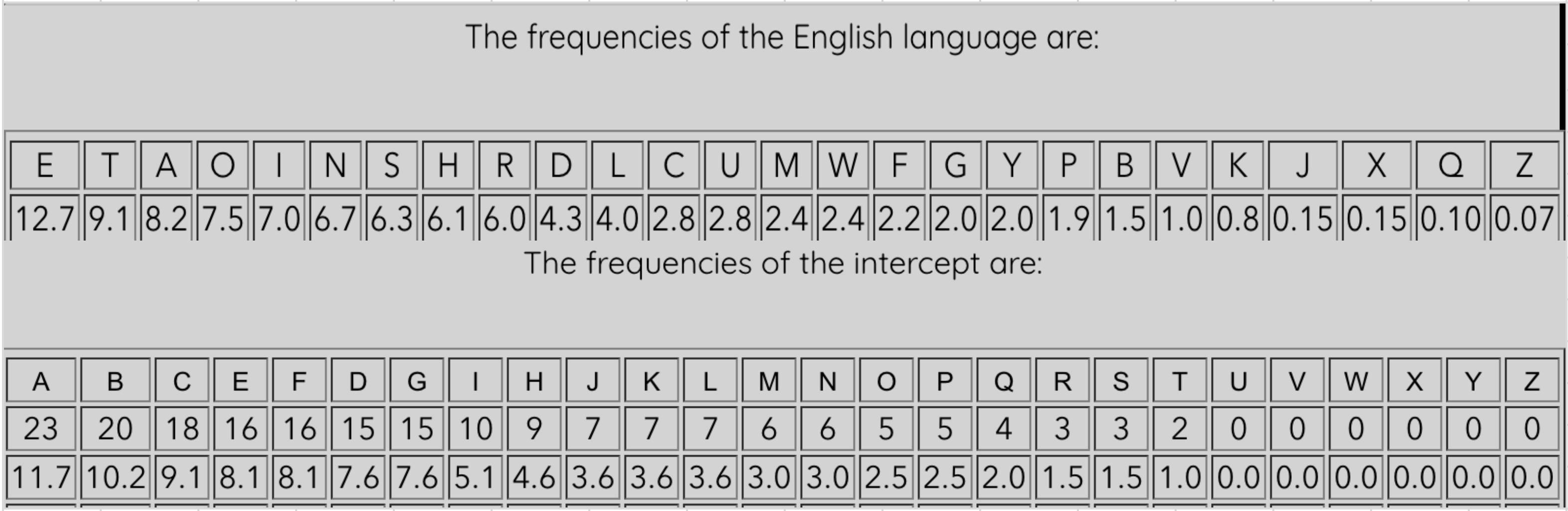
Student name: Wenhao Lu
Student number:S3810097
Class number:COSC2536

Q1

	convert into binary numbers																	
Key1:	23888	101110101010000	0	1	0	1	1	1	0	1	0	1	0	1	0	0	0	0
Key2:	44567	1010111000010111	1	0	1	0	1	1	1	0	0	0	0	1	0	1	1	1
			□combine Key1 and key2 with XOR method:															
		key4:	1	1	1	1	0	0	1	1	0	1	0	0	0	1	1	1
Key3:	58991	1110011001101111	1	1	1	0	0	1	1	0	0	1	1	0	1	1	1	1
			□combine Key3 and key4 with XOR method:															
			0	0	0	1	0	1	0	1	0	0	1	0	1	0	0	0
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
			0	0	0	4096	0	1024	0	256	0	0	32	0	8	0	0	0
			□convert into decimal number:															
		Master key:	5416															

q2



The frequencies of the English language are:

E	T	A	O	I	N	S	H	R	D	L	C	U	M	W	F	G	Y	P	B	V	K	J	X	Q	Z
12.7	9.1	8.2	7.5	7.0	6.7	6.3	6.1	6.0	4.3	4.0	2.8	2.8	2.4	2.4	2.2	2.0	2.0	1.9	1.5	1.0	0.8	0.15	0.15	0.10	0.07

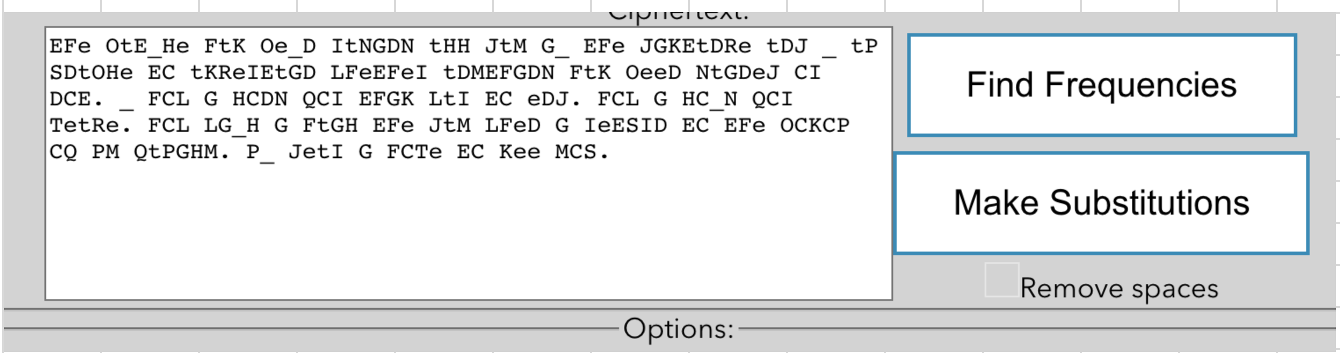
Table1

The frequencies of the intercept are:

A	B	C	E	F	D	G	I	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
23	20	18	16	16	15	15	10	9	7	7	7	6	6	5	5	4	3	3	2	0	0	0	0	0	0
11.7	10.2	9.1	8.1	8.1	7.6	7.6	5.1	4.6	3.6	3.6	3.6	3.0	3.0	2.5	2.5	2.0	1.5	1.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0

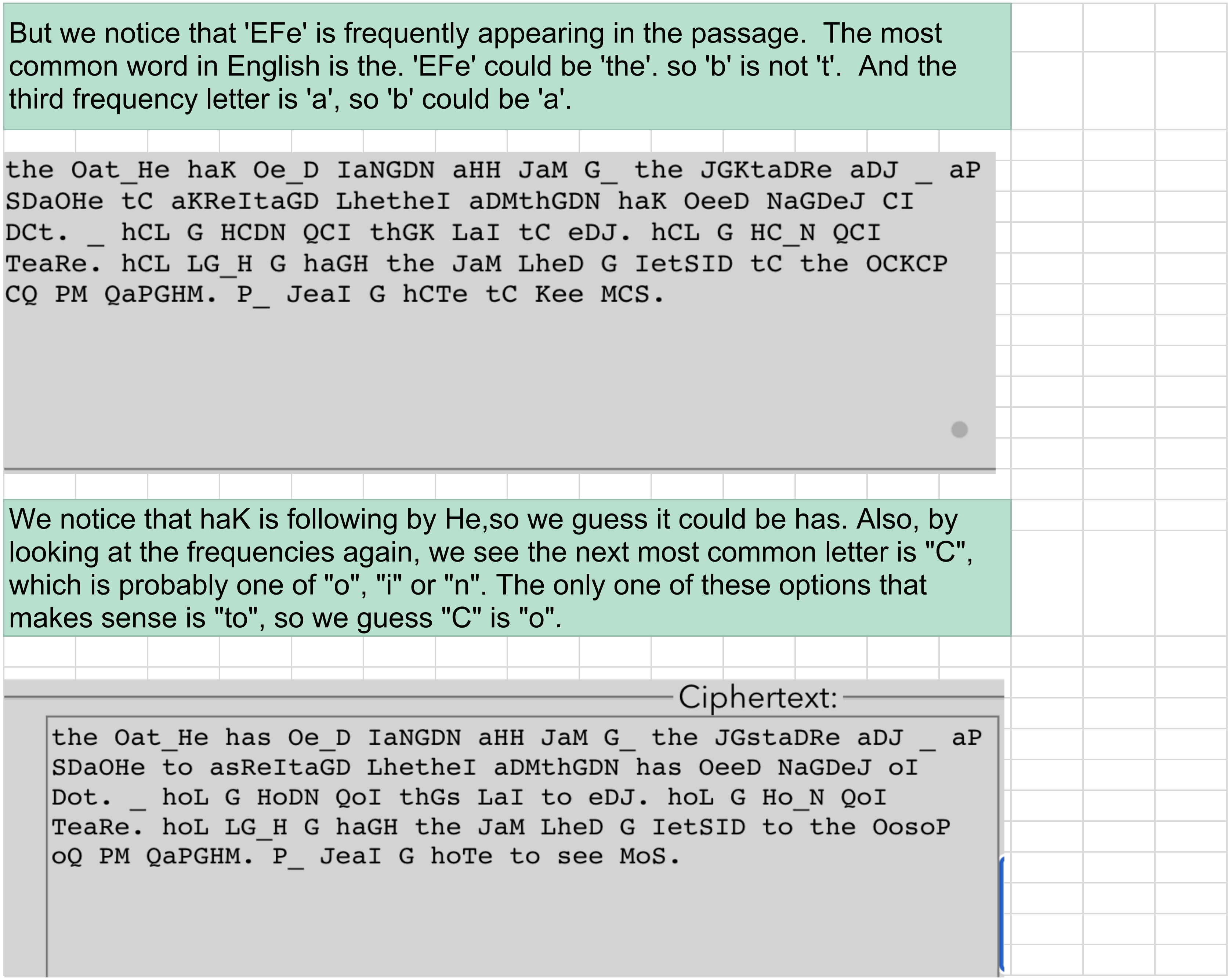
Table2

We see the most common cyphertext letter is a and b. From table 1 above, we guess that these two letters represent 'e' and 't' respectively, and make substitution we get:



Ciphertext:

```
EFe OtE_He FtK Oe_D ItNGDN tHH JtM G_ EFe JGKEtDRe tDJ _ tP
SDtOHe EC tKReIEtGD LFeEFeI tDMEFGDN FtK OeeD NtGDeJ CI
DCE. _ FCL G HCDN QCI EFGK LtI EC eDJ. FCL G HC_N QCI
TetRe. FCL LG_H G FtGH EFe JtM LFeD G IeESID EC EFe OCKCP
CQ PM QtPGHM. P_ JetI G FCTe EC Kee MCS.
```



But we notice that 'EFe' is frequently appearing in the passage. The most common word in English is the. 'EFe' could be 'the'. so 'b' is not 't'. And the third frequency letter is 'a', so 'b' could be 'a'.

```
the Oat_He haK Oe_D IaNGDN aHH JaM G_ the JGKtaDRe aDJ _ aP
SDaOHe tC aKReItaGD LhetheI aDMthGDN haK OeeD NaGDeJ CI
DCt. _ hCL G HCDN QCI thGK LaI tC eDJ. hCL G HC_N QCI
TeaRe. hCL LG_H G haGH the JaM LheD G IetSID tC the OCKCP
CQ PM QaPGHM. P_ JeaI G hCTe tC Kee MCS.
```

We notice that haK is following by He,so we guess it could be has. Also, by looking at the frequencies again, we see the next most common letter is "C", which is probably one of "o", "i" or "n". The only one of these options that makes sense is "to", so we guess "C" is "o".

```
the Oat_He has Oe_D IaNGDN aHH JaM G_ the JGstaDRe aDJ _ aP
SDaOHe to asReItaGD LhetheI aDMthGDN has OeeD NaGDeJ oI
Dot. _ hoL G HoDN QoI thGs LaI to eDJ. hoL G Ho_N QoI
TeaRe. hoL LG_H G haGH the JaM LheD G IetSID to the OosoP
oQ PM QaPGHM. P_ JeaI G hoTe to see MoS.
```

from ciphertext line 1, we see the word "aHH" which could be all in english, so "i" was represent by "h"

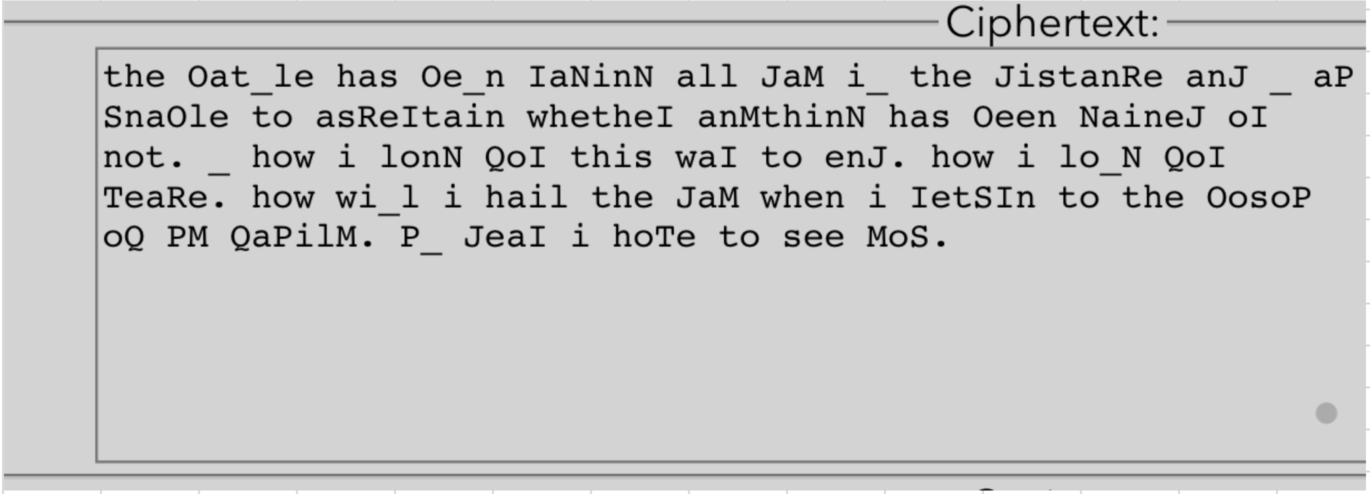
```
the Oat_le has Oe_D IaNGDN all JaM G_ the JGstaDRe aDJ _ aP
SDaOle to asReItaGD LhetheI aDMthGDN has OeeD NaGDeJ oI
Dot. _ hoL G loDN QoI thGs LaI to eDJ. hoL G lo_N QoI
TeaRe. hoL LG_l G haGl the JaM LheD G IetSID to the OosoP
oQ PM QaPGlM. P_ JeaI G hoTe to see MoS.
```

Then we notice that the letter "g" was appearing many time in the passage as a single word, so we guess it could be "i" in english

Ciphertext:

```
the Oat_le has Oe_D IaNiDN all JaM i_ the JistaDRe aDJ _ aP
SDaOle to asReItaiD LhetheI aDMthiDN has OeeD NaiDeJ oI
Dot. _ hoL i loDN QoI this LaI to eDJ. hoL i lo_N QoI
TeaRe. hoL Li_l i hail the JaM LheD i IetSID to the OosoP
oQ PM QaPilM. P_ JeaI i hoTe to see MoS.
```

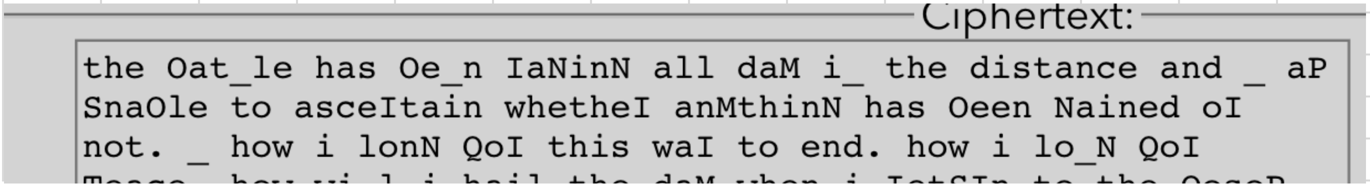
by looking at the frequencies again, we see the next most common letter is "D", which is probably "n". And the word "hoL" was also apearing frequently which could be "How" in english.



Ciphertext:

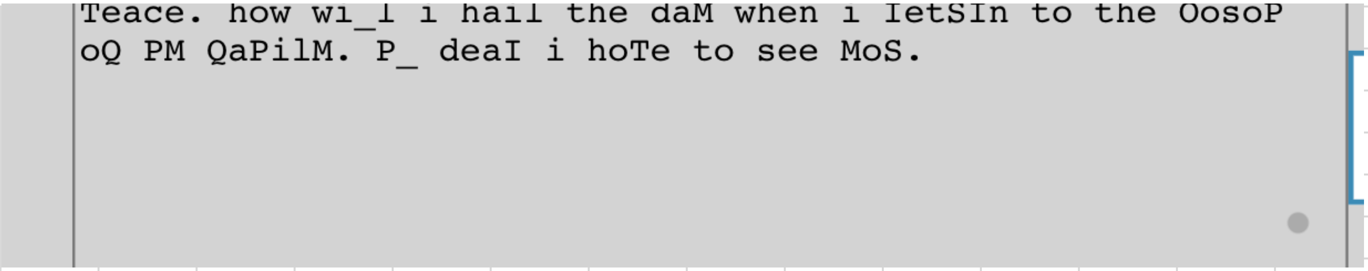
```
the Oat_le has Oe_n IaNinN all JaM i_ the JistanRe anJ _ aP
SnaOle to asReItain whetheI anMthinN has Oeen NaineJ oI
not. _ how i lonN QoI this waI to enJ. how i lo_N QoI
TeaRe. how wi_l i hail the JaM when i IetSIn to the OosoP
oQ PM QaPilM. P_ JeaI i hoTe to see MoS.
```

