

Science Olympiad — Ward Melville Captains' Tryouts 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	250			
2	300			
3	150			
4	200			
5	550			
6	300			
7	350			
8	300			
9	250			
10	400			
11	200			
12	200			
13	150			
14	150			
15	500			
16	100			
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.”

Morse Code:

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

0 -----	2 ••---	4 ••••-	6 -••••	8 ----••
1 •-----	3 •••--	5 •••••	7 --•••	9 -----•

• E	- T	-• N	-- M	-•• D	-•- K	-•- G	--- O
•• I	•- A	•-• R	•-- W	•--• P	•--- J		
••• S	••- U	••-• F	•-•• L	--•• Z	--•- Q		
•••• H	•••- V	-•-• C	-•-- Y	••••- 4			
-••• B	-••- X	••--- 2	•••-- 3	-----• 9			
----- 0	•---- 1	--••• 7	---•• 8				
••••• 5	-•••• 6						

2) **[300 points]** Solve this quote from Marie Curie which has been encoded using the Morbit Cipher. You are told that 1=●●, 7=●-, 9=●x, 2=-●, and 6=-.

2 5 6 5 8 1 9 1 5 9 6 9 8 9 2 3 7 1 8 9 1 2 8 3 1 8 1 3 4 6 4

5 1 9 9 8 7 9 9 7 8 2 8 5 1 3 1 5 3 1 8 1 3 6 4 2 8 2 9 2 6

3 4 6 4 5 1 9 9 8 7 5 9 2 9 9 7 9 1 9 4 6 4 6 4 2 9 5 9 6 4

7 4 8 9 1 9 5 8 1 9 9 5 8 9 6 8 3 4 6 4 8 7 5 9 2 9 9 7 9 1 9

4 7 5 9 2 9 5 4 6 4 7 9 9 8 1 5 6 3 4 1 1 8 4 4 8 6 8 3 6 8 4

2 6 3 1 2 8 8 4 7 9 8 2 9 9 1 9 1 9

3) [150 points] Encode this quote by Aristotle using the keyword of his name.

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

L	F	A	N	D	G	R	O	W	A	N	D	D	E	C	A	Y

4) [200 points] Decode this quote by Johnny Weir encoded using the Caesar cipher.

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

7) [350 points] Solve this aristocrat with errors by Richard P. Feynman where the English trigraph ING is replaced by IN'.

J URZBXS NRBO RBUO SRK GJM~~R~~BRXAR YRSFRXR PXTFJX' SRK

XZLR TM ITLSKJX' ZXG XTFJX' ITLSKJX'

	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	2		2	6	4	3	2	1	2	1		12	6	5	2			11	1	3
Replacement																										

8) [300 points] Decode this Affine cipher about the region that has produced a 138-pound cabbage, a 65-pound cantaloupe, and a 35-pound broccoli. The ciphertext letters DOD decrypt to the plaintext letters TAT for reference for A and B.

D	Z	Y	Q	L	Y	O	D	U	D	O	D	Y	K	H	O	J	O	U	A	O

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9) [250 points] Solve this quote from Oliver Heaviside which has been encoded using the Pollux Cipher. You are told that 4,3=●, 6,9=—, 8,1=x

3448334374283243732337034083238303323735275330580227232278235

04382402373832387234303723247320432033305873470243822270257222

8280332573327523503234825227733272402437303258443827327237233

7720343303803223732502228232583754473350822274523872548330223

747335727358222025

10) [400 points] Gabriel, has faithfully followed the steps of the RSA key-generation algorithm. Here are the results:

$$p = 947$$

$$q = 809$$

$$n = 766123$$

$$\phi = 764368$$

$$e = 357501$$

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

Enter the computed value of d , NOT the formula.

11) **[200 points]** Encode the word OLYMPIAD using the matrix BUST.

$$\begin{pmatrix} B & U \\ S & T \end{pmatrix} \equiv \begin{pmatrix} 1 & 20 \\ 18 & 19 \end{pmatrix}$$

O	L	Y	M	P	I	A	D

12) **[200 points]** Decode this Vigenere cipher by an unknown author where VOTKN decrypts to EASCA.

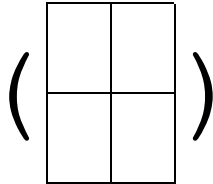
E	C	N	I	G	K	S	S	E	U	R	H	Q	M	B	G	Z	F	B	R	C	Z	Z	W	H	N	C	S	L	F

R	B	E	Q	Q	V	O	T	K	N	E	Q	I	I	A	X	S	U	P	R	N	C	S	T	Q

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13) [150 points] Compute the decryption matrix using the keyword ADVA.

$$\begin{pmatrix} A & D \\ V & A \end{pmatrix} \equiv \begin{pmatrix} 0 & 3 \\ 21 & 0 \end{pmatrix}$$



14) [150 points] Solve this quote by William Ramsay, the Scottish chemist who discovered the noble gases, encoded using an unknown cipher.

K	I	L	T	I	V	H	H	R	H	N	Z	W	V	Y	B	G	I	R	Z	O	Z	M	W	U	Z	R	O	F	I	V	;		
																															;		
G	S	V	U	Z	R	O	F	I	V	H	Z	I	V	T	V	M	V	I	Z	O	O	B	Z	S	F	M	W	I	V	W			
G	R	N	V	H	N	L	I	V	M	F	N	V	I	L	F	H	G	S	Z	M	G	S	V	H	F	X	X	V	H	H	V	H	;
																																	;
B	V	G	G	S	V	B	Z	I	V	F	H	F	Z	O	O	B	O	V	U	G	F	M	X	S	I	L	M	R	X	O	V	W	.
																																.	

15) **[500 points]** Decode this patristocrat cipher by Galileo Galilei that includes the plaintext SCIENCE.

HTOLM KIHPT KPVKX HMTXM IAMRL IAPYH IGPVR IAPLK

RTZHK TPICP YIAIA MALQJ SMYMR KPTHT FPVRK HTFSM

HTZHD HZLRS

	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	1		2	1	10	8	1	7	5	8		1	9	1	6	3	9		3		2	3	3
Replacement																										

16) **[100 points]** Cloe has faithfully followed the steps of the RSA key-generation algorithm. But has forgotten the last step—how to encrypt a message. First, Here are the results from the other steps:

$$q = 811 \quad \phi = 255960$$

$$p = 317 \quad d = 132721$$

$$e = 151681 \quad n = 257087$$

As it comes to pass, Brianna is on vacation in Hawaii, and Cloe needs a document that is stored in the company safe. They are communicating via email, and both know it is very unwise to trust the security of computers in a hotel lobby. Cloe needs to tell Brianna his/her public key, knowing well that it can be read by untrustworthy parties. List the minimum set of numbers that Cloe needs to email to Brianna in order for Brianna to be able to decode the message.

Additionally, Brianna wants to transmit the combination to the safe (which is 9976) in the response email, but encrypted with RSA. What should formula should Brianna compute in order to know the ciphertext to transmit?

Enter the minimum values to transmit:

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Enter the formula (using correct numbers) to transmit: