# North Carolina Science Olympiad — Code Busters State Test 2018

Names of participants: (Please print neatly)	
School Name:	
V JV1 JV2 JV3	
Warning: Do not open this packet until given permission to do so.	
<b>Note:</b> There are useful notes after this page.	
Scoring:	
Time to solve first problem:	(use to calculate Ronus below)

Question	Value	Incorrect letters	Deduction	Score
Timed	100			
1	120			
2	100			
3	75			
4	300			
5	120			
6	140			
7	350			
8	120			
9	125			
10	50			
11	100			
12	125			
13	300			
14	50			
15	250			
16	150			
17	350			
18	60			
19	120			
Bonus				
Final Score				

The following tables might be useful during the event.

	A	В	С	D	E	F	G	H	Ι	J	K	L	M	N	0	P	Q	R	S	T	Ū	٧	W	Х	Y	Z
A	Α	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z
В	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Ζ	А
С	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	W	Χ	Y	Ζ	А	В
D	D	Ε	F	U	Н	Ι	J	K	L	М	Ν	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z	Α	В	С
E	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Ζ	Α	В	С	D
F	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Ζ	Α	В	С	D	E
G	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	W	Χ	Y	Ζ	А	В	С	D	Ε	F
Н	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z	А	В	С	D	Ε	F	G
I	Ι	J	K	L	М	Ν	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z	Α	В	С	D	Ε	F	G	Н
J	J	K	L	М	Ν	0	Р	Q	R	വ	Т	IJ	V	M	Χ	Y	Ζ	А	В	С	D	Ε	F	G	Н	I
K	K	L	М	N	0	Р	Q	R	S	Т	U	V	W	Χ	Y	Ζ	Α	В	С	D	Ε	F	G	Н	Ι	J
L	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Ζ	А	В	С	D	Ε	F	G	Н	Ι	J	K
M	М	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L
N	N	0	Р	Q	R	S	Т	U	V	M	Χ	Y	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М
0	0	Р	Q	R	S	Т	U	V	W	Χ	Y	Ζ	Α	В	С	D	Ε	F	U	Н	Ι	J	K	L	М	N
P	Р	Q	R	S	Т	U	V	W	Χ	Y	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0
Q	Q	R	S	Т	U	V	M	Χ	Y	Ζ	Α	В	$\cup$	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р
R	R	S	Т	IJ	V	W	Χ	Y	Ζ	А	В	$\cup$	О	Ε	F	G	Н	Ι	Ŋ	K	L	М	Ν	0	Р	Q
S	S	Т	U	V	W	Χ	Y	Z	Α	В	$\cup$	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R
T	Т	U	V	W	Χ	Y	Ζ	Α	В	$\cup$	О	Ε	F	G	Н	Ι	Ŋ	K	L	М	N	0	Р	Q	R	S
Ū	U	V	M	Χ	Y	Ζ	Α	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т
V	V	W	Χ	Y	Ζ	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U
W	M	Χ	Y	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V
X	Χ	Y	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M
Y	Y	Ζ	Α	В	С	D	Ε	F	G	Н	I	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	M	Χ
Z	Z	А	В	С	D	Ε	F	G	Н	Ι	J	K	L	М	N	0	Р	Q	R	S	Т	U	V	W	Χ	Y
	_																									

AAAABA       B         AAABA       C         AAABBA       E         AABAAA       F         AABBAB       G         AABBBA       III         ABAAAA       IVI         ABAABAB       K         ABABBA       L         ABABBB       M	AAAA	Α
AAABB       D         AABAA       E         AABAB       F         AABBA       G         AABBB       H         ABAAA       I/J         ABAAB       K         ABABA       L	AAAAB	В
AABAA       E         AABAB       F         AABBA       G         AABBB       H         ABAAA       I/J         ABAAB       K         ABABA       L	AAABA	C
AABAB       F         AABBA       G         AABBB       H         ABAAA       I/J         ABAAB       K         ABABA       L	AAABB	D
AABBA       G         AABBB       H         ABAAA       I/J         ABAAB       K         ABABA       L	AABAA	Е
AABBB       H         ABAAA       I/J         ABAAB       K         ABABA       L	AABAB	F
ABAAA         I/J           ABAAB         K           ABABA         L	AABBA	G
ABAAB K ABABA L	AABBB	Н
ABABA L	ABAAA	I/J
	ABAAB	K
ABABB M	ABABA	L
	ABABB	M

Ι

GH

5

A B

CDFF

3

4

J

K L M

ABBAA	N
ABBAB	O
ABBBA	P
ABBBB	Q
BAAAA	R
BAAAB	S
BAABA	T
BAABB	U/V
BABAA	W
BABAB	X
BABBA	Y
BABBB	Z

R S T

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

0

N

#### **Frequency Table of English letters:**

Ε	12.51%	S	6.54%	С	3.06%	G	1.96%	K	0.67%
Т	9.25%	R	6.12%	U	2.71%	M	1.92%	X	0.19%
Α	8.04%	Н	5.49%	M	2.53%	Y	1.73%	J	0.16%
0	7.60%	L	4.14%	F	2.30%	В	1.54%	Q	0.11%
I	7.26%	D	3.99%	P	2.00%	V	0.99%	Z	0.09%
N	7 09%								

#### **Frequency Table of Spanish letters:**

E	14.08%	I	5.98%	M	3.08%	Y	1.09%	Z	0.47%
Α	12.16%	L	5.24%	P	2.89%	V	1.05%	Ñ	0.17%
0	9.20%	D	4.67%	В	1.49%	G	1.00%	X	0.14%
S	7.20%	T	4.60%	Н	1.18%	F	0.69%	K	0.11%
N	6.83%	U	4.69%	Q	1.11%	J	0.52%	M	0.04%
R	6.41%	С	3.87%						

For the purposes of cryptograms it is customary to treat n and ñ as distinct letters, but a and á are the same letter. Likewise for e and é, and i and í. In other words, all the accent marks get amputated when working with cryptograms. Also, while some older Spanish dictionaries consider ch, ll, and rr, to be their own letters—this has fallen out of modern usage. Accordingly, "burro" is considered as five letters: "b-u-r-r-o" and not as four letters "b-u-rr-o."

#### **Famous Phrases**

#### Gettysburg address:

FOUR SCORE AND SEVEN YEARS AGO OUR FATHERS BROUGHT FORTH ON THIS CONTINENT, A NEW NATION, CONCEIVED IN LIBERTY, AND DEDICATED TO THE PROPOSITION THAT ALL MEN ARE CREATED EQUAL.

#### Declaration of Independence:

WHEN IN THE COURSE OF HUMAN EVENTS IT BECOMES NECESSARY FOR ONE PEOPLE TO DISSOLVE THE POLITICAL BANDS WHICH HAVE CONNECTED THEM WITH ANOTHER AND TO ASSUME AMONG THE POWERS OF THE EARTH, THE SEPARATE AND EQUAL STATION TO WHICH THE LAWS OF NATURE AND OF NATURE'S GOD ENTITLE THEM, A DECENT RESPECT TO THE OPINIONS OF MANKIND REQUIRES THAT THEY SHOULD DECLARE THE CAUSES WHICH IMPEL THEM TO THE SEPARATION.

#### Constitution of United States of America:

WE THE PEOPLE OF THE UNITED STATES, IN ORDER TO FORM A MORE PERFECT UNION, ESTABLISH JUSTICE, INSURE DOMESTIC TRANQUILITY, PROVIDE FOR THE COMMON DEFENSE, PROMOTE THE GENERAL WELFARE, AND SECURE THE BLESSINGS OF LIBERTY TO OURSELVES AND OUR POSTERITY, DO ORDAIN AND ESTABLISH THIS CONSTITUTION FOR THE UNITED STATES OF AMERICA.

#### MAGNA CARTA (In Latin):

JOHANNES DEI GRACIA REX ANGLIE, DOMINUS HIBERNIE, DUX NORMANNIE, AQUITANNIE ET COMES ANDEGAVIE, ARCHIEPISCOPIS, EPISCOPIS, ABBATIBUS, COMITIBUS, BARONIBUS, JUSTICIARIIS, FORESTARIIS, VICECOMITIBUS, PREPOSITIS, MINISTRIS ET OMNIBUS BALLIVIS ET FIDELIBUS SUIS SALUTEM.

School	V	IV1	JV2	IV3

Timed question [100 Points]: Solve this Aristocrat which is a quote by Scott Adams. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

## RPCI CFZ IPZ BXXM IPCI JBN CFZ IPZ OKFMI LZUZFCIKBU

## BO PNTCUM RPB RKEE NUXZFMICUX FZCEKIJ

	A	В	$\mathbf{C}$	D	$\mathbf{E}$	F	G	H	I	J	K	L	$\mathbf{M}$	N	<b>0</b>	P	Q	R	S	T	$\mathbf{U}$	$\mathbf{V}$	$\mathbf{W}$	$\mathbf{X}$	Y	$\mathbf{Z}$
Frequency		5	8		3	6			9	2	4	1	4	3	2	6		3		1	5			4		8
Replacement																										

1) [120 Points] Solve this Aristocrat which is a quote from John W. Gardner and starts with WE ARE.

#### HP EKP FGXBYXCEWWR DEFPN HYBV E JPKYPJ GD LKPEB

#### GSSGKBCXYBYPJ ZKYWWYEXBWR NYJLCYJPN EJ YXJGWCZWP

#### SKGZWPTJ

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

2) [100 Points] William Arthur Ward once said this about what to look for. It has been encoded using the Vigenère cipher using a very common five letter word. You have been told that the 13<sup>th</sup> through the 20<sup>th</sup> letters in the code (AMKHWSIJ) actually is the word DISCOVER. What does the message decode to?

В	P	В	R	0		J	A	В	I	С		Y	W	A	M	K		H	W	S	I	J	Y	P	В	F	W
х	В	F	R	G		Y	P	В	v	K		В	M	P	S	E		J	P	L	Α	Т	W	Q	K	K	G
<u> </u>					J		ı		ı	ı																	
Z	ъ		т	TAT	]	G	М	P	х	7	ĺ	s	W	R	V	K	ĺ	J	Т	s	I	K					
	В	Q	L	W		6	IAI	P	Λ	A		٥	W	Т	٧	V		J		3		V					

3) **[75 Points]** Using a key of **TURN** encode the string **JUXTAPOSING** using the Hill Cipher with a 26 character alphabet. e.g.

$$\begin{pmatrix} T & U \\ R & N \end{pmatrix} \equiv \begin{pmatrix} 19 & 20 \\ 17 & 13 \end{pmatrix}$$

J	Ū	X	T	A	P	0	S	Ι	N	G	

4) [300 Points] Solve this Xenocrypt which is a translation of a quote by Frank Clark into Spanish.

MGXG SP ATBXG MVLML XS VSLPYHLV LPEG EVLBXS, ZYB

XLVZS KTSBML XS ÑTS PL WYXL ZS KGAUGBS XS KGZLZ

USÑTSJLZ

Frequency	
Replacement	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Ñ	0	P	Q	R	S	T	U	V	W	X	Y	$\mathbf{Z}$
y	2	5			2		7	1		1	3	12	4		2		4			13	4	2	5	1	8	3	6
ent																											

5) [120 Points] Solve this Aristocrat which is a quote by Albert Einstein which has the word **ART** in it once and **THE** three times.

## LMJ QDXL NJPVLTOVB LMTEK ZJ YPE JIAJSTJEYJ TX LMJ

### QCXLJSTDVX. TL TX LMJ XDVSYJ DO PBB LSVJ PSL PEH

#### XYTJEYJ

Frequency Replacement

	A	B	C	D	$\mathbf{E}$	F	G	H	I	J	K	L	$\mathbf{M}$	N	O	P	Q	R	S	T	U	$\mathbf{V}$	W	X	Y	Z
y	1	3	1	4	5			1	1	14	1	10	4	1	2	5	2		5	8		5		7	5	1
nt																										

6) **[140 Points]** A message from Stephen Hawking encrypted with the Affine Cipher using an alphabet of 26 characters has been received. You have been told that the 2<sup>nd</sup> and 3<sup>rd</sup> characters are the letters **HE**. With that knowledge, what does this message say?

