

# Science Olympiad — SSSS

## someone1580's 2019 Codebusters Test

### 2019

## Exam Preparation

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.

- 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 .999999999
- 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.
- 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.
- 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

- 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 KFXMFXYP**  
**SAMPLE SENTENCE**

and the students answered (underlined letters indicate mistakes)

**SAMPLE SENTENCE**

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

**SAMPLE SENTENCE**

It is considered correct with two letter mistakes.

- For questions which have a numeric answer (such as determining the a= and b= values), no mistakes are allowed.
- 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.
- When scoring the Baconian ciphers (with strange text or symbols), they can write the answer under the Baconian 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.
- 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 100 points from the score until it would be zero. If a question is worth 240 points and they get 4 letters wrong, you would start with 240 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 40 points for that question. If they had gotten 5 or more letters wrong on a 240 point question, they would receive 0 points for that question. With a 650 point question, they could get 8 letters wrong and receive 50 points (2 free letters then  $6 \times 100 = 600$  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 100 points for the timed question.
- 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	2,160	1:xx	1,920	2:xx	1,680	3:xx	1,440	4:xx	1,200
5:xx	960	6:xx	720	7:xx	480	8:xx	240	9:xx	0

and then add the seconds value from this table:

X:00	240	X:01	236	X:02	232	X:03	228	X:04	224	X:05	220
------	-----	------	-----	------	-----	------	-----	------	-----	------	-----

X:06	216
X:12	192
X:18	168
X:24	144
X:30	120
X:36	96
X:42	72
X:48	48
X:54	24

X:07	212
X:13	188
X:19	164
X:25	140
X:31	116
X:37	92
X:43	68
X:49	44
X:55	20

X:08	208
X:14	184
X:20	160
X:26	136
X:32	112
X:38	88
X:44	64
X:50	40
X:56	16

X:09	204
X:15	180
X:21	156
X:27	132
X:33	108
X:39	84
X:45	60
X:51	36
X:57	12

X:10	200
X:16	176
X:22	152
X:28	128
X:34	104
X:40	80
X:46	56
X:52	32
X:58	8

X:11	196
X:17	172
X:23	148
X:29	124
X:35	100
X:41	76
X:47	52
X:53	28
X:59	4

For example if they solved the time question at the 6:46 mark, you would add 720 (from the 6:xx entry in the first table) to 56 (from the X:46 entry in the second table) to get a bonus of 776. If they had solved it in exactly 4:00 minutes, you would add 1200 and 240 to get a bonus of 1440.

- Add up all the scores and put the total on the bottom of score sheet.
- 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.
- 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	19
2	18
3	14
4	9
5	13
6	11
7	10
8	3
9	17
10	16
11	12
12	7
13	6
14	5
15	15
16	8
17	1
18	Timed
19	4
20	2

- 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 [150 points] Decrypt this quote from Arnold Shwarzenegger. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

**XGU OQHIX XGSWB S LNW MU SI XGU INTU NI UKUHAMQFA  
THE WORST THING I CAN BE IS THE SAME AS EVERYBODY**

**UCIU. S GNXU XGNX.  
ELSE. I HATE THAT.**

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

1) **[150 points]** Decode this phrase which is encoded with the Caesar Cipher.

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

  

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

  

T	K	K	J	S	X	J
O	F	F	E	N	S	E

2) **[100 points]** Encode this quote by Albert Einstein with the Atbash Cipher.

I	N	T	H	E	M	I	D	D	L	E	O	F	D	I	F	F	I	C	U	L	T	Y	L	I	E	S
R	M	G	S	V	N	R	W	W	O	V	L	U	W	R	U	U	R	X	F	O	G	B	O	R	V	H

  

O	P	P	O	R	T	U	N	I	T	Y
L	K	K	L	I	G	F	M	R	G	B

3) [250 points] Decrypt this nonsense using the Baconian Cipher.

