

Science Olympiad — Scioly.org Codebusters Test  
2019

Timed Question [400 points] Solve this Aristocrat. When you have solved it, raise your hand so that the time can be recorded and the solution checked.

**NCPH HV BXAVIR GVC, RVPH YCVHZP AVI HJBP HZPH QIZ  
JUST TO INFORM YOU, MOST QUOTES FOR THIS TEST ARE**

**WVRBXE AIVR DVPHP VX HJZ PHCLZXH PWBZXWZ VOGRDBQL  
COMING FROM POSTS ON THE STUDENT SCIENCE OLYMPIAD**

**TBSB.  
WIKI.**

|             | 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 | 7 | 4 | 2 | 1 |   | 2 | 11 | 4 | 2 |   | 2 |   | 1 | 1 | 9 | 2 | 5 | 1 | 1 |   | 11 | 3 | 5 | 1 | 7 |
| Replacement | F | I | U | P | G | X | Y | T  | R | H | Z | D | V | J | L | S | A | M | K | W | B | O  | C | N | Q | E |

1) [325 points] Solve this Aristocrat which is a quote from the Scioly.org forum rules and has the word "rules" in it.

HEXMZAEXKQ XJ AUBQB NYMBQ DEMM NBQYMA EK WZKQ XN  
**VIOLATIONS OF THESE RULES WILL RESULT IN BANS OR**

DZNKEKIQ ZQQBQBT AX SXYN ZOOXYKA, TFBKTEKI XK UXD  
**WARNINGS ASSESSED TO YOUR ACCOUNT, DEPENDING ON HOW**

BINBIEXYQ AUB HEXMZAEXK EQ.  
**EGREGIOUS THE VIOLATION IS.**

|             | 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 | 11 |   | 3 | 10 | 1 |   | 2 | 4 | 1 | 10 |   | 6 | 6 | 2 |   | 12 |   | 1 | 3 | 3 |   | 1 | 12 | 5 | 6 |
| Replacement | T | E  | M | W | I  | P | X | V | G | F | N  | Q | L | R | C | J | S  | K | Y | D | H | Z | B | O  | U | A |

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

$$\begin{pmatrix} F & L \\ E & X \end{pmatrix} \equiv \begin{pmatrix} 5 & 11 \\ 4 & 23 \end{pmatrix}$$

$$\begin{pmatrix} 19 & 9 \\ 8 & 3 \end{pmatrix}$$

## How to solve

The inverse of the matrix can be computed using the formula:

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}^{-1} = (ad - bc)^{-1} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

In this case we have to compute  $(ad - bc)^{-1}$  Using [modular multiplicative inverse \(https://en.wikipedia.org/wiki/Modular\\_multiplicative\\_inverse\)](https://en.wikipedia.org/wiki/Modular_multiplicative_inverse) math

$$\begin{pmatrix} 5 & 11 \\ 4 & 23 \end{pmatrix}^{-1} = (5 * 23 - 11 * 4)^{-1} \begin{pmatrix} 23 & -11 \\ -4 & 5 \end{pmatrix}$$

We start by finding the modulo 26 value of the determinant:

$$(5 * 23 - 11 * 4) \bmod 26 = 71 \bmod 26 = 19$$

Looking up 19 in the table supplied with the test (or by computing it with the [Extended Euclidean algorithm](https://en.wikipedia.org/wiki/Extended_Euclidean_algorithm)

([https://en.wikipedia.org/wiki/Extended\\_Euclidean\\_algorithm](https://en.wikipedia.org/wiki/Extended_Euclidean_algorithm))) we find that it is 11 which we substitute into the formula to compute the matrix:

$$\begin{aligned} (5 * 23 - 11 * 4)^{-1} \begin{pmatrix} 23 & -11 \\ -4 & 5 \end{pmatrix} &\equiv 11 \begin{pmatrix} 23 & -11 \\ -4 & 5 \end{pmatrix} \bmod 26 \equiv \begin{pmatrix} 11 * 23 & 11 * -11 \\ 11 * -4 & 11 * 5 \end{pmatrix} \bmod 26 \equiv \begin{pmatrix} 253 & -121 \\ -44 & 55 \end{pmatrix} \bmod 26 \equiv \\ \begin{pmatrix} 253 \bmod 26 & -121 \bmod 26 \\ -44 \bmod 26 & 55 \bmod 26 \end{pmatrix} &\equiv \begin{pmatrix} 19 & 9 \\ 8 & 3 \end{pmatrix} \end{aligned}$$

3) [75 points] Solve this quote from the Scioly Assassination 133: Zoo Escape thread which has been encoded with the Caesar Cipher.

