Science Olympiad — Lower Merion

Captains Tryouts 2020

2019

Timed Question **[250 points]** Solve this quote from Randy Pausch. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

U IN TRUCT JR FXXM AIBUCT VZC XBXSH YIH U AIBX GXVJ,
I AM GOING TO KEEP HAVING FUN EVERY DAY I HAVE LEFT,

EXWIZLX JAXSX UL CR RJAXS OIH RV GUVX. HRZ QZLJ AIBX
BECAUSE THERE IS NO OTHER WAY OF LIFE. YOU JUST HAVE

JR YXWUYX OAXJAXS HRZ ISX I JUTTXS RS IC XXHRSX.
TO DECIDE WHETHER YOU ARE A TIGGER OR AN EEYORE.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	7	4	5		1	1	2	6	10	8		3	1	1	2		1	10	8	5	8	4	2	22	3	5
Replacement	H	V	N	X	B	K	L	Y	A	T	Z	S	P	M	W	Q	J	O	R	G	I	F	C	E	D	U

1) **[400 points]** Decrypt the following message. It has been encoded in Hill with a keyword of TART.

$$\begin{pmatrix} T & A \\ R & T \end{pmatrix} \equiv \begin{pmatrix} 19 & 0 \\ 17 & 19 \end{pmatrix}$$

M	L	A	N	K	W	X	O	Y	S	G	P	B	K	T	F	T	P	W	T	K	M	G	U	L	H	Y
C	**H**	**A**	**N**	**G**	**E**	**T**	**H**	**E**	**W**	**O**	**R**	**L**	**D**	**B**	**Y**	**B**	**E**	**I**	**N**	**G**	**Y**	**O**	**U**	**R**	**S**	**E**

How to solve

The inverse of the matrix can be computed using the formula:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1} = (ad - bc)^{-1} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

In this case we have to compute $(ad - bc)^{-1}$ Using modular multiplicative inverse (https://en.wikipedia.org/wiki/Modular_multiplicative_inverse) math

$$\begin{pmatrix} 19 & 0 \\ 17 & 19 \end{pmatrix}^{-1} = (19 * 19 - 0 * 17)^{-1} \begin{pmatrix} 19 & 0 \\ -17 & 19 \end{pmatrix}$$

We start by finding the modulo 26 value of the determinent:

$$(19 * 19 - 0 * 17) \mod 26 = 361 \mod 26 = 23$$

Looking up 23 in the table supplied with the test (or by computing it with the Extended Euclidean algorithm (https://en.wikipedia.org/wiki/Extended_Euclidean_algorithm)) we find that it is 17 which we substitute into the formula to compute the matrix:

$$(19 * 19 - 0 * 17)^{-1} \begin{pmatrix} 19 & 0 \\ -17 & 19 \end{pmatrix} \equiv 17 \begin{pmatrix} 19 & 0 \\ -17 & 19 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} 17 * 19 & 17 * -0 \\ 17 * -17 & 17 * 19 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} 323 & 0 \\ -289 & 323 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} 323 \mod 26 & 0 \mod 26 \\ -289 \mod 26 & 323 \mod 26 \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix}$$

With the inverse matrix we can now decode

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} M \\ L \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 12 \\ 11 \end{pmatrix} \equiv \begin{pmatrix} 11 * 12 + 0 * 11 \\ 23 * 12 + 11 * 11 \end{pmatrix} \equiv \begin{pmatrix} 132 \\ 397 \end{pmatrix} \equiv \begin{pmatrix} 2 \\ 7 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} C \\ H \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} A \\ N \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 0 \\ 13 \end{pmatrix} \equiv \begin{pmatrix} 11 * 0 + 0 * 13 \\ 23 * 0 + 11 * 13 \end{pmatrix} \equiv \begin{pmatrix} 0 \\ 143 \end{pmatrix} \equiv \begin{pmatrix} 0 \\ 13 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} A \\ N \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} K \\ W \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 10 \\ 22 \end{pmatrix} \equiv \begin{pmatrix} 11 * 10 + 0 * 22 \\ 23 * 10 + 11 * 22 \end{pmatrix} \equiv \begin{pmatrix} 110 \\ 472 \end{pmatrix} \equiv \begin{pmatrix} 6 \\ 4 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} G \\ E \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} X \\ O \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 23 \\ 14 \end{pmatrix} \equiv \begin{pmatrix} 11 * 23 + 0 * 14 \\ 23 * 23 + 11 * 14 \end{pmatrix} \equiv \begin{pmatrix} 253 \\ 683 \end{pmatrix} \equiv \begin{pmatrix} 19 \\ 7 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} T \\ H \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} Y \\ S \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 24 \\ 18 \end{pmatrix} \equiv \begin{pmatrix} 11*24+0*18 \\ 23*24+11*18 \end{pmatrix} \equiv \begin{pmatrix} 264 \\ 750 \end{pmatrix} \equiv \begin{pmatrix} 4 \\ 22 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} E \\ W \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} G \\ P \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 6 \\ 15 \end{pmatrix} \equiv \begin{pmatrix} 11*6+0*15 \\ 23*6+11*15 \end{pmatrix} \equiv \begin{pmatrix} 66 \\ 303 \end{pmatrix} \equiv \begin{pmatrix} 14 \\ 17 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} O \\ R \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} B \\ K \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 1 \\ 10 \end{pmatrix} \equiv \begin{pmatrix} 11*1+0*10 \\ 23*1+11*10 \end{pmatrix} \equiv \begin{pmatrix} 11 \\ 133 \end{pmatrix} \equiv \begin{pmatrix} 11 \\ 3 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} L \\ D \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} T \\ F \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 19 \\ 5 \end{pmatrix} \equiv \begin{pmatrix} 11*19+0*5 \\ 23*19+11*5 \end{pmatrix} \equiv \begin{pmatrix} 209 \\ 492 \end{pmatrix} \equiv \begin{pmatrix} 1 \\ 24 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} B \\ Y \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} T \\ P \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 19 \\ 15 \end{pmatrix} \equiv \begin{pmatrix} 11*19+0*15 \\ 23*19+11*15 \end{pmatrix} \equiv \begin{pmatrix} 209 \\ 602 \end{pmatrix} \equiv \begin{pmatrix} 1 \\ 4 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} B \\ E \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} W \\ T \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 22 \\ 19 \end{pmatrix} \equiv \begin{pmatrix} 11*22+0*19 \\ 23*22+11*19 \end{pmatrix} \equiv \begin{pmatrix} 242 \\ 715 \end{pmatrix} \equiv \begin{pmatrix} 8 \\ 13 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} I \\ N \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} K \\ M \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 10 \\ 12 \end{pmatrix} \equiv \begin{pmatrix} 11*10+0*12 \\ 23*10+11*12 \end{pmatrix} \equiv \begin{pmatrix} 110 \\ 362 \end{pmatrix} \equiv \begin{pmatrix} 6 \\ 24 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} G \\ Y \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} G \\ U \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 6 \\ 20 \end{pmatrix} \equiv \begin{pmatrix} 11*6+0*20 \\ 23*6+11*20 \end{pmatrix} \equiv \begin{pmatrix} 66 \\ 358 \end{pmatrix} \equiv \begin{pmatrix} 14 \\ 20 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} O \\ U \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} L \\ H \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 11 \\ 7 \end{pmatrix} \equiv \begin{pmatrix} 11*11+0*7 \\ 23*11+11*7 \end{pmatrix} \equiv \begin{pmatrix} 121 \\ 330 \end{pmatrix} \equiv \begin{pmatrix} 17 \\ 18 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} R \\ S \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} Y \\ R \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 24 \\ 17 \end{pmatrix} \equiv \begin{pmatrix} 11*24+0*17 \\ 23*24+11*17 \end{pmatrix} \equiv \begin{pmatrix} 264 \\ 739 \end{pmatrix} \equiv \begin{pmatrix} 4 \\ 11 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} E \\ L \end{pmatrix}$$

$$\begin{pmatrix} L & A \\ X & L \end{pmatrix} * \begin{pmatrix} R \\ O \end{pmatrix} \equiv \begin{pmatrix} 11 & 0 \\ 23 & 11 \end{pmatrix} * \begin{pmatrix} 17 \\ 14 \end{pmatrix} \equiv \begin{pmatrix} 11*17+0*14 \\ 23*17+11*14 \end{pmatrix} \equiv \begin{pmatrix} 187 \\ 545 \end{pmatrix} \equiv \begin{pmatrix} 5 \\ 25 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} F \\ Z \end{pmatrix}$$

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2) **[700 points]** Solve this Patristocrat by Roger de Rabutin de Bussy.

HLQMB RMAQU WPWZM HQTAB YAQUW NAOMA UMJUA BEGAQ
ABSEN CEIST OLOVE ASWIN DISTO FIREI TEXTI NGUIS

SMQUS MQIHP PHBYM BDABY PMQUS MEOMH U
HESTH ESMAL LANDE NKIND LESTH EGREA T

Absence is to love as wind is to fire; it extinguishes the small and enkindles the great.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	8	6		1	2		1	5	1	1		1	11	1	2	4	8	1	3	1	7		3		3	1
Replacement	I	N	P	K	G	Z	U	A	M	X	Q	B	E	F	R	L	S	C	H	W	T	Y	O	J	D	V

3) **[350 points]** Solve this quote by Amy Sedaris.

J ZUJOE JZ'M CSSR KSH I DAHMSO ZS MDAOR ZJFA IBSOA.
I THINK IT'S GOOD FOR A PERSON TO SPEND TIME ALONE.

JZ CJWAM ZUAF IO SDDSHZVOJZX ZS RJMQSWAH LUS ZUAX
IT GIVES THEM AN OPPORTUNITY TO DISCOVER WHO THEY

IHA IOR ZS KJCVHA SVZ LUX ZUAX IHA IBLIXM IBSOA.
ARE AND TO FIGURE OUT WHY THEY ARE ALWAYS ALONE.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	13	3	3	4	1	2		7	9	9	2	3	6		8		1	4	14		6	3	2	5		13
Replacement	E	L	G	P	K	M	Z	R	A	I	F	W	S	X	N	B	C	D	O	J	H	U	V	Y	Q	T

4) **[250 points]** Solve this K2 Aristocrat.

YDAADMECZ JSX FRJS DY AXRIJ HXIEIJRCUX EI MSRJ BRNXI
FOLLOWING THE PATH OF LEAST RESISTANCE IS WHAT MAKES

TDJS BXC RCW HELXHI UHDDNXW.
BOTH MEN AND RIVERS CROOKED.

Replacement	R	T	U	W	X	Y	Z	S	E	V	N	A	B	C	D	F	G	H	I	J	K	L	M	O	P	Q
K2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	3	2	4	6	4	1		4	6	6		1	2	2				6	4	1	2		2	8	2	1

5) **[150 points]** Solve this Caesar Cipher.

G	V	F	G	C	V		I	R	I	V	C	P		J	L	T	T	V	V	U		L	E	C	V	J	J		K	Y	V	P		Y	R	M	V
P	**E**	**O**	**P**	**L**	**E**		**R**	**A**	**R**	**E**	**L**	**Y**		**S**	**U**	**C**	**C**	**E**	**E**	**D**		**U**	**N**	**L**	**E**	**S**	**S**		**T**	**H**	**E**	**Y**		**H**	**A**	**V**	**E**

W	L	E		Z	E		N	Y	R	K		K	Y	V	P		R	I	V		U	F	Z	E	X	.
F	**U**	**N**		**I**	**N**		**W**	**H**	**A**	**T**		**T**	**H**	**E**	**Y**		**A**	**R**	**E**		**D**	**O**	**I**	**N**	**G**	.

How to solve

Since there are no single letter words we look for the double letter words and find ZE.

We can use a simple trick to test them quickly which only requires looking up 8 characters: six letters mapping the beginning (A B I M O U) and two letters at the end (O E).The letters are for the beginning and for the end.

The starting letters match against As/At/An/Am, Be/By, In/It/Is/If, Me/My, Of/Or/On, and Up/Us. The ending letters match against dO/gO/nO/sO/tO and hE/wE.

Using the beginning letter A gives AF with a key of Z

Using the beginning letter B gives BG with a key of Y

Using the beginning letter I gives a common word IN with a key of R

Using the beginning letter M gives MR with a key of N

Using the beginning letter O gives OT with a key of L

Using the beginning letter U gives UZ with a key of F

Using the ending letter O gives 'JO' with a key of Q

Using the ending letter E gives 'ZE' with a key of A

Based on this, we believe that the key row is R which we can use to decode the remaining letters

We can confirm it by using the R row to decode the first long word 'GVFGCV', we see it comes out as 'PEOPLE' which confirms our guess and we can use it to decode the remainder of the letters.

6) **[400 points]** Solve this aristocrat.

EUTZKQ YWK ZB U MEFZMJ. IEJXJ ZB JKFWQE YWK YFX JUME
HAVING FUN IS A CHOICE. THERE IS ENOUGH FUN FOR EACH

FY WB. MEFFBZKQ IF EUTJ YWK OJRJKOB FK VFW FKHV.
OF US. CHOOSING TO HAVE FUN DEPENDS ON YOU ONLY.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency		5			7	10		1	2	8	9		4		2		3	1		2	4	2	6	2	5	5
Replacement	X	S	M	B	H	O	W	L	T	E	N	Q	C	J	D	K	G	P	Z	V	A	Y	U	R	F	I

7) **[200 points]** Decode the following Baconian cipher.

BELOW	**EARTH**	**A KISS**	**BOMBS**	**AM BOY**	**BEARD**	**YAHOO**	**BASIC**	
BABAA	**AABBB**	**AAAAA**	**BAABA**	**AABAA**	**BAABB**	**AABAA**	**BAAAA**	
W	**H**	**A**	**T**	**E**	**U/V**	**E**	**R**	
BANJO	**UNDER**	**POINT**	**YACHT**	**STRIP**	**MIGHT**	**OFFER**	**CREEK**	**BOOTY**
BABBA	**ABBAB**	**BAABB**	**AAABB**	**ABBAB**	**AAABB**	**ABBAB**	**ABAAA**	**BAABA**
Y	**O**	**U/V**	**D**	**O**	**D**	**O**	**I/J**	**T**
FATSO	**ASHES**	**GRAVY**	**AN APE**					
BABAA	**AABAA**	**ABABA**	**ABABA**					
W	**E**	**L**	**L**					

Whatever you do, do it well.

The letters are mapped as:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B

8) **[400 points]** The following quote needs to be decoded with the Affine Cipher where ***a*=7** and ***b*=15**.

