

Science Olympiad — Submission Test for SSSS 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.
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 SENTFNCF

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

SAMPL 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 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.
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 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.
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	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:07	212	X:08	208	X:09	204	X:10	200	X:11	196
X:12	192	X:13	188	X:14	184	X:15	180	X:16	176	X:17	172
X:18	168	X:19	164	X:20	160	X:21	156	X:22	152	X:23	148
X:24	144	X:25	140	X:26	136	X:27	132	X:28	128	X:29	124
X:30	120	X:31	116	X:32	112	X:33	108	X:34	104	X:35	100
X:36	96	X:37	92	X:38	88	X:39	84	X:40	80	X:41	76
X:42	72	X:43	68	X:44	64	X:45	60	X:46	56	X:47	52
X:48	48	X:49	44	X:50	40	X:51	36	X:52	32	X:53	28
X:54	24	X:55	20	X:56	16	X:57	12	X:58	8	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.

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	13
2	12
3	15
4	14
5	11
6	24
7	9
8	22
9	10
10	8
11	7
12	17
13	6
14	20
15	5
16	21
17	4
18	19
19	Timed
20	23
21	18
22	3
23	16
24	2
25	1

0. 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] Decode this timed Aristocrat by Maya Angelou. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

S'TD ODZVUDM YIZY EDKEOD BSOO WKVCDY BIZY GKQ AZSM,
 I'VE LEARNED THAT PEOPLE WILL FORGET WHAT YOU SAID,

EDKEOD BSOO WKVCDY BIZY GKQ MSM, RQY EDKEOD BSOO
 PEOPLE WILL FORGET WHAT YOU DID, BUT PEOPLE WILL

UDDV WKVCDY IKB GKQ PZMD YIDP WDDO.
 NEVER FORGET HOW YOU MADE THEM FEEL.

	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	6	3	18	6		3		5		10		5		11	2	4	1	6	2	2	5	4		9	6
Replacement	S	W	G	E	P	J	Y	C	H	X	O	Q	D	Z	L	M	U	B	I	V	N	R	F	K	T	A

1) [80 points] Encode this quote by Plato using the Atbash Cipher.

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

V	E	R	O
E	V	I	L

2) [100 points] Solve this quote from Oscar Wilde which has been encoded with the Caesar Cipher.

A	V	S	P	C	L	P	Z	A	O	L	Y	H	Y	L	Z	A	A	O	P	U	N	P	U	A	O	L
T	O	L	I	V	E	I	S	T	H	E	R	A	R	E	S	T	T	H	I	N	G	I	N	T	H	E

D	V	Y	S	K	.	T	V	Z	A	W	L	V	W	S	L	L	E	P	Z	A	,	A	O	H	A	P	Z	H	S	S	.
W	O	R	L	D	.	M	O	S	T	P	E	O	P	L	E	E	X	I	S	T	,	T	H	A	T	I	S	A	L	L	.

3) [120 points] Encode this quote from Mahatma Gandhi using a Caesar Cipher with a shift of 12.

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

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

4) [200 points] Solve this aristocrat. It has the word "over" in it twice.

PXLUXPEZ PL ODPXR ETH LUCH ETPXR, DAHV UXO DAHV
 INSANITY IS DOING THE SAME THING, OVER AND OVER

URUPX, SQE HYJHKEPXR OPIIHVHXE VHLQFEL.
 AGAIN, BUT EXPECTING DIFFERENT RESULTS.

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

5) [250 points] Solve this aristocrat. It comes from the song "Imagine" by John Lennon and includes the word "dreamer".

TPG WNT XNT D'W N LSZNWZS, RGK D'W OPK KAZ POJT POZ.
YOU MAY SAY I'M A DREAMER, BUT I'M NOT THE ONLY ONE.

D APYZ XPWZLNNT TPG'JJ QPDO GX.
I HOPE SOMEDAY YOU'LL JOIN US.

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

6) [300 points] Solve this K1 aristocrat.

YH'U RD IUT SDYRS VQOA HD MTUHTGWQM, VTOQIUT Y KQU Q
IT'S NO USE GOING BACK TO YESTERDAY, BECAUSE I WAS A

WYXXTGTRH ETGUDR HPTR.
DIFFERENT PERSON THEN.

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

7) [350 points] Solve this K2 aristocrat.

JE NX UXRK ED, UERKJ RGRTDJK KAX VLIIXDK, UEIDX URVB
 SO WE BEAT ON, BOATS AGAINST THE CURRENT, BORNE BACK

VXRJXYXJJYP TDKE KAX FRJK.
 CEASELESSLY INTO THE PAST.

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

8) [400 points] Solve this aristocrat without a hint.

VB ZBN OLJV, JQ RIUWVOLZ VB, NB JGMQL ABMOQLWE, BO
 DO NOT READ, AS CHILDREN DO, TO AMUSE YOURSELF, OR

WUTL NIL JGFUNUBMQ, EBO NIL CMOCBQL BE UZQNMNRNUBZ.
 LIKE THE AMBITIOUS, FOR THE PURPOSE OF INSTRUCTION.

ZB, OLJV UZ BOVLO NB WUKL.
 NO, READ IN ORDER TO LIVE.

	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	14	2		3	1	2		3	5	1	11	5	8	10		6	2		1	8	6	4			6
Replacement	Y	O	P	J	F	B	M	Q	H	A	V	E	U	T	R	Z	S	C	G	K	I	D	L	W	X	N

9) [450 points] Alexa severely misheard a phrase from Ralph Waldo Emerson which has the word "path" twice and then encoded it as an Aristocrat. What did it come out as?

QM PVMH AM LEIT HKT NEHK YEX STEQ, AM OVJHTEQ LEIT
DO KNOT GO WARE THE PATH MAY LEAD, GO INSTEAD WARE

QEIT OJ PVML NEHK EVQ STEUT E HIEOS.
DARE IS KNOW PATH AND LEAVE A TRAIL.

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

10) [400 points] Solve this patristocrat that includes the phrase "what lies" three times.

ZDMKE YSPOS DYQHL PMQHZ DMKEY SPOSJ WISLP MISKY
WHATL IESBE HINDU SANDW HATLI ESBEF OREUS ARETI

QUBMK KSIPA WBVMI SHKWZ DMKEY SPZYK DYQLP
NYMAT TERSC OMPAR EDTOW HATLI ESWIT HINUS

What lies behind us and what lies before us are tiny matters compared to what lies within us.

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

11) [500 points] Solve this K1 patristocrat. The keyword is "science".

COWMN CTLCJ OCOBS MCNYY NMMWJ MKONT LCSMN LDJTL
TALEN THIS ATARG ETNOO NEELS ECANH ITGEN IUSHI

CJOCO BSMCN YNMM WJMKO NJMM
TSATA RGETN OONEE LSECA NSEE

Talent hits a target no one else can hit. Genius hits a target no one else can see.

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		2	9	1						6	2	4	12	8	7				3	3			3		4	
Replacement	Q	R	T	U	V	W	X	Y	Z	S	C	I	E	N	A	B	D	F	G	H	J	K	L	M	O	P

12) [650 points] Solve this K1 patristocrat. The keyword is a type of facial expression.

GLKAL ZESZR LHOVE LKPZN LXPZH IWHPL VSAES ASZLJ
FANTA SYISH ARDLY ANESC APEFR OMREA LITYI TISAW

LEIGB KOPHZ ALKOS KQSA
AYOFU NDEFS TANDI NGIT

Fantasy is hardly an escape from reality. It is a way of understanding it.

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

13) [700 points] Solve this patristocrat without a hint. It is a quote from Sir Arthur Conan Doyle, the author of Sherlock Holmes.

TIVWR HSI FP VVQBN BWF AV JFQQT IBOIB GBNMH GGBKQ
 WHENY OUHAV EELIM INATE DALLW HICHI SIMPO SSIBL

VAIVW TIFAV PVZZV NFBWG IHTVP VZBNM ZHKFK QVNSG
 ETHEN WHATE VERRE MAINS HOWEV ERIMP ROBAB LEMUS

AKVAI VAZSA I
 TBETH ETRUT H

When you have eliminated all which is impossible, then whatever remains, however improbable, must be the truth.

