

Science Olympiad — RHS Codebuster

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.
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 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

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

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 [100 points] Solve this Quote by Albert Einstein. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

^AJC AZTMRW BGD TMQMTAD: AZD HMTNDGWD BMX ZHUBM

"TWO THINGS ARE INFINITE: THE UNIVERSE AND HUMAN

WAHOTXTAF; BMX T'U MCA WHGD BSCHA AZD HMTNDGWD."

STUPIDITY; AND I'M NOT SURE ABOUT THE UNIVERSE."

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

1) [150 points] Decode this Caesar cipher which is a quote by Bernard M. Bauch

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

2) [100 points] Solve this Mark Twain Quote encoded by an Atbash Cipher

" R U B L F G V O O G S V G I F G S , B L F W L M ' G S Z E V
 " I F Y O U T E L L T H E T R U T H , Y O U D O N ' T H A V E
 G L I V N V N Y V I Z M B G S R M T . "
 T O R E M E M B E R A N Y T H I N G . "

3) [250 points] Solve this Affine Cipher where A=5

B	E	C	F	H	Z	A	F	E	C	F	E	F	C	T	H	Q	Q	F	A	C	U	H	N	V	Z	N	A	C
I	T	D	O	E	S	N	O	T	D	O	T	O	D	W	E	L	L	O	N	D	R	E	A	M	S	A	N	D
M	F	U	R	H	E	E	F	Q	B	O	H	.	"															
F	O	R	G	E	T	T	O	L	I	V	E	.	"															

4) [700 points] Solve this K2 encoded Spanish Xenocrypt with an English Keyword

ÑÑKFK EZX OKÑ GZIRNZÑ OR UAUAN PQ UAOZ. QIK RÑ HKGK
 "SOLO HAY DOS MANERAS DE VIVIR TU VIDA. UNO ES COMO

ÑA IZOZ TQRNZ QI GAFZBNK. RF KPNK RÑ HKGK ÑA PKOK
 SI NADA FUERA UN MILAGRO. EL OTRO ES COMO SI TODO

TQRNZ QI GAFZBNK ".
 FUERA UN MILAGRO ".

Replacement	Z	S	H	O	R	T	B	E	A	D	C	F	G	I	J	K	L	M	N	Ñ	P	Q	U	V	W	X	Y
K2	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	2			1	4	5	2	5		14			7	7	5	3	6	7		2	3			1		10

Translation: "There are only two ways to live your life. One is as though nothing is a miracle. The other is as though everything is a miracle."

5) [450 points] Solve this K1 encoded Patristocrat

FSGCS FHZFG KTFSN HOLGC BLHOF SNTXL DCSKT XLDCN
 INSAN ITYIS DOING THESA METHI NGOVE RANDO VERAG

CFSIW HLEUL JHFSN KFMM L DLSHD LGWRH G
 AINBU TEXPE CTING DIFFE RENTR ESULT S

"Insanity is doing the same thing, over and over again, but expecting different results."

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

6) [300 points] Decode this Aristocrat which is a quote by Oscar Wilde

"C EQ LT JZSASY IGEI LTQSIQSL C BTX'I OXBSYLIEXB E
 "I AM SO CLEVER THAT SOMETIMES I DON'T UNDERSTAND A

LCXMZS DTYB TK DGEI C EQ LEWCXM."
 SINGLE WORD OF WHAT I AM SAYING."

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

9) [250 points] Encrypt this Dr. Seuss quote using the Vigenere cipher with keyword THINKERY

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

10) [400 points] Solve this Baconian that starts with SO MANY

21453867124356781458123456872145813467528361742583614
 BAAABABBABABABBAAAAAABBAABABBAAAAABABBABABBABABAABBAA

S O M A N Y B O O K S

57281435678213465871452813465871425381465871425831458
 ABBAABABBABABABAABAABAABAABAABAABAABAABAABAABAABAABA

S O L I T T L E T I

617245381
 BABBAABAA

M E

"So many books, so little time."

