

Science Olympiad — Submission Test for SSSS 2019

Names of participants: (Please print neatly)

School Name: _____

V JV1 JV2 JV3

Warning: Do not open this packet until given permission to do so.

Note: There are useful notes after this page.

Scoring:

Time to solve first problem: _____ (use to calculate Bonus below)

Question	Value	Incorrect letters	Deduction	Score
Timed	150			
1	80			
2	100			
3	120			
4	200			
5	250			
6	300			
7	350			
8	400			
9	450			
10	400			
11	500			
12	650			
13	700			
14	500			
15	600			
16	100			
17	300			
18	120			
19	160			
20	250			
21	200			
22	400			
23	120			
24	450			
Bonus				
Final Score				

The following tables might be useful during the event.

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

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
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

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

1	3	5	7	9	11	15	17	19	21	23	25
1	9	21	15	3	19	7	23	11	5	17	25

AAAAA	A	AABBA	G	ABBAA	N	BAABA	T
AAAAB	B	AABBB	H	ABBAB	O	BAABB	U/V
AAABA	C	ABAAA	I/J	ABBBA	P	BABAA	W
AAABB	D	ABAAB	K	ABBBB	Q	BABAB	X
AABAA	E	ABABA	L	BAAAA	R	BABBA	Y
AABAB	F	ABABB	M	BAAAB	S	BABBB	Z

Frequency Table of English letters:

E - 12.51%	S - 6.54%	C - 3.06%	G - 1.96%	K - 0.67%
T - 9.25%	R - 6.12%	U - 2.71%	W - 1.92%	X - 0.19%
A - 8.04%	H - 5.49%	M - 2.53%	Y - 1.73%	J - 0.16%
O - 7.60%	L - 4.14%	F - 2.30%	B - 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%
A - 12.16%	L - 5.24%	P - 2.89%	V - 1.05%	Ñ - 0.17%
O - 9.20%	D - 4.67%	B - 1.49%	G - 1.00%	X - 0.14%
S - 7.20%	T - 4.60%	H - 1.18%	F - 0.69%	K - 0.11%
N - 6.83%	U - 4.69%	Q - 1.11%	J - 0.52%	W - 0.04%
R - 6.41%	C - 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,
VICOMITIBUS, PREPOSITIS, MINISTRIS ET OMNIBUS BALLIVIS ET FIDELIBUS SUIS SALUTEM.

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,

EDKEOD BSOO WKVCDY BIZY GKQ MSM, RQY EDKEOD BSOO

UDDV WKVCDY IKB GKQ PZMD YIDP WDDO.

	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																											

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

V	E	R	O

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

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

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	.
																												.

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	.
																													.

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

PXLUXPEZ PL ODPXR ETH LUCH ETPXR, DAHV UXO DAHV

URUPX, SQE HYJHKEPXR OPIIHVHXE VHLQFEL.

	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																											

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 LSNWZS, RGK D'W OPK KAZ POJT POZ.

D APYZ XPWZLNT TPG'JJ QPDO GX.

	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																										

6) [300 points] Solve this K1 aristocrat.

YH'U RD IUT SDYRS VQOA HD MTUHTGWQM, VTOQIUT Y KQU Q

WYXXTGTRH ETGUDR HPTR.

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																										

7) [350 points] Solve this K2 aristocrat.

JE NX UXRK ED, UERKJ RGRDJK KAX VLIIXDK, UEIDX URVB

VXRJYXJJYP TDKE KAX FRJK.

Replacement																																					
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 RIUVOLZ VB, NB JGMQL ABMOQLWE, BO

WUTL NIL JGFUNUBMQ, EBO NIL CMOCBQL BE UZQNOMRNUBZ.

ZB, OLJV UZ BOVLO NB WUKL.

	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																																						

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

QEIT OJ PVML NEHK EVQ STEUT E HIEOS.

	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																										

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

ZDMKE YSPOS DYQHL PMQHZ DMKEY SPOSJ WISLP MISKY

QUBMK KSIPA WBVMI SHKWZ DMKEY SPZYK DYQLP

	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																										

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

COWMN CTLCJ OCOBS MCNYY NMMWJ MKONT LCSMN LDJTL

CJOCO BSMCN YNMM WJMKO NJMM

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																										

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

GLKAL ZESZR LHOVE LKPZN LXPQH IWHPL VSAES ASZLJ

LEIGB KOPHZ ALKOS KQSA

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																										

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

TIVWR HSIFF VVQBN BWFAV JFQQT IBOIB GBNMH GGBKQ

VAIVW TIFAV PVZZV NFBWG IHTVP VZBNM ZHKFK QVNSG

AKVAI VAZSA I

	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																										

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

NDJVB JW XZ I FI FDATAI ABV LJÑJZKXVIAXBV INZIMIZ FI

CXLI U CXCXZ ABV SIWXBV. SJZLJZ ABV AFIWJ U CJVAJZ

ABV BWILXI.

	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																											

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

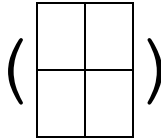
ZC UCL MWEGWFON. FCYWOC WEECEWU OCRC WQ OXWYMC, MWEC

YNZOWZBC WUCU WEECEWU MNEN YX YXUYN.

	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																											

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

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



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

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?

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

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

19) [160 points] Using a keyword of "Winnie", encode this famous quote by A.A. Milne using the Vigenère cipher.

P	E	O	P	L	E	S	A	Y	N	O	T	H	I	N	G	I	S	I	M	P	O	S	S	I	B	L	E	B	U	T	I

D	O	N	O	T	H	I	N	G	E	V	E	R	Y	D	A	Y

20) [250 points] The following quote from Santosh Kalwar has been encoded using a running key cipher against a famous document. What does it say?

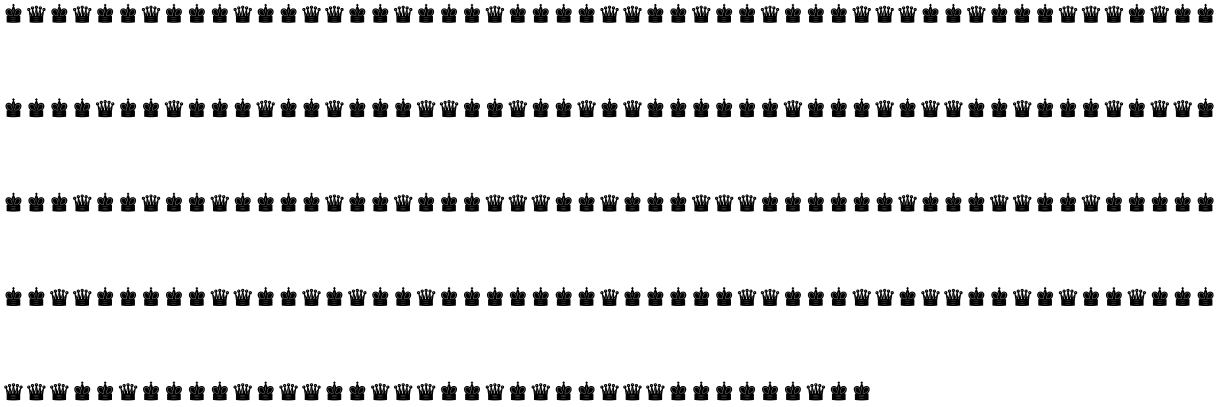
E	D	E	F	A	Z	B	S	M	P	U	S	V	K	X	S	W	K	U	K	I	N	Q	N	Q	V	E	A	V	Z	U	S

F	O	K	E	F	Q	M	Y	M	D	D	S	D	G	Q	S	K	C	Z	S	G	V	C	L	D	M	F	D	O	G	T	W

Q	L	P	W	X	S	M	U	S	T	A	M	W	Q	S	S	P	R	G	W	G	Y	Y	G	H	V	Y	A	I	C	V	V

V	A	K

21) [200 points] The following encodes a phrase by Christopher Paolini using a Baconian alphabet. You have been told that it starts out with "live" What does it say?



22) [400 points] The following symbols encodes a phrase by St. Francis Of Assisi using a Baconian alphabet. What does it say?



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:

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

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

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: