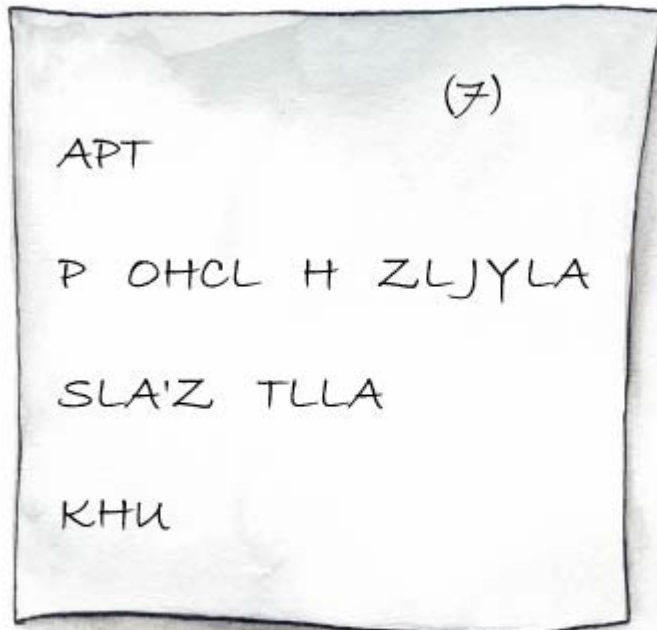
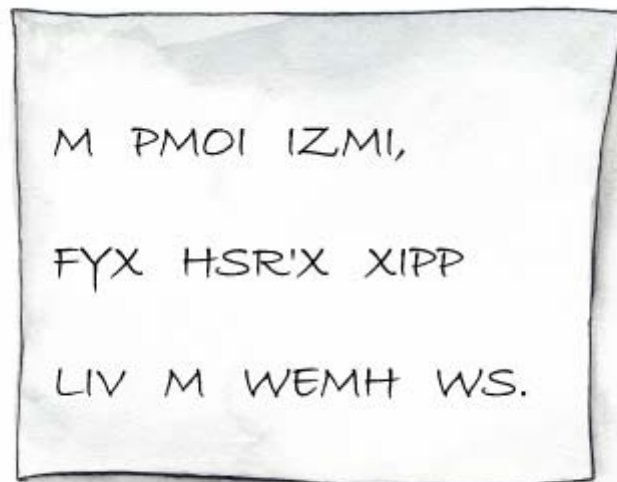


Chapter 3: Breaking Caesar Ciphers (Text page 21)

1. Decrypt Dan's note to Tim.



2. Decrypt Dan's second note to Tim.



(Text page 22)

3. Decrypt each answer by first figuring out the keys. Let the one-letter words help you.

a. **Riddle:** What do you call a happy Lassie?

Answer:

E		N	S	P	P	C		G	S	P	P	M	I						

b. **Riddle:** Knock, knock. *Who's there?* Cash. *Cash who?*

Answer:

O		Q	T	K	C		E	U	A		C	K	X	K		Y	U	S	K
Q	O	T	J			U	L		T	A	Z								

c. **Riddle:** What's the noisiest dessert?

Answer:

W		G	Q	F	S	O	A												

4. Decrypt the following quotation:

H	S		R	S	X		A	S	V	V	C		E	F	S	Y	X		C	S	Y	V	
H	M	J	J	M	G	Y	P	X	M	I	W		M	R									
Q	E	X	L	I	Q	E	X	M	G	W	,		M		E	W	W	Y	V	I			
C	S	Y		X	L	E	X		Q	M	R	I		E	V	I							
K	V	I	E	X	I	V	.																

—Albert Einstein

Name _____ Date _____

(Text page 24)

Decrypt each of the following quotations. Tell the key used to encrypt.

5.

P	K	B		K	X	N		K	G	K	I		D	R	O		L	O	C	D	
Z	B	S	J	O		D	R	K	D		V	S	P	O		Y	P	P	O	B	C
S	C		D	R	O		M	R	K	X	M	O		D	Y		G	Y	B	U	
R	K	B	N		K	D		G	Y	B	U		G	Y	B	D	R				
N	Y	S	X	Q	.																

—Theodore Roosevelt Key = _____

6.

J	A	J	S		N	K		D	T	Z	'	W	J		T	S		Y	M	J		
W	N	L	M	Y		Y	W	F	H	P	,		D	T	Z	'	Q	Q		L	J	Y
W	Z	S		T	A	J	W		N	K		D	T	Z		O	Z	X	Y			
X	N	Y		Y	M	J	W	J	.													

—Will Rogers Key = _____

(Text page 25)

7.

R	C	A	B		J	M	K	I	C	A	M	A	W	U	M	B	P	Q	V	O			
L	W	M	A	V	'	B		L	W		E	P	I	B		G	W	C					
X	T	I	V	V	M	L		Q	B		B	W		L	W		L	W	M	A	V	'	B
U	M	I	V		Q	B	'	A		C	A	M	T	M	A	A	.						

—Thomas A. Edison

Key = _____

8.

Q	B	A	'	G		J	N	Y	X		O	R	U	V	A	Q		Z	R,		V		
Z	N	L		A	B	G		Y	R	N	Q.		Q	B	A	'	G		J	N	Y	X	
V	A		S	E	B	A	G		B	S		Z	R,		V		Z	N	L				
A	B	G		S	B	Y	Y	B	J.		W	H	F	G		J	N	Y	X				
O	R	F	V	Q	R		Z	R		N	A	Q		O	R		Z	L					
S	E	V	R	A	Q.																		

—Albert Camus

Key = _____

Name _____ Date _____

(Text page 25)

9.

O	C	P	A	Q	H	N	K	H	G	'	U	H	C	K	N	W	T	G	U	C	T	G	R
G	Q	R	N	G	Y	J	Q	F	K	F	P	Q	V	T	G	C	N	K	B	G	J	Q	
Y	E	N	Q	U	G	V	J	G	A	Y	G	T	G	V	Q	U	W	E	E	G	U	U	
Y	J	G	P	V	J	G	A	I	C	X	G	W	R	.									