Q	ט	V	Н	ß	L	Y	٧	Ι	Z	٧	L	S	F	S	Н	Q	Z	ט	٧	K	K

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7	_	[350 the v			_		thi	is K1	Key	enc	code	ed P	atris	stoc	erat	wh	iich	is a	a qu	ote	by I	saa	c A	sim	OV	and	staı	ts	witl	h
RL	JA	Z	LM	ΊL	S	IJ	ĹΧ	WR	QM	INJ	U	Z	LOI	ΗA	. 1	1V	QI	M	N	AN	ZW	0	KE	'L	Z					
BJ	JI	Z	ZR	BK	Ά	SI	ΕW	MF	AS	LA	J	L	πc	ďΟ	· c	CI:	MA	A	S	IS	ΙL	X	NC	AC	W					
LZ	AΙ	Α	IK	FV	L	Oź	ZN	WO																						
	K	1	A	B	C	D	E	F G	Н	Ι.	J k	ΚL	M	N	0	P	Q	R	S	T U	J <b>V</b>	W	X	Y	$\mathbf{Z}$					
	_	enc	′ ⊢	1 2	1			3	1	9	6 3	3 12	2 5	6	7		2	3	5	1	. 2	6	2		8					
Rep	lac	eme	nt																											
8								wing	-					Ze	wai	il h	as b	eer	n en	code	ed u	sin	g a i	run	ning	g ke	y ci	pho	er	
	i	agai	nst a	ı ran	nous	s ac	ocui	ment	. • • • • • • • • • • • • • • • • • • •	nai C	ioes	il S	say?																	
R	В	C E	F	G	М	F	J	M	v		Y	T :	I G	7 2	7 (	2 3	٧		[ <i>]</i>	A U	P	G	Е	Q	s	Q		0	Z	L
•	•	•	•		•	•			•			•	•	•	•	•	_		•								<u>.                                    </u>	•	•	
Р	0	J	P	W	Т	М	F	( L	] -	L	V	L	P	I	В	A		F	V	7 E	: I	<b>E</b> 1	N	E	K	L		<u> </u>	I	Ι

С	V	0	E	F	G	Q	R	K	В	P	Н	T	I	X	Ū	G	X	V	K

9) [125 Points] Solve this Aristocrat which is a quote from Roy T. Bennett.

## YPAANYY RY XIJ DIO DRVD ZIP DQSN ABRKMNU, MPJ DIO

## ZIP KQEN Q HIYRJRSN URCCNGNXAN JI JDN OIGBU

	A	B	$\mathbf{C}$	D	E	F	G	H	I	J	K	L	M	N	0	P	Q	R	S	T	U	$\mathbf{V}$	W	X	Y	$\mathbf{Z}$
Frequency	4	2	2	6	1		2	1	8	5	2		2	9	3	4	3	6	2		3	1		2	5	2
Replacement																										

10) [50 Points] A quote from Ralph Waldo Emerson has been encoded using a Caesar Cipher. What does it say?

J	V	G	U	В	Н	G		N	Z	0	V	G	v	В	A		В	A	R		F	G	N	E	G	F		A	В	G	U	v	A	T	
	1						l I									ļ				L															
J	V	G	U	В	Н	G	1	J	В	E	X		В	Α	R		s	V	A	V	F	U	R	F		Α	В	G	U	V	A	Т			
	<u> </u>			<u> </u>			j			<u> </u>						ļ			<u> </u>						]								j		
G	U	R		С	E	V	M	R		J	V	Y	Y		A	В	G		0	R		F	R	Α	G		G	В		L	В	Н	].		
											l		<u> </u>	ļ		<u> </u>		ļ		<u> </u>	ļ					J			j						
L	В	H		U I	N :	I I	3	G	В		J	V	A		V	G																			

11) [100 Points] Encode the string THE GODS TOO ARE FOND OF A JOKE using the Affine Cipher with a=5 and b=20.

7	E	G	0	D	S	T	0	0	A	R	E	F	0	N	D	0	F	A	J	0	K	E

School	V	JV1	JV2	JV3

12) [125 Points] Using a key of OUTSHINED encode the string ACCOMPLISHMENT using the Hill Cipher with a 26-character alphabet. e.g.

$$\begin{pmatrix} O & U & T \\ S & H & I \\ N & E & D \end{pmatrix} \equiv \begin{pmatrix} 14 & 20 & 19 \\ 18 & 7 & 8 \\ 13 & 4 & 3 \end{pmatrix}$$

Z	A	С	С	0	M	P	L	I	S	H	M	E	N	T	

### DSDIF WJMLU T GXVW EF ZIXH BZXOMZ AMCD MB WDIIT OADT

#### VOBDWWMLU. JXH ZTL WJMLUB BDH BETAA GDD BDH

#### **MEOXIWTLW**

	A	В	$\mathbf{C}$	D	$\mathbf{E}$	F	$\mathbf{G}$	H	I	J	K	L	$\mathbf{M}$	N	<b>0</b>	P	Q	R	S	T	$\mathbf{U}$	$\mathbf{V}$	$\mathbf{W}$	$\mathbf{X}$	Y	$\mathbf{Z}$
Frequency	4	7	1	10	3	2	2	4	5	3		5	7		4				1	6	3	2	8	5		4
Replacement																										

<sup>13) [300</sup> Points] Alexa severely misheard a phrase from Isaac Asimov in Epigraph in "Isaac Asimov's Book of Science and Nature Quotations" and then encoded it as an Aristocrat. What did it come out as?

14) **[50 Points]** Using a code word of **WIZARD**, encode the following quote from Albert Einstein using the Vigenère cipher.

N O	A M O T	JNT	OF	EXP	E R	I M I	E N T	I A 1	IC	N	CA	N	EV	ER	PR	OVE	ME
RIG	G H T ;	A	SING	LE	EX	P E I	RII	MEN	1 T	CA	N	P R	0 V	E	ME	WROP	1 G .

LPHIN MIBMU BMWLM XTNTG QBJQL YIXUT RMQXR EIRWZ

IWIGT WKUTW IIDIW MXYWQ YQWRM QXRQR EINTH QWTXK

UTJWM BMJIU LTKI

	A	B	$\mathbf{C}$	D	E	F	G	H	I	J	K	L	M	N	0	P	Q	R	S	T	U	V	$\mathbf{W}$	X	Y	$\mathbf{Z}$
Frequency		4		1	2		2	2	12	3	3	4	9	3		1	8	6		9	5		10	6	3	1
Replacement																										

<sup>15) [250</sup> Points] Solve this Patristocrat which is a quote by Nikola Tesla and begins with MY BELIEF.

	School	V JV1 JV2 JV3
16) [150 Daintal The following symbols encodes a phress by	Stanhan Hawking usin	a a Decenien alphabet

16) [150 Points] The following symbols encodes a phrase by Stephen Hawking using a Baconian alphabet. What does it say?

Answer:			

TBXHK WRWRY ATGCV QTUPH GCWYV KFYVT HGUXH KWRYF

TLRTB VQYVU GHVUH SRVQT GCVHU STFRY ZHKVV QRGTA

HGVEG HMMQY VTU

<b>K</b> 1	A	В	C	D	$\mathbf{E}$	F	G	H	I	J	K	L	$\mathbf{M}$	N	O	P	Q	R	S	T	U	$\mathbf{V}$	W	X	Y	Z
Frequency	2	2	3		1	3	8	10			4	1	2			1	5	7	2	10	6	12	4	2	7	1
Replacement																										

<sup>17)</sup> **[350 Points]** Solve this Patristocrat of a quote by Chad Sugg, encoded using a K1 key. The first five letters are **IFYOU**.

18) <b>[60 Points]</b> You know that a message has been encrypted using the Affine Cipher with an alphabet of 26 characters. You have discovered that the message <b>UDMMSV</b> decodes to say <b>PUZZLE</b> . What are the values of <i>a</i> and <i>b</i> in the function $ax + b$ that were used to encode the message?
a= $b=$
19) [120 Points] The following strange headlines appeared in the newspaper but in reality, they are a Baconian encoded message from Henry Petroski where some letters encode as one character and the others as another in a pattern. You know that the message starts out as <b>ASENGINE</b> . What does the message decode to?
Answer:
As his loyal guest he was sorry if you spent today, my day, lying round.
Enemy ocean worth zilch.
Do not guess badly.
He did claim he put amply known trend by the ocean beach.
He was by its newly clear round glass.
Known: if you speak mercy, lucky trend on two super giant teeth.
Happy! My day, know a baker in who empty bread with a brown shape he put.
Below lucky album label whose quiet voice links panel
In old lives bring quilt.