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

14) [500 points] Solve this xenocrypt. It may include the Spanish word for "life".

NDJVB JW XZ I FI FDATAI ABV LJÑJZKXVIAXBV INZIMIZ FI
 BUENO ES IR A LA LUCHA CON DETERMINACION ABRAZAR LA

CXLI U CXCXZ ABV SIWXBV. SJZLJZ ABV AFIWJ U CJVAJZ
 VIDA Y VIVIR CON PASION. PERDER CON CLASE Y VENCER

ABV BWILXI.
 CON OSADIA.

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

15) [600 points] Solve this xenocrypt without a hint.

ZC UCL MWEWFON. FCYWOC WEECEWU OCRC WQ OXWYMC, MWEC
NO SOY PERFECTA. COMETO ERRORES TODO EL TIEMPO, PERO

YNZOWZBC WUCU WEECEWU MNEN YX YXUYN.
MANTENGO ESOS ERRORES PARA MI MISMA.

	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	12		9	2	1					1	4	5		5		1	1			6		12	3	6	3
Replacement	U	G	O	K	R	C	F	Q	B	V	J	Y	P	A		T	H	L	D	W	X	S	Z	E	I	M	N

16) [100 points] Using a key of HALF compute the decryption matrix for a 2x2 Hill with a 26 character alphabet.

$$\begin{pmatrix} H & A \\ L & F \end{pmatrix} \equiv \begin{pmatrix} 7 & 0 \\ 11 & 5 \end{pmatrix}$$

$$\begin{pmatrix} 15 & 0 \\ 19 & 21 \end{pmatrix}$$

17) [300 points] Using a key of "beginning" encode the string "To be or not to be, that is the question" using the Hill Cipher with a 26-character alphabet.

$$\begin{pmatrix} B & E & G \\ I & N & N \\ I & N & G \end{pmatrix} \equiv \begin{pmatrix} 1 & 4 & 6 \\ 8 & 13 & 13 \\ 8 & 13 & 6 \end{pmatrix}$$

T	O	B	E	O	R	N	O	T	T	O	B	E	T	H	A	T	I	S	T	H	E	Q	U	E	S	T	I	O	N
D	J	C	G	T	E	B	N	K	D	J	C	S	G	J	U	N	J	G	O	R	G	G	W	I	T	Q	M	Z	M

18) [120 points] A phrase by Eleanor Roosevelt has been encoded using the Vigenère cipher with a code word of "present". What does it say?

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

23) [120 points] Ella and Haileigh want to communicate with each other using RSA for encryption. Ella generates RSA keys obtaining the following values:

$$\begin{aligned}n &= 60931427 & e &= 29105887 \\ \phi &= 60915816 & d &= 44105407 \\ q &= 7853 & p &= 7759\end{aligned}$$

Likewise, Haileigh also generates RSA keys resulting in the values

$$\begin{aligned}p &= 2927 & d &= 24034181 \\ n &= 25292207 & \phi &= 25280640 \\ e &= 23391821 & q &= 8641\end{aligned}$$

They ask each other for the public keys in order to communicate. What information do they each need to transmit in response?

You must also determine what formula Ella needs to calculate in order to decrypt the value 73983 from Haileigh

Enter the minimum values that Ella needs to transmit to Haileigh:

60931427	29105887	
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These two numbers can be in either order.

Enter the minimum values that Haileigh needs to transmit to Ella:

25292207	23391821	
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These two numbers can be in either order.

Write the formula Ella needs to calculate in order to decrypt the value 73983 from Haileigh

$73983 \wedge 44105407 \bmod 60931427$
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24) [450 points] Special Agent, Haylee, has the following RSA public key:

$$n = 2065919 \quad e = 193877$$

Unfortunately for them, A quantum computer has successfully factored their n

$$2065919 = 1873 * 1103$$

Compute the value of their private key:

Enter the computed private key:

1544093
