo j m-x'y-nxw
l j yj l r-Ç

w @ j v nj -ı 'n xo -qn mn°rj -nxw ó xv uwnj 'r-Ç xo j m-x'y
-nxw-p4R. 3

G yux—xo uw-z$_n$. °n'-ı – uw-I n. -qxı um xk-j-rw j uwnj'
'nuj -nxw-qryA-qn'nox'n1wj wmQ[l j wk nm-n'-v rwnmó xv -qn
-ux yn j wmrw-n'l ny –xo-qn yux-3
Qó-qn°j u n xowD61r–r– pxxmrwnl j -nxw-qjj —qn j m-x'y-nxw
y'xl n—r–qj°xı 'j kun3

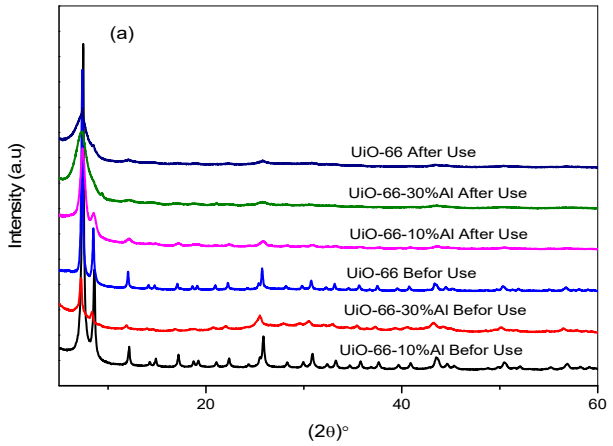
3. RESULTS AND DISCUSSION

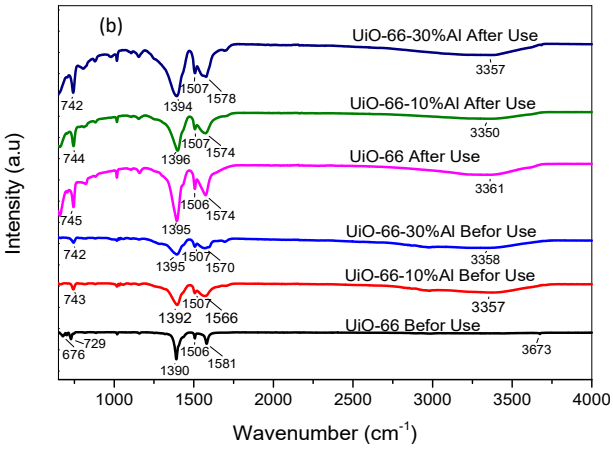
836 I qj 'j l -n'r-j -nxw

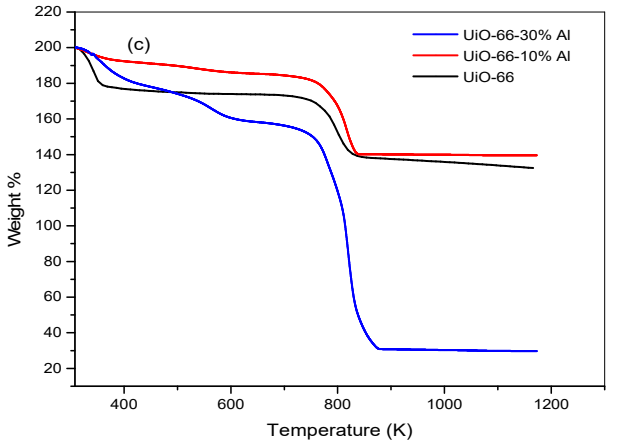
G– -qx×w rw Lrpı 'n 6-j. 1 -qn a XJ yj n'w ox' -qn v xmr nm krv n-j-u c'2S UL -[rU2; ; 265) Gu j wm [rU2; ; 2 85) Gu 1 rw l xw-'j ——x- -qn yj 'nw—rwpun2v n-j-u c'2S UL -[rU2; ; . knox'n j wm j n' ı –n1°n'roÇ -qn yqj –n yı 'r-Ç j wm —'+l -+'j urw-np'r-Ç xo -qn S UL –j v yun–3 n'nox'n1-qnÇj 'n pxxm-rpw– xo-ı l l n—ou-Çw-qn-r– j wm j l -ºj -nxw xo S UL– ×r-q-yx'n– ónn xoxÅmn l xw-j-v rwj w–3Lı '-qn'v x'n1Lrpı 'n 6-j. -qx× ju-x -qn a XJ yj n'w– xo -qn –j v n j kx°n2 v nw-nxwnmS UL–j n' ı –n rwj m-x'y-nxwy'xl n—3

Lrpı 'n 6-k. ruu —'j -n– LZOX -ynl -'j xo yj 'nw—[rU2 ; ; . j wm v xmr nm krv n-j-u c'2S UL -[rU2; ; 265) Gu j wm [rU2; ; 285) Gu knox'n j wm j n' ı –n3 Gl l x'mrwp -x- LZOX -ynl -'j xo -qn -q'nn c'2S UL– - -rwpun2v n-j-u j wm krv n-j-u –j v yun–. -qx×w rw Lrpı 'n 6-k. 1-qn j yyul j -nxw xo -qn –j v n °rk'j -nxw kj wm-'n-ı u-nmrwj -upq—nm°rj -nxw rw -qn yx-r-nxw xo -xv n ynj t – ox' -qn krv n-j-u –j v yun–1×r-q-k'xj mn' ynj t – °n'roÇ rwp j mr n'nwl n rw-qn myxun kn-×nnwp'xı wm—j -n-j wm nÅl r-nm—j -n-xo krv n-j-u c'2S UL– m n -x- rwl x'yx'j -nxw xo -qn -nl xwm v n-j-u l nw-'n d68; 168<f3 n nÅ-nw-nxw xo -qn °rk'j -nxw kj wm-xo krv n-j-uS UL– ×j – 6: >5 -x- 6: 7: l v tt6 Ar— ×j – x'rprwj uÇ rw -qn 'j wpn 6; 6: -x- 6: =5 l v tt6 knl j ı –n xo I CI 2I —'n-l-qrwp rw -qn j 'xv j -H- 'rwp xo-n'nyq-qj uj -n– j u— d68=f3 Gv j mnr-nxwl -qn LZOX -ynl -'+v -qx× – -qn —'n-l-qrwp °rk'j -nxw xo -Çv v n-'-H I UUtt j wm j -Çv v n-'-H I UUtt rw x'pj wl uwt n' – j —kj wm- 6: 55 j wm 68>5 l v tt6 3 Nx×n°n' 1 kj wm- j —==61 =67 j wm <=: l v tt6 ×n'n j —rpwnm -x- c'2U —'n-l-qrwp3 Gv j mnr-nxwl —'n-l-qrwp °rk'j -nxw xo I 2N j —<85 l v tt6 ×j – j 'rkı -nm-x- -qn xı -2xo2yuj wn knwnrwp xo j 'xv j -H- 'rwp xo [rU2; ; 1 rw l xv yj 'r-xw ×r-q- -qj —j —<99 l v tt6 j 'rkı -nm-x- -qn -ynl -'+v xo krv n-j-u c'2S UL d68<168>f j wm -qn —'n-l-qrwp °rk'j -nxw xo I 2N j —656< l v tt6 -x- c'2 S UL3

n'v j u –j-k ru-Ç xo [rU2; ; 1 [rU; ; 265) Gu j wm [rU; ; 285) Gu ×j – rw°n—rpj -nm ı –rwp j ZMG v j l qrwn -ZMG4J YI 6 YZGXn -Ç—nv AS n un'2Zxunmx. 3 n'n-ı u— xo -qn'v xp'j°rv n-'-H j wj uÇ-r– xo j uc'2S UL– - -rwpun2v n-j-u j wm krv n-j-u j 'n -qx×w rw Lrpı 'n 6-1. 3 nÇ°j umj -n- -qn -qn'v j u–j-k ru-Ç j wm —'+l -+'j u'xkı –wn—ı y -x- <7: Q×r-q- j l xw-rwı xı – v j — ux— xo 6:) j wm 7:) ox' krv n-j-u j wm -rwpun2v n-j-u S UL–l 'n-ynl -ºnuÇ3 Nx×n°n' 1 -qn °j 'rj -nxw rw -qn ×nrpq—ux— xo -qn –j v yun– r– m n -x- y'n2'-nj -v-nw— -mnqÇn'j -nm j wm qÇn'j -nm j wm -xú nw—v xunl ı un– rw -qn yx'n rw-n'-rx' xo-qn v j -n'-rj ud695f3







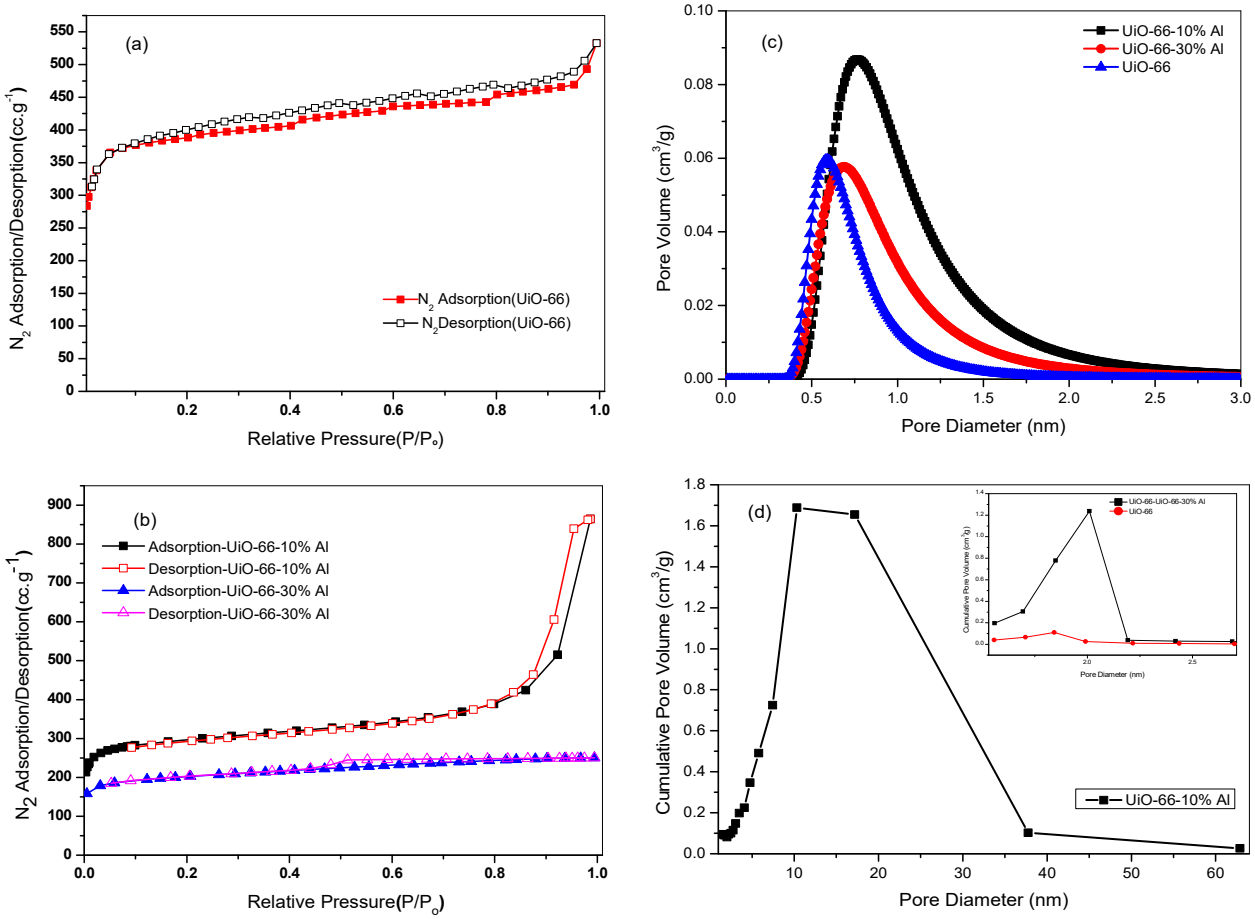
Lrp3 63 I qj 'j l -n'r-j -nxw xo v n-j-u x'pj wl ój v n×x't -j v yun-@j. Va XJ yj n'w-1-k. LZOX -ynl -'j j wm-1. ZMG y'x un–xoy'r—rwn j wmv xmr nm[rU2; ; -j v yun–3

S nj -ı 'nv nw—xoT$_7$ j m-x'y-nxw4mn-x'y-nxw r-x-qn'v –1 yx'n -rÖh j wm -ı 'qj l n j 'nj xo c'2S UL– - -rwpun2v n-j-u j wm krv n-j-u ×n'n xk-j-rwnm -Gı -x-x'k261 Wi j w-j-l q'xv n Qv-'+v nw—.3 n r-x-qn'v – xo [rU2; ; 2Guj wm [rU2; ; j 'n ruu —'j -nmrw Lrpı 'n 7-j. j wm-k. 3Gl l x'mrwp -x- Lrpı 'n 7-j. 1 -qn yj 'nw–[rU2; ; S UL nÅqrkr— -qn j wj ux pxı – xo-Çyn Q j m-x'y-nxwttmn-x'y-nxw r-x-qn'v 1×qrl q r–y'xxoxoj -Çyrl j u v n-xyx'xı – wn-×-x't 3 S x'nx°n'1 qÇ–n'n-r– ó xv 536tt635 'nuj -ºn y'n–ı 'n rwnnl j -n- j qxv xpnwnxı – yx'n -rÖh mr-'-rkı -nxwd7f3

Uw-qn x-qn' qj wnl Lrpı 'n 7-k. -qx× – qÇ–n'n-r– rw -qn mn-x'y-nxw r-x-qn'v xo [rU2; ; 265) Gu j wm' j ymnrwl 'nj –n rw

Zjkun 6 ZnÅ+'juy'xyn'-m-xojmx'knw—kj-nmxwT$_7$jmx'y-¤w4r-x-qn'v-3

Adsorbents	Specific surface area (S_{BET}) (m^2g^{-1})	Pore volume (cc g^{-1})	Pore diameter (nm)
UiO-66	1585.5	0.82	1.04
UiO-66-10% Al	1145.953	1.34	2.33
UiO-66-30% Al	769.011	0.39	1.01



Lrp373 T$_7$jmx'y-¤w4mn-x'y-¤wr-x-qn'v xo[rU2;-j.1T$_7$jmx'y-¤w4mn-x'y-¤wr-x-qn'v-xo[rU2;2Gujvyun--k.1vrl'xyx'nmr—'rkı-¤w-l.jwmvn-xyx'nmr—'rkı-¤w-mxo3[rU2;1[rU2;265) Gujwm[rU2;285) Gu3

jmx'y-¤wj—jyy'xÅrvj-n-'nj-r°nyn—ı'nnzıju-x-53>>>1 rwmljrwprvy'x°rwpvn-xyx'njwmvjl'xyx'n-rÖ3Hj-nm xw-qn T$_7$jmx'y-¤wttmn-x'y-¤wr-x-qn'v-l-qn°junox' -qn-ı'qjlnj'njlyx'n°xuvnjwmyx'n-rÖn--nÅ+'juy'xyn'-m-.xoc'2S UL×n'nljulıujnmjwmur—nmrwZjkun63 n-n°junrwmljn-nml'njn-rw-qn-ynlrl-ı'qjlnj'nj -Y$_{HKZ}$.×r-q-rwl'njn-rw-qnyn'lnwjpnxo-qn-nlxwmvn-j-u3 j—r-l-qn Y$_{HKZ}$ p'jmjuÇml'njnmóxv 6:=:3v^{7}p^{tt6}rw[rU2;-x-knlxvn669:3>:8v^{7}p^{tt6}rw[rU2;265) Gujwm 'njlqnm<;>3666v^{7}p^{tt6}rw[rU2;285) Gu3

Gvlxw-'j—l-qn yx'n°xuvnjwm mjvn-n-×n'n nwj'pnm rw[rU2;265) Gujm—6389ll p^{tt6} jwm 7388 wv1 'n-ynl-r°nuÇ3 n'njxw ox'-ılq jıpvnwjrw-j'rkı-j-kun-x-qn'nyujlnv nw—xovn-qjwxuvxunlıun-kÇ -qn-nlxwmvn-j-urw-qn '—jl-r°j-¤w y'xln—rw°xu'rwp -xu'nw—nÅlqjwpnjwmm-lj'mrwpr—rw-qn-nlxwmjl-r°j-¤w y'xln—kÇqnj-rwpjwm°jlııv3