T	C		P	O	O		J	Y		O	T	G	T	C	F	,	M	P	G	R		V	Z	D	M		Y	Z	C		P	C	K
I	**N**		**A**	**L**	**L**		**O**	**F**		**L**	**I**	**V**	**I**	**N**	**G**	,	**H**	**A**	**V**	**E**		**M**	**U**	**C**	**H**		**F**	**U**	**N**		**A**	**N**	**D**

O	P	Z	F	M	S	R	E	.		O	T	Y	R		T	L		S	J		W	R		R	C	A	J	B	R	K	,		C	J	S
L	**A**	**U**	**G**	**H**	**T**	**E**	**R**	.		**L**	**I**	**F**	**E**		**I**	**S**		**T**	**O**		**B**	**E**		**E**	**N**	**J**	**O**	**Y**	**E**	**D**	,		**N**	**O**	**T**

A	Z	L	S		R	C	K	Z	E	R	K	.
J	**U**	**S**	**T**		**E**	**N**	**D**	**U**	**R**	**E**	**D**	.

How to solve

Using the given value of $\mathrm{a} = 7$ and $\mathrm{b} = 15$ we can calcuate using the formula $a * x + b \mod 26$

T	**C**	**P**	**O**	**O**	**J**	**Y**	**O**	**T**	**G**	**T**	**C**	**F**	**M**	**P**	**G**	**R**	**V**	**Z**	**D**	**M**	**Y**	**Z**	**C**	**P**	**C**	**K**	**O**	**P**	**Z**	**F**	**M**	**S**	**R**	**E**	**O**

The first step is to encode the common letters **ETAOIN** to see what they would map to.

$$
\begin{array}{llllll}
E(4) & \rightarrow & 4 * 7 + 15 & \rightarrow & 43 \mod 26 & \rightarrow & R(17) \\
T(19) & \rightarrow & 19 * 7 + 15 & \rightarrow & 148 \mod 26 & \rightarrow & S(18) \\
A(0) & \rightarrow & 0 * 7 + 15 & \rightarrow & 15 \mod 26 & \rightarrow & P(15) \\
O(14) & \rightarrow & 14 * 7 + 15 & \rightarrow & 113 \mod 26 & \rightarrow & J(9) \\
I(8) & \rightarrow & 8 * 7 + 15 & \rightarrow & 71 \mod 26 & \rightarrow & T(19) \\
N(13) & \rightarrow & 13 * 7 + 15 & \rightarrow & 106 \mod 26 & \rightarrow & C(2)
\end{array}
$$

Filling in the letter we found (RSPJTC), we get a bit more of the answer.

T	**C**	**P**	**O**	**O**	**J**	**Y**	**O**	**T**	**G**	**T**	**C**	**F**	**M**	**P**	**G**	**R**	**V**	**Z**	**D**	**M**	**Y**	**Z**	**C**	**P**	**C**	**K**	**O**	**P**	**Z**	**F**	**M**	**S**	**R**	**E**	**O**
I	**N**	**A**			**O**			**I**		**I**	**N**			**A**		**E**							**N**	**A**	**N**			**A**				**T**	**E**		

Next, encode the next 5 common letters **SRHLD**.

$$
\begin{array}{llllll}
S(18) & \rightarrow & 18 * 7 + 15 & \rightarrow & 141 \mod 26 & \rightarrow & L(11) \\
R(17) & \rightarrow & 17 * 7 + 15 & \rightarrow & 134 \mod 26 & \rightarrow & E(4) \\
H(7) & \rightarrow & 7 * 7 + 15 & \rightarrow & 64 \mod 26 & \rightarrow & M(12) \\
L(11) & \rightarrow & 11 * 7 + 15 & \rightarrow & 92 \mod 26 & \rightarrow & O(14) \\
D(3) & \rightarrow & 3 * 7 + 15 & \rightarrow & 36 \mod 26 & \rightarrow & K(10)
\end{array}
$$

We know the reverse mapping of 5 more letters (LEMOK), which we can fill in.

T	**C**	**P**	**O**	**O**	**J**	**Y**	**O**	**T**	**G**	**T**	**C**	**F**	**M**	**P**	**G**	**R**	**V**	**Z**	**D**	**M**	**Y**	**Z**	**C**	**P**	**C**	**K**	**O**	**P**	**Z**	**F**	**M**	**S**	**R**	**E**	**O**
I	**N**	**A**	**L**	**L**	**O**		**L**	**I**		**I**	**N**		**H**	**A**		**E**				**H**			**N**	**A**	**N**	**D**	**L**	**A**			**H**	**T**	**E**	**R**	**L**

We will convert the next 5 most frequent letters **CUMFP**.

$$
\begin{array}{lcrcrcl}
C(2) & \rightarrow & 2*7+15 & \rightarrow & 29 & \mod 26 & \rightarrow & D(3) \\
U(20) & \rightarrow & 20*7+15 & \rightarrow & 155 & \mod 26 & \rightarrow & Z(25) \\
M(12) & \rightarrow & 12*7+15 & \rightarrow & 99 & \mod 26 & \rightarrow & V(21) \\
F(5) & \rightarrow & 5*7+15 & \rightarrow & 50 & \mod 26 & \rightarrow & Y(24) \\
P(15) & \rightarrow & 15*7+15 & \rightarrow & 120 & \mod 26 & \rightarrow & Q(16)
\end{array}
$$

The next 5 letters we know are (DZVYQ), so we will fill those in.

T	C	P	O	O	J	Y	O	T	G	T	C	F	M	P	G	R	V	Z	D	M	Y	Z	C	P	C	K	O	P	Z	F	M	S	R	E	O
I	N	A	L	L	O	F	L	I		I	N		H	A		E	M	U	C	H	F	U	N	A	N	D	L	A	U		H	T	E	R	L

Next, encode the next 5 common letters **GWYBV**.

$$
\begin{array}{lcrcrcl}
G(6) & \rightarrow & 6*7+15 & \rightarrow & 57 & \mod 26 & \rightarrow & F(5) \\
W(22) & \rightarrow & 22*7+15 & \rightarrow & 169 & \mod 26 & \rightarrow & N(13) \\
Y(24) & \rightarrow & 24*7+15 & \rightarrow & 183 & \mod 26 & \rightarrow & B(1) \\
B(1) & \rightarrow & 1*7+15 & \rightarrow & 22 & \mod 26 & \rightarrow & W(22) \\
V(21) & \rightarrow & 21*7+15 & \rightarrow & 162 & \mod 26 & \rightarrow & G(6)
\end{array}
$$

We know the reverse mapping of 5 more letters (FNBWG), which we can fill in.

T	C	P	O	O	J	Y	O	T	G	T	C	F	M	P	G	R	V	Z	D	M	Y	Z	C	P	C	K	O	P	Z	F	M	S	R	E	O
I	N	A	L	L	O	F	L	I	V	I	N	G	H	A	V	E	M	U	C	H	F	U	N	A	N	D	L	A	U	G	H	T	E	R	L

We will convert the remaining 5 letters **KXJQZ**.

$$
\begin{array}{lcrcrcl}
K(10) & \rightarrow & 10*7+15 & \rightarrow & 85 & \mod 26 & \rightarrow & H(7) \\
X(23) & \rightarrow & 23*7+15 & \rightarrow & 176 & \mod 26 & \rightarrow & U(20) \\
J(9) & \rightarrow & 9*7+15 & \rightarrow & 78 & \mod 26 & \rightarrow & A(0) \\
Q(16) & \rightarrow & 16*7+15 & \rightarrow & 127 & \mod 26 & \rightarrow & X(23) \\
Z(25) & \rightarrow & 25*7+15 & \rightarrow & 190 & \mod 26 & \rightarrow & I(8)
\end{array}
$$

The remaining 5 letters we know are (HUAXI), so we will fill those in.

T	C	P	O	O	J	Y	O	T	G	T	C	F	M	P	G	R	V	Z	D	M	Y	Z	C	P	C	K	O	P	Z	F	M	S	R	E	O
I	N	A	L	L	O	F	L	I	V	I	N	G	H	A	V	E	M	U	C	H	F	U	N	A	N	D	L	A	U	G	H	T	E	R	L

The solution is now complete!

9) **[250 points]** The following quote needs to be encoded with the Vigenère Cipher with a keyword of **ORCHARD**

O	R	C	H		A	R		D		O	R	C	H	A		R	D		O	R	C	H	A	R		D	O		R	C	H		A	R	D	O	R	,
L	O	V	E		I	S		A		F	R	U	I	T		I	N		S	E	A	S	O	N		A	T		A	L	L		T	I	M	E	S	,
Z	**F**	**X**	**L**		**I**	**J**		**D**		**T**	**I**	**W**	**P**	**T**		**Z**	**Q**		**G**	**V**	**C**	**Z**	**O**	**E**		**D**	**H**		**R**	**N**	**S**		**T**	**Z**	**P**	**S**	**J**	,

C	H	A		R	D	O	R	C	H		A	R	D	O	R		C	H		A	R	D	O	R		C	H	A	R	.
A	N	D		W	I	T	H	I	N		R	E	A	C	H		O	F		E	V	E	R	Y		H	A	N	D	.
C	**U**	**D**		**N**	**L**	**H**	**Y**	**K**	**U**		**R**	**V**	**D**	**Q**	**Y**		**Q**	**M**		**E**	**M**	**H**	**F**	**P**		**J**	**H**	**N**	**U**	.

10) **[300 points]** The following quote by Martin Luther King Jr. needs to be encoded with the Affine Cipher using ***a*=15** and ***b*=7**.

H	U	M	A	N		S	A	L	V	A	T	I	O	N		L	I	E	S		I	N		T	H	E		H	A	N	D	S		O	F
I	**V**	**F**	**H**	**U**		**R**	**H**	**Q**	**K**	**H**	**G**	**X**	**J**	**U**		**Q**	**X**	**P**	**R**		**X**	**U**		**G**	**I**	**P**		**I**	**H**	**U**	**A**	**R**		**J**	**E**

T	H	E		C	R	E	A	T	I	V	E	L	Y		M	A	L	A	D	J	U	S	T	E	D	.
G	**I**	**P**		**L**	**C**	**P**	**H**	**G**	**X**	**K**	**P**	**Q**	**D**		**F**	**H**	**Q**	**H**	**A**	**M**	**V**	**R**	**G**	**P**	**A**	.

How to solve

Using the given value of $\mathrm{a}=15$ and $\mathrm{b}=7$ we can calcuate using the formula $a*x+b \mod 26$

$$H(7) \rightarrow 7*15+7 \rightarrow 112 \mod 26 \rightarrow I(8)$$
$$U(20) \rightarrow 20*15+7 \rightarrow 307 \mod 26 \rightarrow V(21)$$
$$M(12) \rightarrow 12*15+7 \rightarrow 187 \mod 26 \rightarrow F(5)$$
$$A(0) \rightarrow 0*15+7 \rightarrow 7 \mod 26 \rightarrow H(7)$$
$$N(13) \rightarrow 13*15+7 \rightarrow 202 \mod 26 \rightarrow U(20)$$
$$S(18) \rightarrow 18*15+7 \rightarrow 277 \mod 26 \rightarrow R(17)$$

We already computed for A and know that it is H

$$L(11) \rightarrow 11*15+7 \rightarrow 172 \mod 26 \rightarrow Q(16)$$
$$V(21) \rightarrow 21*15+7 \rightarrow 322 \mod 26 \rightarrow K(10)$$

We already computed for A and know that it is H

$$T(19) \rightarrow 19*15+7 \rightarrow 292 \mod 26 \rightarrow G(6)$$
$$I(8) \rightarrow 8*15+7 \rightarrow 127 \mod 26 \rightarrow X(23)$$
$$O(14) \rightarrow 14*15+7 \rightarrow 217 \mod 26 \rightarrow J(9)$$

We already computed for N and know that it is U

We already computed for L and know that it is Q

We already computed for I and know that it is X

$$E(4) \rightarrow 4*15+7 \rightarrow 67 \mod 26 \rightarrow P(15)$$

We already computed for S and know that it is R

We already computed for I and know that it is X

We already computed for N and know that it is U

We already computed for T and know that it is G

We already computed for H and know that it is I

We already computed for E and know that it is P

We already computed for H and know that it is I

We already computed for A and know that it is H

We already computed for N and know that it is U

$$D(3) \quad \rightarrow \quad 3*15+7 \quad \rightarrow \quad 52 \mod 26 \quad \rightarrow \quad A(0)$$

We already computed for S and know that it is R

We already computed for O and know that it is J

$$F(5) \quad \rightarrow \quad 5*15+7 \quad \rightarrow \quad 82 \mod 26 \quad \rightarrow \quad E(4)$$

We already computed for T and know that it is G

We already computed for H and know that it is I

We already computed for E and know that it is P

$$C(2) \quad \rightarrow \quad 2*15+7 \quad \rightarrow \quad 37 \mod 26 \quad \rightarrow \quad L(11)$$

$$R(17) \quad \rightarrow \quad 17*15+7 \quad \rightarrow \quad 262 \mod 26 \quad \rightarrow \quad C(2)$$

We already computed for E and know that it is P

We already computed for A and know that it is H

We already computed for T and know that it is G

We already computed for I and know that it is X

We already computed for V and know that it is K

We already computed for E and know that it is P

We already computed for L and know that it is Q

$$Y(24) \quad \rightarrow \quad 24*15+7 \quad \rightarrow \quad 367 \mod 26 \quad \rightarrow \quad D(3)$$

We already computed for M and know that it is F

We already computed for A and know that it is H

We already computed for L and know that it is Q

We already computed for A and know that it is H

We already computed for D and know that it is A

$$J(9) \quad \rightarrow \quad 9*15+7 \quad \rightarrow \quad 142 \mod 26 \quad \rightarrow \quad M(12)$$

We already computed for U and know that it is V

We already computed for S and know that it is R

We already computed for T and know that it is G

We already computed for E and know that it is P

We already computed for D and know that it is A

11) **[200 points]** The following quote by Benedict Cumberbatch needs to be decoded with the Vigenère Cipher with a keyword of **PENGUIN**

P	E	N	G	U	I	N	P	E	N	G	U	I	N	P	E	N	G	U	I
I	L	R	L	O	Z	G	W	I	E	E	I	C	T	T	X	N	C	U	G
T	**H**	**E**	**F**	**U**	**R**	**T**	**H**	**E**	**R**	**Y**	**O**	**U**	**G**	**E**	**T**	**A**	**W**	**A**	**Y**

N	P	E	N	G	U	I	N	P	E	N	G	U	I	N	P	E	N	G	U
S	G	S	Z	E	I	C	E	H	I	Y	L	N	P	R	B	S	E	K	W
F	**R**	**O**	**M**	**Y**	**O**	**U**	**R**	**S**	**E**	**L**	**F**	**T**	**H**	**E**	**M**	**O**	**R**	**E**	**C**

I	N	P	E	N	G	U	I	N	P	E	N	G	U	I	N	P	E	N	G
P	N	A	P	R	T	A	Q	A	V	M	G	O	M	V	B	I	X	B	H
H	**A**	**L**	**L**	**E**	**N**	**G**	**I**	**N**	**G**	**I**	**T**	**I**	**S**	**N**	**O**	**T**	**T**	**O**	**B**

U	I	N	P	E	N	G	U	I	N	P	E	N	G	U	I	N	P	E	N
Y	Q	A	N	S	H	X	W	W	Z	U	S	E	Z	T	W	A	T	M	F
E	**I**	**N**	**Y**	**O**	**U**	**R**	**C**	**O**	**M**	**F**	**O**	**R**	**T**	**Z**	**O**	**N**	**E**	**I**	**S**

G	U	I	N	P	E	N	G
M	L	M	N	I	J	H	T
G	**R**	**E**	**A**	**T**	**F**	**U**	**N**

12) **[550 points]** Solve this Patristocrat that has been encoded with a K1 cipher.

