North Carolina Science Olympiad — Code Busters Test 1

2018

You will need:
1. Folders for each of the teams to hold the tests
2. Sufficient copies of the test for all teams. They don't need to be stapled.
3. Multiple timers which have a lap function on them - ideally one per volunteer.   The timer app on an iPhone or Android Phone that has a stopwatch function with lap function is sufficient.

Before the event begins:
1. Practice starting the timers and using the lap function to record the times. Make sure volunteers understand how to use the lap function and are not accidentally stopping the timer completely.
2. Memorize the answer to the timed question.
3. Check to make sure that this key matches the test you are proctoring.
4. Place one copy of the test for each team in the provided folders with the first page outside the folder.
5. Adjust desks and chairs – teams may have up to 3 students for this event.

Running the Event

1. When the students enter the room, instruct them to sit down, DO NOT OPEN THE FOLDER, and put their names, school name and school number on the first page.
2. Encourage them to write their team number on all the other pages AFTER they begin the test. This way if their papers gets separated from each other we can make sure to give them credit.
3. **CRITICAL**: Check to see that students have ONLY brought
     i. Something to write with (pencils, pens, erasers)
     ii. Five function calculators (addition, subtraction, multiplication, division, and usually square root). The calculator can have a simple memory store/recall function but must not have a modulus or other scientific and programmable functions. If their calculator doesn't meet these requirements, they may not use it.
     iii. If there are spare calculators in the kit, you may loan up to one per team to use for the test.
     iv. If the student has a smart watch (Apple watch, Samsung Gear, etc.) they will need to put it away.
4. Instruct the students that if they answer the timed question within 10 minutes, they can be awarded a bonus if they solve the timed question with no more than 2 letters incorrect.
     i. When they have a solution for the cryptogram they should raise their hand.
     ii. Let them know that you will announce when the 10-minute time is up. After the first 10 minutes, no additional bonus points will be awarded.
     iii. When you see a team raise their hand, hit the LAP function and head to the team.
     iv. Determine if their answer is correct (see next page for grading), If so, write the time on their score sheet.
     v. If their score is incorrect (more than 2 letters incorrect), tell the team that the answer is wrong, but DO NOT tell them what is wrong. They can continue to work on the question and raise their hand again to be checked. A team has an unlimited number of attempts during the 10-minute bonus.
5. Tell the teams that they do not have to fill in the frequency table. It is simply there as an aid to them solving the cryptogram. It will not be graded.
6. Some students may never have used a non-scientific calculator. You should have them enter a simple formula on their calculator: 1 / 26 = * 26 = .. Most will be surprised to see that the answer is not rounded to 1 as they expected but .9999999999
7. When the timers hit the 10-minute point, announce that no bonus points will be awarded and put away the timers. The students may continue to work on the question, but they may not receive any extra points.
8. A team is not restricted to only the timed question during the 10 minutes. They can move on or split up the work if they would like, but it is in their best interest to try for the bonus.

9. When time is up, have the students put writing instruments down and put their answer pages back into the folder in the correct order.

How to grade

1. Teams can have up to two incorrect letters total on their cryptogram and still be correct. The frequency of the incorrect letter is irrelevant. See the example below.

If the cryptogram was as shown:

KZBAOF KFXMFXYF

SAMPLE SENTENCE

and the students answered (underlined letters indicate mistakes)

SAMPLF SFNTFNCF

then it counts as four mistakes (even though the mistake was only in the letter E) and the answer DOES NOT count. However, if they put

SAMPUL SENTENCE

It is considered correct with two letter mistakes.

2. For questions which have a numeric answer (such as determining the a= and b= values), no mistakes are allowed.

3. Teams do NOT have to fill in the frequency table. It is simply there as an aid to them solving the cryptogram. It WILL NOT be graded. It is included in the answer key as an aid to the grader.

4. When scoring the Baconian ciphers (with strange text or symbols), they can write the answer under the Dancing Man symbols or on the line provided. Note that you will see lots of As and Bs, but they are not graded as the answer, only what they put on the answer line.