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | D | , | W | T | , | H | S | T | U | X | C | X | I | T | A | N | P | G | D | Q | D | I | . | P | U | I | T | G | P | A | A | , |
| N | O | , | H | E | , | S | D | E | F | I | N | I | T | E | L | Y | A | R | O | B | O | T | . | A | F | T | E | R | A | L | L | , |

  

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G | D | Q | D | I | H | S | D | C | , | I | W | P | K | T | U | T | A | X | C | V | H | . |   |
| R | O | B | O | T | S | D | O | N | , | T | H | A | V | E | F | E | E | L | I | N | G | S | . |

## How to solve

We start out by looking for short words to decode and then see if that encoding makes sense. Since we have a single letter word, we try out P=A and P=I.

With P=A we look in the decoding table for a P in the A column and see that it is the P row

Using the P row to decode the first long word 'STUXCXITAN', it comes out as 'DEFINITELY'

With P=I we look in the decoding table for a P in the I column and see that it is the H row

Using the H row to decode the first long word 'STUXCXITAN', it comes out as 'LMNQVBMTG'

Based on this, we believe that the key row is P which we can use to decode the remaining letters

4) [180 points] A phrase from the 1000 Ways to Get Kicked Out of Walmart thread has been encoded using the Vigenère cipher with a code word of RICE. What does it say?

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

  

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

  

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | G | P | S | K | W | H | E | J | Q | C | R | F | Z | K | K | Z | V |
| L | Y | N | O | T | O | F | A | S | I | A | N | O | R | I | G | I | N |

5) [300 points] This quote from the Your Daily Random Comment thread has been encoded using the beginning of a famous document. What does it say?

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

6) [100 points] Encode this quote from the Pennsylvania 2019 thread into the Atbash alphabet.

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | O | U | T | H | E | A | S | T | A | N | D | N | O | R | T | H | E | A | S | T | S | E | E | M | T | O | H | A | V | E |   |   |   |
| H | L | F | G | S | V | Z | H | G | Z | M | W | M | L | I | G | S | V | Z | H | G | H | V | V | N | G | L | S | Z | E | V |   |   |   |
| S | N | A | Z | Z | Y | N | E | W | W | E | B | S | I | T | E | S | ( | T | H | O | U | G | H | T | H | E | C | O | N | T | E | N | T |
| H | M | Z | A | A | B | M | V | D | D | V | Y | H | R | G | V | H | ( | G | S | L | F | T | S | G | S | V | X | L | M | G | V | M | G |
| A | P | P | E | A | R | S | T | H | E | S | A | M | E | ) | . |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Z | K | K | V | Z | I | H | G | S | V | H | Z | N | V | ) | . |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

7) [750 points] Solve this Xenocrypt which is a translation of a quote from the The Event That "Got Away" thread into Spanish and has been encoded with a K1 alphabet using an English keyword.

**TY, J GVYNUMÑC VÑVUQFNUC. OVLVFNT YTLVF VÑVXNOC VPC  
AH, Y VEHICULO ELECTRICO. DEBERIA HABER ELEGIDO ESO**

**PCLFV VÑ LFTKC OVÑ FCLCQ UMTROC QMGV ÑT CDCFQMRNOTO.  
SOBRE EL BRAZO DEL ROBOT CUANDO TUVE LA OPORTUNIDAD.**

| K1          | 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   |   |   | 11 | 1 |   | 7 | 2 |   |   | 1 | 1 | 5 | 4 | 5 | 6 | 6 | 2 | 4 | 2 |   | 7 | 4 | 13 |   | 1 | 3 |   |
| Replacement | M | Ñ | O  | P | Q | R | V | W | X | Y | Z | B | U | I | L | D | S | T | N | K | A | C | E  | F | G | H | J |

Translation: *Oh, and electric vehicle. I should have chosen that over Robot Arm when I had the chance.*

8) [300 points] Solve this quote from the thread Poorly Run Event Stories that has been encoded using a Baconian Cipher. The first two letters are TO.

