

Science Olympiad — Ward Melville

Captains' Tryouts

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)

SAMPLE 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 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:
5:xx	960	6:xx	720	7:xx	480	8:xx	240	9:

and then add the seconds value from this table:

X:00	240	X:01	236	X:02	232	X:03	228	X:04	
X:06	216	X:07	212	X:08	208	X:09	204	X:10	
X:12	192	X:13	188	X:14	184	X:15	180	X:16	
X:18	168	X:19	164	X:20	160	X:21	156	X:22	
X:24	144	X:25	140	X:26	136	X:27	132	X:28	
X:30	120	X:31	116	X:32	112	X:33	108	X:34	
X:36	96	X:37	92	X:38	88	X:39	84	X:40	
X:42	72	X:43	68	X:44	64	X:45	60	X:46	

X:48	48
X:54	24

X:49	44
X:55	20

X:50	40
X:56	16

X:51	36
X:57	12

X:52	
X:58	

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	5
2	15
3	10
4	7
5	8
6	6
7	2
8	9
9	1
10	12
11	11
12	4
13	14
14	13
15	3
16	Timed
17	16

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] Solve this quote by French biologist Louis Pasteur encoded with a monoalphabetic cipher about his beliefs relating to how knowledge transcends borders and is a part of entire human race, not just the individual. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

**JSFYHSY RHMBJ HM SMPHZAI, WYSCPJY RHMBKYOVY WYKMHVJ
SCIENCE KNOWS NO COUNTRY, BECAUSE KNOWLEDGE BELONGS**

**ZM QPTCHFZI, CHO FJ ZQY ZMASQ BQFSQ FKKPTFHCZYJ ZQY
TO HUMANITY, AND IS THE TORCH WHICH ILLUMINATES THE**

**BMAKO .
WORLD .**

	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	4	4			6		9	2	6	5		8		3	4	6	2	6	2		2	2		10	7
Replacement	R	W	A	P	Q	I	X	N	Y	S	L	F	O	J	D	U	H	K	C	M	Z	G	B	V	E	T

1) [250 points] Solve this monoalphabetic cipher which is a quote by Steve Carell using the K1 alphabet where the keyword is the first name of one of his roles.

OG 'F ABG R NRFGSE CTRA GB VB SISEL ESNRZS RAV SISEL
IT 'S NOT A MASTER PLAN TO DO EVERY REMAKE AND EVERY

ESPESRGOBA BW OPBAF . OG 'F YHFG JQRG O 'IS USSA QOESV
RECREATION OF ICONS . IT 'S JUST WHAT I 'VE BEEN HIRED

GB VB .
TO DO .

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	6	8	1		7	5	9	1	3	1		2		2	6	2	2	7	13	1	1	4	1		1	1
Replacement	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	M	I	C	H	A	E	L	B	D	F	G	J	K

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
-●x---x-x●●●●x●●x-●x--●xx●●x-●xx●-●●x●●x●●-●x●xx●●x●●●
N O T H I N G / I N / L I F E / I S

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

xx-x---xx-●●●x●xx●●-●x●x-●x-●x●x-●●xx●●x-
xx●●x●●●xx---x
/ T O / B E / F E A R E D / I T / I S / O

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

-●x●-●●x-●---xx-x---xx-●●●x●xx●●-x-●x-●●x●x●-
●x●●●x-x---x
N L Y / T O / B E / U N D E R S T O

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

---x-●●xx-●x---x●---xx●●x●●●xx-x●●●●x●xx-x●●x--
x●xx-x---x
O D / N O W / I S / T H E / T I M E / T O

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

x●●-x-●x-●●x●x●-●x●●●x-x●-x-●x-●●xx--x---x●-
●x●xx●●●x---
/ U N D E R S T A N D / M O R E / S O

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
xx-x●●●●x●-x-xx●--x●xx--x●-x-●--xx●●-●x●x●-x●-●xx●-●●x
/ T H A T / W E / M A Y / F E A R / L

9 1 9 1 9
●x●●●x●●●x
E S S

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

A R I S T O T L E A R I S T O T L E A R I S T O T L E A R I S T O T L E

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

A R I S T O T L E A R I S T O T L

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

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
I	S	U	P	P	O	S	E	B	E	I	N	G	F	I	E	R	C	E	I	S	A	V	E	R	Y	G	O	O

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
T	H	I	N	G	,	A	N	D	A	V	E	R	Y	C	O	O	L	T	H	I	N	G	.	B	U	T	M	O	R	E

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
T	H	A	N	F	I	E	R	C	E	,	I	T	H	I	N	K	I	'	M	A	S	T	R	O	N	G

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
P	E	R	S	O	N	A	N	D	A	S	T	R	O	N	G	I	N	D	I	V	I	D	U	A	L	.	A	N	D

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	.
T	H	A	T	'	S	W	H	A	T	I	T	A	K	E	W	I	T	H	M	E	E	V	E	R	Y	D	A	Y	.

