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Key To The Extraterrestrial Messages

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Dr. Campaigne presented a series of 29 messages from outer space in "Extraterrestrial Intelligence," NSA Technical Journal, Vol. XI, No. 2, pp. 101 ff. and in the Special Mathematics and Engineering Issue of the Journal, pp. 117 ff. The following article develops a key to these messages. Paragraph numbers parallel the serial numbers of the messages reprinted in the appendix below. This includes two new series—30 and 31—not included in the previous article.

At every step in the solution we make a guess at the meaning. Evidence will quickly accumulate to verify or refute this guess. The possibility of ambiguity of two consistent solutions is very remote. Only in the last steps, where verification is thin, could this happen.

1. There are 21 symbols, in the order given by this message.

2. B is equivalent to AA, C to AAA, etc. That is, $A=1$; $B=2$; $C=3$; $D=4$; $E=5$; $F=6$; $G=7$.

3. The symbol L means the two things that follow are the same. LXY means $x=y$.

4. Each statement has 5 symbols, and begins with L. The 4 symbols after L must be considered as two things. Each statement has a K as the third letter, which must be the start of the second thing. Is $B=KAA$; $C=KBA$; $C=KAB$; $D=KCA$? If KBA means $B+A$, it fits.

5. These verify our conclusions on 4. The first means $6=1+(2+3)$, the last means $1+(2+3)=(1+2)+3$.

6. Each has five symbols as in 4. They mean $1=M21$; $2=M31$; $1=M32$. Obviously MXY means $x-y$.

7. These translate $N=1-1$; $N=2-2$; $N=3-3$. N stands for zero, 0.

8. These translate $1=O11$; $0=O01$; $2=O12$; $2=O21$; $0=O02$; $0=O20$; $4=O22$, etc. OXY means the product $X\times Y$.

9. These verify the conclusions of 8. The first says that $6=1\times 2\times 3$, the last $4\times(5\times 6)=(4\times 5)\times 6$.

Note: So far we have seen two kinds of symbols: digits A through G and N, and operators L, K, M, and O. The two digits following the operator are the operands.

10. Translates into $4=R22$; $2=R21$; $1=R20$; $3=R31$; $1=R30$. RXY must mean X^Y, exponentiation. R is another binary operator.

[redacted]

11. Translates into $2^3 = 4+4$; $2^3 = 1+7$; $2^3 = 2\times 4$; $2^2 = 4$, verifying our previous conclusions.

12. Translates into $3^2 = 4+5$; $3^2 = 3\times 3$. Further verification.

Note: In our culture we use parentheses to group closely associated terms, and as a first step it helps, even though it is not necessary, to put in parentheses. To do so unambiguously, start at the right and read left to the first operator symbol; put parentheses about the operator and the two quantities to its right. Repeat until no pair of parentheses contains more than an operator and two quantities.

13. Translates into $J = 2^3$; $J = 1+7$; $J+1 = 3\times 3$; $J+1 = 3^2$, therefore $J = 8$.

14. We can only introduce parentheses by assuming P is an operator, so we get $2 = P84$; $4 = P82$; $1 = P33$; and $3 = P62$. Thus $P\times Y = X \div Y$, division.

15. Assume U is an operator, getting U12; U23; U34; U58; U68; U78; $U2^3 3^2 = U89$. The smaller is first in each case; so perhaps UXY means X precedes Y or $X < Y$.

16. The new character Q must be an operator. Transcribed it gives us Q: $0 = 1$; Q: $1 = 3$; Q: $1 = 1+1$; Q: $0 = 1\times 1$; Q: $2^2 = 2$; Q: $2 < 2$; Q: H$(1=1)$ $(1=2)$; Q|Q: $3 = 3$|; Q: $8 < 7$.

Clearly Q means "the following statement is false." Then the next to the last is read "it is false that $3 \neq 3$." QL will be translated $\neq$. The second new symbol is not clear, except that it is an operator whose operands are statements, not quantities, a Boolean operator.

Note: Q is an operator with only one operand, unary.

17. Putting in parentheses shows that S is also a unary operator operating on statements. Transcribed they are: S: $1 = 1$; S: $1 < 2$; S: $2 = 1+1$; S: $1 = 1\times 1$; S: $0 = 1-1$; S: H|$(6 = 1\times 6)$ $(1 = 6 \div 6)$|; S: H|$(1 = 1)$ $(2 = 2)$|. It is apparent that S means "the following statement is true" or "it is asserted that." The next to the last message shows that HXY means "X implies Y" or "X is a consequence of Y" or maybe "X is logically equivalent to Y."

18. Our rule for parentheses breaks down unless T is a different kind of symbol. The first message shows that T may be a unary operator on quantities, so that AT or TA is a quantity. The third message shows that it must be the first, since T is last. Putting in parentheses this way gives $1T = 1$; $2T = 1T+1$; $5T = 2T+3T$; $6T = 3T\times 2T$; $7T = 7$; $10T = 8$. T must be an ending. On one digit it makes no difference. It combines the two digits 10 to make 8. Octal arithmetic?

19. Transcribes to $123T = 1\times 8^2 + (2\times 8^1 + 3)$;
$321T = 3\times 8^2 + (2\times 8^1 + 1\times 8^0)$;
$4567T = (4\times 8^3 + 5\times 8^2) + (6\times 8^1 + 7\times 8^0)$.

Clearly T indicates that "the preceding digits form an octal number." Possibly it is an octal point; if so, digits may occur after it.

Note: Because of the way grouping is implied, it is sufficient to have a marker at the end of a number in order to clearly isolate it as a single *entity*.

20. In trying to put on parentheses it appears that V is also an ending. But this one combines with both quantities (that is, digits.) and operator. Transcribing by *treating V and the preceding symbol as* a single unit for the time being, we get:

$8 \quad 1 + AV$ implies $7 = AV$.

I will use · *for H hereafter. Remember that we are not sure of the* sense of this sign. $H - 3'' = \cdot\ 2 = AV$ (I have omitted the T. Remember that 11T is nine);

$3 \quad AV = \cdot\ 11 = \overline{AV}^2$;

$5 \quad AV \cdot 6 - 1 + AV$.

In the next message if we combine the O and V into one symbol the message does not parse. Try GOV as one symbol, getting

$3 \quad 1 + GOV = \cdot\ 2 = GOV$;

$6 \quad 2 \times SOV = \cdot\ 3 = SOV$;

$3 \quad DOV = \cdot\ 11 = \overline{DOV}^2$;

It is true that $AV + PV = PV + AV$;

It is a tautology that $AV \times PV = PV \times AV$;

It is an identity that $AV + (PV + TV) = (AV + PV) + TV$;

It is asserted that $AV \times (PV \times TV) = (AV + PV) + TV$;

$AV \neq BV = \cdot\ AV - BV \neq BV\ AV$;

$AV \neq BV \cdot AV''' \neq BV''$.

The meaning of V must be that "the preceding letters as a group have an abstract meaning, or are a variable." V is a little like a word spacer.

Note: Putting in parentheses is now complicated by another rule. Each T or V should be packaged with preceding symbols, just how many depending on the parsing of the message. Those preceding T will all be digits. Those preceding V can be expected to reoccur as a group.

21. Putting parentheses in these messages is difficult until we notice that UV appears in each. They then transcribe into:

$0 \quad |2 + (\overline{D}\overline{D}\overline{D}V^2 - DDDV \times 3)| = \cdot\ UV|1 = DDDV|$
$|2 = DDDV|$;

$UV|1 = DV||0 - 1 = DV| = \cdot\ |1 = \overline{DV}^2|$;

$UV|1 = BV||0 = BV| = \cdot\ 0 = BV - \overline{BV}^2$;

It is true that $UV|AV = BV||AV \neq BV|$;

It is true that $UV|AV < BV||BV < AV|$.

In order to complete the parsing we had to assume that UV was a binary operator, and in every case the operands are statements. It is clear from the algebra that UV means "or." The last message shows that U means $\leq$, rather than $<$ as I had it.

[redacted]

22. We notice that TV is used in every message, and parallels the usage of UV. Assuming TV is a binary Boolean operator, the messages parse.

It is false that TV|AV ≤ BV||BV ≤ AV|;
It is false that TV|AV = BV||AV ≠ BV|;
TV|$\overline{\text{AV}}^2$ = 4||0 ≤ AV| = · AV = 2;
AV > BV = · |BV ≤ AV| or |BV = AV|;
It is true that not TV GV HV = · GV or HV;
It is true that GV and HV = · TV GV HV;
AV or (BV or CV) = (AV or BV) or CV;
TV|AV TV|BVCV|| = TV||TV AV BV|CV|;
TV|AV|BV or CV|| = TV|AVBV| or TV|AV CV|;
AV or TV |BV CV| = TV|AV or BV||AV or CV|.

It is apparent that TV means "and." Notice that L is used here to mean "logically equivalent to," although I have written "=".

Note: U is used here for <, not ≤.

Either there is a mistake, or the usage varies.

23. The parsing falters until we realize that JNV occurs in each message, and is probably a word. BAV and CAV also occur in each message. They transcribe into:

JNV |BAV or CAV| BAV;
JNV BAV |BAV and CAV|;
JNV |BAV or CAV||BAV and CAV|;
JNV BAV CAV = · BAV = (BAV or CAV);
JNV BAV CAV = · CAV = (BAV and CAV).

The last two conclusions look like set theory statements. JNV parses like a binary operator. JNV XY could mean "X contains Y" in the set theory sense. Then if UV is "or" in the set theory sense, the union, and TV is "and" in the set theory sense, the intersection, the statements above can be rewritten:

BAV ∪ CAV ⊃ BAV
BAV ⊃ BAV ∩ CAV
BAV ∪ CAV ⊃ BAV ∩ CAV
BAV ⊃ CAV = · BAV = (BAV ∪ CAV)
BAV ⊃ CAV = · CAV = (BAV ∩ CAV).

24. NKV looks like a binary operator of which at least the first operand is a quantity. JAV is uniformly the second operand. From 23 above we are alert to set theory statements. Could it be that NKV says something is a member of some set? Try it. They become

1∈JAV; 2∈JAV; 3∈JAV; 4∈JAV; 5∈JAV; 6∈JAV; 7∈JAV; 11∈JAV; 12∈JAV; AV∈JAV = · AV + 1∈JAV.

JAV is the set of positive integers! It fits!

25. These parse into:

(1 and 2)ε JAV;
((1 and 2) and 3)ε JAV;
(14 and 17)ε JAV;
((77 and 100) and 101)ε JAV;
(AV ⊃ NMV) and (BV ⊃ NMV) =· (AV and BV) ⊃ NMV;
0εJAV;
8εJAV; $8'$εJAV; $8''$εJAV; $8'''$εJAV; $8''''$εJAV; $8'''''$εJAV; $8''''''$εJAV;
$8'''''''$εJAV; BVεJAV =· 8^{BV}εJAV;
(BV and CV)εJAV =· BV + CVεJAV;
(BV and CV)εJAV =· BV × CVεJAV;
(BV and CV)εJAV =· BV^{CV}εJAV;
1/2∉JAV; 1 − 2∉JAV; 0 − 3∉JAV; 7/6∉JAV.

This verifies beyond doubt the guess of 24.

26. There is a new word, JOV. The messages read JAVεJOV:

0 − 1εJOV; 0 − BVεJAV =· BVεJOV;
1/2εJOV; AV and BVεJOV =· AV − BVεJOV;
(AV and BV in JOV) and 0 ≠ BV =· AV ÷ BV in JOV;
1 ÷ 0 not in JAV; 1 ÷ 0 not in JOV;
It is true that (AV ÷ BV) × (CV ÷ DV) = (AV × CV) ÷ (BV × DV);
It is true that AV × DV < BV × CV =· AV ÷ BV < CV ÷ DV. BV × DV ≠ 0;
AVεJAV =· 0 − 1 < AV.

JOV is seen to be the field generated by JAV, in other words, the set of rational numbers. The next to the last message has a garble, an extraneous A.

27. This transcribes to:

(AV =· BV) and (BV =· AV) =· HV.AV.BV.
Clearly HV means "logically equivalent," or "·=·".
(AV ·=· BV) =· (AV =· BV) and (BV =· AV)
(AV ·=· BV) ·=· (AV =· BV) and (BV =· AV).

28. These transcribe to

$\overline{GV^2 = 3}$ =· GV not in JOV;
$\overline{GV^2 = 2}$ =· GV not in JOV;
$\overline{GV^2 = 5}$ =· GV not in JOV;
$GV^2 = 5$ =· GV in JEV;
JOV is in JEV;
JAV is in JEV;
$\overline{GV^2 = 0 - 1}$ =· GV not in JEV.

We have a new set, containing the rationals, and at least one irrational, but not the imaginary $\sqrt{-1}$. JEV is probably the real numbers.

29. These transcribe to

$1 - 2^{n-1}$ in JBV; $1 - 3^{n-1}$ in JBV;

$1 - 4^{n-1}$ in JBV; $1 - \overline{NV}^{n-1}$ in JBV;

NLV JBV = 1 [assuming NLV is one word. Another possible parsing is LV(JBV, 1) = 0]

1/1 in JCV; 1/2 in JCV; 1/3 in JCV; 1/NV in JCV; NLV JCV = 0 [or LV (JCV, 0) = 0. But the two examples suggest that NLV means "a limit of." If NV is an integer this fits perfectly.]

$(1 - 1/2)^2$ in JBV; $(1 - 1/3)^3$ in JBV;

$(1 - 1/4)^4$ in JBV; $\left(1 - \frac{1}{8^{100}}\right)^{8^{100}}$ in JBV;

$\left(1 - \frac{1}{NV}\right)^{NV}$ in JBV; NLV JBV in JEV.

If NLV means limit, then JEV contains the number e, a verification of our guess that JEV named the real numbers.

The last two lessons—30 and 31—were not published with the first twenty-nine because it made too long an exercise.

30. The later messages of this group have the mysterious sequences ABCD, ABCDE, DEFG, etc, each ending with STV. If we bunch these each as a unit, the messages parse. They then say JNV 1 natural number; JNV 2 natural number; JNV 3 natural number; JNV 123 STV natural number; conjecture STV means "the preceding is a set (or sequence)," and JNV means "belongs to." There is doubt about the latter, since we thought earlier that it meant "contains"; AV belongs to 1234 =· AV is a natural number; 12345 or 4567 = 45 as sets; 12345 and 4567 = 1234567 as sets.

31. This last group is of impressive magnitude, 41 messages, of which the thirtieth is quite long. Parsing is eased by the parallel construction of the messages. They transcribe to:

JRAV belongs to CHAV; JRBV belongs to CHAV; JRGV belongs to CHAV; the set JRAV, JRBV, JRCV, JRDV, JREV, JRFV, JRGV belongs to CHAV; [Since all the digits appear in these groups, maybe they are used like subscripts and should be read JR_1, JR_2, etc.]; JO_1 belongs to CHAV; JO_2 belongs to CHAV; JO_{22} belongs to CHAV; the set JO_1, JO_2, JO_3, JO_4, JO_5, JO_6, JO_7, JO_{10}, JO_{11}, JO_{12}, JO_{13}, JO_{14}, JO_{15}, JO_{16}, JO_{17}, JO_{20}, JO_{21}, JO_{22} belongs to CHAV; U_{10} and U_1 - - 22 JO_1 belongs to CHAV [This one must be parsed wrong or garbled]; BL_1 belongs to JR_1; BL_2 belongs to JR_1; BL_3 belongs to JR_2; BL_4 belongs to JR_2; BL_{12} belongs to JR_2;

$AV \leq 3$ and $12 \geq AV$ ·=· BL_{AV} belongs to JR_2;

$AV \geq 13$ and $22 \leq AV$ ·=· BL_{AV} belongs to JR_3;

$AV \leq 23$ and $44 \leq AV$ ·=· BL_{AV} belongs to JR_4;

$AV > 45$ and $66 > AV \Rightarrow BL_{AV}$ belongs to JR_5;
$AV > 67$ and $126 > AV \Rightarrow BL_{AV}$ belongs to JR_6;
$AV > 127$ and $142 > AV \Rightarrow BL_{AV}$ belongs to JR_7;
The set BL_1, BL_3, BL_{14}, BL_{21}, BL_{45}, BL_{67}, BL_{127} belongs to JO_1;
The set BL_2, BL_4, BL_{13}, BL_{24}, BL_{46}, BL_{70}, BL_{140} belongs to JO_2;
The set BL_5, BL_{15}, BL_{37}, BL_{61}, BL_{121} belongs to JO_3;
The set BL_6 and BL_{16} and BL_{40} and BL_{62} and BL_{122} belongs to JO_4;
The set BL_7, BL_{17}, BL_{41}, BL_{63}, BL_{123} belongs to JO_5;
The set BL_{100}, BL_{20}, BL_{42}, BL_{64}, BL_{124} belongs to JO_6 |note a garble here, an N is repeated|;
The set BL_{11}, BL_{18}, $BL_{[illegible]}$, BL_{65}, BL_{125} belongs to JO_7;
The set BL_{12}, $BL_{[illegible]}$, $BL_{[illegible]}$, BL_{66}, BL_{126} belongs to JO_{10};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, BL_{31}, BL_{32}, $BL_{[illegible]}$, BL_{71}, BL_{73}, BL_{76}, BL_{77}, BL_{100}, BL_{101}, $BL_{[illegible]}$, BL_{103}, BL_{104}, BL_{105}, BL_{106}, BL_{107}, BL_{111}, BL_{112}, BL_{113}, BL_{114}, BL_{115}, BL_{116}, BL_{117}, BL_{118}, BL_{141}, BL_{142} belongs to JO_{11};
$BL_{[illegible]}$ and $BL_{[illegible]}$ and BL_{110} belongs to JO_{12};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{13};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{14};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{15};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{16};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{17};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{20};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{21};
The set $BL_{[illegible]}$, $BL_{[illegible]}$, $BL_{[illegible]}$ belongs to JO_{22};
CHAV belongs to KSPV.

The transcription leaves a lot to be resolved. There are several words the meanings of which are yet to be determined. The word CHAV (or CH_1) seems to be central. There are seven words JR, and eighteen words JO_i, and each of these belongs to CHAV. There are 98 words BL_j, each of which seems to belong to a unique JO_i. Does each also belong to a unique JR_i? With this hint we can straighten out the garbled message above; it reads "$0 < AV$ and $AV < 22 \Rightarrow JO_{AV}$ belongs to CHAV"; there was a V omitted. I was also able to reparse six other messages. I will not bore you with the details, since the list above has been corrected.

Since each BL_j belongs to one JR_i and JO_k, these can be displayed in a matrix

	JR_1	JR_2	JR_3	JR_4	JR_5	JR_6	JR_7
JO_1	BL_1	BL_3	BL_{14}	BL_{21}	BL_{45}	BL_{67}	BL_{127}
JO_2	BL_2	BL_4	BL_{13}	BL_{24}	BL_{46}	BL_{70}	BL_{140}
JO_3		BL_5	BL_{15}	BL_{37}	BL_{61}	BL_{121}	
JO_4		BL_6	BL_{16}	BL_{40}	BL_{62}	BL_{122}	
JO_5		BL_7	BL_{17}	BL_{41}	BL_{63}	BL_{123}	
JO_6		BL_{10}	BL_{20}	BL_{42}	BL_{64}	BL_{124}	

JO_7	BL_{11}	BL_{21}	BL_{43}	BL_{65}	BL_{125}					
JO_{10}	BL_{12}	BL_{22}	BL_{44}	BL_{66}	BL_{126}					
JO_{11}	BL	25	47	71	72	73	74	75	76	77
	100	101	102	103	104	105	106	107		
		131	132	133	134	135	136	137		
	140	141	142							
JO_{12}	BL_{16}			BL_{50}	BL_{110}					
JO_{13}			BL_{27}	BL_{51}	BL_{111}					
JO_{14}			BL_{30}	BL_{52}	BL_{112}					
JO_{15}			BL_{31}	BL_{53}	BL_{113}					
JO_{16}			BL_{32}	BL_{54}	BL_{114}					
JO_{17}			BL_{33}	BL_{55}	BL_{115}					
JO_{20}			BL_{34}	BL_{56}	BL_{116}					
JO_{21}			BL_{35}	BL_{57}	BL_{117}					
JO_{22}			BL_{36}	BL_{60}	BL_{120}					

Remember that these are not decimal numbers. There is only one cell with more than one entry, and the subscripts in it in decimal notation are 21, 39, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98. The larger part of the entries is systematically distributed in the first eight rows. This suggests the periodic table of the chemical elements! On consulting a table we find, sure enough, that elements 57 through 71 are rare earths, and are lumped into one cell. Some, but not all, authorities also list 89 through 103 as rare earths. Elements 21 and 39 are Scandium and Yttrium.

CHAV must mean the periodic table. JR_x means column x, and JO_y means row y. BL_Z means element Z. The meaning of KSPV is not known, except that it is a generalization of "periodic table." It may merely mean table, or scientific fact, or university subject.

Looking back over the exercise we see we have penetrated the meaning of the basic symbols, and even more important, have learned some of the syntax rules of the notation, and have caught mistakes in the process. We have a few words for sophisticated concepts, and, given more data, with a little labor we could establish its translation.

The concepts used here are the basic ones of number, sets, and physical constants which any cultures must share. How bizarre the syntax and values of a culture could be I cannot conjecture, but any civilizations capable of sending a message across space must have many things in common.

APPENDIX

Recently a series of radio messages was heard coming from outer space. The transmission was not continuous, but cut by pauses into pieces which could be taken as units, for they were repeated over and over again. The pauses show here as punctuation. The various combinations have been represented by letters of the alphabet, so that the messages can be written down. Each message except the first is given here only once. The serial number of the message has been supplied for each reference.

1 ABCDEFGHIJKLMNOPQRSTUV
ABCDEFGHIJKLMNOPQRSTUV
ABCDEFGHIJKLMNOPQR etc

2 AA. B AAA.C. AAAA.D. AAAAA.E. AAAAAA.F. AAAAAAA.G

3 LAA. LBB. LCC. LDD. LEE. LFF. LGG

4 LBKAA. LCKBA. LCKAB. LDKCA. LDKBB. LDKAC: LEKDA.
LEKCB. LEKBC. LEKAD. LFKEA. LFKDB. LFKCC. LFKBD.
LFKAE -

5 LFKAKBC LFKCKBA. LGKAKBD. LGKCKAC. LKAKBCKKABC

6 LAMBA. LBMCA. LAMCB. LCMDA. LBMDB. LAMDC. LDMEA.
LCMEB. LBMEC. LAMED

7 LNMAA. LNMBB. LNMCC. LNMDD. LNMEE. LNMFF. LNMGG

8 LAOAA. LNONA. LBOAB. LBOBA. LNONB. LNOBN. LDOBB;
LDOAD. LFOAF. LFOBC

9 LFOAOBC. LFOCOBA. LFOBOCA; LODOEFOODEF

10 LDRBB LBRBA. LARBN. LCRCA. LARCN

11 LRBCKDD. LRBCKAG. LRBCOBD. LRBBD

12 LRCBKDE. LRCBOCC

13 LJRBC. LJKAG. LKJAOCC. LKJARCB

14 LBPJD. LDPJB. LAPCC. LCPFB

15 UAB. UBC; UCD; UEJ; UFJ; UGJ; URBCRCB.

16 QLNA; QLAC; QLAKAA; QLNOAA; QLRBBB; QUBB; QHLAALAB;
QQLCC; QUJG.

17 SLAA; SUAB; SLBKAA; SLAOAA; SLNMAA; SHLFOAFLAPFF; SHLAALBB

18 LATA, LBTKATA; LETKBTCT; LFTOCTBT; LGTG; LANTJ.

19 LABCTKOARJBKOBRJAC;
LCBATKOCRJBKOBRJAOARJN;
LDEFGTKKODRJCOERJBKOFRJAOGRJN;

20 HLJKAAVLGAV.
HLAATHCAVLBAV.
HLCAVLAPTHAVB
HLEAVLFKAAV
HLCKAGDVLBCDV.
HLFGBSOVLCSOV
HLCDOVLAATHDOVB
SLKAVFVKFVAV
SLOAVTVOPVAV.
SLKAVKPVTVKKAVPVTV.
SLOAVOPVSVOOAVPVSV.
HQLAVBVQLMAVBVMBVAV.
HQLAVBVQLRAVBVRBVAV

21 HLNKNMRDODVBODOVCUVLADODVLBODV
HUVLADVLMNADVLAROVB
HUVLABVLNBVLNMBVRBVB.

SUVLAVBVQLAVBV.
SHVUAVBVUBVAV

22 QTVUAVBVUBVAV.
QTVLAVBVQLAVBV.
HTVLRAVBHUNAVLAVB.
HQUAVBVUVUBVAVLBVAV.
SHQTVGVHVUVQCVQHV.
SHQUVGVHVTVQGVQHV.
LUVAVUVBVCVHVUVAVBVCV.
LTVAVTVBVCVTVTVAVBVCV.
LTVAVUVBVCVUVTVAVBVTVAVCV.
LUVAVTVBVCVTVUVAVBVUVAVCV

23 JNVUVHAVCAVBAV.
JNVBAVTVBAVCAV.
JNVUVBAVCAVTVBAVCAV.
HJNVHAVCAVLHAVHVHAVCAV.
HJNVHAVCAVLCAVTVHAVCAV.
HTVJNVHAVCAVJNVCAVBAVLHAVCAV.
HLJNVHAVCAVJNVQCAVQHAV.
SHTVJNVHAVCAVJNVCAVUAVJNVBAVUAV

24 NKVAJAV.
NKVBJAV.
NKVCJAV.
NKVDJAV.
NKVEJAV.
NKVFJAV.
NKVGJAV.
NKVAATJAV.
NKVABTJAV.
HNKVAVJAVNKVKAVAJAV

25 NKVTVABJAV.
NKVTVTVABCJAV.
NKVTVADTACTJAV.
NKVTVTVGGTANNTANATJAV.
HTVJNVAVNMVJNVBVNMVJNVTVAVBVNMV.
NKVNJAV.
NKVJJAV.
NKVRJBJAV.
NKVRJCJAV.
NKVRJHJAV.
NKVRJJJAV.
NKVRJANTJAV.
NKVRJANNTJAV
NKVRJANNNTJAV
HNKVRVJAVNKVRJBVJAV

HNKVTVBVCVJAVNKVKBVCVJAV
HNKVTVBVCVJAVNKVUBVCVJAV
HNKVTVBVCVJAVNKVRBVCVJAV.
QNKVPABJAV.
QNKVMABJAV.
QNKVMNCJAV.
QNKVPGFJAV

26 NKVJAVJOV.
NKVMNAJOV.
HNKVMNBVJAVNKVBVJOV.
NKVPABJOV.
HNKVTVAVBVJOVNKVMAVBVJOV.
HTVNKVTVAVBVJOVQLNBVNKVPAVBVJOV.
QNKVPANJAV.
QNKVPANJOV.
SLOPAVBVPCVHVPUAVCVOBVDV
SHHOAVDVOHVCVHPAVBVPACVDV.QLOBVOVN
HNKVAVJAVUMNAAV.

27 HTVHAVBVHHVAVHVAVBV.
HHVAVBVTVHAVBVHHVAV
HVHVAVBVTVHAVBVHHVAV

26 HLRCVBCQNKVGVJOV.
HLRGVBBQNKVGVJOV
HLRGVBEQNKVGVJOV.
HLRGVBENNKVGVJEV.
NKVJOVJEV.
NKVJAVJEV.
HLRGVBMNAQNKVGVJEV

29 NKVMARBMNAJBV.
NKVMARCMNAJBV.
NKVMARDMNAJBV.
NKVMARNVMNAJBV.
LNLVJBVA.
NKVPAAJCV.
NKVPABJCV.
NKVPACJCV.
NKVPANVJCV.
LNLVJCVN
NKVRMAPABBJBV.
NKVRMAPACCJBV.
NKVRMAPADDJBV.
NKVRMAPARJANNTRJANNTJBV.
NKVRMAPANVNVJBV.
NKVRLVJBVJEV.

30. JNVAJAV;
JNVBJAV;
JNVCJAV;
JNVABCSTVJAV;
HJNVAVABCDSTVJNVAVJAV;
LUVABCDESTVDEFGSTVDESTV;
LTVABCDESTVDEFGSTVABCDEFGSTV;

31. JNVJRAVCHAV;
JNVJRBVCHAV;
JNVJRGVCHAV;
JNVJRAVJRBVJRCVJRDVJREVJRFVJRGVSTVCHAV.
JNVJOAVCHAV;
JNVJOBVCHAV;
JNVJOBBVCHAV;

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JNVJOAVJOBVJOCVJODVJOEVJOFVJOGV
JOANVJOAAVJOABVJOACVJOADVJOAEVJOAFVJOAGV
JOBNVJOBAVJOBBVSTVCHAV :
HTVUNAVUAVBBTJNVJOAVVCHAV :
JNVBLAVJRAV .
JNVBLBVJRAV .
JNVBLCVJRBV
JNVBLDVJRBV
JNVBLABVJRBV .
HVTVQUAVCQUABTAVJNVBLAVVJRBV .
HVTVQUAVACTQUBBTAVJNVBLAVVJRCV
HVTVQUAVBCTQUDDTAVJNVBLAVVJRDV .
HVTVQAVDETQUFFTAVJNVBLAVVJREV .
HVTVQUAVFGTQUABFTAVJNVBLAVVJRFV .
HVTVQUAVABGTQUADBTAVJNVBLAVVJRGV :
JNVBLAVBLCVBLACVBLBCVBLDEVBLFGV
BLABGVSTVJOAV .
JNVBLBVBLDVBLADVBLBDVBLDFV
BLGNVBLACNVSTVJOBV :
JNVBLEVBLAEVBLCGVBLFAVBLABAVSTVJOCV .
JNVTVTVTVTVBLFVBLAFVBLDNVBLFBVBLABBVSTVJODV .
JNVBLGVBLAGVBLDAVBLFCVBLABCVSTVJOEV .
JNVBLANNBLBNVBLDBVBLFDVBLABDVSTVJOFV .
JNVBLAAVBLBAVBLDCVBLFEVBLABEVSTVJOGV :
JNVBLABVBLBBVBLDDVBLFFVBLABFVSTVJOANV .
JNVBLBEVBLDGVBLGAVBLGBVBLGCVBLGDV
BLGEVBLGFVBLGGVBLANNVBLANAVBLANBVBLANCV
BLANDVBLANEVBLANFVBLANGVBLACAVBLACBV
BLACCVBLACDVBLACEVBLACFVBLACGVBLADNV
BLADAVBLADBVSTVJOAAV :
JNVTVTVBLBFVBLENVBLAANVJOABV .
JNVBLBGVBLEAVBLAAAVSTVJOACV :
JNVBLCNVBLEBVBLAABVSTVJOADV .
JNVBLCAVBLECVBLAACVSTVJOAEV :
JNVBLCBVBLEDVBLAADVSTVJOAFV .
JNVBLCCVBLEEVBLAAEVSTVJOAGV :
JNVBLCDVBLEFVBLAAFVSTVJOBNV :
JNVBLCEVBLEGVBLAAGVSTVJOBAV :
JNVBLCFVBLFNVBLABNVSTVJOBBV :
JNVCHAVKSPV
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