USJAF DMZAO PNGUZ TSFZU LAZOR NDMHP NOJAF DMLAU
IFYOU RENOT HAVIN GFUNI DONTC AREWH ATYOU REDOI

ZTLAZ OLAUO YAGMA ZSUZL EAYMO PUZTM XEMXU SMEOA
NGDON TDOIT MOVEO NFIND SOMET HINGE LSELI FESTO

AEPAD O
OSHOR T

If you're not having fun - I don't care what you're doing - don't do it. Move on. Find something else, life's too short.

K1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	13			4	4	3	2	1		2		5	8	3	8	4		1	4	3	8			2	2	9
Replacement	O	P	Q	R	S	U	V	W	X	Y	Z	D	E	A	T	H	B	C	F	G	I	J	K	L	M	N

13) **[550 points]** A quote has been encoded using the Pollux Cipher for you to decode. You are told that 1=●, 2=–, 5=×, 6=●, 8=×, 9=–

225125212515512552121522252252251152522251521525525222
––×●–×–●–×●××●–××–●–●×–––×––×––×●●×–×–––×●×–●×–××–×–––
M A K E A C O M M I T M E N T T O

55111151251112511521522155112151125215511151515521225222
××●●●●×●–×●●●–×●●×–●×––●××●●–●×●●–×–●××●●●×●×●××–●––×–––
H A V I N G F U N S E E Y O

51125121552111515111525511215121511151521521151115512521
×●●–×●–●××–●●●×●×●●●×–××●●–●×●–●×●●●×●×–●×–●●×●●●××●–×–●
U R B E S T F R I E N D S A N

52115522512521251552511522515511215222512155212252225112
×–●●××––×●–×–●–×●××–×●●×––×●××●●–●×–––×●–●××–●––×–––×●●–
D M A K E T I M E F O R Y O U

51215511115222521115211151151511155125215211551221512
×●–●××●●●●×–––×–●●●×–●●●×●●×●×●●●××●–×–●×–●●××●––●×●–
R H O B B I E S A N D P A

5111511151152225215111
×●●●×●●●×●●×–––×–●×●●●
S S I O N S

How to solve

Since we are told the mapping of 125689 ciphertext, we can build the following table:

0	1	2	3	4	5	6	7	8	9
●–×	●	–	●–×	●–×	×	●	●–×	×	–

Based on that information we can map the cipher text as:

225125212515512552121522252252251152522251521525525222
––×●–×–●–×●××●–××–●–●×–––×––×––×●●×–×–––×●×–●×–××–×–––
M A K E/ A / C O M M I T M E N T/ T O

55111151251112511521522155112151125215511151515521225222
××●●●●×●–×●●●–×●●×–●×––●××●●–●×●●–×–●××●●●×●×●××–●––×–––
/ H A V I N G / F U N / S E E/ Y O

51125121552111515111525511215121511151521521151115512521
×●●–×●–●××–●●●×●×●●●×–××●●–●×●–●×●●●×●×–●×–●●×●●●××●–×–●
U R / B E S T/ F R I E N D S / A N

52115522512521251552511522515511215222512155212252225112
×–●●××––×●–×–●–×●××–×●●×––×●××●●–●×–––×●–●××–●––×–––×●●–
D / M A K E/ T I M E/ F O R / Y O U

51215511115222521115211151151511155125215211551221512

×●–●××●●●●×–––×–●●●×–●●●×●●×●×●●●××●–×–●×–●●××●––●×●–

R / H O B B I E S / A N D / P A

5111511151152225215111

×●●●×●●●×●●×–––×–●×●●●

S S I O N S

Which means that the hint has provide all of the cipher digit mapping and there is no work to solve it

---

14) **[350 points]** Solve this quote by Justin Timberlake.

OKT STAO LRIO RSFNO STCJU RYFJT CA OKRO VFN ITRYYV

THE BEST PART ABOUT BEING ALONE IS THAT YOU REALLY

HFJ'O KRZT OF RJAQTI OF RJVSFHV. VFN HF QKRO VFN

DON'T HAVE TO ANSWER TO ANYBODY. YOU DO WHAT YOU

QRJO.

WANT.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	3		2			10		3	3	6	4	1		4	11		3	10	4	7	1	6			3	1
Replacement	S	M	I	F	J	O	Z	D	R	N	H	P	C	U	T	X	W	A	B	E	G	Y	Q	K	L	V

15) **[250 points]** Decode the following message in Baconian.

,./,.?,./<.?<>/,>/,.?,./,./<./<./<./<>/<.?,./,>?,.?,.
AAAAABAAABABBBAABAAABAAAAAABAABAABAABBABABAAAABBAABAA
A S P I R E T O I N S

/<.?<>/,>/,.?,./,./<./,./,>/,>/,./<.?,>?,>?,./,./<./<
ABABBBAABAAABAAAAAABAAAAAABAABAAAABABABBABBAAAAAABAAB
P I R E B E F O R E

.?,./,>/,./<./<.?,>/<>?,.?,./<./,./,>/,
ABAAAABAAAABAABABABABBBAABAAABAAAAAABAA
W E E X P I R E

Aspire to inspire before we expire.

The A letters are represented by ',./' and the B letters by '<>?'

16) **[400 points]** Solve the following Spanish aristocrat.

YEDTRL RGWGDW DBNL, ILRL GB ETJXGMWL YLTWSJMD SDMD
CUANDO DESEAS ALGO, TODO EL UNIVERSO CONSPIRA PARA

HEG MGDBJYGW IEW WEGCLW.
QUE REALICES TUS SUEÑOS.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Ñ	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency		3	1	7	5		8	1	2	3		7	4	1					3	2	3			8	1	3	
Replacement	H	L	Ñ	A	U	K	E	Q	T	I	B	O	R	G	Y	M	X	J	D	P	N	W	Z	S	V	C	F

Translation: *When you want something, the whole universe conspires to make your wish come true.*