5) [550 points] Solve this Xenocrypt cipher by Pablo Neruda where XWG decrypts to ASI.

WJCJ AJM ZMX XHBGQMOQ KXAGQMAGX AJMLZGWOXHQRJW CX
 SOLO CON UNA ARDIENTE PACIENCIA CONQUISTAREMOS LA

QWKCQMBGBX AGZBXB LZQ BXHX CZU, NZWOGAGX V BGYMGBXB
 ESPLENDIDA CIUDAD QUE DARA LUZ, JUSTICIA Y DIGNIDAD

X OJBJW CJW FJRÑHQW. XWG CX KJQWGX MJ FXÑHX AXMOXBJ
 A TODOS LOS HOMBRES. ASI LA POESIA NO HABRA CANTADO

QM SXMJ.
 EN VANO.

	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	7	11	6			2	12	5		13	3	2	11	1	2	5		10	2	1		1	1	10	21	1	6
Replacement	C	D	L	Ñ	F	H	I	R	X	O	P	Q	N	J	B	T	W	E	M	V	K	Z	Y	S	A	G	U

Translation: *Only with a burning patience can we conquer the splendid City which will give light, justice and dignity to all mankind. In this way the song will not have been sung in vain.*

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 GJMRBRXAR YRSFRXR PXTFJX' SRK
I LEARNT VERY ERLY TEH DIFERENCE BETWENE KNOWIN' TEH

XZLR TM ITLSKJX' ZXG XTFJX' ITLSKJX'
NAME OF SOMTHIN' AND NOWIN' SOMTHIN'

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

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
T	H	E	G	R	E	A	T	S	T	A	T	E	O	F	A	L	A	S	K	A

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

3448334374283243732337034083238303323735275330580227232
●●●x●●●●x●-x●-●●x●-●●xx●●xx●-●x●x●●-

●x●●-x●●●x●xx--x-●--

S H A L L I R E F U S E M Y

7823504382402373832387234303723247320432033305873470243
xx-●●x●●x-●x-●x●x●-●xx-●●●x●x-●-●x●-

x●●-x●●●x●xx●●xx-●●

D I N N E R B E C A U S E I D

82227025722282803325733275235032348252277332724024373
x---xx-●x---x-xx●●-●x●●-x●-●●x●-●●x-●--xx●●-x-●x-●●x●

O N O T F U L L Y U N D E

0325844382732723723377203433038032237325022282325837544
x●-●x●●●x-x●-x-●x-●●xx-x●●●●x●xx●-●-●x●-●x---

x-●-●x●x●●●

R S T A N D T H E P R O C E S

73350822274523872548330223747335727358222025

x●●●xx---x●●-●xx-●●x●●x--●x●x●●●x-x●●x---x-●

S O F D I G E S T I O N

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.

103973

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
A	T	E	K	T	G	I	F

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

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

R O B I N	R O B I N	R O B I N	R O B I N	R O B I N
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
A N D I D	E A S C A	N C H A N	G E T H E	W O R L D

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

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

0	5
9	0

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

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

HTOLM KIHPT KPVKX HMTXM IAMRL IAPYH IGPVR IAPLK
 INQUE STION SOFSC IENCE THEAU THORI TYOFA THOUS

RTZHK TPICP YIAIA MALQJ SMYMR KPTHT FPVRK HTFSM
 ANDIS NOTWO RTHTH EHUMB LEREA SONIN GOFAS INGLE

HTZHD HZLRS
 INDIV IDUAL

In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual

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

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:

$$\begin{aligned}q &= 811 & \phi &= 255960 \\p &= 317 & d &= 132721 \\e &= 151681 & n &= 257087\end{aligned}$$

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:

257087	151681	
---------------	---------------	--

These two numbers can be in either order.

Enter the formula (using correct numbers) to transmit:

$9976 \wedge 151681 \bmod 257087$