5. As you score each question, if correct, put the number of incorrect letters (0, 1, or 2) next to the question number on the scoring page. Also, put the value for the question into the score column. If they get more than 2 letters wrong, subtract 50 points from the score until it would be zero. If a question is worth 120 points and they get 4 letters wrong, you would start with 120 points (for up to 2 letters wrong) and then subtract 100 points for the next two letters wrong ending up with a final score of 20 points for that question. If they had gotten 5 or more letters wrong on a 120 point question, they would receive 0 points for that question. With a 350 point question, they could get 8 letters wrong and receive 50 points (2 free letters then 6 × 50 = 300 points off). Just put the incorrect cost deduction on the score sheet and subtract it from the value for the question. Under no circumstance should the score for any question be less than zero. Note that while the timed question must have 2 or fewer letters incorrect in order to get the timing bonus, a team solving the timed question after the 10 minutes passed would be accepted as correct with 3 incorrect letters receiving 50 points for the timed question.

6. If they correctly answered the timed question in 10-minutes or less with 2 or fewer letters incorrect, you need to compute the bonus time. Take the value for the minute from this first table below

0:xx	1,620		1:xx	1,440		2:xx	1,260		3:xx	1,080		4:xx	900
5:xx	720		6:xx	540		7:xx	360		8:xx	180		9:xx	0

and then add the seconds value from this table:

X:00	180		X:01	177		X:02	174		X:03	171		X:04	168		X:05	165
X:06	162		X:07	159		X:08	156		X:09	153		X:10	150		X:11	147
X:12	144		X:13	141		X:14	138		X:15	135		X:16	132		X:17	129
X:18	126		X:19	123		X:20	120		X:21	117		X:22	114		X:23	111
X:24	108		X:25	105		X:26	102		X:27	99		X:28	96		X:29	93
X:30	90		X:31	87		X:32	84		X:33	81		X:34	78		X:35	75
X:36	72		X:37	69		X:38	66		X:39	63		X:40	60		X:41	57
X:42	54		X:43	51		X:44	48		X:45	45		X:46	42		X:47	39
X:48	36		X:49	33		X:50	30		X:51	27		X:52	24		X:53	21
X:54	18		X:55	15		X:56	12		X:57	9		X:58	6		X:59	3

For example if they solved the time question at the 6:46 mark, you would add 540 (from the 6:xx entry in the first table) to 42 (from the X:46 entry in the second table) to get a bonus of 582. If they had solved it in exactly 4:00 minutes, you would add 900 and 180 to get a bonus of 1080.

7. Add up all the scores and put the total on the bottom of score sheet.

8. You must break all ties. Indicate the tie breaker by adding .1 to the score of the team ahead. With multiple teams tied, you will add more. I.e. if five teams all scored 200 points, the final scores that you would enter on the score sheet would be 200.4, 200.3, 200.2, 200.1 and 200.

9. To determine how to break the tie, you need to look at the correctly answered questions in the order from the table below. If both teams answered the same (i.e. they answered the question with zero mistakes) then you go on to the next question. If one team had no mistakes and the other team had one mistake, then the team with no mistakes is ahead. For example, if one team answered question #8 (which is the highest value question) and another team didn't, the first team will be ahead.

Tie Breaker Order	Question #
1	8
2	15
3	12
4	18
5	6
6	5
7	1
8	4
9	2
10	3
11	10
12	11
13	14
14	17
15	Timed Question
16	9
17	16
18	7
19	13
20	19

10. If there is still a tie (typically when you have teams which answered either zero, one or two questions) then you will need to look at the tie breaker questions again and count the number of correctly answered letters. The team with the most correctly matched letters is to be ahead.

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

EP GERHCK FAKHK XC IKWHQXQL ZXFAERF FKWGAXQL. XF'C
OF COURSE THERE IS LEARNING WITHOUT TEACHING. IT'S

NRCF GEYYEQIT HKPKHHKJ FE VT WQEFAKH QWYK: CGXKQGK.
JUST COMMONLY REFERRED TO BY ANOTHER NAME: SCIENCE.

	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	4		5		7	8	5	7	2	1	12	2		1		2	7	3		2		1	4	6	3	1
Replacement	H		S		O	T	C	R	L	D	E	G		J		F	N	U		Y		B	A	I	M	W

1) **[125 Points]** Using a key of **SURFBOARD** encode the string **PHILOSOPHICAL** using the Hill Cipher with a 26-character alphabet. e.g.

$$\begin{pmatrix} S & U & R \\ F & B & O \\ A & R & D \end{pmatrix} \equiv \begin{pmatrix} 18 & 20 & 17 \\ 5 & 1 & 14 \\ 0 & 17 & 3 \end{pmatrix}$$

P	H	I	L	O	S	O	P	H	I	C	A	L
A	M	N	E	J	G	V	B	Q	C	Q	I	F	O	G

2) **[120 Points]** The following has been encoded using a running key cipher against a famous document. What does it say?

