North Carolina Science Olympiad — Code Busters State Test
2018

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 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 50 points from the score until it would be zero. If a question is worth 120 points and they get 4 letters wrong, you would start with 120 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 20 points for that question. If they had gotten 5 or more letters wrong on a 120 point question, they would receive 0 points for that question. With a 350 point question, they could get 8 letters wrong and receive 50 points (2 free letters then 6 × 50 = 300 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 50 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	1,620		1:xx	1,440		2:xx	1,260		3:xx	1,080		4:xx	900
5:xx	720		6:xx	540		7:xx	360		8:xx	180		9:xx	0

and then add the seconds value from this table:

X:00	180		X:01	177		X:02	174		X:03	171		X:04	168		X:05	165
X:06	162		X:07	159		X:08	156		X:09	153		X:10	150		X:11	147
X:12	144		X:13	141		X:14	138		X:15	135		X:16	132		X:17	129
X:18	126		X:19	123		X:20	120		X:21	117		X:22	114		X:23	111
X:24	108		X:25	105		X:26	102		X:27	99		X:28	96		X:29	93
X:30	90		X:31	87		X:32	84		X:33	81		X:34	78		X:35	75
X:36	72		X:37	69		X:38	66		X:39	63		X:40	60		X:41	57
X:42	54		X:43	51		X:44	48		X:45	45		X:46	42		X:47	39
X:48	36		X:49	33		X:50	30		X:51	27		X:52	24		X:53	21
X:54	18		X:55	15		X:56	12		X:57	9		X:58	6		X:59	3

For example if they solved the time question at the 6:46 mark, you would add 540 (from the 6:xx entry in the first table) to 42 (from the X:46 entry in the second table) to get a bonus of 582. If they had solved it in exactly 4:00 minutes, you would add 900 and 180 to get a bonus of 1080.

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

10. 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 Aristocrat which is a quote by Scott Adams. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

RPCI CFZ IPZ BXXM IPCI JBN CFZ IPZ OKFMI LZUZFCIKBU

WHAT ARE THE ODDS THAT YOU ARE THE FIRST GENERATION

BO PNTCUM RPB RKEE NUXZFMICUX FZCEKIJ

OF HUMANS WHO WILL UNDERSTAND REALITY

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

1) **[120 Points]** Solve this Aristocrat which is a quote from John W. Gardner and starts with **WE ARE**.

`HP EKP FGXBYXCEWWR DEFPN HYBV E JPKYPJ GD LKPEB`
<mark>WE ARE CONTINUALLY FACED WITH A SERIES OF GREAT</mark>

`GSSGKBCXYBYPJ ZKYWWYEXBWR NYJLCYJPN EJ YXJGWCZWP`
<mark>OPPORTUNITIES BRILLIANTLY DISGUISED AS INSOLUBLE</mark>

`SKGZWPTJ`
<mark>PROBLEMS</mark>

	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	4	2	7	2	6	2		8	6	2		3		10		2	3	1		1	8	5	10	3
Replacement	X	T	U	F	A	C	O	W	Q	S	R	G	Z	D	J	E	K	Y	P	M	V	H	L	N	I	B

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2) **[100 Points]** William Arthur Ward once said this about what to look for. It has been encoded using the Vigenère cipher using a very common five letter word. You have been told that the 13th through the 20th letters in the code (**AMKHWSIJ**) actually is the word **DISCOVER**. What does the message decode to?

F	I	X	E	S
B	P	B	R	O
W	**H**	**E**	**N**	**W**

F	I	X	E	S
J	A	B	I	C
E	**S**	**E**	**E**	**K**

F	I	X	E	S
Y	W	A	M	K
T	**O**	**D**	**I**	**S**

F	I	X	E	S
H	W	S	I	J
C	**O**	**V**	**E**	**R**

F	I	X	E	S
Y	P	B	F	W
T	**H**	**E**	**B**	**E**

F	I	X	E	S
X	B	F	R	G
S	**T**	**I**	**N**	**O**

F	I	X	E	S
Y	P	B	V	K
T	**H**	**E**	**R**	**S**

F	I	X	E	S
B	M	P	S	E
W	**E**	**S**	**O**	**M**

F	I	X	E	S
J	P	L	A	T
E	**H**	**O**	**W**	**B**

F	I	X	E	S
W	Q	K	K	G
R	**I**	**N**	**G**	**O**

F	I	X	E	S
Z	B	Q	L	W
U	**T**	**T**	**H**	**E**

F	I	X	E	S
G	M	P	X	A
B	**E**	**S**	**T**	**I**

F	I	X	E	S
S	W	R	V	K
N	**O**	**U**	**R**	**S**

F	I	X	E	S
J	T	S	I	K
E	**L**	**V**	**E**	**S**

<mark>When we seek to discover the best in others, we somehow bring out the best in ourselves.</mark>

3) **[75 Points]** Using a key of **TURN** encode the string **JUXTAPOSING** using the Hill Cipher with a 26 character alphabet. e.g.

$$\begin{pmatrix} T & U \\ R & N \end{pmatrix} \equiv \begin{pmatrix} 19 & 20 \\ 17 & 13 \end{pmatrix}$$

J	U	X	T	A	P	O	S	I	N	G	Z
Z	X	L	O	O	N	C	E	W	T	Q	L

4) **[350 Points]** Solve this Xenocrypt which is a translation of a quote by Frank Clark into Spanish.

MGXG SP ATBXG MVLML XS VSLPYHLV LPEG EVLBXS, ZYB
TODO EL MUNDO TRATA DE REALIZAR ALGO GRANDE, SIN

XLVZS KTSBML XS ÑTS PL WYXL ZS KGAUGBS XS KGZLZ
DARSE CUENTA DE QUE LA VIDA SE COMPONE DE COSAS

USÑTSJLZ
PEQUEÑAS

	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	2	5				2		7	1		1	3	12	4		2		4			13	4	2	5	1	8	3	6
Replacement	M	N	Y	J	G	W	O	Z	B	Ñ	C	A	T	K	Q	X	L	F	H	E	U	P	R	V	D	I	S

Translation: Everyone tries to accomplish something big, without realizing that life is made up of small things.

5) **[120 Points]** Solve this Aristocrat which is a quote by Albert Einstein which has the word **ART** in it once and **THE** three times.

LMJ QDXL NJPVLTOVB LMTEK ZJ YPE JIAJSTJEYJ TX LMJ
THE MOST BEAUTIFUL THING WE CAN EXPERIENCE IS THE

QCXLJSTDVX. TL TX LMJ XDVSYJ DO PBB LSVJ PSL PEH
MYSTERIOUS. IT IS THE SOURCE OF ALL TRUE ART AND

XYTJEYJ
SCIENCE

	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	3	1	4	5			1	1	14	1	10	4	1	2	5	2		5	8		5		7	5	1
Replacement	P	L	Y	O	N	Q	Z	D	X	E	G	T	H	B	F	A	M	V	R	I	J	U	K	S	C	W

6) **[140 Points]** A message from Stephen Hawking encrypted with the Affine Cipher using an alphabet of 26 characters has been received. You have been told that the 2nd and 3rd characters are the letters **HE**. With that knowledge, what does this message say?

Q	U	V	H	S	L	Y	V	I	Z	V	L	S	F	S	H	Q	Z	U	V	K	K
T	H	E	U	N	I	V	E	R	S	E	I	N	A	N	U	T	S	H	E	L	L

7) **[350 Points]** Solve this K1 Key encoded Patristocrat which is a quote by Isaac Asimov and starts with the word **FACTS**.

```
RLJAZ LMILS ILXWR QMNJU ZLOHA NVQIM NANZW OKFLZ
FACTS AREAH EAPOF BRICK SANDT IMBER ITISO NLYAS

BJJIZ ZRBKA SIWMF ASLAJ LOJWO CIMAA SISIL XNOAW
UCCES SFULT HEORY THATC ANCON VERTT HEHEA PINTO

LZALA IKFVL OZNWO
ASTAT ELYMA NSION
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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	11	2	1			3		1	9	6	3	12	5	6	7		2	3	5		1	2	6	2		8
Replacement	T	U	V	W	X	Y	Z	D	E	C	L	A	R	I	N	G	B	F	H	J	K	M	O	P	Q	S

8) **[120 Points]** The following quote from Ahmed Zewail has been encoded using a running key cipher against a famous document. What does it say?

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

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

U I T A N N I E E    T C    O M E    S A N D E G
C V O E F G Q R K    B P    H T I    X U G X V K  .
I N V E S T I N G    I N    T H E    F U T U R E  .
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9) **[125 Points]** Solve this Aristocrat which is a quote from Roy T. Bennett.

YPAANYY RY XIJ DIO DRVD ZIP DQSN ABRKMNU, MPJ DIO
SUCCESS IS NOT HOW HIGH YOU HAVE CLIMBED, BUT HOW

ZIP KQEN Q HIYRJRSN URCCNGNXAN JI JDN OIGBU
YOU MAKE A POSITIVE DIFFERENCE TO THE 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	4	2	2	6	1		2	1	8	5	2		2	9	3	4	3	6	2		3	1		2	5	2
Replacement	C	L	F	H	K	X	R	P	O	T	M	J	B	E	W	U	A	I	V	Q	D	G	Z	N	S	Y

10) **[50 Points]** A quote from Ralph Waldo Emerson has been encoded using a Caesar Cipher. What does it say?

JVGUBHG NZOVGVBA BAR FGNEGF ABGUVAT.
WITHOUT AMBITION ONE STARTS NOTHING.

JVGUBHG JBEX BAR SVAVFURF ABGUVAT.
WITHOUT WORK ONE FINISHES NOTHING.

GUR CEVMR JVYY ABG OR FRAG GB LBH.
THE PRIZE WILL NOT BE SENT TO YOU.

LBH UNIR GB JVA VG.
YOU HAVE TO WIN IT.

11) **[100 Points]** Encode the string **THE GODS TOO ARE FOND OF A JOKE** using the Affine Cipher with *a=5* and *b=20.*

T	H	E	G	O	D	S	T	O	O	A	R	E	F	O	N	D	O	F	A	J	O	K	E
L	D	O	Y	M	J	G	L	M	M	U	B	O	T	M	H	J	M	T	U	N	M	S	O

12) **[125 Points]** Using a key of **OUTSHINED** encode the string **ACCOMPLISHMENT** using the Hill Cipher with a 26-character alphabet. e.g.

$$\begin{pmatrix} O & U & T \\ S & H & I \\ N & E & D \end{pmatrix} \equiv \begin{pmatrix} 14 & 20 & 19 \\ 18 & 7 & 8 \\ 13 & 4 & 3 \end{pmatrix}$$

A	C	C	O	M	P	L	I	S	H	M	E	N	T	Z
A	E	O	T	O	P	G	I	V	Y	I	V	X	V	I

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13) **[300 Points]** Alexa severely misheard a phrase from Isaac Asimov in Epigraph in "*Isaac Asimov's Book of Science and Nature Quotations*" and then encoded it as an Aristocrat. What did it come out as?

DSDIF WJMLU T GXVW EF ZIXH BZXOMZ AMCD MB WDIIT OADT

EVERY THING A BOUT MY CROW SCOPIC LIFE IS TERRA PLEA

VOBDWWMLU. JXH ZTL WJMLUB BDH BETAA GDD BDH

UPSETTING. HOW CAN THINGS SEW SMALL BEE SEW

MEOXIWTLW

IMPORTANT

	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	4	7	1	10	3	2	2	4	5	3		5	7		4			1	6	3	2	8	5			4
Replacement	L	S	F	E	M	Y	B	W	R	H	J	N	I	D	P	Z	X	Q	V	A	G	U	T	O	K	C

14) **[50 Points]** Using a code word of **WIZARD**, encode the following quote from Albert Einstein using the Vigenère cipher.

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

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

15) **[250 Points]** Solve this Patristocrat which is a quote by Nikola Tesla and begins with **MY BELIEF**.

