

$FYWM hgk]Xf][Y 5gm`!Ni fØW_k Y]gi b[Yb. A]b]ghYf 8cVf]bXh V`Y]Vh \ Ufh°$

; Yf]WX hgi fhY]``Yf_`Àfh`FØW_k Y]gi b[Yb`j cb`5gm`gi WXYbXYb U`g`fYWX hgk]Xf]["'=bbYba]b]ghYf`8cVf]bXh`_ØbX][h : cfhZØ\fi b['Ubž'k Ug`ni '?cbhfcj YfgYb`ZØ\fh"



: $fUb_Zi fh^*fC XYfŁ^*8Yi hgW `Ub X^! ^9]b^*U_hi Y^*Yg^! fhY]^*XYg 6Yf^]bYf^JYfk U^*hi b[g[Yf]W hg^*\Uh'X]Y^*Ni fØW_k Y]gi b[Yb^*j cb 5gmgi W Yb XYb^*Ub^*XYi hgW Yb^*; fYbnYb^*U^*g^*fYW hgk]Xf][^Yf_^Afh^*] <math>\oplus$ XYa __cb_fYhYb^*: U^**k UfYb^*XfY]^*gca U^*]gW Y^*5gmgi W Yb XYz^*X]Y^*Ua - "^A U]^*& \&) ^Ua ^6U\b\cZ^*: fUb_Zi fh^*fC XYfŁ^*Y]b^*5gm^[Ygi W \\Ai *YfhYbz^*j cb^*XYf^6i bXYgdc^*]nY]^*ni fØW_[Yk]YgYb^*k cfXYb^**8]YgY j Yfk]Yg^*Ui Z^*X]Y^*5bbU\a Yz^*Dc^*Yb^*gY]^*Y]b^*g]W YfYf^*8f]hhghUUh^**8]Y F]W hYf^ghY^*hYb^*ZYghz^*XUgg^*XUg^*8i V^*]b!J YfZU\fYb^*Y]b[Y\U^*hYb XØfZYbz^*i bX^*XUgg^*X]Y^*6i bXYgfY[]Yfi b[^JYfdZ]W hi b[Yb^*[Y[YbØVYf^*XYb 91 !FYW hgj cfgW f]ZhYb^*\Uh'*8 Ug^*I fhY]^*_ObbhY^*k Y]hfY]W YbXY : c^*[Yb^*ZØf^*X]Y^*DfUl]g^*XYf^*; fYbn_cbhfc^**Yb^*]b^*8Yi hgW ^*UbX^*\UVYbz^*XUX]Y^*6i bXYgdc^*]nY]^*V]g^*Ub[^Yfa AW h][^hk Ufz^*X]YgY

Ni fØW_k Y]gi b[Yb'c\bY'Y]bY'j cf\Yf][Y'DfØZ b['Xi fWkni ZØ\fYb"'HU[YggWk Ui 'VYf]WkhYhž'XUgg'X]YgY'9bhgWkY]Xi b['X]Y'YfghY [Yf]Wkh`]WkY', VYfdfØZ b['XYf'bYi Yb'FY[Y`i b[Yb'j cb 6i bXYq]bbYba]b]ghYf'5`YI UbXYf'8cVf]bXh`]gh"

 $6i bXYg]bbYba]b]ghYf'8cVf]bXh'ff7GI E'_ØbX][hY'Ubž'X]Y \\ i a ghf]hhYbYb'FØW_k Y]gi b[Yb'hfchn'XYg'I fhY]`g'Zcfhni gYhnYb''9f \\ VYnY]WkbYhY'XUg'I fhY]`'U`g' 9]bnY`ZU``YbhgWkY]Xi b['i bX'ZcfXYfh j cb'XYf'6i bXYgfY[]Yfi b['VYggYfY'6Y[fØbXi b[Yb'ZØf'X]Y \\ dfU_h]n]YfhYb'Ni fØW_k Y]gi b[Yb'''+b'Y]bYf'+fcb]Y'XYf'; YgWk]WkhY _\ObbhYb'X]Y'Zcfh[YgYhnhYb'A U\siden bU\a Yb'\YXcWk'fYWkh`]WkYb'8fi W_Ui Z'8cVf]bXh'YfnYi [Ybž'ZU``g'k Y]hYfY'; Yf]WkhY'\A\b`]WkY'I fhY]`Y Z\A``Yb'''8Yf'A]b]ghYf'k]Yg'XUfUi Z'\]bž'XUgg'X]Y'j YfgWk\AfZhYb ?cbhfc``Yb'Ub'XYb'; fYbnYb'ni 'Y]bYa 'F\ØW_[Ub['XYf'5gm`nU\`Yb [YZ\hat{Z}\hat{N}\hat{Y}\hat{N}'\hat{A}\hat{N}\hat{N}'\hat{A}\hat{N}'\hat{N}$

?cbhfcj YfgYb]bbYf\U`V XYf @UbXYgfY[]Yfi b[

 $8]Y ""i "Yfi b["j cb"G]Y[Zf]YX"@cfY_"ff781 £ ž \\ A][fUh]cbgghUUhggY_fYhÅf"]b "6UXYb!K ØfhhYa VYf[ž'gcf[h'ZØfni gÅhn`]WXYb "NØbXghcZZ']b "XYf'8]g_i gg]cb"" <math>\Rightarrow$ "Y]bYa "]bnk]gWXYb [Y`ÒgWX hYb" \Rightarrow ghU[fUa !J]XYc"VY\Ui dhYhY"@cfY_ž'Y]b" [fØbYf JYfk U'hi b[gf]WX hYf" \UVY"X]Y"Ni fØW_k Y]gi b[Yb"ZØf"] "Y[U"Yf_`Afh" 8]Yg"ZØ\fhY'ni "\YZh][Yf"?f]h]_'j cb"?c" "Y[Ybž']bgVYgcbXYfY j cb"XYf"; fØbYb"8 Ub]Y"U"9j Yfg"i bX"GUgWX U"6]bXYf"j cb"XYf"GD8 ž X]Y"@cfY_g"FØW_hf]hh'ZcfXYfhYb""9j Yfg'k UfbhY'j cf"Y]bYf 8]g_fYX]h]Yfi b["XYf" \Rightarrow gh]n"i bX"6]bXYf"VYhcbhYž"XUgg"X]Y I bUV\Ab[][_Y]h'XYf"; Yf]WXhY"b]WXh"]b": fU[Y"[YghY"h'k YfXYb qc"hY"

±0Zc`[Y`XYf`?cbhfcjYfgYb'jYfgiWkhY'@cfY_ž'g]Wk'_`UfnighY``Ybž
XUgg`Yf`X]Y`IbUV\Àb[][_Y]h`XYf`≯gh]n`b]Wkh`]bZfU[Y`ghY``Yb`kc``hY"
8YbbcWk`kifXY`gY]bY`9bhgWki`X][ib['jcb'BihnYfb'U`g'kYb][
[`UiVkØfX]['kU\f[YbcaaYb"`8Yf`GdfYWkYf`XYg
JYfkU`hib[g[Yf]Wkhg`6Yf`]b`k]Yg'UiZ'XUg'BYihfU`]hÀhgdf]bn]d`XYf
F]WkhYf`\]b`ibX'jYfifhY]`hY`X]Y`dYfgÒb`]WkYb`5b[f]ZZY`UiZ'X]YgY
bUWk`XYa`IfhY]`"`@Uih`GKF`[UV`Yg'j]Y`Y`6Ygcf[b]g`ØVYf`X]Y

 $5b[f]ZZY^UiZ^F]WAhYfZ^X]Y^]a^Ni[Y^XYf^dc^]h]gWAYb^8YVUhhY^ni^XYbFØW_kY]gib[Yb^ni[YbcaaYb^\UVYb"]$

FYW hg`U[YibXFYU_h]cbYb

 $8]Y `9b hg W Y] Xi b [`XYg'; Yf] W hg'k]Yg' 8 c V f] b X hg' 5 f[i a YbhUh] c b ni f Ø W_ž g] W `Ui Z'5 fh]_Y ``+& `XYg' 5 9 I J `ni `VYfi ZYbž `XU `Yg `Ub `Y] b Y f \] b f Y] W Yb XYb `8 Uf `Y[i b [`Y] b Yf'; YZÅ \ f Xi b [`ZØf `X] Y `OZZYbh`] W Y G] W Yf \Y] h c XYf `C f X bi b [`[YZY \ `h' \ UVY " 8 Yf `F] W hYf Vi b X `i b X `X] Y J Yfk U `hi b [gf] W hYf j Yf V Å b XY 'j Yfi fh Y] `hYb `X] Y `5 b [f] ZZY `Ui Z' X] Y $\frac{1}{2} gh] n `i b X `Zc f X Yfh Y b `Y] b Y b `f Y g d Y_hj c ``Yb `I a [Ub [" `N8 : `n] h] Yfh 5 g m `f Y W hg Y I d Yfh Y b z' X] Y `X] Y `6 i b X Y g f Y [] Y fi b [`Ui Z Z c f X Y f b z' X] Y f Y W h`] W Y ; fi b X `U [Y `ZØf `X] Y `Ni f Ø W_k Y] gi b [Yb `ni `Ø V Y f X Y b _Y b i b X `_` Uf Y `Dc g] h] c b Yb `ni `V Y n] Y \ Y b "$

8]Y 5b[Y`Y[Yb\Y]h'V`Y]Vh'Ub[YgdUbbhžXU'X]Y 6i bXYgdc`]nY]
ni bÀW gh'k Y]hYf\]b'X]Y FØW_k Y]gi b[Yb'Ub'XYb'; fYbnYb
Xi fW ZØ\fYb'XUfZžUVYf'XYf'8fi W_'Ui Z'X]Y 6i bXYgfY[]Yfi b[
k UW gYb'_ObbhYžZU``g'À\b`]W Y'9bhgW Y]Xi b[Yb'UbXYfYf'; Yf]W hY
Zc`[Yb"'@cV'j cb'XYb'A YbgW YbfYW hgcf[Ub]gUh]cbYb'k]fX'g]W
Yfgh'XUbb'Y]bghY``Ybž'k Ybb'X]Y'Yi fcdUfYW hgk]Xf][Yb'DfU_h]_Yb
XYf'Ni fØW_k Y]gi b[Yb'j cb'5gm`gi W YbXYb'VYYbXYh'k YfXYb"
8cVf]bXhg'9f_`Àfi b['ni f': cfhZØ\fi b['XYf'A U» bU\a Yb'nY][hž'XUgg
X]Y'8YVUhhY'i a 'A YbgW YbfYW hY'i bX'; fYbn_cbhfc``Yb']b
8Yi hgW `UbX'k Y]hYf\]b'Y]b'Ài »Yfgh'_cbhfcj YfgYg'H\Ya U'V`Y]Vh"

8 YhU]`g	
J cfZU``	A][fUh]cbg
Cfh	: fUb_Zi fh`fCXYfŁž'8Yi hgWX`UbX
EiY``Yb	• k k k "gk f"XY
	• kkk"hU[YggW\Ui"XY
	• k k k "nXZ\Yi hY"XY

6Ygi WXYb G]Y i bg Ui Z. b!U["bYh