17) **[500 points]** A quote has been encoded using the Morbit Cipher for you to decode. You are told that 2=●●, 4=●−, 6=●×, 7=×●, 8=−●

```
2 6 1 3 1 7 9 7 6 1 7 7 2 5 3 2 2 7 5 2 6 2 9 3 4 8 7 8 6
●●●×−−−×−−×●×−×●●×−−×●×●●●××−×●●●●×●××●●●×●●×−−×●−−●×●−●●×
S   O   M  E T I  M  E S  / T H   E/ S  I  M  P   L
```

```
6 9 7 2 6 2 9 6 1 6 2 6 7 3 4 6 6 9 3 1 3 4 6 6 7 4 6
●××−×●●●●×●●×−●×−−●×●●●××●−×●−●×●××−−×−−−×●−●×●××●●−●×
E /T H   I  N  G   S   /A  R   E /M  O   R   E /F
```

```
2 3 8 5 4 9 6 8 6 9 3 6 4 9 6 2 9 6 1 6 2 8 7 4 7 8 6
●●−×−●××●−×−●×−●●××−−×●×●−×−●×●●×−●×−−●×●●−●×●●−×●−●●×
U   N / A  N  D   /M  E A  N  I  N  G   F   U   L
```

```
9 7 2 6 4 9 6 7 3 4 2 7 8 6 9 7 2 6 6 9 2 6 4 9 6 1 4
×−×●●●●×●−×−●××●−×●−●●×●−●●××−×●●●●×●××−●●●×●−×−●×−−●−
/T H   A  N  /A  L   L   /T H   E /B   A  N  Q
```

```
7 4 7 9 7 2 5 2 9 6 9 7 2 6 6 7 1 9 1 7 8 7 8 6 8 6
×●●−×●×−×●●●××●●×−●××−×●●●●×●××●−−×−−−×●−●×●−●●×−●●×
 U   E T S  / I  N  /T H   E /W  O  R  L   D
```

How to solve

Since we are told the mapping of 24678 ciphertext, we can build the following table:

1	2	3	4	5	6	7	8	9
— −× ×− ××	●●	— −× ×− ××	●−	— −× ×− ××	●×	×●	−●	— −× ×− ××

Based on that information we can map the cipher text as:

```
2 6 1 3 1 7 9 7 6 1 7 7 2 5 3 2 2 7 5 2 6 2 9 3 4 8 7 8 6
●●●×       ×●  ×●●×  ×●×●●●    ●●●●×●  ●●●×●●    ●−−●×●−●●×
S              I    E                                L
```

```
6 9 7 2 6 2 9 6 1 6 2 6 7 3 4 6 6 9 3 1 3 4 6 6 7 4 6
●×  ×●●●●×●●  ●×  ●×●●●××●  ●−●×●×        ●−●×●××●●−●×
E   H            S  /        E             E/ F
```

```
2 3 8 5 4 9 6 8 6 9 3 6 4 9 6 2 9 6 1 6 2 8 7 4 7 8 6
●●  −●  ●−  ●×−●●×    ●×●−  ●×●●  ●×  ●×●●−●×●●−×●−●●×
            D                          F   U   L
```

```
9 7 2 6 4 9 6 7 3 4 2 7 8 6 9 7 2 6 6 9 2 6 4 9 6 1 4
  ×●●●●×●−  ●××●  ●−●●×●−●●×  ×●●●●×●×  ●●●×●−  ●×  ●−
   H        /       L       H    E
```

```
7 4 7 9 7 2 5 2 9 6 9 7 2 6 6 7 1 9 1 7 8 7 8 6 8 6
×●●−×●  ×●●●  ●●  ●×  ×●●●●×●××●      ×●−●×●−●●×−●●×
```

U H E/ R L D

At this point in time, 4 ciphertext characters still need to be mapped. With ×× unknown, looking at unknowns which are next to × which would result in three in a row, we find the sequence 61 where we know that 6 ends with × which means that 1 cannot be ××, so we can eliminate that possibility. Also,we find the sequence 97 where we know that 7 starts with × which means that 9 cannot be ××, so we can eliminate that possibility.

1	2	3	4	5	6	7	8	9
— –× ×–	●●	— –× ×– ××	●–	— –× ×– ××	●×	×●	–●	— –× ×–

Based on that information we can map the cipher text as:

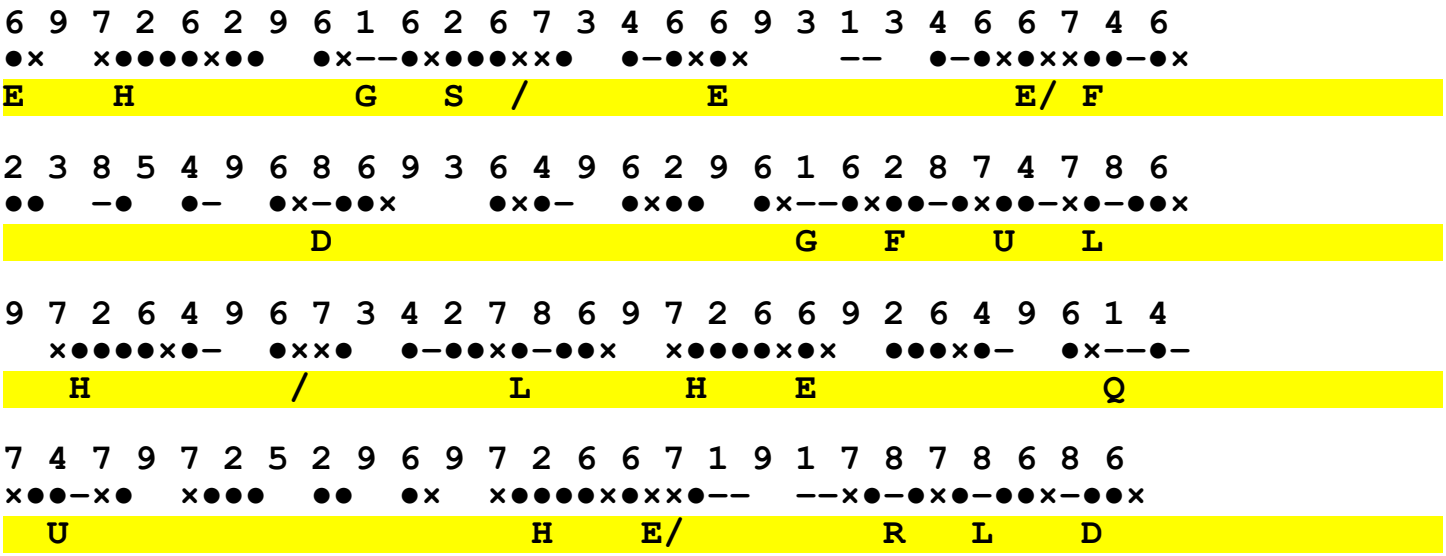
```
2 6 1 3 1 7 9 7 6 1 7 7 2 5 3 2 2 7 5 2 6 2 9 3 4 8 7 8 6
●●●×        ×●  ×●●×  ×●×●●●      ●●●●×●  ●●●×●●      ●––●×●–●●×
S              I     E                                   L

6 9 7 2 6 2 9 6 1 6 2 6 7 3 4 6 6 9 3 1 3 4 6 6 7 4 6
●×  ×●●●●×●●   ●×  ●×●●●××●   ●–●×●×          ●–●×●××●●–●×
E    H                S  /          E                E/ F

2 3 8 5 4 9 6 8 6 9 3 6 4 9 6 2 9 6 1 6 2 8 7 4 7 8 6
●●  –●   ●–   ●×–●●×     ●×●–   ●×●●   ●×   ●×●●–●×●●–×●–●●×
              D                          F    U   L

9 7 2 6 4 9 6 7 3 4 2 7 8 6 9 7 2 6 6 9 2 6 4 9 6 1 4
  ×●●●●×●–    ●××●   ●–●●×●–●●×   ×●●●●×●×   ●●●×●–    ●×   ●–
  H              /          L       H     E

7 4 7 9 7 2 5 2 9 6 9 7 2 6 6 7 1 9 1 7 8 7 8 6 8 6
×●●–×●   ×●●●   ●●   ●×   ×●●●●×●××●        ×●–●×●–●●×–●●×
  U                    H     E/         R    L     D
```