Y L T Y E R X S G	T W	Z N D L	E	N E M X	E Q V
C H A R A C T E R	I S	L I K E	A	T R E E	A N D

K E I Y L I G W F Q	P Z D S	F	G Y M D A K . K L T
R E P U T A T I O N	L I K E	A	S H A D O W . T H E

W Y F H Q P	C F	E V N X	O X	T I T V C	V O	C L ;
S H A D O W	I S	W H A T	W E	T H I N K	O F	I T ;

M P G	X Z R W	C J	X K S	D I S E	B J B E G .
T H E	T R E E	I S	T H E	R E A L	T H I N G .

3) **[120 Points]** The following headlines appeared in the newspaper but in reality, they are a Baconian encoded message where some letters encode as one character and the others as another in a pattern. You know that the message starts out as **TRAVEL**. What does the message decode to?

```
Large green enemy teach after voice alarm alter daily fight.
BAABA BAAAA AAAAA BAABB AABAA ABABA ABAAA ABBAA BAABA AABBB
  T     R     A     U/V   E     L     I/J   N     T     H
Angry known model trust upper judge after human heart asked drama guide.
AABAA BABBA ABBAB BAABB ABBAA AABBA AABAA BAAAA BAAAB ABBAB BAAAA BAABA
  E     Y     O     U/V   N     G     E     R     S     O     R     T
Movie giant never apply.
ABAAA BAAAB AAAAA ABBBA
 I/J    S     A     P
Brain dream cause added audio began fifth lunch early.
AAAAA BAAAA BAABA ABBAB AABAB AABAA AAABB BAABB AAABA
  A     R     T     O     F     E     D     U/V   C
Inner peace album added extra money issue.
AAAAA BAABA ABAAA ABBAB ABBAA ABAAA ABBAA
  A     T     I/J   O     N     I/J   N
Dandy yacht under entry force.
BAABA AABBB AABAA AABAA ABABA
  T     H     E     E     L
First mixer given every itchy zebra.
AAABB AABAA BAAAA AAAAA ABBBA AAAAA
  D     E     R     A     P     A
Heavy lemon asked about angry legal bloom after heavy robin began extra
BAAAA BAABA ABBAB AABAB AABAA BABAB ABBBA AABAA BAAAA ABAAA AABAA ABBAA
  R     T     O     F     E     X     P     E     R     I/J   E     N
fancy entry.
AAABA AABAA
  C     E
```

4) **[125 Points]** Solve this Aristocrat which is a quote from John Sladek.

VFK WDVDUK, BSSIUZPOL VI GICK GSPKOVPGVG, HPEE XK

KMBSVEN EPQK VFK RBGV, IOEN CIUK KMRKOGPTK.

	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	2	5	2	6	1	5		12	1	2	2	4	6	1	2	4	1	3	8	1	1		1	
Replacement	J	A	M	U	L	H	S	W	O	Z	E	G	X	Y	N	I	K	P	C	V	R	T	F	B	Q	D

5) **[140 Points]** A message encrypted with the Affine Cipher using an alphabet of 26 characters has been intercepted. You have been told that the last two characters of the message are the letters **KE**. With that knowledge, what does this message say?

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

6) **[250 Points]** Solve this Patristocrat which is a quote by Nick Powers and begins with **IT IS**.

BNBWB	XHJWW	BPYRN	JNTIO	WUROM	NDRYI	VWJCO	INSTR
ITISI	MPOSS	IBLET	OTRAN	SCEND	THELA	WSOFN	ATURE

EJSUI	OJOYE	MRNRT	XBORN	DINEJ	STSOM	RTWNI	OMBOK
YOUCA	NONLY	DETER	MINET	HATYO	URUND	ERSTA	NDING

JCOIN	STRDI	WUDIO	KRM
OFNAT	UREHA	SCHAN	GED

	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		6	2	4	3		1	9	7	2		5	10	11	1		10	5	6	3	1	7	2	3		
Replacement	Q	I	F	H	Y	V	K	P	A	O	G	X	D	T	N	B	Z	E	U	R	C	W	S	M	L	J