**BACDEGFHIJLKMNOQSPRTUVXWZBYDACFEHGHIKJLNOQPSUWRTVYAXZCBDEFGIKMHOQ  
BAABAABBABBAAAABAABBBABBABBABAABAABAABBBBAABAABBBBAABBABBABAAAABAA  
T O S H O W T H E P O W E**

**JSUWYALNCPGRITKMVOXQZSBWYDACFEHGJLIKNMQSUWYPRFACEVGIKXMQZSUWB  
BAAAABBABAABABABABABAAAABAABABABBAABAABAAAAAABBBAAAABAABAAAABAAB  
R O F F L E X T A P E I S**

**YACEGDIFKMQHSUWYAJLNCEPGIKRTVMXOQSZUWYBDACEFGHJLIKNPMROTVQXSZBUW  
AAAAABABAAAABAAAABBBAAAABAABBBABAABAAAABAAAABBBBAABBABABBABABBAA  
A W E D T H I S S P O O N**

**YDACEGFHIKMOJLNSUWYAPCREGITKV  
ABAAAABBAAAABBBAAAAAABABAAAABAB  
I N H A L F**

**To show the power of FlexTape, I sawed this spoon in half!**

The A letters are represented by 'ACEGIKMQSUWY' and the B letters by 'BDFHJLNPRTVXZ'

9) [120 points] Encode this phrase from the Way Too Early Predictions thread using the Vigenère cipher with the key Cornell.

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

  

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| C | C | C | C | C | C | C | C | C | C |
| I | D | E | N | T | I | T | I | E | S |
| Z | Q | I | Y | E | K | H | Z | R | W |

10) [525 points] Solve this Aristocrat with errors which is a quote from the Scioly Assassination 133: Zoo Escape thread.

NC SPJ'V UOV NCONS PR IPWQHOKR... YNEO HWQO IOZ  
 AH DON'T GET AHEAD OF YOURSELF... MAKE SURE YEW

VCTJE VZTAO NFPWV ODOQIZNQO IPW HVOM NV UQNJSYN'H  
 THINK TWICE ABOUT EVERYWARE YOU STEP AT GRANDMA'S

CPWHO TJ ROFQWNQI  
 HOUSE IN FEBRUARY

|             | 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 | 2 | 2 |   | 5 | 5 | 4 | 1 |   | 1 | 10 | 13 | 6 | 7 | 3 | 3 | 3 | 2 | 7 | 6 |   | 2 | 3 |
| Replacement | C | Z | H | V | K | B | Q | S | Y | N | L | X | P | A  | E  | O | R | F | D | I | G | T | U | J | M | W |

11) [700 points] Solve this Patristocrat which is a quote from the Your Daily Random Comment thread.

**MHMYP NRXKP SRRSH PCRVK ERGBL VUPZN KUPPN KBZLJ**  
**ILIKE TOUSE GOOGL EDOCS FORMY CHEAT SHEET SMAYB**

**PNUZN KFULM BWRNR WZWLP APWNK NUZNX KPKVU PZSKU PPNK**  
**ETHAT SWHYI MNOTO NANYE VENTS THATU SESCH EATSH EETS**

"I like to use Google docs for my cheat sheets... Maybe that's why I'm not on any events that uses cheat sheets."

|                    | 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>Frequency</b>   | 1 | 3 | 1 |   | 1 | 1 | 1 | 2 |   | 1 | 10 | 4 | 3 | 11 |   | 13 |   | 7 | 2 |   | 7 | 3 | 4 | 2 | 1 | 6 |
| <b>Replacement</b> | V | M | D | Q | F | W | R | L | J | B | S  | Y | I | T  | Z | E  | P | O | G | X | H | C | N | U | K | A |

12) [275 points] Using a key of MULTITONE encode the string MEMBRANOPHONES using the Hill Cipher with a 26-character alphabet.

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix}$$

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | E | M | B | R | A | N | O | P | H | O | N | E | S |   |
| S | U | I | O | Z | B | D | U | I | N | Y | U | H | T | A |

## How to solve

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} * \begin{pmatrix} M \\ E \\ M \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix} * \begin{pmatrix} 12 \\ 4 \\ 12 \end{pmatrix} \equiv \begin{pmatrix} 12 * 12 + 20 * 4 + 11 * 12 \\ 19 * 12 + 8 * 4 + 19 * 12 \\ 14 * 12 + 13 * 4 + 4 * 12 \end{pmatrix} \equiv \begin{pmatrix} 356 \\ 488 \\ 268 \end{pmatrix} \equiv \begin{pmatrix} 18 \\ 20 \\ 8 \end{pmatrix} \pmod{26} \equiv \begin{pmatrix} S \\ U \\ I \end{pmatrix}$$