13) [200 points] Compute the decryption key for the following Hill Cipher

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

$$\begin{pmatrix} 15 & 0 \\ 11 & 19 \end{pmatrix}$$

14) [400 points] Solve this Spanish Xenocrypt which is a quote by A. A. Milne

"CM SRHGR YBIR XTR HMYM RJ BLVEJBACR, VRPE HE QMSE

"LA GENTE DICE QUE NADA ES IMPOSIBLE, PERO NO HAGO

HMYM GEYEJ CEJ YBMJ".

NADA TODOS LOS DIAS".

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

Translation: "People say nothing is impossible, but I do nothing every day."

15) [250 points] Solve this Running Key Cipher encoded with a famous document

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

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

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

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

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

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

16) [250 points] Solve this Baconian Cipher that ends with "ove"

wisalarsnwdairsswalrsandiwslandariswsalarnsdislwandai
 BAABAABBABABABBABBABBAAAABAAAABBABBABAABABAAAABAAAABA
 T O M O R R O W W E M

rsslandiwslaanrdisswlaranswadislandislrswanardsiwsala
 BBAAAAABAABAABAABBABBABAABBBAAAAAAAAAAABBBAABBABABABAA
 A K E O U R A P O L

rsnwdiarslsandiswlaandirsslwanardsiwaslarndislswandar
 BBABAABBAABAABAABAABAABBABAABBABABBAABAABAABAABAABB
 O G I E S T O N I G H

swisalrasndiswlanadrssislandwisalarndiswsarlaswandislr
 BBABABABAAAABAABAABBAAAABAABAABAABBABBABAABBBAAAAAB
 T W E M A K E O U R

aswnardswisarlasnd
 ABBABBABBAABBAABAA
 M O V E

Tomorrow we make our apologies, tonight we make our move

17) **[450 points]** Ella and Isabella are accountants for a very large bank, and have started a friendship. They communicate via email, because they live thousands of miles apart. Isabella gets curious and asks Ella the year that they were born. Ella doesn't mind telling Isabella, but they know that the bank monitors all employee emails, and is afraid of being the victim of age discrimination. Therefore, Isabella suggests that they use RSA, and they provides their public key: (201277, 101639). Ella replies with the ciphertext 174071. Isabella's private key is 92999. In what year was Ella born?

Enter the answer:

1955

18) **[500 points]** Decode this Hill cipher which is a quote from the Communist Manifesto which has keyword TRAP

$$\begin{pmatrix} T & R \\ A & P \end{pmatrix} \equiv \begin{pmatrix} 19 & 17 \\ 0 & 15 \end{pmatrix}$$

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

19) [275 points] Decode this message encrypted with an Affine Cipher that starts with THEW

R	J	U	G	O	M	U	M	R	I	O	N	P	J	A	M	M	S	I	U	R	J	O	N	E	Q	U	R	R	S
T	H	E	W	I	S	E	S	T	M	I	N	D	H	A	S	S	O	M	E	T	H	I	N	G	Y	E	T	T	O

D	U	A	H	N
L	E	A	R	N

20) [400 points] Solve this Spanish Xenocrypt which is a Donald Trump quote

OHORJO ÑJSYE SÑ XSPCÑHCXE RGCOXS. OHORJO XSÑCKHE SÑ
 NINGUN SUEÑO ES DEMASIADO GRANDE. NINGUN DESAFIO ES

XSPCÑHCXE RGCOXS. OCXC XS TE FJS FJSGSPEN BCGC
 DEMASIADO GRANDE. NADA DE LO QUE QUEREMOS PARA

OJSÑAGE KJAJGE SÑAC PCÑ CTTC XS OJSÑAGE CTMCOMS.
 NUESTRO FUTURO ESTA MAS ALLA DE NUESTRO ALCANCE.

	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	4	1	17		9	2	7	5		9	2		2	11	12	4		4	17	4				10	1		
Replacement	T	P	A	X	O	Q	R	I	Z	U	F	H	C	V	S	N	M	B	G	E	L	W	K	J	D	Ñ	Y

Translation: *No dream is too big. No challenge is too great. Nothing we want for our future is beyond our reach.*