```
LPHIN  MIBMU  BMWLM  XTNTG  QBJQL  YIXUT  RMQXR  EIRWZ
MYBEL  IEFIS  FIRMI  NALAW  OFCOM  PENSA  TIONT  HETRU

IWIGT  WKUTW  IIDIW  MXYWQ  YQWRM  QXRQR  EINTH  QWTXK
EREWA  RDSAR  EEVER  INPRO  PORTI  ONTOT  HELAB  ORAND

UTJWM  BMJIU  LTKI
SACRI  FICES  MADE
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	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		4		1	2		2	2	12	3	3	4	9	3		1	8	6		9	5		10	6	3	1
Replacement	K	F	J	V	H	X	W	B	E	C	D	M	I	L	Z	Y	O	T	G	A	S	Q	R	N	P	U

16) **[150 Points]** The following symbols encodes a phrase by Stephen Hawking using a Baconian alphabet. What does it say?

(Up arrows are B, down are A)

↑↓↖↘↘↓↘↘↑↓↓↘↓↑↘↘↓↘↓↓↘↓↘↓↓↘↖↘↓↘↘↑↑↖↘↓↑↘↘↓↑↖↓↖↖↓↖↓↑↘↘↘↖↖↘↓↖
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17) **[350 Points]** Solve this Patristocrat of a quote by Chad Sugg, encoded using a K1 key. The first five letters are **IFYOU**.

TBXHK WRWRY ATGCV QTUPH GCWYV KFYVT HGUXH KWRYF

TLRTB VQYVU GHVUH SRVQT GCVHU STFRY ZHKVV QRGTA

HGVEG HMMQY VTU

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	2	3		1	3	8	10			4	1	2			1	5	7	2	10	6	12	4	2	7	1
Replacement	D	F	G	J	K	L	N	O	P	Q	U	V	W	X	Z	C	H	E	M	I	S	T	R	Y	A	B

18) **[60 Points]** You know that a message has been encrypted using the Affine Cipher with an alphabet of 26 characters. You have discovered that the message **UDMMSV** decodes to say **PUZZLE**. What are the values of a and b in the function $ax + b$ that were used to encode the message?

$a=$ **7** $b=$ **19**

19) **[120 Points]** The following strange headlines appeared in the newspaper but in reality, they are a Baconian encoded message from Henry Petroski where some letters encode as one character and the others as another in a pattern. You know that the message starts out as **ASENGINE**. What does the message decode to?

Answer: ___As engineers, we were going to be in a position to change the world - not just study it._____

As his loyal guest he was sorry if you spent today, my day, lying round.

AA	AAA	BAAAB	AABAA	AB	BAA	AABBA	AB	AAA	ABBAA	AABAA		AA	BAA		BAAAA	BAAAB
A		S	E		N		G		I/J	N		E			E	R	S

Enemy ocean worth zilch.

BABAA	AABAA	BABAA	AABAA
W	E	W	E

Do not guess badly.

BA	AAA	AABAA	AABBA
R		E	G

He did claim he put amply known trend by the ocean beach.

AB	BAB	ABAAA	AB	BAA	AABBA	BAABA	ABBAB	AA	AAB	AABAA	ABAAA
O		I/J		N	G	T	O		B	E	I/J

He was by its newly clear round glass.

AB	BAA	AA	AAA	ABBBA	ABBAB	BAAAB	ABAAA
N		A		P	O	S	I/J

Known: if you speak mercy, lucky trend on two super giant teeth.

BAABA		AB	AAA	ABBAB	ABBAA		BAABA	ABBAB	AA	ABA	AABBB	AAAAA	ABBAA
T		I/J		O	N		T	O		C	H	A	N

Happy! My day, know a baker in who empty bread with a brown shape he put.

AABBA		AA	BAA		BAAB	A	AABBB	AA	BAA	BABAA	ABBAB	BAAA	A	ABABA	AAABB	AB	BAA
G		E			T		H		E	W	O	R		L	D		N

Below lucky album label whose quiet voice links panel

ABBAB	BAABA	ABAAA	BAABB	BAAAB	BAABA	BAAAB	BAABA	BAABB
O	T	J	U/V	S	T	S	T	U/V

In old lives bring quilt.

AA	ABB	BABBA	ABAAA	BAABA
D		Y	I/J	T