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} * \begin{pmatrix} B \\ R \\ A \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix} * \begin{pmatrix} 1 \\ 17 \\ 0 \end{pmatrix} \equiv \begin{pmatrix} 12 * 1 + 20 * 17 + 11 * 0 \\ 19 * 1 + 8 * 17 + 19 * 0 \\ 14 * 1 + 13 * 17 + 4 * 0 \end{pmatrix} \equiv \begin{pmatrix} 352 \\ 155 \\ 235 \end{pmatrix} \equiv \begin{pmatrix} 14 \\ 25 \\ 1 \end{pmatrix} \pmod{26} \equiv \begin{pmatrix} O \\ Z \\ B \end{pmatrix}$$

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} * \begin{pmatrix} N \\ O \\ P \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix} * \begin{pmatrix} 13 \\ 14 \\ 15 \end{pmatrix} \equiv \begin{pmatrix} 12 * 13 + 20 * 14 + 11 * 15 \\ 19 * 13 + 8 * 14 + 19 * 15 \\ 14 * 13 + 13 * 14 + 4 * 15 \end{pmatrix} \equiv \begin{pmatrix} 601 \\ 644 \\ 424 \end{pmatrix} \equiv \begin{pmatrix} 3 \\ 20 \\ 8 \end{pmatrix} \pmod{26} \equiv \begin{pmatrix} D \\ U \\ I \end{pmatrix}$$

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} * \begin{pmatrix} H \\ O \\ N \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix} * \begin{pmatrix} 7 \\ 14 \\ 13 \end{pmatrix} \equiv \begin{pmatrix} 12 * 7 + 20 * 14 + 11 * 13 \\ 19 * 7 + 8 * 14 + 19 * 13 \\ 14 * 7 + 13 * 14 + 4 * 13 \end{pmatrix} \equiv \begin{pmatrix} 507 \\ 492 \\ 332 \end{pmatrix} \equiv \begin{pmatrix} 13 \\ 24 \\ 20 \end{pmatrix} \pmod{26} \equiv \begin{pmatrix} N \\ Y \\ U \end{pmatrix}$$

$$\begin{pmatrix} M & U & L \\ T & I & T \\ O & N & E \end{pmatrix} * \begin{pmatrix} E \\ S \\ Z \end{pmatrix} \equiv \begin{pmatrix} 12 & 20 & 11 \\ 19 & 8 & 19 \\ 14 & 13 & 4 \end{pmatrix} * \begin{pmatrix} 4 \\ 18 \\ 25 \end{pmatrix} \equiv \begin{pmatrix} 12 * 4 + 20 * 18 + 11 * 25 \\ 19 * 4 + 8 * 18 + 19 * 25 \\ 14 * 4 + 13 * 18 + 4 * 25 \end{pmatrix} \equiv \begin{pmatrix} 683 \\ 695 \\ 390 \end{pmatrix} \equiv \begin{pmatrix} 7 \\ 19 \\ 0 \end{pmatrix} \pmod{26} \equiv \begin{pmatrix} H \\ T \\ A \end{pmatrix}$$



13) [200 points] Solve this Aristocrat which is a quote from the Your Daily Random Comment thread.

**"BDYOM, T ETBGFJJFY JDVFDGF EOIA YDEG BUF UOIEOM DG  
 "TODAY, I WITNESSED SOMEONE WALK DOWN THE HALLWAY ON**

**BUFTX UOGYJ."  
 THEIR HANDS."**

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

14) [675 points] Solve this K2 Patristocrat which is a quote from the How to Get to Nationals and Beat Troy thread.

**DWYIB NTDGR ITYKY EGXAA TYBOR NBBIY KOEBL NKORK  
 SHORT ANSWE RNOYO UWILL NOTBE ATTRO YBUTM AYBEY**

**YEIBR NLGXA AYTRQ NK  
 OURTE AMWIL LONED AY**

Short answer: No, you will not beat Troy, but maybe your team will one day.

| <b>Replacement</b> | N | O | P | Q | R | U | V | W | X | Z | S | A | L | T | Y | C | H | I | D | B | E | F | G | J | K | M |
|--------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <b>K2</b>          | 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>Frequency</b>   | 4 | 6 |   | 2 | 3 |   | 3 |   | 4 |   | 5 | 2 |   | 5 | 3 |   | 1 | 5 |   | 4 |   |   | 1 | 2 | 7 |   |

15) [200 points] Solve this Aristocrat which is a quote from the Anatomy and Physiology B/C thread.