in line 1, we notice the word"JistanRe" which is probably the word "distance" in english, so we guess that "J" and "R" represent "d" and "c" respectively.



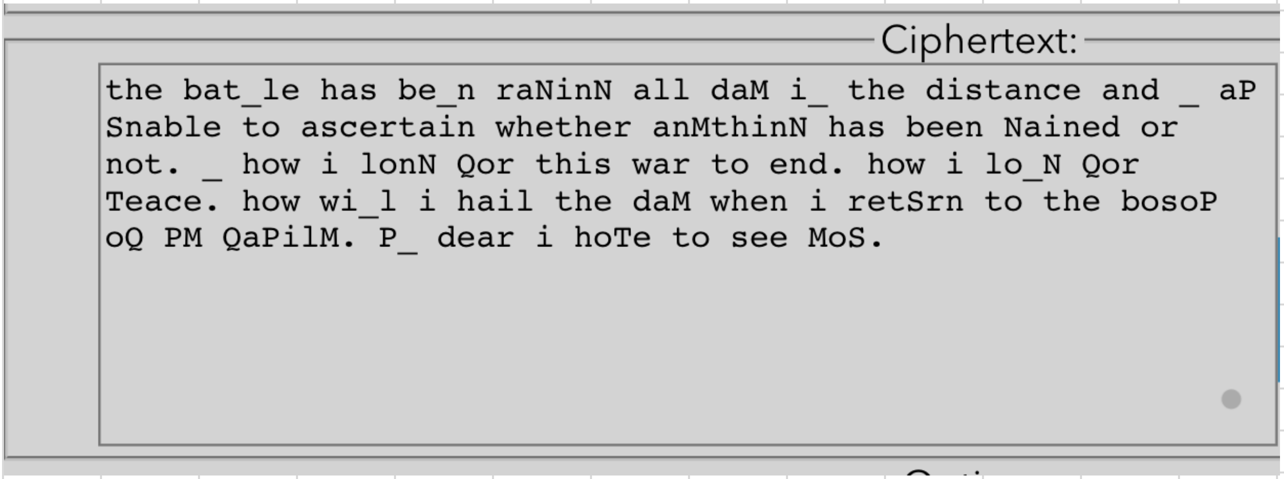
Ciphertext:

```
the Oat_le has Oe_n IaNinN all daM i_ the distance and _ aP
SnaOle to asceItain whetheI anMthinN has Oeen Nained oI
not. _ how i lonN QoI this waI to end. how i lo_N QoI
Teace. how wi_l i hail the daM when i IetSIn to the OosoP
```



```
Teace. how wi_l i hail the daM when i IetSIn to the OosoP
oQ PM QaPilM. P_ deaI i hoTe to see MoS.
```

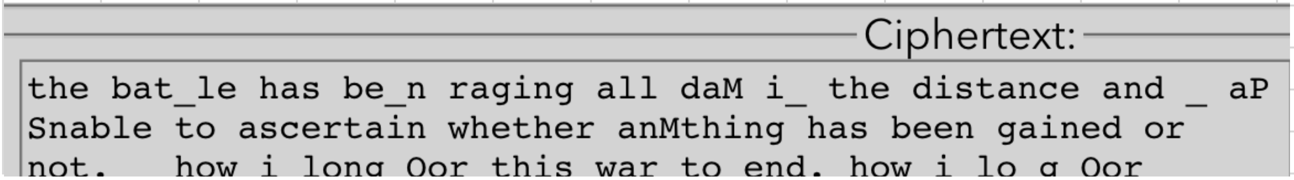
We see the word "whethel", which could be "whether", so "l" is r.
in the third line, the phrase "has Oeen" which could be "has been", so "o" is "b"