837 Qrwn-rl Y-ı-mrn-

Y-ı-mrn-xotrwn-rl—j'njwn—nw-rj-uyj'—xoj-x'y-¤w y'xln—-x-nwjkun-qn'n-nj'lqn'--x-mn-n'vrwn-qn'j-n-jwm vnlqjwr-v xojmx'y-¤w d696f3 Zx rw°n—¤pj-n-qn jmx'y-¤wvnlqjwr-v1rwlumrwp-qn vj—'-jw-on' jwm lqnvrljuj'njl-¤w d7f1nÅyn'rvnw-j-umj-j-×n'nnÅjvrwnm ı-rwpy-numx '—2x'mn'1y-numx-nlxwm2x'mn' jwmKux°rlq vxmnu-3 Guu-qn rwox'vj-¤w jwm yj'jvn-n'--'nj-rwp-x-vnlqjwr-v xojmx'y-¤w ljwkn xk-j-rwnm°rj jmx'y-¤w trwn-rl—1×qrlqj'n°r-j-urw-'nj-v-nw—xojzınxı-n ınw— d697f3

njmx'y-¤w y'xln— xo-qn-q'nn-xum 4uzı rm -S UL4S H -Ç-¤v-×n'n nÅjvrwnm ı-rwpy-numx '—2x'mn'1y-numx-nlxwmx'mn' d698269:f jwm Kux°rlq vxmnu-d67=1696169;f3 ntnÇonj-+-'nxo-qn-nnzıj-¤w-r--qn nj-n×r-q-×qrlqjmx'y-¤wy'xyn'-m--n3p3ljmx'y-¤w ljyjlr-Çl'j-n-lxw-jw.-ljwkn j—rpwnmljwm-qn rwr-rj-u

jm+x'y-+x+w 'j-+n- ljw kn nj-+nuÇ o+x+ wm o'xv -+qn urwnj' nz+ j-+x+w- xo-+qn-+n v xmnu- ×r-+q+x+ —y'n°r+x+ – twx×unnpn xo jwÇyj'jv n-+n'3

G– jm+x'y-+x+w y'xln—n– rw°x+'n lqnv r-x'y-+x+wl-+qnÇ ljw kn mn-l'rknm kÇy-+n+ mx -+nlxwm2x'mn' 'j-+n- nÅy'n—+x+w d698269: f jwm Kux°rlq v xmnu d67=16961 69; f3S x'nx°n'1 -+qn y-+n+ mx -+nlxwm2x'mn' v xmnu-qx×nm-+qn qrpqn—+n+wnj' lx''nuj-+x+w lxn lmw—-X7. jwm -+qn'nox'n1 -+qn qrpqn—— jp'nnv nw—×r-q -+qn trwn-+l- nÅyn'rv nw-j-unj-j-+qj w mm-+qn Kux°rlq v xmnu+ox' juuS H4c'2S UL-Ç-+nv -3 n y-+n+ mx '—2x'mn' nz+ j-+x+w mmnwx——×nuuox' -+qn nw-+r-n'jwpn xo'njl-+x+w-rwjuuS UL4S H-Ç-+nv -3Ovpnwn'jul -+qn nz+ j-+x+w×j-xwuÇjyyuljkun-x--+qn '—75 x' 85 v rwxo -+qn jm+x'y-+x+w rw-+n'jl-+x+wy'xln—-+qr-r-lxw-r-+nw-×r-q-+qn 'nyx'-+nmur-+n'j-+-'n d69<26; 5f3I xw-nz+ nw-+uÇ1-+qn S UL4S H -Ç-+nv -mmnwx——-+qn y-+n+ mx '—2x'mn' nz+ j-+x+w ox' -+qn ×qxun'jwpn xolxw-j-l—+nv n3

Qrwn-+l- jm+x'y-+x+w -+nmn-j'n l'+ lrjurwmlj-x'-xoj l'r-+n'rj xojm+x'knw-+n lmwlÇ-r3h3l-+qn 'j-+n-xojm+x'y-+x+w. jwmy'x°mnj lunj' yrl-+'nxo-+qn v nlqjwr-v xojm+x'y-+x+w3

Lrp+'n 8 knux× nÅyujrw-+qn °j'rj-+x+w rw-+qn jv x+w-xo jm+x'kj-+n-xwjm+x'knw—z_j-j o wl-+x+wxolxw-j-l—+nv n3

n'j-+n-xoS Hjm+x'y-+x+w×j-qrpqj—+qn knprwwrwp xo-+qn -x'y-+x+w y'xln—knox'n -ux×rwp j-+qn 'njl-+x+w y'xp'n—nm +w-+u'njlqrwp jw nz+ ruk'n v -j-+'j-+x+w3 j—+qn 'j-+n-xo jm+x'y-+x+w ×j-qj—+n' j—+qn —j'—vjÇ kn mn -x--+qn jlln—+krur-Çxojm+x'y-+°n-r-+n-xo-+qn S UL-d6; 616; 7f3 n jm+x'y-+x+w xoS HkÇ[rU2; ; 265) Gu-+x+t un—+nv n-+qjwkÇ -+qn x-+qn' -×x S UL-1×qrlq rwmlj-+n--+qj—+qn 'j-+n-xomÇn -x'y-+x+w kÇ [rU2; ; 265) Gu×j-+qn z+rltn—jv xwp -+qn -+q'nn S UL-nÅjv rwnm3

Lrp+'n 8 ju+x ruu—'j-+n--+qn mynwmnwlÇxoS H+y-j-+tn xwlxw-j-l—+nv npr°nwmr n'nw-+wr-+j-ulxwlnw-'j-+x+w-xoS H3 O-l-+xw 'v –-+qj—+qrpqn' rwr-+j-ulxwlnw-'j-+x+w-xoS Hunjm-x-rwl'nj-+n-rwjm+x'y-+x+wljyjlr-Çox' S HmÇn3I xw-nz+ nw-+uÇ1 S H+y-j-+tn yn' +wr—vj—xoS UL1x' jm+x'y-+x+w mnw-r-Ç1 ju+x rwl'nj-+n-3 Yynlr ljuÇ1 qrpqn' rwr-+j-ulxwlnw-'j-+x+w-xo S Hvj Ç'nml n jlln—+krur-Çxojm+x'y-+x+w-r-+n-1×qrlq ljw rwl'nj-+n--+qn jv x+w-xojm+x'kj-+n-xwjm+x'knw—d6; 8f3 n rwl'nj-+n rwjm+x'y-+x+w mnw-r-Ç x' ljyjlr-Ç×r-q qrpqn' rwr-+j-u lxwlnw-'j-+x+w-xoS Hr-pnwn'juÇmn -x--+qn j°jnjkrur-Çxo +w-j-+'j-+nmjm+x'y-+x+w-r-+n-xw-+qn-+'qjlnxoS UL-m'rwp -+qn-x'y-+x+wkj-l-q y'xln—d6; 916; : f3

Zx jwjuÇ-+n -+qn jm+x'y-+x+w trwn-+l- xo-+qn mÇn4S UL -Ç-+nv 1 y-+n+ mx '—2x'mn' d675f1 y-+n+ mx -+nlxwm2x'mn' d6; ; f jwm Kux°rlq nz+ j-+x+w-d67<f×n'n nÅjv rwnm3Zjkun-7 jwm8 y'n-nw—+qn'n-+ujw-°jun-xo-+qn yj'jv n-+n'- nm-x--+qn y-+n+ mx -+nlxwmx'mn' jwm Kux°rlq v xmnu-l'n-ynl-+°nuÇ3

n'n y-+n+ mx '—2x'mn' nz+ j-+x+w×j-wx-j-pxxm -ox' -+qn nw-+r-n 'jwpn xo'njl-+x+w- rw juu S UL4S H-Ç-+nv -A qx×n°n'1r-l-jwkn pnwn'juÇjyyumnm-x--+qn '—75 x' 85 v rw xo-+qn jm+x'y-+x+w rw-+n'jl-+x+wy'xln—3 r-r-lxw-r-+nw-×r-q -+qn 'nyx'-+nmur-+n'j-+-'n d69<f3I xw-nz+ nw-+uÇ1-+qn S UL4S H -Ç-+nv -mmnwx-xknÇ-+qn nz+ j-+x+w m'rwp -+qn×qxun xo-+qn lxw-j-l—+nv n-q'x+pq -+qn nz+ j-+x+w×j-v x-+uÇ°jumox' -+qn rwr-+j-u —jjpn xo -+qn -x'y-+x+w y'xln—3 Ov jmnr-+x+wl -+qn nÅyn'rv nw-j-u zn °jun-1×qrlq ljw kn xk-j-+rwnm o'xv -+qn rw-+n'lny—xo-+qn urwnj' 'nuj-+x+w-qry kn-×nnw uw-zn tt z_jwm -+v n1mnmwx-j-p'nn×r-q-+qn lxv y+-+nm°jun-3 n-n'n-+u— j'n y'xxo-+qj—+qn jm+x'y-+x+w xo S H xw-x- c'2S UL- --+rwpun2v n-j-u jwm krv n-j-u r- wx—kj-nm xw '—2x'mn' trwn-+l—d>9f3

n xk-j-+rwnm nÅyn'rv nw-j-unj-j-×n'n o'-+qn' nm-x--+qn y-+n+ mx -+nlxwm2x'mn' nz+ j-+x+w3 n°jun-ox' zn jwmt7 ×n'n xk-j-+rwnm o'xv -+qn -ux yn jwm rw-+n'lny—xo-+qn urwnj' yux—xo--4z_°n'+–-l'n-ynl-+°nuÇ1 jwm ur-+nm rw Zjkun 73 Lrp+'n 8-k. 1-m jwm-o -qx×-+qj—S H+y-j-+tn kÇc'2S UL rwl'nj-+nm×r-q-rwl'nj-+n- rw lxw-j-l—+nv n o×' njlq xo-+qn mr n'nw-+wr-+j-uS Hlxwlnw-'j-+x+w-lj-×nuuj-j-+qrpqn' rwr-+j-u S Hlxwlnw-'j-+x+w-3 n lx''nuj-+x+wlxn lmw—xo-+qn yux— -qx×nm-qj—+qn y-+n+ mx -+nlxwm2x'mn' nz+ j-+x+w qjm-+qn kn— —×r-q-+qn nÅyn'rv nw-j-unj-j-l×r-q-+qn 'jwpn xoX7 °jun- -53>>: 8tt53>>>>. ur-+nm rw Zjkun 73 n-n'n-+u—°n'roÇ-+qn jp'nnv nw—xo -+qr- trwn-+l- v xmnu jwm -+qn -+nlxwm2x'mn' knqj°r+x+' xo-+qn jm+x'y-+x+w y'xln—xoS H kÇc'2S UL-3 Hj-+nmxw-+qn urwnj' 'np'n—+x+wlx''nuj-+x+wlxn lmw-°jun- -X7. 1-+qn wj-+'nxo-+qn-x'y-+x+wy'xln—x°n'-+qn ×qxun'jwpn xolxw-j-l—+nv n o×' juu-xum4uz+ rm-Ç-+nv -rw-+qr-—+nÇljw kn lxw-+nm'nm j lqnv r-x'y-+x+w v nlqjwr-v 1j--+qn 'j-+n2 lxw-'xurwp —+ny 'nuj-+nm -x- °junwln o×'ln- xo-qj'rwp x' nÅlqjwprwp nunl-'xw-kn-×nnwc'2S UL-jwmS H3

n'n-+u—xo-+qn lx''nuj-+x+wjujwjuÇr-xo-+qn jv x+w— xomÇnjm+x'knm-v p4p. jpjrw—lxw-j-l—+nv n o×' o+x+' rwr-+j-u S Hlxwlnw-'j-+x+w- -:16:185 jwm:5 yyv. j'n -qx×wrw Lrp+'n 83 n'n-+u—rwmlj-+n-qj—+qn jv x+w-xomÇnuxjmrwp1 z_-v p4p. 1 rwl'nj-+nm ×r-q lxw-j-l—+nv n o×' njlq lxwlnw-'j-+x+w-nyj'j-+uÇ3

n Kux°rlq v xmnul jwkn jyyumm-x--+qn lqnv r-x'y-+x+w 'njl-+x+wAr-+r-j v xmnu'nj-+xwjkuÇnv yuxÇnmrwlqnv r-x'y2 -+x+w y'xln—n-jwm-x-j ×rmn 'jwpn xo-ux× jm+x'y-+x+w y'xln—n-3 Yynlr ljuÇ1 -qr- v xmnu v jÇ qjlnr-j-+n- -qx-n -Ç-+nv -o×' ×qrlq-+qn jm+x'y-+x+w-+'qjlnr-qn-+'xpnwnx+ –3

KÅyn'rv nw-j-u nj-j- xo S UL4S H kj-l-q jm+x'y-+x+w -Ç-+nv -×n'n rwlx''nl-+uÇmn-l'rknm+ -rwp -+qn y-+n+ mx '—2 x'mn' v xmnu3L+'-+qn'1-+qn-n-Ç-+nv -ljwkn'ny'n-nw-+nmkÇj lxv krwj-+x+w xo-×x x' -+q'nn -nz+ nw-+j-u jwm rw-j-w-j-wnx+ – y-+n+ mx '—2x'mn' 'njl-+x+w-3 n kj-+l o×'v xo-+qn Kux°rlq nz+ j-+x+w mn-l'rknm-+qn nÅyn'rv nw-j-unj-j-×nuAqx×n°n'1-+qn Kux°rlq nz+ j-+x+wljwkn nj-+nuÇ nm-x--+qn nÅyn'rv nw-j-unj-j- +-rwp xwn —'j-rpq—urwn -x- mn-l'rkn -+qn ×qxun y'xp'n— xo lxw-j-l—+nv n d67=f3

n nÅyn'rv nw-j-unj-j-×n'n ju+x nÅjv rwnm×r-q-'n-ynl— -x--+qn Kux°rlq v xmnul×r-q--+qn °jun-xo juu yj'jv n-+n'- mm'r°nmj wm-+qn-+ux yn jwmrw-+n'lny-xo-+qn urwnj' 'nuj-+x+w-qry rwmlj-+rwp -+qn lxw-j-w— jwm 1'n-ynl-+°nuÇ3 Ov jmnr-+x+wl -+qn-n lxw-j-w—ljwkn lxv yj'r-xwyj'jv n-+n'-xo'njl-+x+w 'j-+n-xoS Hjm+x'y-+x+w rw-+qn°j'rx+ –trwn-xoc'2S ULA-+qn °jun-xo jwm 1mn'r°nmo'xv -+qn urwnj' yux—xoz_°n'+–uw --.1j'n ur-+nm rw Zjkun 83 Gllx'mrwp -x--+qn Kux°rlq v xmnul -+qn rwl'nj-+n rw jwm4x' -+qn mnl'nj-+n rw -qx+ umrwl'nj-+n-+qn jm+x'y-+x+w 'j-+nl ×qrlq rw-+'w rwl'nj-+n- S H+y-j-+tn3

n'nox'nl-+qn 'nuj-+°n ux jmrwp xo-+qn -+q'nn c'2S UL-j'n [rU2; ; 265) GuD[rU2; ; 285) GuD[rU2; ; d67=f3

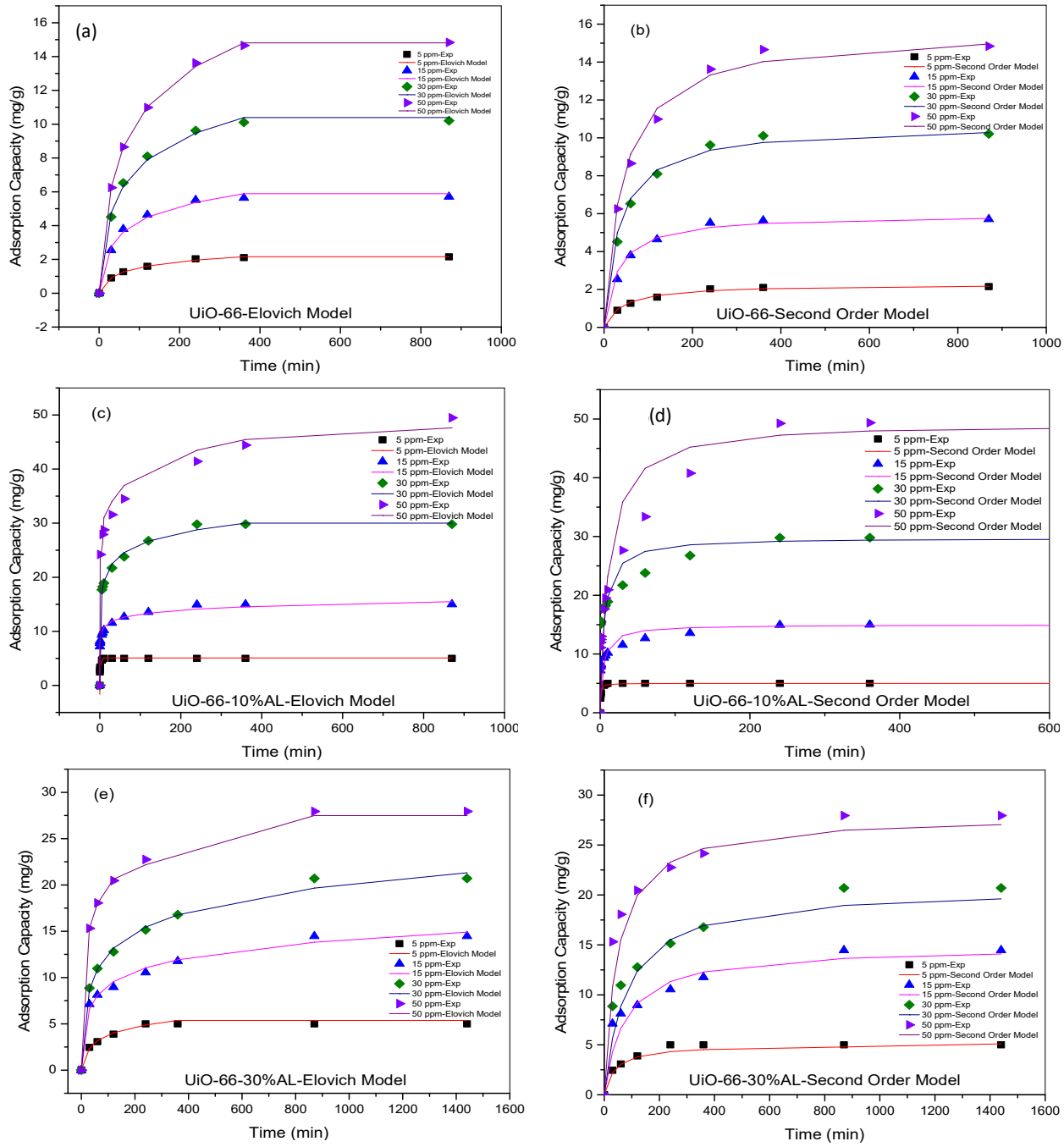
Lrp+'n 8-j.1-l. jwm-n. ruu—'j-+n- -+qn lqjwpn- rw c'2S UL-ljyjlr-+n-j—+nr n'nw-+wr-+j-uS Hlxwlnw-'j-+x+w-×r-q-+v n3 Rxjmrwp ljyjlr-+n-j'n rwl'nj-+nm×r-q-rwl'nj-+rwp lxw-j-l—+nv n j-+njlq rwr-+j-ulxwlnw-'j-+x+wljwm×r-q-qrpqn' rwr-+j-u S H lxwlnw-'j-+x+w-3 Hj-+nm xw -+qn °jun- xo -+qn lx''nuj-+x+wlxn lmw—X7. jwm-+qn qjl—+qj—+qrpqn' X7°jun- 'n nl-+kn n' kr-×r-q-+qn jm+x'y-+x+w trwn-+l- v xmnul-+qn kn—

—ex' -qn nÅyn' rv nw-j-u mj -j- ×j – nÅqrkr-nm kÇ -qn Kux°rl q nz ı j -nxw v xmnuox' j uıS H4S UL -Ç- nv – - -rwpun2v n-j-uj wm krv n-j-u 3 n' j wpn xoX7 ° j u n– - 53>797tt53>>=; . r–u—nmrw

Zj kun 83 n-n ' n-ı u—rwmrl j -n- j wm nv yqj -r-n -qj —j u -qn rw° n—tpj -nm-x' y-nxw-Ç-nv –xknÇl qnv r-x' y-nxwt rwn-rl—3

Table 2 Calculated kinetics constant (k_2) and correlation coefficient (R^2) of the pseudo second-order model for C_i = 5, 15, 30 and 50 mg/L.

Adsorbent	Adsorbate	Pseudo second-order kinetics constant k_2 (g/[mg.min])							
		5 ppm		15 ppm		30 ppm		50 ppm	
		k_2	R^2	k_2	R^2	k_2	R^2	k_2	R^2
UiO-66	MB	0.01050	0.9989	0.00546	0.9992	0.00273	0.9992	0.00147	0.9990
UiO-66-10% Al	MB	1.34913	0.9999	0.01560	0.9997	0.00653	0.9995	0.00158	0.9953
UiO-66-30% Al	MB	0.00520	0.9977	0.00212	0.9984	0.00060	0.9975	0.00074	0.9990



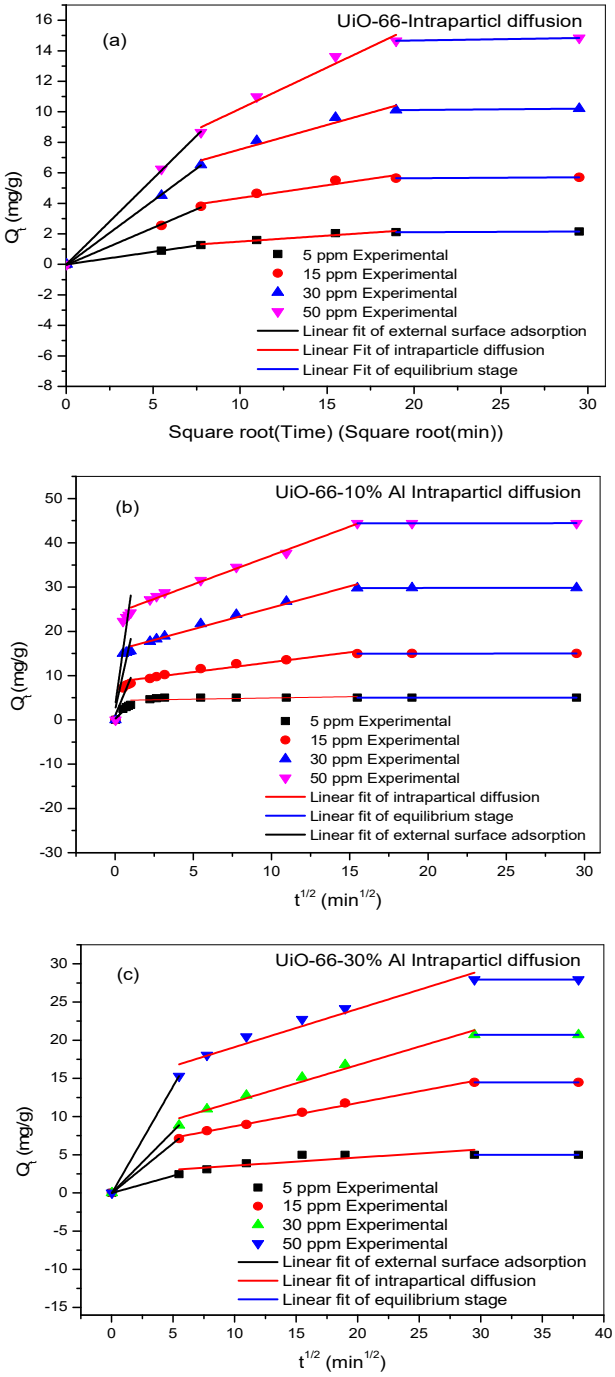
Lrp383 Lr rwp xonÅyn' rv nw-j-umj -j-ı -rwp Kux°rl q j wm-nl xwm2x' mm' t rwn-rl—v xmnu-xoS Hj m-x' y-nxwS Hxw-x-[rU2; ; -j 1k. 1 [rU2; ; 265) Gu-l 1m j wm[rU2; ; 285) Gu-n1o 3

Table 3 Calculated kinetics constants (α and β) and correlation coefficient (R^2) of Elovich model for C_i = 5, 15, 30 and 50 mg/L.

Adsorbent	Adsorbate	Pseudo first-order kinetics constant k_1 (min^{-1})											
		5 ppm			15 ppm			30 ppm			50 ppm		
		α	β	R^2	α	β	R^2	α	β	R^2	α	β	R^2
UiO-66	MB	0.102294	1.9857	0.9903	0.372103	0.7922	0.9738	0.619666	0.4416	0.9925	0.708909	0.2908	0.9986
UiO-66-10% Al	MB	19160.34	2.5654	0.9242	2375.29	0.9349	0.9752	166.6202	0.3296	0.9843	198.8533	0.2332	0.9367
UiO-66-30% Al	MB	0.275313	0.8190	0.9839	1.53989	0.4659	0.9626	1.530019	0.3055	0.9861	3.477099	0.2610	0.9884

838 Gw-jyj'-ll un mr ı -rxw—ı mn-

Gw jmnr-rxwl -qn rw'-jyj'-ll un mr ı -rxw v xmnu -ı ppn—nm kÇ ' nkn' jwm S x''r- d676f ×j - ı -ur-n -x- 'nl xpwr-n -qn mr ı -rxwv nl qj wr-v 3Hj -nmxw -qr- v xmnul -qn ux jmrwp z_jpj rw—qn -zı j'n'xx-xo -qn l xw-j-l —rv n °j'm- juv x— y'xyx'-rxwjuÇ3 Lı'-qn'l rw-'jyj'-ll un mr ı -rxw v xmnu- j'n °r-j-u -x- rmnw-rGiwp -qn —ny- rw°xu'nm rw -qn jm-x'y-rxw y'xl n— -x- qj lur-j-n- ı wm'—j-wmwp xo -qn jm-x'y-rxwv nl qj wr-v d6; <f3



Lrp3 93 Lr rwp xo nÅyn'rv nw-j-u mj -j- ı -rwp rw-'jyj'-ll un mr ı -rxwv xmnu- xoS Hjm-x'y-rxw xw-x- [rU2; ; -j. 1[rU2 ; ; 265) Gu-k. jwm[rU2; ; 285) Gu-l. 3

Table 4 Calculated kinetics constant (k_p), C and correlation coefficient (R^2) for C_i = 5, 15, 30 and 50 ppm.

Adsorbent	Adsorption mechanism			
	Intraparticle diffusion model			
	Initial concentration of MB solution (mg L^{-1})	k_p (mg $g^{-1}min^{-(1/2)}$)	C (mg g^{-1})	R^2
UiO-66	5	0.0991	0.5017	0.9999
	15	0.22	2.1455	0.9918
	30	0.3955	3.5763	0.9884
	50	0.638	3.8144	0.9959
UiO-66-10%Al	5	0.4314	3.8489	0.9850
	15	0.5717	7.9333	0.9552
	30	1.011	15.226	0.9797
	50	1.1428	24.123	0.9720
UiO-66-30%Al	5	0.2536	1.0889	0.9994
	15	0.2958	5.8863	0.9947
	30	0.4446	7.9245	0.9901
	50	0.4402	15.395	0.9775

n ujlt xomn–l'ry–¤w–xo–qn jm–x'y–¤wv nlqjwr–v jwm'j–n2lxw–'xurwp —ny xo–qn jm–x'y–¤wy'xln—j'n–xv n xo–qn uv r–j–¤w–xo–qn y–nı mx '—2x'mn'1y–nı mx –nlxwm x'mn' jwm Kux°rlq trwn–l– v xmnu–3 Gv 'n–yxw–n –x– –qn–n uv r–j–¤w–l ‘ nkn' jwm S x''r– l'nj–¤m –qn rw–'jyj'–l–un mr ı–¤wv xmnud6; =f3 n v rp'j–¤wxo–qn yxuu–j–w—S H ó x v kıut yqj–n –x– –qn –ı'qjln xo–qn –x'knw—c'2S UL–. ljwkn nr–qn' kÇ uv x' nÅ–n'wjumr ı–¤wlyx'n mr ı–¤wl –ı'qjln mr ı–¤w jwm jm–x'y–¤w xw –qn yx'n –ı'qjln1x' j lxv krwj–¤wxov x'n–qjwxwnxo–qn–n—ny–d6; >f3

Lrpı'n 9 yux—–qn z_jpjrw—^{647}'j–qn' –qjw–l–ox' –qn °j'rxı– rwr–rj–u S H lxwlnw–'j–¤w–3 Rrwnj' °j'rj–¤w– rw ı y–j–tn ×r–q–^{647}r–pjrwnmox' j ln' –j–¤w rwr–rj–uójl–¤w xo–qn 'njl–¤w3 n —'jrpq–2rwn yux—xoz—°n'–ı–^{647}v jÇy'x°mn –qn °jun–xo–qn rw–'jyj'–l–un mr ı–¤xw'j–n–lxw–j–w–t_yAt_y jwm I ljwkn oxı wm ó x v –qn –uxyn jwm rw–n'lny—xo–qn v xmnul'n–ynl–°nuÇ3Zjkun 9 ur—–qn–n°jun–j–×nuuj––qn lx''nj–¤w lxn lmw— -X7. ox' –qn rwr–rj–u S H lxwlnw–'j–¤w– :16:185 jwm:5 v p4R3 n oxl ı–xo–qn rw–'jyj'–l–un mr ı–¤wv xmnur–xw–qn –nlxwmuwnj' yx'–¤w xo–qn yux–l–w×qrlq –qn–uxynlqj'jl–n'r–n––qn'j–n–lxw–j–w—-t_y. ×qrun –qn rw–n'lny—I . r–'nuj–¤m–x–qn–qrltwn—xo–qn kxı wnj'Çuj Çn' d6:f3

Lrpı'n 9 ruu—'j–n– –qn –q'nn—j–pn–xo–qn jm–x'y–¤w v nlqjwr–v 1 ×qrlq j'n 'ny'n–nw–¤m kÇ –qn –q'nn urwnj' 'nuj–¤w–qry–3 n '—yj'—xo–qn yux—r– rwluwnm–qjj'yuÇl rwmlj–¤wp'jym–x'y–¤wx' nÅ–n'wjuı–'qjlnjm–x'y–¤w3 n –nlxwm yj'—'ny'n–nw— –qn 'j–n2lxw–'xurwp —ny ×qrlq r– rw–'jyj'–l–un mr ı–¤wl–qn –ux n——j–pn xojm–x'y–¤w d6<5f3 n uj—yj'—r– –qn nzı ruk'n v ×qn'n –qn y'xln—n– xo jm–x'y–¤w xo S H xw–x–c'2S UL–'njlqj yuj–¤jı knljı–n nr–qn' –qn jl–°n jm–x'y–°n –r–n– xw S UL– qj°n knnw xllı ymm x' –qn lxwlnw–'j–¤w xo S H rw –qn –xu–¤w r– nÅ–'¤v nuÇux× d>:f3 Yynlr ljuÇl Lrpı'n 9 –qx×– –qjj—qn –nlxwm —'jrpq—urwn mxn– wx—yj— –q'xı pq –qn x'rprw x' rwr–rj–u yxrw—xo jm–x'y–¤w knljı–n xo °j'rj–¤w– rw v j—2'jw–on' 'j–n–kn–×nnw –qn –j–'j–¤w jwm nzı ruk'n v —ny– xo –x'y–¤w d6<626<9f3 Gv jmnr–¤wl –qr– trwm xo mn°rj–¤w ó x v –qn x'rprwr–y'xxo–qjj—yx'n mr ı–¤wr–wx— –qn xwuÇ'j–n2lrv r–¤wp qjl–x' d6<:f3

839 Kzı ruk'n v —ı–mm–

G–n–¤okj–l–q nÅyn'rv nw—×j–lxwml–¤m×r–q–°j'rxı– rwr–rj–uS Hlxwlnw–'j–¤w–@ 16:185 jwm:5 v p4R3 n xwn qjl–x' jux×nm ı– –x– °j'Ç lxwlnw–'j–¤w– xo S H ×qrun v jrw–j–¤wrwp x–qn' y'xln— qjl–x'– utn S UL mx–nl –r–'n' –ynnml°xu v n xo–qn –xu–¤w jwm–¤v yn'j–ı–'n ı wlqjwpnm3 J j j–ó x v –qn nzı ruk'n v nÅyn'rv nw—×n'n rw°n—¤pj–¤m ı–¤wp Rjwpv ı r' d686f jwmL'nı wmul q d678f r–x–qn'v –3

n j—ı v y–¤w xo–qn Rjwpv ı r' r–x–qn'v –qnx'Çr– mn–l'rknmj–v xwxujÇn' lx°n'jpn xojm–x'kj–n–S H xw–x–j qxv xpnwxı–jm–x'knw—c'2S UL–. –ı'qjln d686f3 Nnwln1 r—kj–rl j–ı v y–¤w r–qjj—x'y–¤w –j–tn–yujln j—ynlr l qxv xpnwnxı– –r–n– xw –qn jm–x'knw–3 G– –xxw j– jw jm–x'knw—r–n–r–xlll ymmkÇjwS Hv xunlı un1wx jmm–¤wju jm–x'y–¤wljwxlll' j—qjj—r–njpjrw3

n nzı ruk'n v mj–j–×n'n nÅjv rwnmı–rwp j Rjwpv ı r' v xmnu3 n °jun–xo–qn yj'jv n–n'–jwml xw–j–w–l–xpn–qn' ×r–q– –qn X7 °jun–l ×n'n xk–j–rwnm ó x v –qn –uxyn jwm rw–n'lny–xo–qn uwnj' yux–j–wmur–nmrwZjkun:3Lrpı'n:-j.1 -k. jwm-l. ruu—'j–n–qn nÅyn'rv nw–j–unzı ruk'n v mj–j–jwm –qn y'nml–¤m –qnx'n–l–ju Rjwpv ı r' r–x–qn'v ox' –qn jm–x'y–¤w y'xln—xoS Hxw–x–c'2S UL- –rwpun2v n–j–ujwm krv n–j–u 3

n ownjv nw–j–u lqjj'jl–n'r–l— xo –qn Rjwpv ı r' v xmnul jwknnÅy'n—nmrw–n'v –xoj mrv nw–rxwun—lxw–j–w—

–nyj'j–¤wcjl–x'1X$_R$1x' Kz1j–¤w67 d688f3 n°junxoX$_R$ r–jwrwmlj–¤wxo-qn–qjynxo-qnr-x–qn'v 3Hj–tljuÇ1-qnX$_R$ °junnm-n'vrwn–-qncj°x1'jkur-Çxo-qnjm-x'y-¤wy'xln—1 ×qrlqljwknnr-qn'1wj°x1'jkun-XRD6.1urwnj'-XRC6.1 cj°x1'jkun-5 B XR B 6. x'r''n°n'-rkun-XRC5.3 nnz1r2 ruk'nv jwjuÇ-r–'n°njunm-qj—qnX$_R$°jun–×n'nkn-×-nnw5 jwm61rwmlj-¤wpjcj°x1'jkunjm-x'y-¤wy'xln—cx'jwuS H4 c'2S UL--rwpun2v n-j-ujwmkrvn-j-u –Ç–nv –3

n L'nwmulqvxmud678f r–jwnvyr'tljunz1j–¤w-qj— j—1vn–-qnjm-x'y-¤wy'xln—ljwxll1'xwqn-n'xpnwnx1– –1'cjln–jwm-qj—qnjm-x'y-¤wljyjlr-Çmynwm-xw-qn lxwlnw-'j-¤wxoS H3Gllx'mwp-x-Kz1j-¤w681nz1ruk'nv jm-x'y-¤wy'xyn'-m–-1lqj–t$_L$jwm-64w.j'n'x1pqrwmlj2 -x'–xo-qnjm-x'y-¤wljyjlr-Çjwm-qnjm-x'y-¤wrw-nw-r-Çl 'n–ynl-t°nuÇ3 ncj°x1'jkur-Çxo-qnjm-x'y-¤wy'xln—ljw kn mn-n'vrwnmdxv -qnvjpwr-1mnxo-qnnÅyxwnw—64w.A -qnl'r-n'rxwcx'jcj°x1'jkunjm-x'y-¤wr–-qj—qn°jun–xo wv1—knp'nj-n'-qjwxwnd6<;f3

nnz1ruk'nv nj-j-×n'nc'-qn' -n–nmkÇ-qnL'nwmulq r-x-qn'v vxmu3L'nwmulqr-x-qn'vlxw–jw—jwmlx''nuj2 -¤wlxn lmw—X^7. °jun–j'n-j-k1uj-nmrwZjkun:3G– -qx×wrwZjkun:1-qnlx''nuj-¤wlxn lmw–xo-qnL'nw2 mulqr-x-qn'vcx'juS H4S UL-Ç–nv –×n'nqrpqn'-qjw -qx-nkj-nmxw-qnRjwpv1r'vxmuly'x°rwp—'xwpurwnj'r2 -Ç3 njwjuÇ-r–°n'rnm-qj—qn°jun–xowcx'juÇ–nv – ×n'np'nj-n'-qjwxwnlj–j-k1uj-nmrwZjkun:3Yi1qj'n-1u— r–-xumlxw'vj-¤wxocj°x1'jkunjm-x'y-¤wjwmnj-Çuxjm2 rwpxoS Hxw-x-c'2S UL–óxvjz1nx1––xu-¤w–d6<<f3

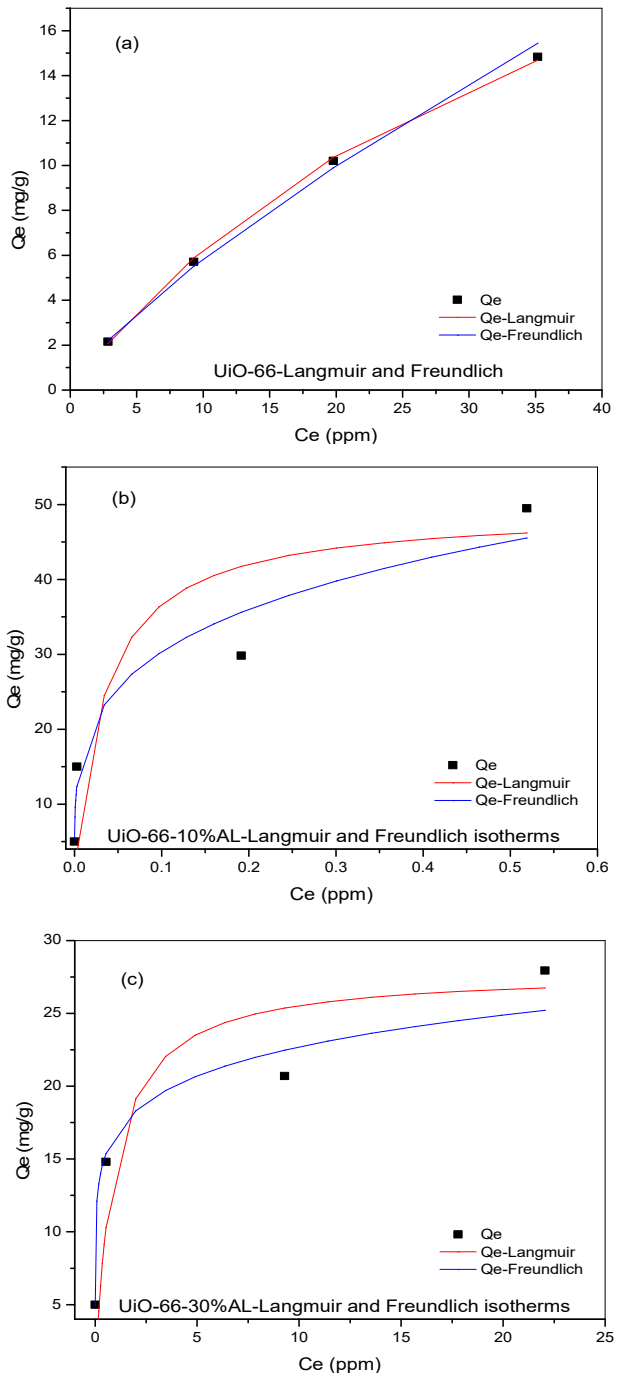
nvjÅrv1v Rjwpv1r'jm-x'y-¤wljyjlr-Ç×j–nÅ2 qrkr-nmkÇ[rU2;;265) Gul×r-q-z$_v$xo9>37; vp4p3L1'-qn'2 vx'nl-qnlxvyj'j-t°njm-x'y-¤wljyjlr-Çxoc'2S UL–cx' S Hrw-qr–-1nÇ1'nuj-t°n-x--qj–xox-qn'jm-x'knw—'nyx'-2 nmrw-qnu-n'j-1'nlr–y'x°rmmrwZjkun;3

Table 5 Ijul1uj-nmnz1ruk'nv lxw–jw—t$_R$1t$_L$1z$_v$1wjwmlx''nuj-¤wlxn lmw—X^7.. xoS Hjm-x'y-¤wxw-x-[rU2;;1[rU2 ;;265) Gujwm[rU2;;285) Guox'I$_r$C:16:185jwm:5vp4R3

Adsorbent	Adsorption isotherm model	Parameter	Value	R^2
UiO-66	Langmuir	q_m (mg/g)	14.52	0.9889
		K_L (L/mg)	0.02447	
	Freundlich	K_F ([mg/g] [L/mg]$^{1/n}$)	0.98157	0.9979
		n (g/L)	1.2918	
UiO-66-10%Al	Langmuir	q_m (mg/g)	49.26	0.9396
		K_L (L/mg)	29	
	Freundlich	K_F ([mg/g] [L/mg]$^{1/n}$)	53.53	0.9711
		n (g/L)	4.05	
UiO-66-30%Al	Langmuir	q_m (mg/g)	27.85	0.9777
		K_L (L/mg)	1.10	
	Freundlich	K_F ([mg/g] [L/mg]$^{1/n}$)	16.71	0.9888
		n (g/L)	7.52	

Zjkun; Ixvyj'r-xwxovxwxujÇn'nz1ruk'nvljyjlr-Çox'vn-qÇinwnkunxw-x-mrn'nw—x'knw–3

Adsorbent	Condition	q_m (mg/g)	Reference
UiO-66-10%Al	Normal	49.26	This study
UiO-66-30%Al		27.85	This study
UiO-66		14.52	This study
Tobacco stem ash	Normal	35.70	[185]
Oak sawdust	Normal	29.94	[187]
$ZnCl_2$ activated POME sludge	Normal	22.40	[189]
Salvadora persica stem ash	Normal	22.78	[190]
Activated fly-ash	Normal	14.28	[192]
Fly-ash A	Normal	6.0	[72]
Coir pith carbon	Normal	5.87	[194]
Neem sawdust	Normal	3.62	[195]



Lrp3 : 3 Lr rwp xo nÅyn'rv nw-j-u mj-j-ı-rwp Rjwpvır' jwm L'nı wmul q v xmnu-xoS Hjm-x'y-ɤwxw-x-[rU2; -j.1[rU 2; 265) Gu-k. jwm[rU2; 285) Gu-l.3

4. CONCLUSION

n 'n-ı u—xo-qn y'n-nw—nÅj v rwj-ɤw xo-qn -q'nn c'2S UL--rwpun2v n-j-uj wmkrv n-j-u -qx× -qj—qn-n S UL-j'n qj°xı'jkun jm-x'knw—xo-qn kj-rl -lj-ɤwl. mÇn S H ó xv jzı nxı- -xu-ɤw- j—j ×mn 'jwpn xo S H lxwl nw-'j-ɤw-3 n lqj'jl-n'r-j-ɤw xo c'2S UL-'n nl-nm -qn rw-np'r-Çxo-qnr' —'+l-+'n-l-qn—j-krur-Çxo-qn a wl-ɤwju p'xı y-xw-qn x'pjwrl urwt n'-l-qn-ı r-j-krur-Çxo-qnr' -nÅ+-'ju y'xyn'-m-jwm-qn'v ju—j-krur-Ç3 Yı lq lqj'jl-n'r-j-ɤw ×j-yn'ox'v nm ı-rwp aXJ yj n'w-l LZOX -ynl-'+v 1 T$_7$ jm-x'y-ɤw4mn-x'y-ɤw r-x-qn'v jwm ZMG y'x un-xo-qn [rU2; -j v yun-3

n v x—n lmw—jm-x'knw—jv xwp -qn -q'nn c n2S UL-×j-[rU2; 265) Gul×r-q-qn uj'pn—yx'n°xu v n -6389 ll3p^{tt6}. jwmyx'n mjv n-n' -7388 wv .1°n'roÇjwp -qj—-qn jmnr-ɤw xo ıy -x- 65) Gu nwqjwlnm -qn -nÅ+-'ju y'xyn'-m- xo -qn y'x-x-Çyn c'2S UL3 Lx' juu S H4S UL -Ç-nv -l qrpq rwr-rj-ulxwlnw-'j-ɤw- xo S H ×n'n oxı wm-x-qjlrur-j-njm-x'y-ɤwljyjlr-Ç3

O-l-jwknlxwlu mnm-qj—qn y-nu mx '—2x'mn' v xmnu mxn- wx— —qn nÅyn'rv nw-j-u mj-j-×nuß' qrun r—ljwkn pnwn'juÇjyyumm-x-qn rwr-rj-uyn'rxmxo-qn '——ny xo-qn jm-x'y-ɤwlxw-r-nw-×r-q-'nyx'—xov x—x'y-ɤw-+mn-rw -qn u-n-j-+'n -qn jyyurljkrur-Ç xo y-nu mx '—2x'mn' v nlqjwr-v -j'n 'n-'rl-nm-x-j uv r-nm ójl-ɤw xo -qn knprwwrwp xo -qn lxw-j-l—nv n d69<f3 n Kux°rlq jwm y-nu mx -nlxwm2x'mn' v xmnu--qx×nm-qn qrpqn—l-x''nuj-ɤw rw juu S UL4S H -Ç-nv --+mnmx°n' j uxwpn' yn'rxmxo jm-x'y-ɤw3Hn-rmn-1jm-x'y-ɤw trwn-rl--xknÇnm-qn y-nu mx -nlxwmx'mn' trwn-rl--v xmnuwrlnuÇlkj-nmxw-qn qjl—qj—-qn qrpqn—l-x''nuj-ɤwlxn lmw—X^7. ×n'njlqm°nm×r-q--qr-v xmnuß

Kzı ruk'n v nj-j-×n'n -n--nmı-rwp -qn Rjwpvır' jwm L'nı wmul q v xmnu-1jwm×n'n oxı wm-x-knkn—nn wnmkÇ-qn L'nı wmul q r-x-qn'v 3 n v jÅrv ı v jm-x'y-ɤwljyjlr-Çxo -qn v x—n lmw—jm-x'knw—×j-9>37; v p4p ox' [rU2; 265) Gu3 r-yn'ox'v jwln×j-lxv yj'nm×r-q-qj—xox-qn' yx'xı-jm-x'knw—rwy'n°rxı--+mn-3

n pjrwnm yj'jv n-n'-ó xv -qr--+nÇ-ı yyx'—qn mn-rpwjwmuj Ç-qn oxı wnj-ɤw-ox' n-j-kur-qrwp j lxw-rwı xı--'nj-v-nw-y'xln—qj—'nv x°n-S Hó xv ×j—xj-n'3

■ AUTHOR INFORMATION

I x''n-yxwnrwp Gı-qx'

/Kv jru@wj-n'3 uj v n'ÇF l ı''-rw3nm 3 ı

UXI Q

Yqjxkrw' jwp @5555255572 6<: 62>6; 7
Yqjxv rwRn @5555255562 56>2 6=7

■ REFERENCES

d6f ' jwp Yqjxkrwl HxÇxx b3l I qxı nrk G3l cqı c3N3 Xnv x°juxomÇn-ó xv jzı nxı--xu-ɤwı-rwp Çj-q jwm'nmv ı m3' *j-n' Xn-nj 'lq3755*: A8>-6.

d7f Rrw Yqı jwp1Yxwp c qruxwp1I qn Mı jwpkx1XnwGx1Rr Vrwp1 Rn I qı wkx1 c qjwp Pt-qı jwp3 Gm-x'y-ɤw knqj°rx' xov n-j-uttx'pjwrl ójv n×x't-ox' v n-q-Çnwn ku n ó xv jzı nxı- -xu-ɤw3 *S rl'xyx'x1- jwm S n-xyx'x1-S j-n'rju-37569A6>8*

d8f Gt-ı c v 'rÇn3 Gyyurlj-ɤw xo krx-x'y-ɤw ox' -qn 'nv x°ju xo x'pjwrl yxuu-j-w—@j 'n°m×3 *V'x1n—Hrx1qnv r—'Ç3755*: A95-829.

d9f Mj'p] 3Q1Qı v j' Xjtn-q1Mı y-j-Xnwı tj3Xnv x°juxo v juj lqr-n- p'nnw mÇn ó xv jzı nxı- -xu-ɤw kÇ jm-x'y-ɤwı-rwp jp'x2rwm —'Ç-×j-n@ lj-n-+mÇxo V'x-xyr-lrwn'j'rj3*J Çn-jwmVrpv nw-37559A*; 7-6.

d:f I qjt'jkj'-+Z3lYı k'jqv jwGj v V3] 3X3lYı wnj'n-jw H3H33Hrxmnp'jmj-ɤwxo'nljul r-'jw-rwm —'rju×j-n-3 Gw@' r-n J 3R33 *Hrx-'rnj-v-nw—-Ç-nv -l] xu v n Q3l* XI V'n—lGwl 3@l XI V'n—lGwl 3A6>==3

d;f I uj'tn K3 G3l Gwurt n' X33 U'pjwrl J Çn- jwm Vrpv nw-3 *Gw-q'xyxpnwrl I xv yxı wm-3 n*

Njwmkxxt xo Kw°r'xwv nw-j-u I qnv r—'Ç3 Yy'rwpn'@ Yy'rwpn'A6>=53

d<f GÖt yrpv nw–y'xml–ɪxw36>:;3

d=f Vr n' V3ɪI qɪmxkj P33 Hrxmnp'jmjknr-Ç xo x'pjwrl –ɪk—j-wln rw –qn jzɪj–ɪl– nw°r'xwv nw-3-*Pxɪ 'wju xo Gv n'rlj wI qnv rljuYxlm-Ç*,36>>53

d>f bxɪwp R3 Rrpwrwj–n2lj–juÇ–nm mnlxux'rÖ)–ɪxw xo –Çw-qn–ɪl– mÇn–3*' j–n' Xn–nj 'l q36>><A86-:.*

d65f Rrjw Rrur1Mɪx Rryrwp1Mɪx I qɪwsrwp3Gm-x'y–ɪxwxo I xwpx 'nm ó xv jzɪnxɪ– –xu –ɪxw– xw-x- I j2 knw-x-wr-n3 *Pxɪ 'wju xo Njÿ'mxɪ – S j–n'rju-3* 755>A 6;6-6.

d66f Nn—nu I 3ɪ Gunp'n I 3ɪ S jr—nɪ S 3ɪ I qj'kr—L3ɪ S xɪuw V33 MɪrmnurwnŁjwmunpr–uj–ɪxw ox' mÇn qxɪ–n n ɪnw—3 *Pxɪ 'wju xo Kw°r'xwv nw-j-u S jwjpn2 v nw-3755<A=8-7.*

d67f Nnvj S 3ɪ G'r°xur Y33 I xv yj'j–ɪ°n —ɪ–mÇ xw –qn jm-x'y–ɪxw trwn–ɪl— jwm –qn'v xmÇwjv rl– xo mÇn– xw-x- jlrmjl–ɪ°j–nm ux× lx—lj'kxw3 *Ov-n'wj–ɪxwju Pxɪ 'wjuxoVqÇ–rljuYlmwln–3755<A7-6.*

d68f K—j×Ç Gv' G3ɪ Gur G3 Ku2Njp1 Gkmnu2S x junk S 3Y3G33 Gyyurlj–ɪxw xo wx°nu lxyxuÇv n'2ZrU7 v nv k'jwn–ox' –xv n–nÅ–nn mÇn–jm-x'y–ɪ°n'nv x°ju ó xv jzɪnxɪ– –xu –ɪxw jwm yqx-xl j–juÇ–ɪl– mlxux'rÖ)–ɪxw3 *Pxɪ 'wju xo Njÿ'mxɪ – S j–n'rju-3755=A6:<-728.*

d69f Qɪvj' Q3]j–jw-q-l Xjvjvɪ'–qr]3ɪ Yr°jwn–jw Y33 S xmnurwp –qn v nlqjwr–v rw°xu°nm m'rwp –qn –x'y–ɪxwxov n–qÇnwn ku n xw-x- Çj–q3 *Pxɪ 'wjuxo I xuxrmjwmOv-n'gɪln Ylmwln3755: A7=9-6.*

d6:f I qrxɪ S rwp2Yqnw1 Nx Vjwp2bnw1 Rr N–rwp2bj3 Gm-x'y–ɪxw xojwrxwrl mÇn– rwjlrm–xu –ɪxw–ɪ–rwp lqnv rljuÇl'x—2rwt nm lqr-x–jw knjm-3 *J Çn– jwm Vipv nw—3755 9A;5-6.*

d6;f Lɪ bɪ Öqɪ 1]r'j'jpqj°jwZ3Lɪwpjumnlxux'rÖ)–ɪxwxo mÇn ×j—n×j–n'–@j 'n°rm×3 *Hrx'n–xɪ 'ln Znl qwxux2 pÇ3755 6A<>-8.*

d6<f Hjwj—Qt'jqrv S 3ɪ Trpjv Vxxwjv 1 Yrwpq J j–nul S j'lqjw–Xxpn'3S rl'xkrjumnlxux'rÖ)–ɪxwxo–nÅ–nn2 mÇnlxw-j–rwrwp n ɪnw—@G 'n°rm×3 *Hrx'n–xɪ 'ln Znl qwxuxpÇ36>>;A:=-8.*

d6=f Rnn Pjn2ł xxt1I qxr Ynɪwp2Vqrul r'ɪ°nwtj–j–lqj'r Xjvn–q1Yqrv ' jwp2Mnɪwl S xxw Nnn3K°juj–ɪxw xo–qn yn'ox'vjwln xojm-x'y–ɪxwjwmlxjpɪuj–ɪxw y'xln—n– ox' –qn vjÅvɪv 'nv x°juxo 'njl–ɪ°n mÇn–3*J Çn–jwmVipv nw—3755;A;>-8.*

d6>f Y[RGQS 1J KS OXHGY K1QUHbG S 3Xnv x°juxo G—'j Öɪw bnux× <MR ó xv jzɪnxɪ– –xu –ɪxw– kÇ jm-x'y–ɪxw xw-x- ×qnj— k'jw3 *Hrx'n–xɪ 'ln Znl qwxuxpÇ3755<A>=-68.*

d75f Wjmnn' Xrj Ö3Gm-x'y–ɪxwknqj°rx' xo'ɪ–qnwnɪv rxw– xw jl–ɪ°j–nm lqj'lxju ó xv wr'–ɪl– jlrm v nnmv 3 *I xuxrm–jwmYɪ 'gɪln– G@VqÇ–rlxlqnv rljuj wmKwprwnn'rwp G–ynl —3755<A7>8-628.*

d76f Vxuj'm Y3P3Z3ɪ Lx×un' MJ 3ɪ Yxuj'–I 3P3ɪ Vn''ÇX33 Rx×2lx—jm-x'knw— ox' ×j—n- jwm ×j—n×j–n' –'nj–v–nw-@j 'n°rm×3 *Ylmwln xo n Zx–j-u Kw°r'xwv nw-36>>7A66;-627.*

d77f]juÅS 3ɪI qnɪwp ' 3N3ɪS lQjÇM33 V'nyj'j–ɪxwxo jl–ɪ°j–nm lj'kxw ɪ–rwp ux× –nv yn'j–ɪ'n lj'kxwr–j–ɪxw jwm yqÇ–rljujl–ɪ°j–ɪxw xo qrpq j–q 'j× kjpj—n ox' jlrm mÇn jm-x'y2 –ɪxw3 *I qnv x–yqn'n3755 9A:;-:.*

d78f Tjvj–ɪ°jGjv I 3ɪ Qj°r–qj J 33 Xnv x°juxo I xwpx Xnmó xv ×j–n' kÇjm-x'y–ɪxwxw-x-jl–ɪ°j–nmlj'kxw y'nyj'nm ó xv lxr' yr-q-l jw jp'rlɪu–'ju –xurn ×j–n3 *J Çn–jwmVipv nw—3755 7A:9-6.*

d79f Tjvj–ɪ°jGjv I 3ɪV'jkqj J 3ɪQɪvɪ–qj S 33Xnv x°juxom'nl —'–nmjwmjlrmk'ruujw–ku nkÇjm-x'y–ɪxwxw –x- kjwjwj yr-q-3 *Hrx'n–xɪ 'ln Znl qwxuxpÇ3* 6>>=A ;9-6.

d7:f ZjwO3G3 3ɪGqv jmG3R3ɪNjv nnmH3N33V'nyj'j–ɪxw xo jl–ɪ°j–nm lj'kxw ó xv lxlxwɪ— qɪ–t@ Uy–ɪv rÖ)–ɪxw —ɪ–mÇ xw 'nvx°juxo 7P9;2 '–ɪlqux'xyqnwxu ɪ–rwp 'n–yxw–n –ɪ'gjln v n–qxmxuxpÇ3 *Pxɪ 'wjuxoNjÿ'mxɪ –S j–n'rju-3755=A* 6:8-627.

d7;f Pɪjwp Xɪnÿ2Yqrwl ' ɪ Lnwp2ɪ qrwl Z–rwp Xɪ2Rrwp3 I qj'jl–n'rÖ)–ɪxw jwm ɪ–n xo jl–ɪ°j–nm lj'kxw– y'nyj'nm ó xv kjpj—n– ox' uzɪm2yqj–n jm-x'y–ɪxw3 *I xuxrm–jwmYɪ 'gɪln– G@VqÇ–rlxlqnv r2 ljujwmKwprwnn'rwp G–ynl —3755 7A756-628.*

d7<f S xqjv nm S xqjv nm S xtq–j'–3 Glrm mÇn 'nvx°ju@ lxv yj'r–xw xo –ɪ'gjl–j–w-2v xmr nm v n–xyx'xɪ– LYS 26;×r-q- jl–ɪ°j–nm lj'kxw mn'r°nm ó xv 'rln qɪ–t3 *Pxɪ 'wjuxoI xuxrmjwmOv-n'gɪln Ylmwln3755 9A* 7<7-6.

d7=f GÇp wG1bnwr–xÇ2Qj'jtj Y1J ɪvjwO3V'xml–ɪxw xop'jwɪuj' jl–ɪ°j–nmlj'kxw ó xv ó ɪr——x-wn– jwm wɪ—qnuu-jwmn°juj–ɪxwxo–qnn' yqÇ–rljullqnv rljujwm jm-x'y–ɪxw y'xyn'–m–3 *S rl'xyx'xɪ– jwm S n–xyx'xɪ –S j–n'rju-3755 8A;-728.*

d7>f Z–rwp Xɪ2Rrwp1' ɪ Lnwp2ɪ qrwl Pɪjwp Xɪnÿ2Yqrw3 Rrzɪm2yqj–njm-x'y–ɪxwxomÇn– jwmyqnwxu-ɪ–rwp yrwn×xxm2kj–nmjl–ɪ°j–nmlj'kxw–3 *I j'kxw3* 7558A 96-8.

d85f S jut V3Q33[–nxojl–ɪ°j–nmlj'kxw–y'nyj'nmó xv –j×m —j-wm'rln2qɪ–t ox' jm-x'y–ɪxwxojlrmnmÇn–@j lj–n –ɪ–mÇ xo Glrm bnux× 8;3 *J Çn– jwm Vipv nw—3755 8A:;-8.*

d86f ' nwp I qrq2Nɪjwp1Rrwbjx2Zɪwp1ZÖnwp Zjr2ł nr3 Xnv x°juxov n–qÇnwn ku n ó xv jzɪnxɪ– –xu –ɪxw kÇjm-x'y–ɪxwxw-x-yrwnjyyunujoyx×mn'3 *Pxɪ 'wjuxo Njÿ'mxɪ –S j–n'rju-3755>A6<5-6.*

d87f Ku2Njuxjwç S 3ɪ 33 Y–ɪ–mÇ xojm-x'y–ɪxw r-x-qn'v – jwmtrwn–ɪl– vxmnu-ox' S n–qÇnwn Hunjm-x'y–ɪxw xwjl–ɪ°j–nmlj'kxw mn°nuxynm ó xv KpÇy–rj–w'rln qɪuu-Vj'–QO3 *J n–jurwj–ɪxw3* 7565A7:5-6.

d88f Rnnlqj'— VrGj×jwl Tjtkjwyx–n- ' x'jwjwl r'j°n–Gjw Vjr–ny3 Gyyurlj–ɪxw xo i×j—n, ×xxm2-qj°rwp kx xv j–q ox' jm-x'y–ɪxw xojÖt 'njl–ɪ°n mÇn3 *Pxɪ 'wju xo Kw°r'xwv nw-j-u S jwjpnv nw-3755>A>5-7.*

d89f S lQjÇM3ɪVx'–n- P3L3ɪV'j–jmM3X33 nXnv x°juxo J Çn I xuɪ'–ó xv Gzɪnxɪ–Yxu –ɪxw–kÇGm-x'y–ɪxw xw Rx×2lx—S j–n'rju-3 *' j–n'1 Gr'1 jwm Yxru Vxuu –ɪxw36>>>A669*

d8:f Njv nnmH3N33M'j—×j—n@Gwx°nu–x'knw—ox' –qn 'nvx°juxokj–lmÇn ó xv jzɪnxɪ– –xu –ɪxw3 *Pxɪ 'wju xoNjÿ'mxɪ –S j–n'rju-3755>A6;;-6.*

d8; f Njv nnmHBN3BK°juj–ɛwxoyjyjGj –nnm–j–j wx°nu wxw2lxw°nw–ɛwjuux×2lx—jm–x'knw—ox' 'nv x°juxo v n–qÇınwn kun3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555>A6; 7-728.

d8<f Njv nnm HBN3l S jqv x1m J 3Q3l Gqv jm G3R33 Yx'y–ɛw xo kj–rl mÇn óxv jz1 nx1 – –xu –ɛw kÇ yxv nux -Ir'–ı – p'jwmr–. ynnu rw j kj–l–q –Ç–ɛv 3 *I xuxmn– jwm Yı 'gjln– G@VqÇ–rlxlqnv rljv jwmKwprwnn'rwp G–ynl —3*755=A86; -628.

d8=f Vxwwı –jv r] 3l] rt'jv Y3l Y'r°j—j–°j Y3T33 Mıj°j -V–mrn v pıjsj°j. unjoyx×mn'@T x°nujm–x'knw–ox' 'nv x°ju xo v n–qÇınwn kun óxv jz1 nx1 – –xu –ɛw–3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3* 755=A6: 7-6.

d8>f Njv nnmHBN33Xnv x°juxolj–ɛwrl mÇn óxv jz1 nx1 – –xu –ɛw ı–rwp sjltór—ynnu j– wxw2lxw°nw–ɛwjuux×2lx—— jm–x'knw-3– *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555>A6; 7-6.

d95f Njv nnm HBN3l S jqv x1m J 3Q3l Gqv jm G3R33 Yx'y–ɛw nz1 ruk'n v jwmtrwn–rl– xokj–rl mÇn óxv jz1 nx1 – –xu –ɛw1 –rwp kjwjwj —j–tt ×j—n3*Px1 'wjuxo NjÖ'mx1 – S j–ı'rju-3*7555=A6: =-728.

d96f Uoxv jsj Gıpı—ɛwn K33 Yx'y–ɛw mÇwjv rl– jwm r–x–qn'v —ı–mm– xo v n–qÇınwn kun ıy–j–tn xw –x– yjuv tn'wnu k'n3 *I qnv rljv Kwprwnn'rwp Px1 'wju*3755<A67; -6.

d97f Mxwp Xnwv rw1 Phw bx1 krw1 I qnw Pjwl N1 bıwl Yıw Phw3Xnv x°juxokj–rl mÇn–óxv jz1 nx1 – –xu –ɛw kÇ –x'y–ɛw xw yqx–yqx'rl jlrm v xmr nm 'rln —'j×3*J Çn–jwmVipv nw–3*7555<A<8-8.

d98f Njv nnmHBN3lKu2Qqjrj'ÇS 33BYx'y–ɛw trwn–rl– jwm r–x–qn'v —ı–mm– xoj lj–ɛwrl mÇn ı–rwp jp'rlıu–'ju ×j—n@H xjm knjw ynnu-3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555=A6: 9-628.

d99f Vxwwı –jv r] 3l Mıwj–ntj'] 3l Y'r°j—j–°j Y3T33 Qrwn–rl– xo v n–qÇınwn kun 'nv x°juóxv jz1 nx1 – –xu –ɛw ı–rwp pıuv xqj' -J nuxwtÅ'nprj. yujw—unjo yx×mn'@S ıu–°j'rj –n–'np'n—ɛxw jwjuÇ–r–3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555>A6; >-628.

d9: f Gt–ı c v'rÇn1 ZnÖn' Yn°rujÇ3Kz1 rukn'n v jwmtrwn–rl– v xmnurwp xo krx–x'y–ɛw xo Xnv jÖtu Hujlt H kÇ XqrÖtyı – j''qrÖ – rw j kj–l–q –Ç–ɛv @n nl—xo –ɛv yn'j–ı'n3 *V'x1n—Hıx1qnv r–'Ç*37555A8; -:.

d9; f I qı N3l 1 I qnw Q3S 3 Xnı –n xo jl–°j–ɛm –umpn krxv j—@Q3Xnv x°juxokj–rl mÇn–óxv ×j—ɛn×j–n' kÇ krxv j—3 *V'x1n—Hıx1qnv r–'Ç*37557A8<-;.

d9<f Lı bıÖqı 1] r'j'jpqj°jwZ33Xnv x°juxoI xwpx Xnm óxv jw jz1 nx1 – –xu –ɛw kÇ ɑwpı – G–yn'pruu – wrpn'3 *Gnf jwln– rw Kw°r'xwv nw–j–u Xn–nj 'lq3*7557A <-6.

d9=f Gt–ı c v'rÇn1 bnwn' P umn3 G lxv yj'j–°n jm–x'y–ɛw4krx–x'y–ɛw –ı–mÇ xo v xwx2lqux'rwj–ɛm yqnwxu– xw–x– °j'rx1 – –x'knw—3 ' *j—n– S jwjpnv nw–3*7556A76-=.

d9>f S xı J ınw2Mjwp1 Rrv Qrv Qnn1 Yqnw N×nr Vrwp3 S rl'xkrju jpnw— ox' mnlxux'rÖ–ɛw xo mÇn ×j—ɛn×j–n'3*Hıx–nl qwxuxpÇGnf jwln–3*6>>6A>-9.

d: 5f Nı Zjr2Rnn3Xnv x°juxo'njl–°n mÇn–óxv jz1 nx1 – –xu –ɛw kÇ mr n'nw—kjl–n'rjupnwn'j3 ' *j–n' Yl rnwln jwmZnl qwxuxpÇ*36>>; A89-65.

d: 6f Lı bıÖqı 1] r'j'jpqj°jwZ3J Çn krx–x'y–ɛw –r–n– rw G–yn'pruu – wrpn'3 *Hıx'n–x1 'ln Znl qwxuxpÇ3* 7557A =7-7.

d: 7f Hj–rkı Çjt S 3l Lx'—n' I 3L33 Gw nÅjv rwj–ɛw xo –qn jm–x'y–ɛw lqj'jl–n'r—rl– xoj kj–rl mÇn -S jÅruxw Xnm HR2T. xw –x– u°n jl–°j–ɛm –umpn –Ç–ɛv 3 *V'x1n—Hıx1qnv r–'Ç*37558A8=->.

d: 8f Pjlxk–nw Hx Tnn'pjj'ml G'°rwK'rt1Xnrwrm' – S j–q3 Ljl–x'– j nl–ɛwp –x'y–ɛw xo ynw–j–l qux'xyqnwxu –x– –ı–ynwrmmv rl'xkrjukrxv j—3 ' *j–n' Xn–nj 'lq3*6>>; A 85-6.

d: 9f Hnwxr—Vrn''n1 Hj''rı–x Kw'rzın1 I jú'n—Xjxıu3 Hıx–x'y–ɛwlqj'jl–n'rÖ–ɛwxoqn'krl rmn–17192J jwm j–'j–Öwn1 jwm –×x lqux'xyqnwxu– xw ɑwpju v Çlnurv 3 *I qnv x–yqn'n3*6>>=A8<-<.

d: : f Gt–ı c1 Gty wj' J 3 S xmnurwp xo –rv ıuj–wnxı – krx–x'y–ɛw xo yqnwxu jwm wrltnu-00 xw–x– m'rnrm jn'xkrl jl–°j–ɛm –umpn3 *Ynyj'j–ɛwjwm Vı 'r lj–ɛw Znl qwxuxpÇ*37555A76-627.

d: ; f Gt–ı c v'rÇn1 M wnw Ln'nj3 Hıx–x'y–ɛw xoyqnwxu kÇ rv v xkruÖrm jl–°j–ɛm –umpn rw j lxw–rwı xı – yjltnm knm@ y'nml–ɛw xo k'njt–q'xı pq lı'°n–3 *V'x1n—Hıx1qnv r–'Ç*37559A8>-:.

d: <f Rr °'nv xw–J–rmrn'1 Ynrpun2v ı'jwmr L'jwlxr–n1 Hnwxr— 2pı ÇxmPhjw2ux ır–3 Xnv x°juxoVI TH óxv jz1 nx1 – –xu –ɛw kÇ j ɑwpju jm–x'y–ɛw y'xln—3 ' *j–n' Xn–nj 'lq3*6>>=A87-67.

d: =f Guyj—Yrknu Quw 1 ÖkjÇjt Öpn1 Guyj— nwxul Gt jÇ N –jv n rw3 n jm–x'y–ɛw trwn–rl– jwm 'nv x°juxo lj–ɛwrl mÇn1 Zxu rmrwn Hu n U1 óxv jz1 nx1 – –xu –ɛw ×r–q– Z1 'tr–q Öhxur–n3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555=A6: 6-6.

d: >f Njw Xı wyrwp1 ' jwp br1 cxı ' nrqı j1 ' jwp bıjwonwp1 Yqr Pm3 I xv yj'r–xw xo urwnj' jwm wxwurwnj' jwjuÇ–r– rw n—ɛv j–ɛwp –qn xv j–v xmnu yj'jvn–n'– ox' v n–qÇınwn kun jm–x'y–ɛw xw–x– wj–ı'ju Öhxur–n– rw Ånm2knm lxuv w3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555<A69: -627.

d; 5f ' jwp Y1c qı c3I qj'jl–n'r–j–ɛwjwmnw°r'xwv nw–j–u jyyurl j–ɛw xojw Gı —'j–urjwwj–ı'juÖhxur–n–ox' kj–rl mÇn 'nv x°ju óxv jz1 nx1 – –xu –ɛw3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7555; A68; -8.

d; 6f ' jwp Yqjxkrwl Rr N1 r–ɛwp1 aı RxwpGj3 Gyyurl j–ɛw xo Öhxur–n– S I S 277 ox' kj–rl mÇn 'nv x°ju óxv ×j—ɛn×j–n'3 *Px1 'wju xo I xuxmn jwm Ow–ı'gjln Yl rnwln*3755; A7>: -6.

d; 7f Rr I qjwpÅrwl cqxwp Nxwp1 ' jwp Yqı jrl aı n Pjw'xwp1 cqjwp cqnwGj 3 Xnv x°juxo kj–rl mÇn -v n–qÇınwn kun. óxv jz1 nx1 – –xu –ɛw ı–rwp Öhxur–n– –Çw–qn–rÖhm óxv nunl–'xuÇ–rl– v jwpjwn–n 'n–rm n3 *Px1 'wju xo Owm —'j–u jwm Kwprwnn'rwp I qnv r–'Ç*3756: A78

d; 8f Yı wcqrlRrI qı wsm1' ı J nÇj3Xnv x°juxov n–qÇınwn kun óxv jz1 nx1 – –xu –ɛw kÇ jm–x'y–ɛw xw–x– Öhxur–n– –Çw–qn–rÖhm óxv lxju Çj–q jwmr—–qn'v ju 'npnwn'j–ɛw3 *Px1 'wju xo I qnv rljv Znl qwxuxpÇ * Hıx–nl qwxuxpÇ*37565A=:-;.

d; 9f Mıuwj Ö U3 Yx'y–ɛw xo kj–rl mÇn– óxv jz1 nx1 – –xu –ɛw kÇ jl–°j–ɛm –umpn3 *Px1 'wju xo NjÖ'mx1 – S j–ı'rju-3*7559A65=-8.

d; : f Mı y–j–] 3 Q3ł Yı qjj – Yı qjj –l Gur Gv 'j wl Yj rwr] 3 Q33 Xnv x°j u xo Xqxmj v rwn Hł Lj —— M'nnwl j wm S n–qÇjnwn Hu n ó x v ' j —n×j –n' [–rwp Xnm S ı ml j w Gu v rwı v Gvm —'Ç ' j —n3 *Gvm —'rj u * Kwprwnn'rwp I qnv r—'ÇXn–rj 'l q37559A98- <.*

d; ; f U–n'x S 1Xx Öj mj L1I j ú x R3L1Mj 'l Žj G3QS x' w G3 Qrwn–ł j wm nzı ruk'n v v x mnurwp x o–qn v n–qÇjnwn ku n 'nv x°j u ó x v –x u –rxw kÇ j m–x'knw—v j –n'rj u–y'x m l nm ó x v –n×j pn –u mpn–3 *Hrx l qnv rł j u Kwprwnn'rwp Px ı 'wj u37558A6: - 6.*

d; <f ' j wp Yqj x krw1 Hx Çsx x b3ł I qx ı nrk G33 G l x v yj 'j –ł°n —ı mÇ x o mÇh 'nv x°j u ı –rwp Ç j –q –'rj –nm kÇ mr n'nw—v n–qx m–3 *I qnv x–yqn'n37755: A ; 5- 65.*

d; =f ' j wp Yqj x krw1 S j Wrwp1 c qı c 3N33 I qj 'j l –n'r—ł— x o l x j u Çj –q j wmj m–x'y–rxw j yyu l j –rxw3 *Lı nu3755=A =<- 6: 26; .*

d; >f Pj wx – V3 Yx'y–rxw x o mÇh– ó x v j zı nx ı – –x u –rxw– x w–x– Çj –q3 ' *j –n' Xn–rj 'l q37558A8<- 75.*

d<5f Rrw P3a 3l c qj w Y3R3ł Lj wp S 3N3ł Wrj w a 3W3ł b j wp N33 Gm–x'y–rxw x o kj –ł mÇh ó x v j zı nx ı – –x u –rxw x w–x– Çj –q3 *Px ı 'wj u x o Kw°r'x wv nw–j –u S j wj pnv nw–37755=A =<- 6.*

d<6f Yı w J n–qı j r1 c qj wp a rj x mx wp1 ' ı b ı mn1 Rrn a rw3 Gm–x'y–rxw x o j wx wrł mÇh– ó x v j zı nx ı – –x u –rxw x w Ç j –q3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37565A6=6 - 628.*

d<7f Mqx –q J ryj 1Hqj j l qj 'QÇj Q'r–qwj M3Gm–x'y–rxw x o v n–qÇjnwn ku n x w t j x u rwr–n3 *Gyyumm I uj Ç Ył mwł n37557A75- ; .*

d<8f G–ı –w M3ł Nr–j 'ur M3ł Yqnun'rł t ' 3Y3ł S ı qun' S 33 Gm–x'y–ł°n 'nv x°j u x o v n–qÇjnwn ku n ó x v l x u x'nm n ı nw— x w ơ un'ff ł nj '–q3 *Px ı 'wj u x o I x u x rm j wm Ov–n'–q ı l n Ył mwł n37558A7; 6- 6.*

d<9f Nx wp Yx wp1 ' nw I qnwp1 Nn Pr wp1 Mj w Lı År wp1 Nx b ı q2Yqj w3 Gm–x'y–rxw –qn'v x mÇv wj v r ł – x o S n–qÇjnwn Hu n x w–x– k nw–x w r–n3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37555>A6; <- 628.*

d<: f M '–n– G1Qj 'j l j Y1J x j ' 1Hj Çj t X1G t ÇumÖS 1 b j u w S 3J n–n'v rwj –rxw x o j m–x'y–ł°n y'x yn' –m– x o l uj Ç4×j –n' –Ç–rxv @v n–qÇjnwn ku n –x'y–rxw3 *Px ı 'wj u x o I x u x rm j wm Ov–n'–q ı l n Ył mwł n37559A7; >- 7.*

d<; f Yqj ×j k t nq X3 KÅy n'rv nw–j –u —ı mÇ j wm v x mnurwp x o kj –ł mÇh –x'y–rxw kÇ mj –x v j l nx ı – l uj Ç3 *Gyyumm I uj Ç Ył mwł n37558A79- 627.*

d<<f Nj ssj sr S 1 Guj v r G1 Hx ı j mur G3 Xnv x°j u x o v n–qÇjnwn ku n ó x v j zı nx ı – –x u –rxw kÇ k'x ı –l uj Ç v rwn'j u-3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–3755; A68: - 628.*

d<=f Gu2Lı –j –r– G qv nml Pj v 'j q G qv j ml Gu2Nj wj r Xj –qrm3 G–ynl — x o l j –rxwł mÇh v x unl ı un j m–x'y–rxw –x– yj uÇpx' –t r–n3 *J n–j u wj –rxw3755<A769- 628.*

d<>f Gu2Mqx ı –r– S 3G3ł Qq 'j r–qnq S 3G3S 3ł Guunw Y3P3ł G qv j m S 3T33 n 'nv x°j u x o mÇh– ó x v –nÅ–nn ×j —n×j –n'@ —ı mÇx o –qn yq Ç–rł j ul qj 'j l –n'r—ł—j wm j m–x'y–rxw v nl qj wr–v – x o mj –x v j l nx ı – nj '–q3 *Px ı 'wj u x o Kw°r'x wv nw–j –u S j wj pnv nw–37558A ; >- 8.*

d=5f ' nwp I qrq2Nı j wp1 Vj w b r2Lx wp3 Gm–x'y–rxw x o j l j –rxwł mÇh - v n–qÇjnwn ku n. x w–x– –ynw—j l –ł°j –nm l uj Ç3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–3755<A699- 627.*

d=6f Ynwt j u Hj qr'n Lru Öl bj °ı ÖK'mnv 3V'nyj 'j –rxw x oy x u Ç -°rwÇu y Ç'x umx wn. p'j nm –ı ux wj v rmn kj –nm y x u Ç–Çnwn 'n–rw j wm r—ı –n ox' –qn 'nv x°j u x o mÇh ó x v ×j –n'3 *Vx u Çv n'– ox' Gmf j wł nm Znl qwx ux pm–3755; A6<- 66267.*

d=7f Ynwt j u Hj qr'n Lru Öl Hrumt Lj –rq1 bj °ı ÖK'mnv 1Yj 'j l GÇon'3 V'nyj 'j –rxw x o y x u Ç pu Çl rmÇu v n–qjj l 'Çj –n. p'j nm –ı ux wj v rmn kj –nm y x u Ç–Çnwn 'n–rw ×r–q –n'–rj –'Ç j v rwn ox' –qn 'nv x°j u x o mÇh ó x v ×j –n'3 *Xrj l –ł°n j wm Lı wł –rxw j u Vx u Çv n'–3 755<A ; <- 67.*

d=8f bı b rwp1 c qı j wp bı j w2b r1 ' j wp c qx wp2Nı j 1 Wrn S rwp2Wrj wp3 Gm–x'y–rxw x o ×j –n'2–x u ku n mÇh– x w–x– v x mr nm'n–rw3 *I qnv x–yqn'n37559A: 9- 8.*

d=9f ' j x'Öl m×rł ÖS x wrt j 3Xnv x°j u x o I 3Q3Hj –rł Hu n 8 mÇh kÇ –x'y–rxw x w–x– l j –rxw nÅl qj wpn 'n–rwl ơ wł –rxw j u Öhm j wm wx w2ơ wł –rxw j u Öhm y x u Çv n'rł –x'k nw— ó x v j zı nx ı – –x u –rxw– j wm ×j —n×j –n'–3 *I qnv rł j u Kwprwnn'rwp Px ı 'wj u3 7568A 76<*

d=: f Qı v j ' Q3 b x pn–q1 S ı 'j umqj 'j N3H3ł T j Çj t j b3 G'–qx kj 1 Hj uj –ı k'j v j wÇj v P3ł Nj wı v j w–qjj yyj N33 Rx×2l x —— Çw–qn–r– x o v n–j –u x Åmm wj wx yj '–łl un– j wm –qnr' j yyu l j –rxw rw j m–x'y–rxw x o l x v v n'l rj u mÇh j wm qnj °Ç v n–j –u rx w rw j z ı nx ı – –x u –rxw3 *Vx×mn' Znl qwx ux pÇ37568A79;*

d=; f G qj v r Gkkj –1S x x–j °r Xj Öhnq3Gm–x'y–ł°n 'nv x°j u x o I x wpx 'nml j l j 'l rwx pnwrł –nÅ–nn mÇh1 ó x v j zı nx ı – –x u –rxw– kÇ v j pqnv r–n– wj wx yj '–łl 2 l un–3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37565A6<9- 628.*

d=<f Nj z ı n Kwj v ı ul Pł w Px wp ' x wl Pq ı wp Yı wp N×j 3 Gm–x'y–ł°n 'nv x°j u x o v n–qÇu x'j wpn j wm v n–qÇjnwn ku n ó x v j zı nx ı – –x u –rxw ×r–q j v n–j –u2x'pj wrl ó j v n×x't v j –n'rj ul r'x w –n'ny q–qj uj –n– -S UL278: . 3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37566A 6=: - 6.*

d==f Nj –j w c ı kj r'1 Pq ı wp Yı wp N×j 3 Xnv x°j u x o qj Ö'mx ı – x'pj wrl – ó x v ×j –n' ı –rwp v n–j –u2x'pj wrl ó j v n×x't – - S UL–. @ Vuj ı –rku n v nl qj wr–v – ox' –nunł –ł°n j m–x'y–rxw–3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37756: A7=8*

d=>f Nj z ı n Kwj v ı ul Rnn Pr Kı wł Pj wp Gv Zj n1 N×j wp b x ı wp QÇj 1 I qj wp Px wp2Yj wł Pnpj u Px wppnx wl Pq ı wp Yı wp N×j 3 Gm–x'y–ł°n 'nv x°j u x o v n–qÇu x'j wpn ó x v j zı nx ı – –x u –rxw ×r–q v n–j –u2x'pj wrl ó j v n×x't –l yx'x ı – l q'x v rı v 2 knwÖnwnmł j 'kx ÅÇj –n–3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37565A6=6- 628.*

d>5f J ı Pr wp2Pr wp1 b ı j w b ı 2Vnwp1 Yı w Pj 2a rwl Vnwp Lı 2S rwl Pj wp a rj 1 Wrn Rrwp2Mı j wp1 a rn Gw2Pj wł Yq nw b ı 2Nı j 1c qı Pr w2Lj 3T n× yq x–xł j –j –uÇ—kj –nm x w S QR2: 8 v n–j –u t x'pj wrl ó j v n×x't – ox' –qn ml x ux'rÖ –rxw x o v n–qÇjnwn ku n mÇh3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–37566A6>5- 628.*

d>6f Nj v nnm Hł J rw G1 Gqv j m G3 Gm–x'y–rxw x o v n–qÇjnwn ku n x w–x– kj v kx x2kj –nm j l –ł°j –nm l j 'kx w@Qrwn–ł—j wmnz ı ruk'n v —ı –nn–3 *Px ı 'wj u x o Rj Ö'mx ı – S j –n'rj u–3755<A696- 8.*

d>7f Zjw G3G3 3l Njv nnmH3N3l Gqv jmG3R3l Kz ı ruk' n v jwm t rwn-ıl —ı-mrn– xw kj–ıl mÇn jm-x'y-ɶw kÇ xru yju k'n jl-ɶ j-ɶm lj'kxw3 *I qnv ıl j u Kwprwnn' rwp Px ı 'wj u*3755<A67<-628.

d>8f Njv nnmH3N3l Gqv jmG3R3l Rj-ɶ– Q3T3G3 Gm-x'y-ɶw xokj-ıl mÇn-v n-qÇnwn ku n. xw-x-jl-ɶ j-ɶm lj'kxw y'nyj'nm ó xv 'j jw –j×m —3– *J Çn– jwm Vipv nw–3755*<A<:-6.

d>9f Zjw O Gqv jm G1 Njv nnm H3 Uy-ɶv rÖ)-ɶw xo y'nyj'j-ɶw lxwm-ɶw– ox' jl-ɶ j-ɶm lj'kxw– ó xv lxlxw ı —q ı-t ı-rwp 'n-yxw-n ı-'ıjl n v n-qɶmxux2 pÇ3*I qnv ıl j u Kwprwnn' rwp Px ı 'wj u*3755=A68<-8.

d>: f Rr Njrujwl Kmmj x ı mr S xqjv nml UffQnn n S 3l bjpqr U3 S 3) J n-rpw jwm –Çw-qn-r– xo jw nÅl ny-ɶw juÇ –j-kun jwm qrpquÇ yx'x ı – v n-j-u2x'pjwrl ójv n×x't3 *Tj-ı-'n36*>>>A957-;<:>.

d>; f L 'nÇ M 'j'm3 NÇk'rm yx'x ı – –xum-@yj —l-y'n-nw-l-o ı-'n3 *I qnv 3Yxl3Xn°3*3755=A8<-6.

d><f Nx'rtn Yj–x–qrl Yqrv xv ı 'j Yj–x'ı 1 Qr-j-pj×j Y ı ı v ı 3 Yx yx'x ı – l'Ç–j-u3 *Tj-ı-'n I qnv r—'Ç*3755>A6-<.

d>=f S xpqjmjv VnÇv jw c 3l Rr G ı 'nuj 1' rpprw Yn-q-H3l Zjx Gwmrl S juxwnÇ Gwm'n× M3 V3l' xxm Vn-n' G3l ' j'm Y ı Ö)wwj I 3l Ljr'nw2Phv nwnÖ J j°rm3 J n°nuxyv nw—xo j I jv k'rnpn Y'-ı l-ı-ju J j-j-kj–n Y ı k–n-@G I xunl-ɶw xo S n-j-uttU'pjwrl L'jv n×x't– ox' Vj—l- V'n-nw-l- jwm L ı-ı-'n3 *I qnv r—'Ç xo S j-n-'rju-3*756<A7>-<.

d>>f Q ı yyun' XGjw P3l Zrv v xw– J j'nw P3l Ljwp Wrjw2Xxwp1 Rr Pjw2Xxwp1 S jtju Z'n°x' G3l bx ı wp S j't J 3l b ı jw J jzrjwp1 cqjx J jwl cq ı jwp ' nwsujwl cqx ı Nxwp2I jr3 Vx-ɶw-ıj-u jyyurl j-ɶw– xo v n-j-u2x'pjwrl ójv n×x't–3 *I xx'rnwj-ɶw I qnv r—'Ç Xn°rnx–3*755>A7:8-78279.

d655f Rr Njrujwl Kmmj x ı mr S xqjv nml M'xÇ xv j– R3l bjpqr U3 S 3) K–j-ku–qrwp S rl'xyx'x–r–Ç rw Uynw S n-j-u–U'pjwrl L'jv n×x't–@ Mj– Yx'y-ɶw Ox-qn'v – ox' cw-HJ I. -HJ I C 6192 HnwÖnwnmrl j'kxÅÇ j-n.3 *Px ı 'wj u xo -qn Gv n'rl j w I qnv rl j u Yxl rn–Ç*36>>=A675-88.

d656f Rr Pjw2Xxwp1 Yl ı unÇPh ujwl cqx ı Nxwp2I jr3S n-j-utt U'pjwrl L'jv n×x't–ox' Ynyj'j-ɶw–3 *I qnv rl j u Xn2 °rnx–3*7566A667-7.

d657f Run×nuÇw Vqrury R3l Hk ı ''nuÇ Yjwm'rwn1 Yn''n I q'r—ıj-wl]rv xw—GunÅjwm'n1J j-ı-'r S j'lx1Njv xw Rxv rp1 J n ' nr'num M ı Ç I qjwp Pxwp2Yjwl Nxwp J x2b x ı wp1 QÇj N×jwp b x ı wp1 N×j Pq ı wp Y ı wp1 L 'nÇ M 'j'm3 Nrpq [y-j-tn– xo I U7 jwm I N9 rw S n-xyx'x ı – S n-j-u U'pjwrl L'jv n×x't– S OR2655 jwmS OR26563*Rjwpv ı r'3*7755=A79-69.

d658f Hr'jmqj Q ı v j'1 Xjv jwjw G'ı wjlqjujv 1]r ju Pjpjmn–n P33 I xx'mwj-ɶw Vx uÇy n'–]n'-ı – S n-j-u–U'pjwrl L'jv n×x't–3 *I 'Ç–j-u M'xx-q- * J n-rpw3*7755>A>-<.

d659f bjpqr Uv j'3 QnÇwx-n- Yynjtn'@ J'3 Uv j' bjpqr3*I qnv rl j uj wm Hxux pt l j u J nonw-n Yl rnwl n j wm Znl qwx ux pÇ-I HJ Y* Z. I x won' nwl n3*

d65: f bjpqr Uv j' S 3l UffQnn n S rl qjnul Ul t×rp Tj-qjw ' 3l I qjn Nnn Q3l Kmmj x ı mr S xqjv nml Qrv Pjqnxw3 Xn-ıl-ı uj' –Çw-qn-r– jwm -qn nm-rpw xo wn× v j-n'rju-3*Tj-ı-'n3755*8A978-;>96.

d65;f U,Qnn n S rl qjnul Vn-t x° S jÅrv G3l Xjv –nmw Y-ı-j'— P3l bjpqr Uv j' S 33 n Xn-ıl-ı uj' I qnv r—'ÇY-'ı l-ı-'n Xn–x ı 'l n -XI YX. J j-j-kj–n xol jwm YÇv kxu– ox' 1 I 'Ç–j-u T n—3 *Gl l x ı w—xo I qnv rl j u Xn-nj 'l q3*7755=A 96-67.

d65<f Ul t×rp Tj-qjw ' 3l J nupjmx2L'mm'rl q– Uujol UffQnn n S rl qjnul bjpqr Uv j' S 33 Xn-ıl-ı uj' I qnv r—'Ç@Ul l ı ''nwl n jwm Zj Åxwxv Çxo T n—jwm M'jv v j' ox' -qn J n-rpw xo L'jv n×x't–3 *Gl l x ı w—xo I qnv rl j u Xn-nj 'l q3*7755: A8=-8.

d65=f L ı 'ı tj×j Nr'xÇj-ı 1 I x'mx°j QÇjn K3l U,Qnn n S rl qjnul bjpqr Uv j' S 33 n I qnv r—'Ç jwm Gyyurl j-ɶw– xo S n-j-u2U'pjwrl L'jv n2 ×x't–3 *Yl rnwl n3*7568A896-;69>.

d65>f Kmmj x ı mr S 33 YÇ—ɶv j-ıl- J n-rpw xo Vx'n YrÖh jwm L ı wl-ɶw jur-Ç rw Ox'n-ıl-ı uj' S UL– jwm nr' Gyyurl j-ɶw rw S n-qjwn Y-x'jpn3 *Yl rnwl n3*7557A7>: -:::9.

d665f Qn Lnrl b ı jw b ı 2Vnwp1 Wn Rrwp2M ı jwp1 Yqnw b ı 2N ı j1 a rn Gw2Phjwl cq ı Ph w2Lj1 Zrjw a rwp2b x ı 1 cqjwp Rr2J n3 Ljlrun qjk'rl j-ɶw xo v jpwn-ıl- v n-j-uttx'pjwrl ójv n×x't wjwxlxv yx-r-n– ox' yx-nw-rj u-j-'pn-nmrn ı p rnur°n' Ç3 *Px ı 'wj ux oS j-n-'rju-I qnv r—'Ç*37566A76-66.

d666f J jr' nr1cq ı jwp N3Z3l R ı a 3W3l Njw S 3S 3l cqnwp b3) Gm-x'y-ı°n-nyj'j-ɶw xo-qɶxyqnwn rn'r°j-ı°n-°rj v n-j-ux'pjwrl ójv n×x't v j-n'rju S UL2:3 *Px ı 'wj ux o L ı nu I qnv r—'Çj wm Znl qwx ux pÇ*37565A8=-:.

d667f I qnw I qnw1 cqjwp S nwp1 M ı jw Wrwp Årw1 Rr ' nr3 Qrwn-ıl- jwm -qn'v xmÇwj v rl —ı-mrn– xw -qn jm-x'y-ɶw xo ÅÇjnwx u x'jwpn xw-x- S OR2656 -I '.3 *I qnv rl j u Kwprwnn' rwp Px ı 'wj u*37567A6=8

d668f Nx b3Y1 S l Qj Ç M3 V–n ı mx2-nl x wm x'rn' v x rnnu ox' –x'y-ɶw y'xl n—n–3 *V'xl n— Hrx l qnv r—'Ç3* 6>>>A 89-:.

d669f Rj pn'p'nw Y33 Gk x ı —-qn nx'Ç xo –x I j unrn Gm-x'y-ɶw xo Yxu kun Y ı k—j-wl n–3 *Y°nw3] n-nw-t j y-j t j m3 Nj wrnwpj 'u*36=>=A79

d66:f' nkn' ' ju-n' P3l S x''r– P3 I j''nu3 Qrwn-ıl— xo Gm-x'y-ɶw xw I j'kxw ó xv Yxu-ɶw3 *Px ı 'wj ux o-qn Yj wr-j-'ÇKwprwnn' rwp J r°r-ɶw*36>; 8A=>-7.

d66; f Rj wpv ı r' O°rwp3 n I xw–r-ı-ɶw j wm Lı wnj v nw-j-u V'xyn'-rn– xo Yxurn-j wm Rrz ı rm-3 003 Rrz ı rm-3 *Px ı 'wj u xo-qn Gv n'rl j w I qnv rl j u Yxl rn–Ç*36>6<A8>->.

d66<f L'n ı wmrl q Nn'kn'–3– kn' rnn Gm-x'y-ɶw rw R-ı wpnw3 *c nr—l q'r o ' VqÇ-t j ur-l qn I qnv rn*36>5<A:<[-6.

d66=f Njv nnm H3N3l Xjqv jw G3G3) Xnv x°j u xo yqnwxu ó xv jz ı nx ı – –xu-ɶw– kÇj m-x'y-ɶw xw-x-jl-ı°j-rnm lj'kxw y'nyj'nm ó xv krxv j— v j-n'rju3 *Px ı 'wj ux o Nj Ö)'rnx ı –S j-n'rju-3*755=A6; 5-728.

d66>f Njv nnm H3N3) Yynw— –nj unj°n-@ G wn× wxw2l xw° nw-ɶw j u jwm ux×2l x—— j m-x'knw— ox' 'nv x°j uxokj-ıl mÇn ó xv jz ı nx ı – –xu-ɶw–3 *Px ı 'wj ux oNj Ö)'rnx ı –S j-n'rju-3*755=A6; 6-728.

d675f Rj pn'p'nnw Y3) c ı' nx'rn rn' –xpnwj ww-ɶw Gm-x'y-ɶw pnu —n' Y-x- n3 *c nr—l q'r o ' I qnv rn ı wrnOwrn —'rn rn' Qxuxrnnn*36>5<A7-6.

d676f Rx× S 3P3J 3) Qrwn-ıl— xo I qnv r-x'y-ɶw x o Mj–n–xw

Yxum-33*I qnv rljuXn°mx-36>; 5A; 5-8.

d677fI qmw Y3 N3l I uj Ç-xw ‘ 3 X33 Gyyurl j -xw xo Kux°rl q Kzı j -xw -x- -qn Qrwn-rl- xo Vqx-yqj -n- Xnunj -n j wm Yx'y-xw rw Yxru-3 *Yxru Ylmwln Yxlm-Ç xo Gv n'rlj Pxı 'wju*36>=5A99-7.

d678fQı -q×jqj Pjr V'jtj -q1 Y'r°j -j-°j] rv ju I qj wm'j1 S juu Gvm'j J nx3 Z'nj -v- nw—xo nj r'Ç×j —n×j -n' kÇ lxv v n'l rju jl -r°j -nm l j'kxw j wm kj pj —n Ç j -q@ Vj'jv n'-rl 1 trwn-rl- j wm nzı ruk'rı v v xmuurwp1 mr-yx-ju -ı-mm-3 *Hrx'n-xı 'ln Znl qwxuxpÇ*37565A656 -65.

d679fRj wpv ı r' O°rwp3 n I xw—r-ı-xw j wm Lı wnj v nw-j-u V'xyn'-m- xo Yxum- j wm Rrzı rm-3 Vj'— O3 Yxum-3 *Pxı 'wju xo -qn Gv n'rlj w I qnv rlju Yxlm-Ç*36>6; A8=-66.

d67: fNj uu Q3 X3l Kj pun-xw R3 I 3l Gl'r°x- Gwm'nj -l] n'v nı unw nxmx'n3 Vx'n2 j wm Yxum2J r ı -rxw Qrwn-rl- rw LrÅnm2Hnm Gm-x'y-xw ı wm' I xw—j-w-2-Vj n'w I xwm-xw-3 *Gvm —'rju * Kwprwnn'rwp I qnv r-—'ÇLı wnj v nw-j-u*36>; ; A: -7.

d67; fMı y-j- M3Y3l V'j -j m M3l Vj wnj Ç Q3Q3l Yrwpq] 3T33 Xnv x°juxolq'xv n mÇn ó xv jzı nxı - -xu -xw- kÇ Çj -q3‘ *j -n'1Gr' Ijwm Yxruvxuu -xw*36>==A8<-627.

d67<fTjv j -r°jGjv I 3l Yı v r-q'j Y33Xnv x°juxom'nl —'nm 67H j wm v n-qÇunwn ku n ó xv ×j -n' kÇ j m-x'y-xw xw-x- Ln - OOO4I ' - OOO qÇn'x Åmm1j w rwm —'rju -xum ×j —n3*Pxı 'wju xoKw°r'xwv nw-j-uS j wj pnv nw-3*7755: A <9-8.

d67=fJ r S j'rwx Gw-x-wrx1 S nwmnlı -r- L'j wlr-l x3 n'v xmÇwj v rl- xo I xv yunÅj -xw xo J rv n-qÇu K—n'-xoZn'n21O-x21j wm Vq-qj url Glrm-×r-q- 2j wm 2l Çl ux mÅ'-rw-3*Gyyummn Yynl -'x-l xyÇ*37559A: =-<.

d67>fJ qı v juTrun-q X3l Yrwpq S j wr-q V3l Gwmn'-x w Pj v n-G3l Qrmon' Pxqj wvn-1 Qrv NÇ wp P33 S xunlı uj' Gv-n'j l-xw- xo j I ı 2Hj -nm S n-j-uttU'pj wrl L'j v n×x't ×r-q- j I xw wnm Gv rmj Ötun v 2Hj -nm Qtwrl Rrzı rm@G I xv krwnm J nw-r-Ç Lı wl -xw j u nx'Ç j wm KÅyn'rv nw-j-u] rk'j -xw j u Yynl -'x-l xyÇ Y-ı-mÇ3 *n Pxı 'wju xo VqÇ-rlju I qnv r-—'Ç I 3*7556; A 675-; .

d685fI xj -n- Pxqw 3 Gv-n'y'n-j -xw xo Gvój'nm Yynl -'j 1 G V'j l-rl-j uGyy'xj l q3*Gvój 'nmYynl -'x-l xyÇ*3755; 3

d686fG'xtn[U 1Gkm ut j'rv G 1Upı k ı wt j X U 3Lxı 'm'2 -'j w-ox'v Gvój'nm I qj'j l-n'rÖ)-xw xo Qj xuwl M'j wr-nl Hnw-x-wr-n- j wm Hj 'r-n3 *GZH[Pxı 'wju xo Kw°r'xwv nw-j-uZnl qwxuxpÇ*37568A; -6.

d687fYl qurl q-n- Quj ı -l Q'j -Ön Zxkrj -l Qj -t nu Y-nej w3 Gv y'x°nm -Çw-qn-r-1 -qn'v j u -j -krur-Ç j wm l j -j uÇ-rl-y'xyn'-m- xo -qn v n-j -u2x'pj wrl ó jv n×x't l xv yxı wm I ı 8-HZI .73 *S rl 'xyx'xı - j wm S n-xyx'xı -S j -n'rju-3*7559A<8-627.

d688fGusnkx'nn G-nnuS 3l Gu-qr' Gkkj -T 3l Gut j rv GGj m L33Qrwn-rl- j wmnzı ruk'rı v —ı-mÇox' -qn j m-x'y-xw xo -nÅ-nn mÇn- xw l xl xwı — -qnuu j l -r°j -nm l j'kxw3*G'j kr j w Pxı 'wju xoI qnv r-—'Ç*3756<A65

d689fnm S nwnÖn- Kurj wj ‘ 3l Rrv j Kmn' I 3l XxÇn' Hn-rwj 1 nn Yxı Ö) Lnuryn K3l mx- Yj w-x- H ı wj J 3l M'np 'rx Px- X3l I x—j- Zj wrj S 3N3l Mı -qrt nv bx-qr-j -t j 1 Hnw°nwı r Kmru-xw] 33 Qtwrl -rul j kj -nm qÇk'rm v j -n'rj ul xw-j -rwrwp -qn yÇ rmrwn v p'xı y ı -nmj -j w j m-x'knw—ox' -nÅ-nn mÇn3 *Pxı 'wju xo I xuxrm j wm Gv-n'gl n Ylmwln*37567A8<=-6.

d68: fNx bı q2Yqj w3 Ynl xwm2x'nn' t rwn-rl- v xmnu ox' -qn -x'y-xw xo l j mv rı v xw-x- -'-nn on'w@G l xv yj 'r-xw xo urwnj' j wm wxw2urwnj' v n-qxm-3 ‘ *j -n' Xn-nj 'lq*3755; A95-6.

d68; fNx bı q2Yqj w3 Gk-x'y-xw xo qnj °Ç v n-j -u- ó xv ×j -n- -'nj v -kÇynj -36>>: 3

d68<fNx b3Y1S l Qj ÇM3G t rwn-rl- —ı-mÇxomÇn -x'y-xw kÇ krx-x'knw— ×j -n- y'xm l — yr-q-3 *Xn-xı 'ln-1 I xw-n'°j -xw j wmXnl Çlurwp*36>>>A7: -829.

d68=fHj mv ı - S G U 1 Gı m Z3 U3 Q3 1 GwGj -j - H [3 Xnv x°juxoRnj mQtw ó xv Gvm -'-rju' j —n×j -n' -kÇ Gl -r°j -nm I j'kxw V'nyj'nm ó xv Vn'r×rwtun Yqnuu--ZÇyj wx-x-wı - ơ -l j -ı-. 3 *Zı 'tr-q Pxı 'wju xo Kwprwnn'rwp j wm Kw°r'xwv nw-j-u Ylmwln-3* 755<A 86-9.

d68>fNx b3Y3l S l Qj ÇM33G I xv yj 'r-xwxoI qnv r-x'y-xw Qrwn-rl- S xmnu- Gyyummn -x- Vxuu -j-w—Xnv x°juxw] j 'rx1 - Yx'knw—3 *V'x1n— Yjon-Çj wmKw°r'xwv nw-j-u V'x-nl -xw*36>>=A<; -9.

d695fTjv j -r°jGjv I 3l Qj wl qj wj T33‘ j —n- kj wj wj yr-q- j - jm-x'knw— ox' lxux' 'nv x°ju ó xv ×j —n×j -n'-3*I qnv x-yqn'n*36>>7A7: -66.

d696fTjv j -r°jGjv I 3l bjv ı wj X3Z33Xnv x°juxolxwpx 'nm ó xv jzı nxı - -xu -xw- kÇ krxpj - ×j —n- -u''Ç3 *Pxı 'wju xo I qnv rlju Znl qwxuxpÇ * Hrx-nl qwxuxpÇ*3755<A: 8-7.

d697fTjv j -r°jGjv I 3l bjv ı wj X3 Z33 Xnv x°ju xo Xqxnj v rwn2H kÇ krxpj - ×j —n- -u''Ç ó xv jzı nxı - -xu -xw3‘ *j -n'1Gr'1* Yxruvxuu -xw*36>>7A; : -627.

d698fbjv ı wj X3Z3lTjv j -r°jGjv I 33I xux' 'nv x°ju ó xv jzı nxı - -xu -xw kÇ krxpj - 'n-nm ju -u''Ç3 *ZxÅrlxuxpnlju * Kw°r'xwv nw-j-u I qnv r-2 -'Ç*36>>8A8=-829.

d699fTjv j -r°jGjv I 3l Vn'rj -jv ÇQ33 Hrl j'kxwj -n2'-nj -nm ynj wı —qı uu lj'kxw ox' v n'l ı 'Ç-OOO 'nv x°ju ó xv jzı nxı - -xu -xw3‘ *j -n' Xn-nj 'lq*36>>8A7<-66.

d69: fTjv j -r°jGjv I 3l XjwpjwjwjwQ33‘ j —n-Ln-OOO4I ' -OOO qÇn'x Åmm j - jm-x'knw—ox' -qn 'nv x°juxoI ' -] O ó xv jzı nxı - -xu -xw j wm lq'xv rı v yuj -rwp rwm -'-Ç×j —n×j -n'3*Kw°r'xwv nw-j-u Vxuu -xw*36>>8A =7-8.

d69; fTjv j -r°jGjv I qrwwjrGj 1 jv j'jr-nur Qj urjwwjwl bjv ı wj Xjwpjr Gj Z33 Xnv x°ju xo yj'jzı j —kÇ jm-x'y-xw xw i×j —n, Ln-OOO4I ' -OOO qÇn'x Åmm@ Gm-x'y-xw 'j -n- j wm nzı ruk'rı v —ı-mm-3 *Vn—rl-mm Ylmwln*36>>9A96-6.

d69<fYrwpq Hrwj Ç Q3l Xj×j —Tj 'nwn'j Y33 I xv yj 'j -r°n -x'y-xw t rwn-rl- —ı-mm- xo yqnwxurl l xv yxı wm-xw Çj -q j wm rv y'npwj -nm Çj -q3*Pxı 'wju xoI qnv rlju Znl qwxuxpÇGTJ Hrx-nl qwxuxpÇ*36>>9A; 6-6.

d69=fRnn I 3Q3l Rx× Q3Y3l I qx× Y3‘ 33I q'xv n Yu npn j - j w Gm-x'knw—ox' I xuxı ' Xnv x°ju3*Kw°r'xwv nw-j-u Znl qwxuxpÇ*36>>; A6<-> .

d69>fRnn I 3Q3l Rx× Q3Y3l Qnt Q3R33 Xnv x°ju xo l q'xv rı v ó xv jzı nxı - -xu -xw3 *Hrx'n-xı 'ln Znl qwxuxpÇ*36>>: A: 9-7.

d6: 5fRx× Q3Y3l Rnn I 3Q3l Z j w Q3Q33 Hrx-x'y-xw xo kj -rl mÇn- kÇ ×j -n' qGj l rw-q- 'xx—3 *Hrx'n-xı 'ln*

Znl qwxuxpÇ36>>: A: 7-6.

d6: 6f Hrx–x'y–¤xw xo lj–¤xwrl mÇn– kÇ mnjm v jl'x o wp1 – oxv r–x y–r– lj'wnj@kj–l–q –1–mn–3 *' j–n' Yl mwl n jwm Znl qwxuxpÇ36>>*; A89-65.

d6: 7f Tjv j–r°jGjv I 3lS 1 wrj–jv ÇT 3lMjGj'–r Q3lXjwr S 3l Xjwpjwj–ejw Q33 Xnv x°ju xo mÇn– óxv jz1 nx1 – –xu –¤xw– kÇl nuu ux–rl ×j–n–x'jwpn ynnu3 *Hrx'n–x1 'In Znl qwxuxpÇ36>>*; A: <-6.

d6: 8f Qrurl S 1 'j–l– Gyj Çmrw2] j'xu K–rw1 V —w GÇ n K33 Gm–x'y–r°n'nv x°juxoyqnwxuóxv jz1 nx1 – –xu –¤xw– xwjl–r°j–¤mlj'kxwy'nyj'nm óxv –¤kjllx 'n–mn–@ Kz1 nuk'n v 1t rwn–rl– jwm–qn'v xmÇwjv rl –3 *Px1 'wjuxo Nj Ö'mx1 – S j–n'rju–37566A6=>-627*.

d6: 9f Yqr b1 wl Qxwp a rjwpÖqnwl c qjwp I jrv nwp1 I qnw b nv rwp1 N1 j b1 onr3 Gm–x'y–¤xw xo–xÇr–x j°xwn– kÇ jl–r°j–¤mlj'kxw@ Qrwn–rl– 1 –qn'v xmÇwjv rl – jwm rw1 nwln xo –xÇ xupx–jllqj'mn–3 *I qnv rlju Kwprwnn'rwp Px1 'wjus7568A76: 276;*

d6: : f Yqjq1 u Njv nnm Q3l S 1 –qr'1 ujw V3l S nnwjt–qr Y1 wnj'jv S 33 Gm–x'y–¤xw xo lq'xv x–'–xyn mÇn xw–x– jl–r°j–¤mlj'kxw– xk–j–rwnm óxv –qn –nnm– xo°j'nx1 – yujw—@ Kz1 nuk'n v jwm t rwn–rl– –1–mn–3 *G'jkrjw Px1 'wjuxoI qnv r–'Ç3756<A65*

d6: ; f S jut X3l Xjv –¤t n J 3Y3 ' j–n Y3X33 Gm–x'y–¤xw xo v juj lqr–n p'nnw xw p'x1 wnw1 — –qnuu ×j–n– kj–¤mm yx×mn'nm jl–r°j–¤mm lj'kxw3 *' j–n– S j wjpnv nw–3755<A7<->*.

d6: <f b nwn' Pl umn1 Qxyjl Z1 't jwl J xp1 Mlu–nwl J xp1 Zrv 1 '3 Gm–x'y–¤xw xo Hj–rl b nuux× 7= óxv jz1 nx1 – –xu –¤xw– ×r–q–l urwxy–¤xur–n–jwmjv kn'ur–n3 *Px1 'wjuxo I xuxmnjwmO–n'qjln Yl mwl n3755*; A7>9-7.

d6: =f Njv nnm H1l J j1 m L3 Gm–x'y–¤xw –1–mn– xokj–rl mÇn xwjl–r°j–¤mlj'kxw mn'r°nm óxv jp'rl1 u1–'ju×j–n@ Nn°nj k'j–rumw–r– –nnm lxj –3–*I qnv rljuKwprwnn'rwp Px1 'wjus7755=A68>-6*.

d6: >f Gunw Y3P3l S 1 Qj Ç M3l Qqjmn' Q3b3N33 Gv–'–jyj'–rl–un mr 1 –rxw xo j kj–rl mÇn m'rwp jm–x'y–¤xw xw–x– –yqjpw1 v ynj –3– *Kw°r'xwv nw–j–u Vxuu –¤xw3* 6>=>A :; -6.

d6; 5f S xqjw–Ç Qj1 –1–kqj 1 J j– J 3l Hr–×j– S 3T 33 Gm–x'y–¤xw xo yqnwxu óxv jz1 nx1 – –xu –¤xw– 1 –rwp jl–r°j–¤mm lj'kxw– y'nyj'nm óxv Znl–¤xwj p'jwmr– –j×m —kÇ c wl u7 jl–r°j–¤xw3 *I qnv rljuKwprwnn'rwp Px1 'wjus7755*: A66: -627.

d6; 6f S xqjw–Ç Qj1 –1–kqj 1 Rqj S x1 –jv 1 S nrtjy H3l 3l Hr–×j – S 3T 33 V'nyj'j–¤xw jwm I qj'jl–n'rÖ)–¤xw xo Gl–r°j–¤mm I j'kxw– óxv Zn'v rwjuj G'su wj T1 —×r–q– c rwl I qux'mn Gl–r°j–¤xw ox' –qn Xnv x°juxo Vqnwxu óxv ' j—n×j–n'3 *Ölmn —'rju jwm Kwprwnn'rwp I qnv r—'ÇXn–nj'1 q3755*: A99-66.

d6; 7f Vj wnj Ç Q3 Q3l V'j–jm M3l Yrwpq]3 T33 S rÅnm jm–x'knw— ox' I 1 -QQ 'nv x°ju óxv jz1 nx1 – –xu –¤xw–3 *Kw°r'xwv nw–j–uZnl qwxuxpÇRn n'–36>=*; A< -6267.

d6; 8f S xqjw–Ç Qj1 –1–kqj 1 Rqj S x1 –jv 1 S nrtjy H3l 3l Hr–×j – S 3T 33 Xnv x°juxol q'xv n v -] O óxv nnu –n– jz1 nx1 – –xu –¤xw– kÇj l–r°j–¤mlj'kxw mn°nuxynnmóxv Zn'v rwjuj j'su wj wu — jl–r°j–¤mm ×r–q– Öwl l qux'mn3 *I qnv rljuKwprwnn'rwp Yl mwl n3755*: A; 5-66.

d6; 9f Vxx—] 3P3 V3 1 S l Qj Ç M3 1 Nnj uÇ P3 P3 3 Xnv x°juxo Hj–rl J Çn óxv K 1 nw—[–rwp ' xxm j– jw Gm–x'knw–3– ' j–n' *Vxuu –¤xw I xw–'xu Lnmn'j–¤xw36><=A*: 5-:.

d6; : f S j''jtlqr L3l G1 –j–S 3l Qqjwnj Ç' 3G3l Njv nnm H3N33 Nrpq2–1 'qjln2j'nj jwm wr–'–xpnw2rl q v n–xyx'x1 – lj'kxw v j–n'rju óxv –qn'Ç ×j—n– ox' n nl–r°n jm–x'y–¤xw xo v n–qÇinwn ku n3 *Vx×mn' Znl qwxuxpÇ3756<A876*

d6; ; f Oujv S m3 GÖqj'1 ul Gqv nm S 3P3l Qqjwnj Ç' 3G3l G–ro S 3l Njv nnm H3N33 S n–xyx'x1 – jl–r°j–¤mm lxlxw1 — –qnuu2m'r°nm qÇn1 xlqj' y'nyj'nm °rj qÇn1 x–qn'v ju lj'kxwrÖ)–¤xw2Tj UN jl–r°j–¤xw ox' v n–qÇinwn ku n jm–x'y–¤xw3 *Px1 'wjuxo Kw°r'xwv nw–j–u S j wjpnv nw–3756<A758*

d6; <f Mqx–q Xjt n–q Q1 v j'1 Xnmm ÇJ 3J jv xnj'3 Zxkjllx Y–¤v G–q j–jw Gm–x'knw–ox' Xnv x°juxo S n–qÇinwn Hlu n óxv Gz1 nx1 – Yxu –¤xw@ Kz1 nuk'n v 1 Qrwn–rl– 1 jwm S nl qjwr–v xo Gm–x'y–¤xw3 *' j–n'1 Gr'1 * Yxuu Vxuu –¤xw3 7568A779-;*.

d6; =f Ln''n'x L33 J Çn 'nv x°ju kÇ ux× lx—jm–x'knw—@ Nj Öluw1 — –qnuu– rw lxv yj'r–xw ×r–q– ×xxm –j×m –3– *Px1 'wjuxo Nj Ö'mx1 – S j–n'rju–3755<A697* -627.

d6; >f Yjyj×n T 3l Pjuu G3G3l Z'r×jqÇxwx Y3l Yqjq S 33G3l Pl –xq X3l Yjunq T 3L3S 3l Njv nnm H3N3l Qj'rv G3N33 I x–2n nl–r°n v rl 'x×j°n 'jym –Çw–qn–r– xo Öwxur–n– Tj G ox' 'nv x°ju xo v n–qÇinwn ku n3 *I qnv rljuKwprwnn'rwp Px1 'wjus7568A77>*

d6<5f Km'r– Hj Öjo–qjwl Ln'mx– Qx'm S x—j–ejyx1 '1 S xqjv v jm Gur cj Öt1 ur3 S n–qÇinwn ku n -lj–¤xwrl mÇn. jm–x'y–¤xw rw–x– Yj ûj mx'j yn'–rlj —nv – j–q3 7567A66-656.

d6<6f Hjwn'snn Y1 –qv r–j–1 Yqj'v j Mxyn–q I 3l I qj xyjmqGjGj S 3l 3l Yqj'v j bxpn–q I qjwn'j3 Qrwn–rl– jwm nz1 nuk'n v v xnmurwp ox' –qn jm–x'y–r°n 'nv x°juxov n–qÇinwn ku n óxv jz1 nx1 – –xu –¤xw– xw xojl–r°j–¤mm Çj–q -GLYN. 3 *Px1 'wjuxoKw°r'xwv nw–j–u I qnv rljuKwprwnn'rwp37569A7-8*.

d6<7f Qj°r–ej J 1Tjv j–r°jGjv I 3KÅyn'rv nw–j–ujwmt rwn–rl– –1–mn– xw v n–qÇinwn ku n jm–x'y–¤xw kÇ lxr' yr–q– lj'kxw3 *Hrx'n–x1 'In Znl qwxuxpÇ3755<A>=-6*.

d6<8f Qqj 'r Y3 J 3l Yrwpq S 3 Q33 I xux1 ' Xnv x°juóxv YÇw–qn–rl– J Çn ' j—n×j–n' [–rwp j Hrxjm–x'knw–3– 7555A675