**Y ESKYSWS GP DOYRX VOP O QSOXJZS AVSZS BHI FOR GHWS  
I BELIEVE MS PAINT HAS A FEATURE WHERE YOU CAN MOVE**

**O DOZX HQ O DYFXJZS QZHG HRS KHFOXYHR XH ORHXVSZ.  
A PART OF A PICTURE FROM ONE LOCATION TO ANOTHER.**

|             | 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 | 1 |   | 3 | 1 | 3 | 3 | 9 |   | 3 | 2 |   |   |   | 10 | 2 | 3 | 5 | 11 |   |   | 3 | 2 | 7 | 5 | 6 |
| Replacement | W | Y | G | P | B | C | M | O | J | U | L | Z | X | D | A  | S | F | N | E  | K | Q | H | V | T | I | R |

16) [350 points] Solve this Aristocrat which is a quote from the Science Olympiad at MIT Invitational 2019 thread.

**...AGW TWRUBDWK BWDWR WJWDA RYZWKJURCK OUNN LW AGW  
...THE DESIGNER GENES EVENT SUPERVISOR WILL BE THE**

**DEAUCDENR RYZWKJURCK? (U AGUDX UA'R TWRUBDWK BWDWR.)  
NATIONALS SUPERVISOR? (I THINK IT'S DESIGNER GENES.)**

|             | 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 | 3 | 8 | 2 |   | 3 |   |   | 3 | 6 | 1 |   | 3 | 1 |   |   | 10 |   | 2 | 9 |   | 15 | 1 | 2 | 2 |
| Replacement | T | G | O | N | A | M | H | C | J | V | R | B | Y | L | W | X | Z | S  | F | D | I | Q | E  | K | U | P |

17) [725 points] Solve this Xenocrypt which is a translation of a quote from the Those Moments You Will Never Forget thread into Spanish and has been encoded with a K1 alphabet using an English keyword.

**WA ESF WFGQVSF, HAQ ZSDQ QAGWF VW RM BDMRWD WJWAGS,  
EN LOS ESTADOS, UNA HORA ANTES DE MI PRIMER EVENTO,**

**SGDSF VSF USRBQLWDSF VW WCHMBS O OS XHMRSF Q UQPQD  
OTROS DOS COMPAÑEROS DE EQUIPO Y YO FUIMOS A CAZAR**

**BMDMGQF.  
PIRITAS.**

| Replacement      | Q | T | U | V | W | X | Y | Z | M | I | N | E | R | A | L | S | B | C | D | F  | G | H | J | K  | Ñ | O | P |
|------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|---|---|---|----|---|---|---|
| <b>K2</b>        | 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 |
| <b>Frequency</b> | 4 | 4 | 1 | 7 | 1 | 9 | 5 | 3 |   | 1 |   | 1 | 6 |   |   | 2 | 1 | 9 | 4 | 12 |   | 2 | 4 | 10 | 1 |   | 1 |

Translation: *At states, one hour before my first event, 2 other teammates and I went pyrite-hunting.*

18) [200 points] This quote from the Your Daily Random Comment thread has been encoded using a key, and you know that the first two letters are LV. Figure out what the rest of it says.

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

Click on any two columns to choose the decode problem

## How to solve

Indeterminate Solution! Please choose other letters.

19) [125 points] Andrew and Lauren want to communicate with each other using RSA for encryption. Andrew generates RSA keys obtaining the following values:

$$\begin{aligned} p &= 163 & e &= 8597 \\ q &= 521 & d &= 22253 \\ \phi &= 84240 & n &= 84923 \end{aligned}$$

Likewise, Lauren also generates RSA keys resulting in the values

$$\begin{aligned} e &= 90119 & q &= 163 \\ p &= 751 & n &= 580523 \\ d &= 75479 & \phi &= 579000 \end{aligned}$$

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 Lauren needs to calculate in order to transmit the value 446 to Andrew

Enter the minimum values that Andrew need to transmit to Lauren:

|              |             |  |
|--------------|-------------|--|
| <b>84923</b> | <b>8597</b> |  |
|--------------|-------------|--|

*These two numbers can be in either order.*

Enter the minimum values that Lauren need to transmit to Andrew:

|               |              |  |
|---------------|--------------|--|
| <b>580523</b> | <b>90119</b> |  |
|---------------|--------------|--|

*These two numbers can be in either order.*

Write the formula Lauren needs to calculate in order to transmit the value 14566 to Andrew

|  |
|--|
| <b><math>14566 \wedge 8597 \text{ mod } 84923</math></b> |
|--|

## How to solve

Andrew needs to send only their public key ( $e=8597, n=84923$ ) to Lauren

Lauren needs to send only their public key ( $e=90119, n=580523$ ) to Andrew

Lauren needs to use Andrew's public key ( $n = 84923, e = 8597$ ) in order to encrypt the value 14566.

Hence the formula is:  $\text{value} \wedge e \text{ mod } n$