Ciphertext:

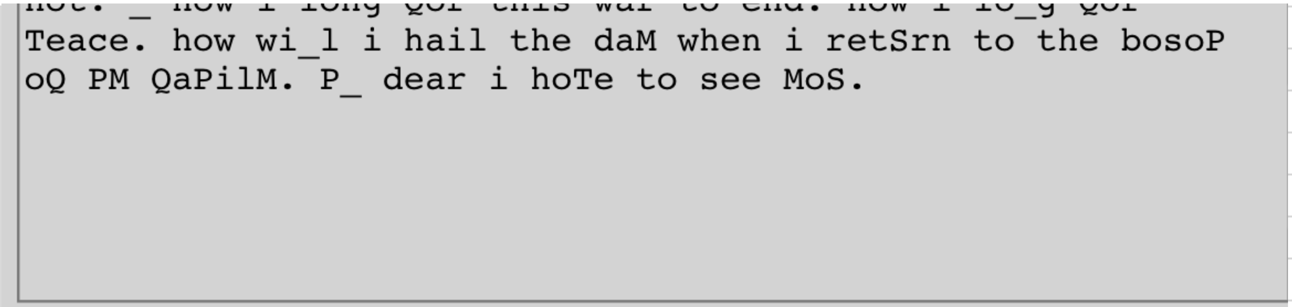
```
the bat_le has be_n raNinN all daM i_ the distance and _ aP
Snable to ascertain whether anMthinN has been Nained or
not. _ how i lonN Qor this war to end. how i lo_N Qor
Teace. how wi_l i hail the daM when i retSrn to the bosoP
oQ PM QaPilM. P_ dear i hoTe to see MoS.
```

we notice the word "raNinN" which is probably "raging", "g" was represented by "n". "



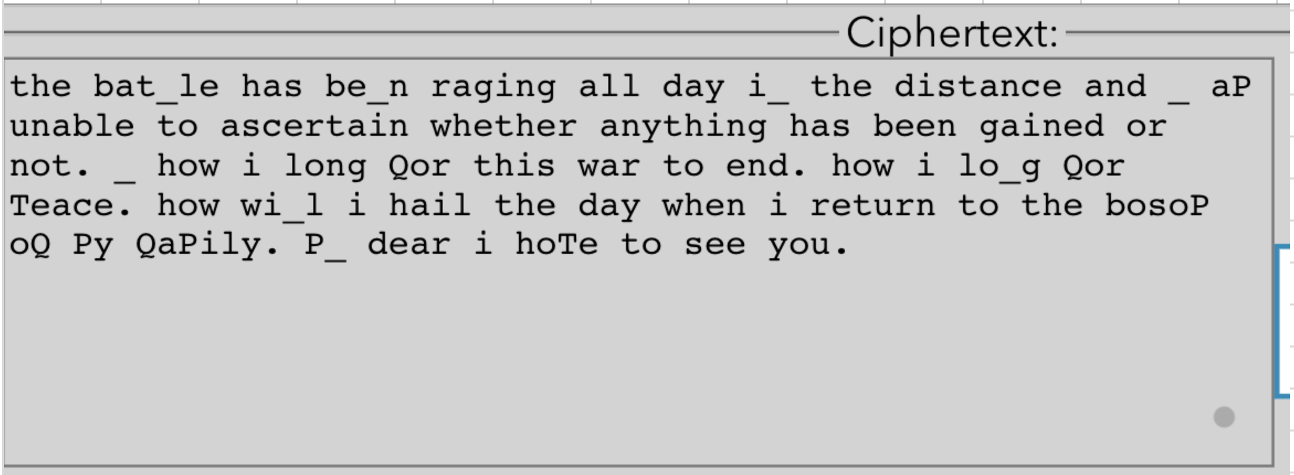
Ciphertext:

```
the bat_le has be_n raging all daM i_ the distance and _ aP
Snable to ascertain whether anMthing has been gained or
not.   how i long Oor this war to end. how i lo g Oor
```



```
not. _ how i long Qor this war to end. how i lo_g Qor
Teace. how wi_l i hail the daM when i retSrn to the bosoP
oQ PM QaPilM. P_ dear i hoTe to see MoS.
```