A TIME APART COMES AS THE CHAOS OF HIS GAMES FEELS  
 ABAAA ABABB AAAAA AABBA ABAAA ABBA AAAAA BAABA  
 I/J M A G I/J N A T

SHAME UNTIL ANNOY  
 ABAAA ABBAB ABBA  
 I/J O N

**imagination**

4) [100 points] Encode this quote from Avengers Endgame with a Caesar shift of 7.

Y	O	U	'	R	E	R	E	P	E	A	T	I	N	G	Y	O	U	R	S	E	L	F	!
F	V	B	'	Y	L	Y	L	W	L	H	A	P	U	N	F	V	B	Y	Z	L	S	M	!

5) [200 points] Decrypt this K2 Aristocrat that includes the word "door" twice.

**"LWTC DCT SDDG DU WPEEXCTHH RADHTH, PCDIWTG DETCH;  
"WHEN ONE DOOR OF HAPPINESS CLOSES, ANOTHER OPENS;**

**QJI DUITC LT ADDZ HD ADCV PI IWT RADHTS SDDG IWPI LT  
BUT OFTEN WE LOOK SO LONG AT THE CLOSED DOOR THAT WE**

**SD CDI HTT IWT DCT LWXRW WPH QTTC DETCTS UDG JH."  
DO NOT SEE THE ONE WHICH HAS BEEN OPENED FOR US."**

Replacement	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
<b>K2</b>	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
<b>Frequency</b>	4		11	20	4		4	10	9	2		4				5	2	3	5	19	3	1	9	2		1

6) [200 points] Decrypt this Aristocrat, which is a quote from Joshua J. Marine.

**IAZCCUSMUY ZPU VAZB HZFU CDRU DSBUPUYBDSM ZSX  
CHALLENGES ARE WHAT MAKE LIFE INTERESTING AND**

**LWUPIHDSM BAUH DY VAZB HZFU CDRU HUZSDSMRKC.  
OVERCOMING THEM IS WHAT MAKES LIFE MEANINGFUL.**

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

7) [200 points] Decode this Vigenère cipher with the key "GREEN".

G R E E N G R E E N G R E E N G R E E N G ? R E ? E N G R E E

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

N G R E E N G R E E N G R E ' E N G R E E .

N	R	D	S	W	G	Z	Y	I	V	R	J	F	R	'	X	J	U	I	V	C	.
A	L	M	O	S	T	T	H	E	R	E	D	O	N	'	T	W	O	R	R	Y	.

8) [150 points] Encode this incredibly funny quote with the key "SHAKE".

S H A K E S H A K E S H A K E S H A K E S H A K E S . H ' A

I	U	S	E	D	T	O	T	H	I	N	K	I	W	A	S	I	N	D	E	C	I	S	I	V	E	.	I	'	M
A	B	S	O	H	L	V	T	R	M	F	R	I	G	E	K	P	N	N	I	U	P	S	S	Z	W	.	P	'	M

K E S H A K E S H A K E S .

N	O	T	T	O	S	U	R	E	N	O	W	.	
X	S	L	A	O	Y	W	M	Y	E	X	S	O	.



9) [500 points] Decode this Patristocrat that is about basketball and is by Phil Jackson.

**QEKVQ MKJPO EZWQE KQKLG YVKLF EYJXY SYXOL HGKGT  
THEST RENG T HOFTH ETEAM ISEAC HINDI VIDUA LMEMB**

**KMQEK VQMKJ PQEZW KLFEG KGTKM YVQEK QKLG  
ERTHE STREN GTHOF EACHM EMBER ISTHE TEAM**

*The strength of the team is each individual member. The strength of each member is the team.*

	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	2	6	1		3	14	5	4		1	2	10		1	2		4	2	2	5	2
Replacement	J	Q	P	W	H	C	M	L	X	N	E	A	R	Y	U	G	T	Z	V	B	K	S	F	D	I	O

10) [250 points] Decrypt this Aristocrat that is a quote from E.B. White.