—Thomas A. Edison

Key = _____

10. Challenge.

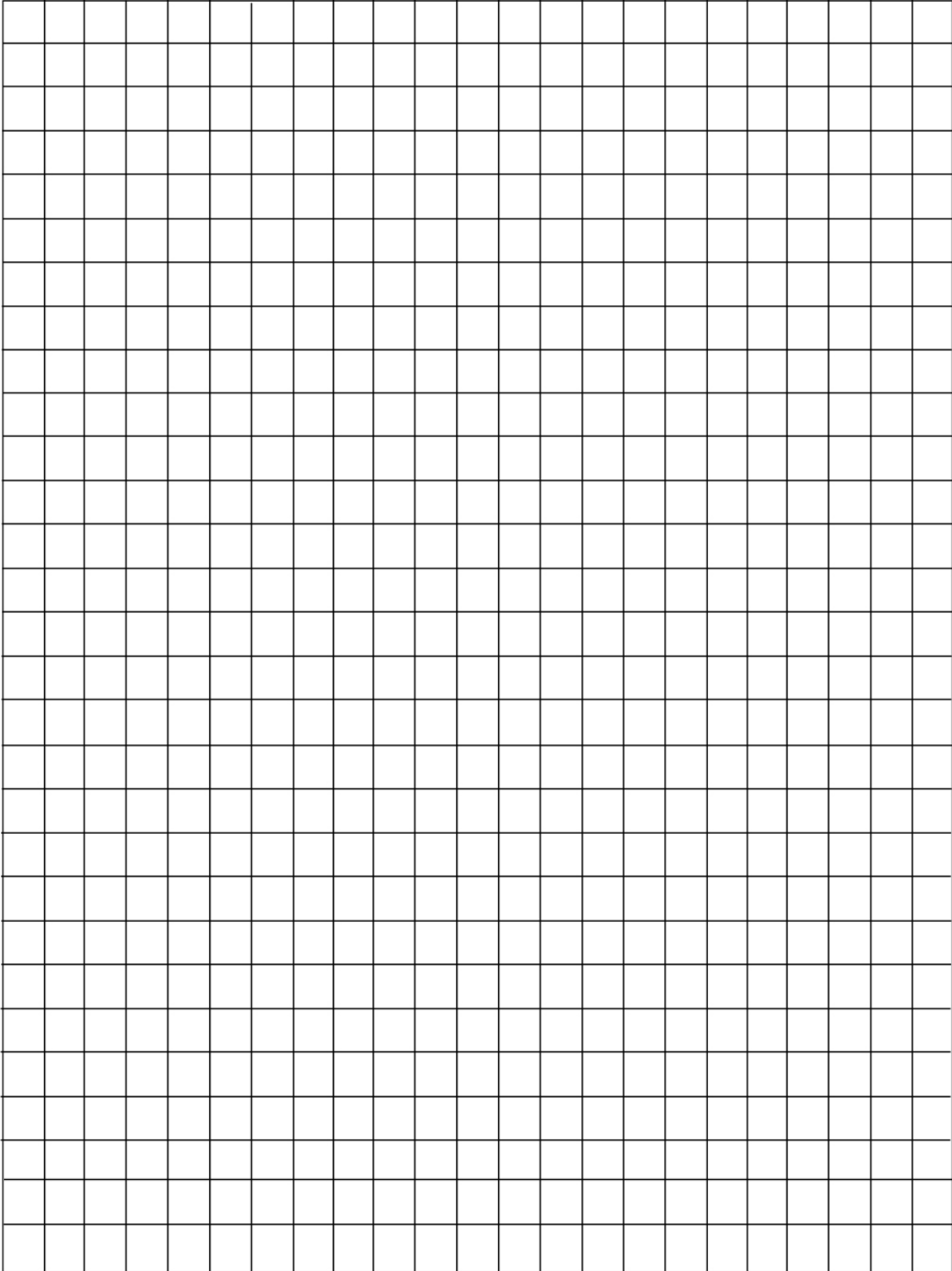
16	14	23	18	4	2		18	2		24	23	14		25	14	1		12	14	23	3		
18	23	2	25	18	1	10	3	18	24	23,		23	18	23	14	3	8		23	18	23	14	
25	14	1		12	14	23	3		25	14	1	2	25	18	1	10	3	18	24	23	.		

—Thomas A. Edison

Key = _____

Name _____ Date _____

You can use this page for your own messages.



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The Cryptoclub: Using Mathematics to Make and Break Secret Codes

Chapter 4: Keyword Ciphers

(Text page 31)

Write the keyword ciphers in the tables. Decrypt the answers to the riddles.

1. Keyword: DAN, Key letter: h

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

Riddle: What is worse than biting into an apple and finding a worm?

Answer: YAFWAFZ DTCY T PGJE.

2. Keyword: HOUSE, Key letter: m

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

Riddle: Is it hard to spot a leopard?

Answer: OU. CVQJ LAQ MUAO CVLC GLJ.

3. Keyword: MUSIC, Key letter: d

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

Riddle: What part of your body has the most rhythm?

Answer: VHPL UXLMLPFN

Name _____ Date _____

(Text page 31)

4. Keyword: FISH, Key letter: a

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

Riddle: What does Mother Earth use for fishing?

Answer: TDA MNQTD FMH RNUTD ONKAR

5. Keyword: ANIMAL, Key letter: g

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

Riddle: Why was the belt arrested?

Answer: ZEH NEBXIDA OF KNY FUDKJ.

6. Keyword: RABBIT, Key letter: f

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

Riddle: How do rabbits travel?

Answer: WS BVKZHDVFZ

7. Keyword: MISSISSIPPI, Key letter: d

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

Riddle: What ears cannot hear?

Answer: IXLN HS ZHLG

Name _____ Date _____

(Text page 32)

8. Keyword: SKITRIP, Key letter: p
(It is a long message, so you may want to share the work with a group.)

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

- [1] OLIL FIL ROL JLRFQWT ZM ROL ZPRJZZI
- [2] HWPG'T TVQ RIQS: ROL RBZ-JFD RIQS RZ
- [3] SQYL XZPYRFQY BQWW GL TFRPIJFD FYJ
- [4] TPYJFD, ROL MQITR BLLVLYJ QY MLGIPFID.
- [5] ROL GPT BQWW WLFAL MIZX ROL SFIV'T
- [6] OLFJKPFIRLIT FR LQNOR FX FYJ ILRPIY FR
- [7] RLY SX TPYJFD.
- [8] ILNQTRIFRQZY MZI XT FIL JPL GD YLCR MIQJFD
- [9] SQHV ROLX PS QY ROL SFIV ZMMQHL.
- [10] ROL RIQS QT WQXQRLJ RZ ROL MQITR
- [11] RBLYRD BOZ TQNY PS, TZ SWLFTL OPIID ZI
- [12] ROLIL XQNOR YZR GL LYZPNO TSFHL.

Name _____ Date _____

(Text page 32)

9. Create your own keyword cipher.

Keyword: _____

Key letter: _____

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

On your own paper, encrypt a message to another group. Tell them your keyword and key letter so they can decrypt.

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Here are extra tables to use when encrypting and decrypting other messages.

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	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	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	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	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z

The Cryptoclub: Using Mathematics to Make and Break Secret Codes

Chapter 5: Letter Frequencies

(Text page 37)

CLASS ACTIVITY: Finding Relative Frequencies of Letters in English

Part 1. Collecting data from a small sample.

- Choose about 100 English letters from a newspaper or other English text. (Note: If you are working without a class, choose a larger sample—around 500 letters. Then skip Parts 1 and 2.)
- Work with your group to count the **As**, **Bs**, etc., in your sample.
- Enter your data in the table below.

Letter Frequencies for Your Sample

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

Part 2. Combining data to make a larger sample.

- Record your data from Part 1 on your class's Class Letter Frequencies table. (Your teacher will provide this table on the board, overhead, or chart paper.)
- Your teacher will assign your group a few rows to add. Enter your sums in the group table.

(Text pages 37–38)

Part 3. Computing relative frequencies.

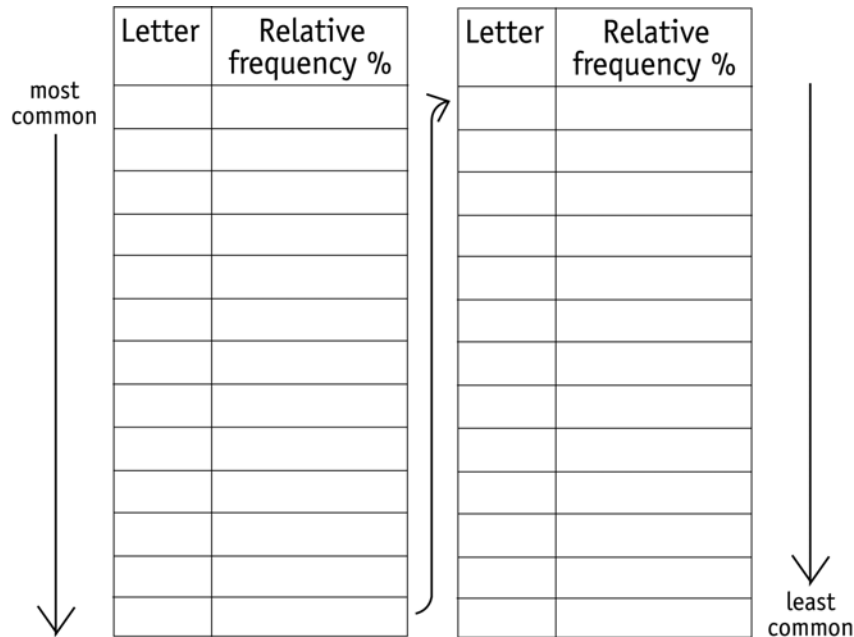
Enter your class’s combined data from the “Total for All Groups” column of Part 2 into the “Frequency” column. Then compute the relative frequencies.