7) **[60 Points]** You know that a message has been encrypted using the Affine Cipher with an alphabet of 26 characters. You have **discovered** that the message **MBQKVI** decodes to say **PONDER**. What are the values of a and b in the function $ax + b$ that were used to encode the message?

a= **11**   *b=* **3**

8) **[350 Points]** Solve this Patristocrat which is a quote by Frederick Maurice Powicke and is encoded using a K1 key.

```
ZAHQP GMAHX ITTPX QZUWU RWKUA YZQPX QZAOY HKZAV
HISTO RYISF ULLOF THEDE ADWEI GHTOF THING SWHIC

ZZRJU UHVRE UWQZU VPOQG PTPXQ ZUDAO WMUQW GAJUD
HHAVE ESCAP EDTHE CONTR OLOFT HEMIN DYETD RIVEM

ROPOK AQZRS TAOWX PGVU
ANONW ITHAB LINDF ORCE
```

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	9			2	1		4	4	1	2	3		2		6	8	9	5	1	4	11	4	6	5	2	10
Replacement	I	J	K	M	P	Q	R	S	U	V	W	X	Y	Z	N	O	T	A	B	L	E	C	D	F	G	H

9) **[75 Points]** The following symbols encodes a phrase using a Baconian alphabet. What does it say?

```
«>»«««»«>»«>»»«>»»««»«>»»«><»«««»»«««>»«><»»»««««»«>»«««<»»«««<»»»«><»»«
ABAAAABABBABBAAABBABBAABABAAABBAABBBAAAAABAAAABBBABBA
  I/J   M    N    O    T    S   U/V   R    E    H    O
»>»«><»««««>»«>»««»«««<»«««««»«><»««»«<»«««>»»»«>«««<»»««««>»«««<«««««
BBABAAAABBBAABAAAAAAABABABAABAAABBBBABBAAAAABAAAAAAAA
   W    H    E    A    L    T    H    Y    B    A    C
»«««>»«>«»«>»»«««»«««<»«««>»«««<»«><»«««<»»««<»«««>»«««<>»«««<»>«««><»«
BAABBABABBAAABAAABAAABABAAABBAAAABBAAABAAABAAABAAAABAABA
   O    N    I    S   I/J   N    G    E    N    E
«««««««««<»«>»«««<««««»»«<»»«>»«>»«««>»«««<»«««>«>»««<»»«<»»»«>»«<»««<«
AAAAAAAABABAAAABBAABBBAABAABAAAABAABABBAAABBABBABAAA
  R    A    L    B   U/V   T   I/J   K    N    O    W
»>«««<>»««»«>»«>«««<»«>»««««>»«««««>»«><»««««<»«««>»«««<»>»«>»««««««<>»
BAAABAABABAAABABAAAABBAAAAABABAAAAABAAAAABBABAAAAAAAB
 I/J   T    S   I/J   N    C    R    E    D   I/J   B
«>»«>«>»«>«>»»««««»»«««<»««<»«>«««>»«««««<>»««>»«««««»>«>»««»«>»»»«««<»
ABABABABBAAAABBAABAAAABABAABAAAAAABAABAAAABBABBAABBBAAAB
  L    Y    D    E    L   I/J   C   I/J   O   U/V   S
```

10) **[120 Points]** Solve this Aristocrat which is a quote from Roy T. Bennett and starts with `DON'T`.

```
WFI'O XNBOZ SFMQ OEHZ EI NIKZQ, QZKQZOB, XFQQEZB,
```

```
NIW KQMWKZB. VEUZ EB OFF BTFQO OF DZ MITNYYS.
```

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

11) **[120 Points]** Solve this Aristocrat which is a quote from Albert Einstein which has the word **ASSURE** in it.

SZ IZR XZKKN MPZWR NZWK SJHHJGWQRJDC JI BMRVDBMRJGC.
DO NOT WORRY ABOUT YOUR DIFFICULTIES IN MATHEMATICS.

J GMI MCCWKD NZW BJID MKD CRJQQ TKDMRDK.
I CAN ASSURE YOU MINE ARE STILL GREATER

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

12) **[300 Points]** Isaac Asimov would be greatly amused by how badly a computer mangled one of his famous sayings before encrypting it. What does it say?

Z AFVFW LJYYGP FVGC FAPGAY MDEGS WHF DW VJC Z IJLZS
A ROBOT MUSSED OBEY ORDERS GIVEN TWO IT BUY A HUMAN

VGDSM ZKKGOW HGZA YJKI FAPGAY HFFP KFSBXDKW HDWI WIG
BEING ACCEPT WEAR SUCH ORDERS WOOD CONFLICT WITH THE

BDAYW XZH.
FIRST LAW.

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

13) **[50 Points]** G. Byrne's observation has been encoded using a Caesar Cipher. What does it say?

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

V J G	P G Y	R T G H K Z	' I W C E C '	K U	F G H K P G F
T H E	N E W	P R E F I X	G U A C A	I S	D E F I N E D

U W E J	V J C V	Q P G	I W C E C O Q N G	G S W C N U
S U C H	T H A T	O N E	G U A C A M O L E	E Q U A L S

C X Q E C F Q ' U	P W O D G T .
A V O C A D O ' S	N U M B E R .

14) **[100 Points]** Hermann Hesse once said this about things to be found. It has been encoded using the Vigenère cipher using a very common five letter word. You have been told that the 25th through the 30th letters in the code (**KERUPQ**) actually is the word **HIDDEN**. What does the message decode to?

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

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

W O R L D	W O R L D	W O R L D	W O R L D	W O R L D	W
O H Y P B	S S I P L	J H Y P P	E B R W O	K T K S H	I
S T H E Y	W E R E I	N T H E M	I N A L L	O F T H E	M

Meaning and reality were not hidden somewhere behind things, they were in them, in all of them

15) **[350 Points]** Solve this K1 Key encoded Patristocrat which is a quote by Brian Herbert and ends with the letters **LITY**.

```
SJRCO IPJYY MCLUY TELPY CLPGJ BPZBP PIZCP KQGJZ
FACTS MEANN OTHIN GWHEN THEYA REPRE EMPTE DBYAP

ZPJBJ YRPKM YMCNY KPBPO CUIJC PCLPZ MEPBM SUIZB
PEARA NCEDO NOTUN DERES TIMAT ETHEP OWERO FIMPR

POOUM YMDPB BPJXU CG
ESSIO NOVER REALI TY
```

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	8	9	1	2		3		4	8	3	4	7	1	4	17	1	2	2	1	5			1		8	6
Replacement	Q	R	T	V	W	X	Y	Z	M	A	D	H	O	U	S	E	B	C	F	G	I	J	K	L	N	P

16) **[75 Points]** Using a key of **XFUN** encode the string **CELEBRATION** using the Hill Cipher with a 26 character alphabet. e.g.

$$\begin{pmatrix} X & F \\ U & N \end{pmatrix} \equiv \begin{pmatrix} 23 & 5 \\ 20 & 13 \end{pmatrix}$$

C	E	L	E	B	R	A	T	I	O	N
O	O	N	M	E	H	R	N	U	E	I	N

17) **[100 Points]** Encode the string **CAN'T JUDGE A BOOK BY ITS COVER** using the Affine Cipher with *a=7* and *b=13*.

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

18) **[300 Points]** Solve this Xenocrypt which is a quote in Spanish by Miguel de Unamuno.

CE FTABFTE AY QB FALABRAUTZ GA TGAEY LQAUREY,
LA CIENCIA ES UN CEMENTERIO DE IDEAS MUERTAS,

EQBMQA GA ACCEY VQAGA YECTU CE OTGE
AUNQUE DE ELLAS PUEDE SALIR LA VIDA

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

19) **[50 Points]** Using a code word of **STAIR**, encode the following quote from Zig Ziglar using the Vigenère cipher.

S	T	A	I	R		S	T		A	I		R	S	T	A	I	R	S	T		A	I		R	S	T	A	I	R	S	
T	H	E	R	E		I	S		N	O		E	L	E	V	A	T	O	R		T	O		S	U	C	C	E	S	S	.
L	A	E	Z	V		A	L		N	W		V	D	X	V	I	K	G	K		T	W		J	M	V	C	M	J	K	.

T	A	I		R	S	T	A		I	R		S	T	A	I		R	S	T		A	I	R	S	T	A	
Y	O	U		H	A	V	E		T	O		T	A	K	E		T	H	E		S	T	A	I	R	S	.
R	O	C		Y	S	O	E		B	F		L	T	K	M		K	Z	X		S	B	R	A	K	S	.