**ROIMKEWZI WP U DOIUH HWTI PUFIO. ALK ZUB YLOT  
PREJUDICE IS A GREAT TIME SAVER. YOU CAN FORM**

**LRWBWLBP SWHCLKH CUFWBD HL DIH HCI YUZHP.  
OPINIONS WITHOUT HAVING TO GET THE FACTS.**

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

11) [300 points] Decrypt this Affine Cipher that is a quote by Abraham Lincoln. The first two letters are "NE"

U	T	H	G	O	B	H	O	O	R	T	U	N	H	U	J	M	H	U	Q	H	Q	S	T	G	J	F	M	B	,	K	P	M
N	E	A	R	L	Y	A	L	L	M	E	N	C	A	N	S	T	A	N	D	A	D	V	E	R	S	I	T	Y	,	B	U	T
F	W	B	X	P	V	H	U	M	M	X	M	T	J	M	H	R	H	U	'	J	N	C	H	G	H	N	M	T	G	,		
I	F	Y	O	U	W	A	N	T	T	O	T	E	S	T	A	M	A	N	'	S	C	H	A	R	A	C	T	E	R	,		
Z	F	S	T	C	F	R	A	X	V	T	G	.																				
G	I	V	E	H	I	M	P	O	W	E	R	.																				

12) [200 points] Encode this phrase with the 2x2 Hill Cipher using the key "HILL".

$$\begin{pmatrix} H & I \\ L & L \end{pmatrix} \equiv \begin{pmatrix} 7 & 8 \\ 11 & 11 \end{pmatrix}$$

T	I	M	E	I	S	V	A	L	U	A	B	L	E
P	L	M	U	S	A	R	X	D	D	I	L	F	J

13) [400 points] Decode this Xenocrypt.

QS FIMXNVB WV FI QAG CAFWV, ZAJF PAF AIXH FB  
MI ESPAÑOL NO ES MUY BUENO, TUVE QUE USAR EL

ZHXEAÑZVH EF KVKBF MXHX FIZV.  
TRADUCTOR DE GOOGLE PARA ESTO.

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

14) [500 points] Decode this Patristocrat that is a quote by Mark Twain. The last word is "do".

FMLVF WWLNE HDESJ VSMWS AMGY Y ZLJSE LIGN RRSV  
TWENT YYEAR SFROM NOWYO UWILL BEMOR EDISA PPOIN

FLIZW FXLFX GVQHF XNFW S AIGIV FISFX NVZWF XLSVL  
TEDBY THETH INGST HATYO UDIDN TDO TH ANBYT HEONE

HWSAI GIIS  
SYOUD IDDO

*Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do*

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

15) [150 points] Encrypt this statement using the Affine Cipher with a key of (5, 11).

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

16) [200 points] Decode this message that is encoded with the Running Key cipher using the Gettysburg Address.

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

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17) **[200 points]** Find the Decryption Matrix from this Encryption Matrix.

$$\begin{pmatrix} C & Z \\ B & X \end{pmatrix} \equiv \begin{pmatrix} 2 & 25 \\ 1 & 23 \end{pmatrix}$$

$$\begin{pmatrix} 11 & 5 \\ 21 & 10 \end{pmatrix}$$

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18) **[600 points]** Mykayla has faithfully followed the steps of the RSA key-generation algorithm. Here are the results:

$$p = 47$$

$$q = 43$$

$$n = 2021$$

$$\phi = 1932$$

$$e = 421$$

Unfortunately, Mykayla doesn't know how to compute the value of  $d$  and needs you to do that final step for her.

Enter the computed value of  $d$ , NOT the formula.

**1597**

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19) **[600 points]** Victoria and Hayley are accountants for a very large bank, and have started a friendship. They communicate via email, because they live thousands of miles apart. Hayley gets curious and asks Victoria the year that they were born. Victoria doesn't mind telling Hayley, but they know that the bank monitors all employee emails, and is afraid of being the victim of age discrimination. Therefore, Hayley suggests that they use RSA, and they provides their public key: (45792281, 6711197). Victoria replies with the ciphertext 9125223. Hayley's private key is 27885749. In what year was Victoria born?

Enter the answer:

**1998**