		Relative Frequency		
Letter	Frequency	Fraction	Decimal (to 3 places)	Percent (%) (to nearest tenth)
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				
Total				

Name _____ Date _____

(Text page 38)

1. a. What percent of the letters in the class sample were the letter **T**? _____%
- b. About how many **T**s would you expect in a sample of 100 letters? _____
- c. If your sample was about 100 letters, was your answer to 1b close to the number of **T**s you found in your sample? _____
2. a. What percent of the letters in the class sample were the letter **E**? _____%
- b. About how many **E**s would you expect in a sample size of 100? _____
- c. About how many **E**s would you expect in a sample of 1000 letters? _____
3. Arrange the letters in your class table in order, from most common to least common.



4. The table on Page 39 of the text shows frequencies of letters in English computed using a sample of about 100,000 letters. How is your class data the same as the data in that table? How is it different? Why might it be different?

Chapter 6: Breaking Substitution Ciphers

(Text page 49)

1. Use frequency analysis to decrypt Jenny’s message, which is shown on the following page.
 - a. Record the number of occurrences (frequency) of each letter in her message. Then compute the relative frequencies.

Letter Frequencies for Jenny’s Message

Letter	Frequency	Relative Frequency		
		Fraction	Decimal (to 3 places)	Percent (%) (to nearest tenth)
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				
Total				

(Text page 49)

- b. Arrange letters in order from the most common to the least common.

In Message		In English	
Letter	Rel. Freq. (%)	Letter	Rel. Freq. (%)
		e	12.7
		t	9.1
		a	8.2
		o	7.5
		i	7.0
		n	6.7
		s	6.3
		h	6.1
		r	6.0
		d	4.3
		l	4.0
		c	2.8
		u	2.8
		m	2.4
		w	2.4
		f	2.2
		g	2.0
		y	2.0
		p	1.9
		b	1.5
		v	1.0
		k	0.8
		j	0.2
		q	0.1
		x	0.1
		z	0.1

- c. Now decrypt Jenny’s message, using the frequencies to help you guess the correct substitutions. Record your substitutions in the Substitution Table below the message.
Tip: Use pencil!

Jenny’s Message

- [1] Y XTNDQ DNQYS EFNFYSU
 [2] JKLM NUUSGUPTQ FXTL JYII
 [3] WYHT NJNL VDTT PYDPGE
 [4] FYPCTFE FS FXT VYDEF
 [5] FJTUFL-VYHT ATSAIT JXS
 [6] PNII YU. YF ESGUQE IYCT
 [7] VGU. ITF'E NII PNII NUQ
 [8] WS FSWTFXTD.

Substitution Table

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					

(Text page 49)

2. Here is another message to decrypt using frequency analysis. The relative frequencies have been computed for you. Record your substitutions in the Substitution Table below the message. Tip: Use pencil!

In Message 2		In English	
Letter	Rel. Freq. (%)	Letter	Rel. Freq. (%)
D	11.4	e	12.7
G	9.8	t	9.1
Q	8.3	a	8.2
T	7.8	o	7.5
C	6.7	i	7.0
K	6.7	n	6.7
E	6.2	s	6.3
L	5.7	h	6.1
N	5.7	r	6.0
S	5.2	d	4.3
I	3.6	l	4.0
U	3.6	c	2.8
J	3.1	u	2.8
M	2.6	m	2.4
Y	2.6	w	2.4
A	1.6	f	2.2
B	1.6	g	2.0
H	1.6	y	2.0
R	1.6	p	1.9
W	1.6	b	1.5
O	1.0	v	1.0
Z	1.0	k	0.8
V	0.5	j	0.2
X	0.5	q	0.1
F	0.0	x	0.1
P	0.0	z	0.1

Message 2

[1] BQGKNJG SDKT CDQ MGVLQETD

[2] BQGKNSLK G CGKNSLJD KDW

[3] SCEQT MLQ CES REQTCNGY.

[4] UKMLQTUKGTDIY, ET CGN G

[5] SEZD MLUQTDDK ALIIGQ GKN

[6] TCD RLY CGN G SEZD SEXTDDK

[7] KDAH. CD NUTEMUIIY WQLTD CDQ,

[8] "NDGQ BQGJJY, TCGKHS CDGOS.

[9] E'N WQETD JLQD RUT E'J GII

[10] ACLHDN UO."

Substitution Table

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																