At this point in time, 4 ciphertext characters still need to be mapped. Since 1 has several options we simply try them and look at the first word or two to see if it makes sense. Trying — for 1 gives us a chunk: GFUL. Trying –× for 1 gives us a chunk: STTETITESTHEBITPLETHINTESERETTREFINKNDTEANINTEFULTHANELLTHEBANTAUETSDNTHEAMRLD. Trying ×– for 1 gives us a chunk: S TTETITESTHEBITPLETHINNSERETTREFINKNDTEANINNFULTHANELLTHEBANKUETSDNTHEETTTRLD. Which means we know that 1 must map to —

1	2	3	4	5	6	7	8	9
—	●●	–× ×– ××	●–	–× ×– ××	●×	×●	–●	–× ×–

Based on that information we can map the cipher text as:

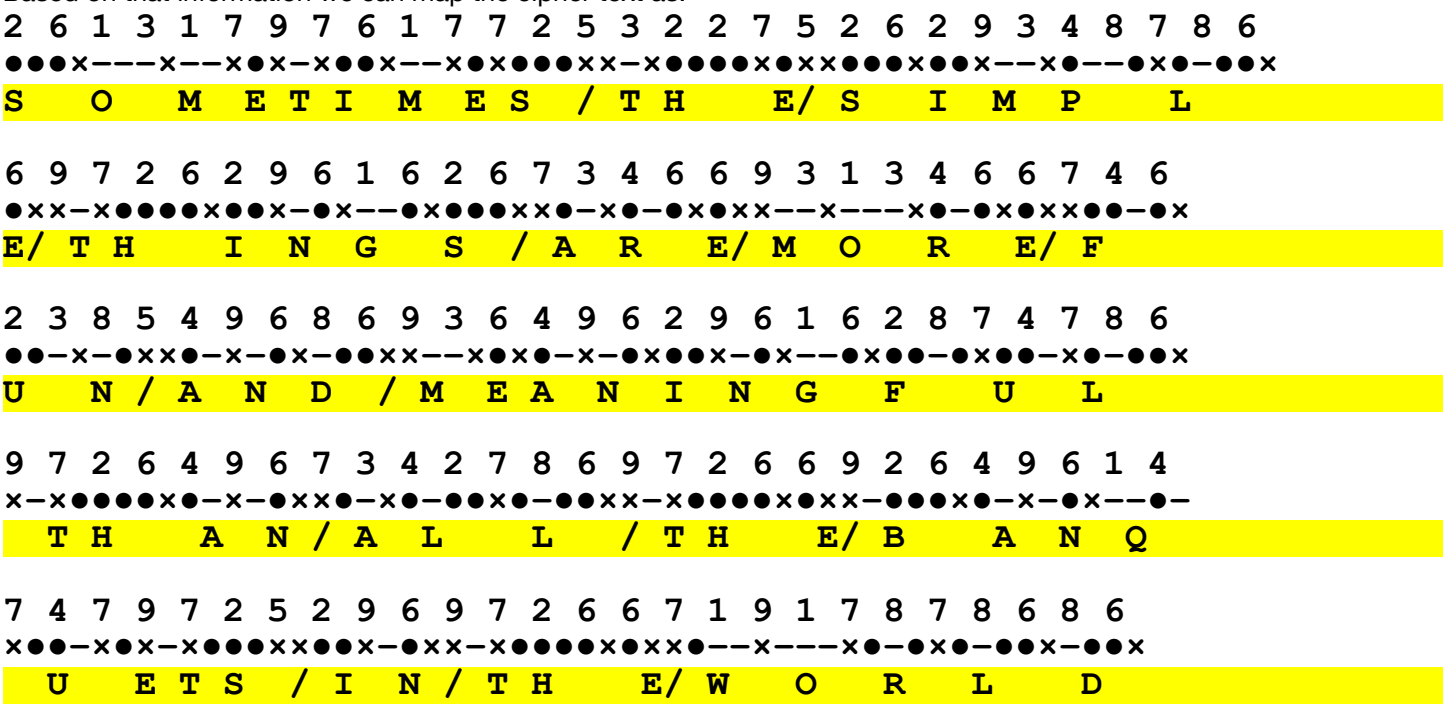
```
2 6 1 3 1 7 9 7 6 1 7 7 2 5 3 2 2 7 5 2 6 2 9 3 4 8 7 8 6
●●●×––   ––×●  ×●●×––×●×●●●      ●●●●×●  ●●●×●●      ●––●×●–●●×
S              I  M  E                                   L
```



At this point in time, 3 ciphertext characters still need to be mapped. Since 3 has several options we simply try them and look at the first word or two to see if it makes sense. Trying –× for 3 gives us a chunk: SOMETIMESTHESIMPLETHINGSAREMOREFUNANDMEANINGFULTHANALLTHEBANQUETSINTHEWORLD. Trying ×– for 3 gives us a chunk: LETHINGSECETOCEFIGANDTNANINGFULTHANE. Trying ×× for 3 gives us a chunk: SMMETIMESHESITPLETHINGSERETMREFINANDTEANINGFULTHANELLTHEBANQUETSINTHEWORLD. Which means we know that 3 must map to –× Eliminating –× as an option for 9 means that 9 must be ×–. Eliminating ×– as an option for 5 means that 5 must be ××.

1	2	3	4	5	6	7	8	9
—	••	–×	•–	××	•×	×•	–•	×–

Based on that information we can map the cipher text as:



Now that we have mapped all the ciphertext characters, the decoded morse code is the answer:

SOMETIMES THE SIMPLE THINGS ARE MORE FUN AND MEANINGFULTHAN ALL THE BANQUETS IN THE WORLD

---

18) **[650 points]** Solve this quote from Donald Trump.

COLWO UDYIL SELUG OVYFI TOPZO CIDQI WTFDI SEULO
ITRYT OLEAR NFROM THEPA STBUT IALWA YSPLA NFORT

VYEZO ZLYPW EUBZT CSNYR BDZTC AYDWU SOVYF LYTYS
HEFUT UREBY FOCUS INGEX CLUSI VELYO NTHEP RESEN

OOVIO TQVYL YOVYE ZSLYI DDWCT
TTHAT SWHER ETHEF UNREA LLYIS

I try to learn from the past, but I always plan for the future by focusing exclusively on the present. That's where the fun really is.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	1	2	5	7	5	3	1		7			8		1	12	2	2	1	6	7	5	6	5		13	6
Replacement	V	C	I	L	F	P	M	Z	A	D	Q	R	K	G	T	B	W	X	N	S	O	H	Y	J	E	U

19) **[300 points]** Encode the following quote from Mark Twain with the Hill cipher with a keyword of DOOR.

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix}$$

N	E	V	E	R	R	E	G	R	E	T	A	N	Y	T	H	I	N	G	T	H	A	T	M	A	D	E
R	**Q**	**P**	**Y**	**D**	**H**	**S**	**C**	**D**	**U**	**F**	**G**	**L**	**S**	**Z**	**V**	**Y**	**V**	**Y**	**R**	**V**	**U**	**R**	**C**	**Q**	**Z**	**K**

How to solve

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} N \\ E \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 13 \\ 4 \end{pmatrix} \equiv \begin{pmatrix} 3*13+14*4 \\ 14*13+17*4 \end{pmatrix} \equiv \begin{pmatrix} 95 \\ 250 \end{pmatrix} \equiv \begin{pmatrix} 17 \\ 16 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} R \\ Q \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} V \\ E \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 21 \\ 4 \end{pmatrix} \equiv \begin{pmatrix} 3*21+14*4 \\ 14*21+17*4 \end{pmatrix} \equiv \begin{pmatrix} 119 \\ 362 \end{pmatrix} \equiv \begin{pmatrix} 15 \\ 24 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} P \\ Y \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} R \\ R \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 17 \\ 17 \end{pmatrix} \equiv \begin{pmatrix} 3*17+14*17 \\ 14*17+17*17 \end{pmatrix} \equiv \begin{pmatrix} 289 \\ 527 \end{pmatrix} \equiv \begin{pmatrix} 3 \\ 7 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} D \\ H \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} E \\ G \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 4 \\ 6 \end{pmatrix} \equiv \begin{pmatrix} 3*4+14*6 \\ 14*4+17*6 \end{pmatrix} \equiv \begin{pmatrix} 96 \\ 158 \end{pmatrix} \equiv \begin{pmatrix} 18 \\ 2 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} S \\ C \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} R \\ E \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 17 \\ 4 \end{pmatrix} \equiv \begin{pmatrix} 3*17+14*4 \\ 14*17+17*4 \end{pmatrix} \equiv \begin{pmatrix} 107 \\ 306 \end{pmatrix} \equiv \begin{pmatrix} 3 \\ 20 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} D \\ U \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} T \\ A \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 19 \\ 0 \end{pmatrix} \equiv \begin{pmatrix} 3*19+14*0 \\ 14*19+17*0 \end{pmatrix} \equiv \begin{pmatrix} 57 \\ 266 \end{pmatrix} \equiv \begin{pmatrix} 5 \\ 6 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} F \\ G \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} N \\ Y \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 13 \\ 24 \end{pmatrix} \equiv \begin{pmatrix} 3*13+14*24 \\ 14*13+17*24 \end{pmatrix} \equiv \begin{pmatrix} 375 \\ 590 \end{pmatrix} \equiv \begin{pmatrix} 11 \\ 18 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} L \\ S \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} T \\ H \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 19 \\ 7 \end{pmatrix} \equiv \begin{pmatrix} 3*19+14*7 \\ 14*19+17*7 \end{pmatrix} \equiv \begin{pmatrix} 155 \\ 385 \end{pmatrix} \equiv \begin{pmatrix} 25 \\ 21 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} Z \\ V \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} I \\ N \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 8 \\ 13 \end{pmatrix} \equiv \begin{pmatrix} 3*8+14*13 \\ 14*8+17*13 \end{pmatrix} \equiv \begin{pmatrix} 206 \\ 333 \end{pmatrix} \equiv \begin{pmatrix} 24 \\ 21 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} Y \\ V \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} G \\ T \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 6 \\ 19 \end{pmatrix} \equiv \begin{pmatrix} 3*6+14*19 \\ 14*6+17*19 \end{pmatrix} \equiv \begin{pmatrix} 284 \\ 407 \end{pmatrix} \equiv \begin{pmatrix} 24 \\ 17 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} Y \\ R \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} H \\ A \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 7 \\ 0 \end{pmatrix} \equiv \begin{pmatrix} 3*7+14*0 \\ 14*7+17*0 \end{pmatrix} \equiv \begin{pmatrix} 21 \\ 98 \end{pmatrix} \equiv \begin{pmatrix} 21 \\ 20 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} V \\ U \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} T \\ M \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 19 \\ 12 \end{pmatrix} \equiv \begin{pmatrix} 3*19+14*12 \\ 14*19+17*12 \end{pmatrix} \equiv \begin{pmatrix} 225 \\ 470 \end{pmatrix} \equiv \begin{pmatrix} 17 \\ 2 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} R \\ C \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} A \\ D \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 0 \\ 3 \end{pmatrix} \equiv \begin{pmatrix} 3*0+14*3 \\ 14*0+17*3 \end{pmatrix} \equiv \begin{pmatrix} 42 \\ 51 \end{pmatrix} \equiv \begin{pmatrix} 16 \\ 25 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} Q \\ Z \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} E \\ Y \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 4 \\ 24 \end{pmatrix} \equiv \begin{pmatrix} 3*4+14*24 \\ 14*4+17*24 \end{pmatrix} \equiv \begin{pmatrix} 348 \\ 464 \end{pmatrix} \equiv \begin{pmatrix} 10 \\ 22 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} K \\ W \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} O \\ U \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 14 \\ 20 \end{pmatrix} \equiv \begin{pmatrix} 3*14+14*20 \\ 14*14+17*20 \end{pmatrix} \equiv \begin{pmatrix} 322 \\ 536 \end{pmatrix} \equiv \begin{pmatrix} 10 \\ 16 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} K \\ Q \end{pmatrix}$$

$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} S \\ M \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 18 \\ 12 \end{pmatrix} \equiv \begin{pmatrix} 3*18+14*12 \\ 14*18+17*12 \end{pmatrix} \equiv \begin{pmatrix} 222 \\ 456 \end{pmatrix} \equiv \begin{pmatrix} 14 \\ 14 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} O \\ O \end{pmatrix}$$
$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} I \\ L \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 8 \\ 11 \end{pmatrix} \equiv \begin{pmatrix} 3*8+14*11 \\ 14*8+17*11 \end{pmatrix} \equiv \begin{pmatrix} 178 \\ 299 \end{pmatrix} \equiv \begin{pmatrix} 22 \\ 13 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} W \\ N \end{pmatrix}$$
$$\begin{pmatrix} D & O \\ O & R \end{pmatrix} * \begin{pmatrix} E \\ Z \end{pmatrix} \equiv \begin{pmatrix} 3 & 14 \\ 14 & 17 \end{pmatrix} * \begin{pmatrix} 4 \\ 25 \end{pmatrix} \equiv \begin{pmatrix} 3*4+14*25 \\ 14*4+17*25 \end{pmatrix} \equiv \begin{pmatrix} 362 \\ 481 \end{pmatrix} \equiv \begin{pmatrix} 24 \\ 13 \end{pmatrix} \mod 26 \equiv \begin{pmatrix} Y \\ N \end{pmatrix}$$

20) **[450 points]** Solve the following Spanish aristocrat.

PU TLC FJX FTÑUK NCLC, XJ NDTXOC, XJ OU OCXOU. PU
TE AMO SIN SABER COMO, NI CUANDO, NI DE DONDE. TE

TLC OJKUNPTLUXPU FJX GKCÑSULTF XJ CKWDSSC; TFJ PU
AMO DIRECTAMENTE SIN PROBLEMAS NI ORGULLO; ASI TE

TLC GCKVDU XC FU TLTK OU CPKT LTXUKT: FJXC TFJ OU
AMO PORQUE NO SE AMAR DE OTRA MANERA: SINO ASI DE

UFPU LCOC UX VDU XC FCA XJ UKUF, PTX NUKNT VDU PD
ESTE MODO EN QUE NO SOY NI ERES, TAN CERCA QUE TU

LTXC FCÑKU LJ GUNEC UF LJT, PTX NUKNT VDU FU NJUKKTX
MANO SOBRE MI PECHO ES MIA, TAN CERCA QUE SE CIERRAN

PDF CMCF NCX LJ FDUXC.
TUS OJOS CON MI SUENO.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Ñ	O	P	Q	R	S	T	U	V	W	X	Y	Z
Frequency	1		25	9	1	17	3			14	14	13	1	10	3	8	11			3	21	31	4	1	20		
Replacement	Y	Z	O	U	H	S	P	V	X	I	R	M	J	C	B	D	T	W	Ñ	L	A	E	Q	G	N	F	K