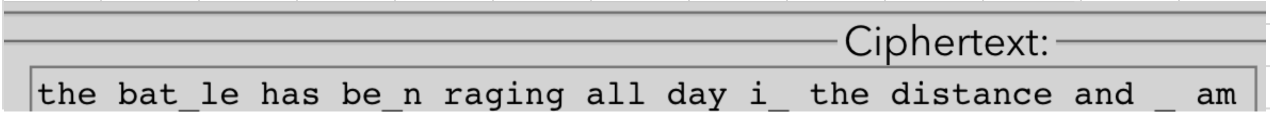
the word "daM" which is probably "day",so "m" is y
in the line4. "retuSrn" is probably the word "return", so "s" is u



Ciphertext:

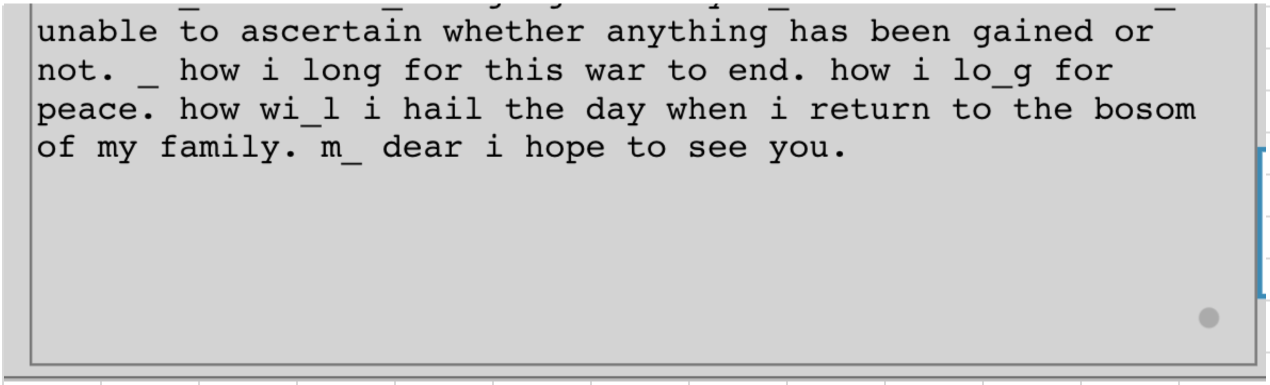
```
the bat_le has be_n raging all day i_ the distance and _ aP
unable to ascertain whether anything has been gained or
not. _ how i long Qor this war to end. how i lo_g Qor
Teace. how wi_l i hail the day when i return to the bosoP
oQ Py QaPily. P_ dear i hoTe to see you.
```

"Oor" which is the word "for", so 'O' is ' f'.
in line4 ,"teace" is probably "peace ,so "t" is "p".
then we move to the last line, "faPily" which is 'family' , so 'p' is 'm'.



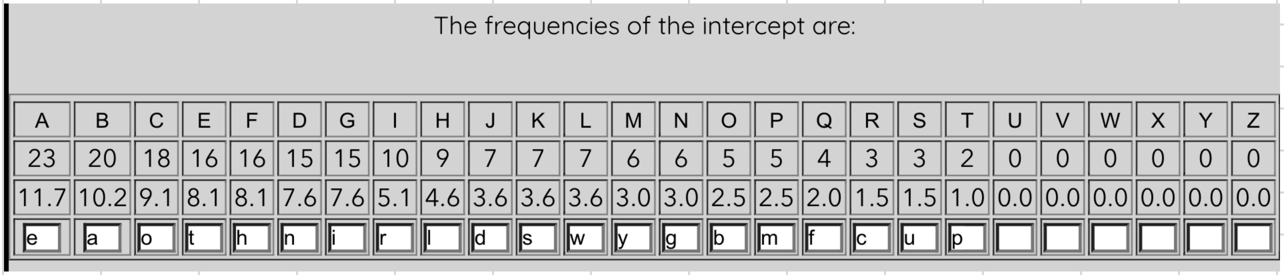
Ciphertext:

```
the bat_le has be_n raging all day i_ the distance and _ am
```



```
unable to ascertain whether anything has been gained or
not. _ how i long for this war to end. how i lo_g for
peace. how wi_l i hail the day when i return to the bosom
of my family. m_ dear i hope to see you.
```

The final list of substitutions is given below:

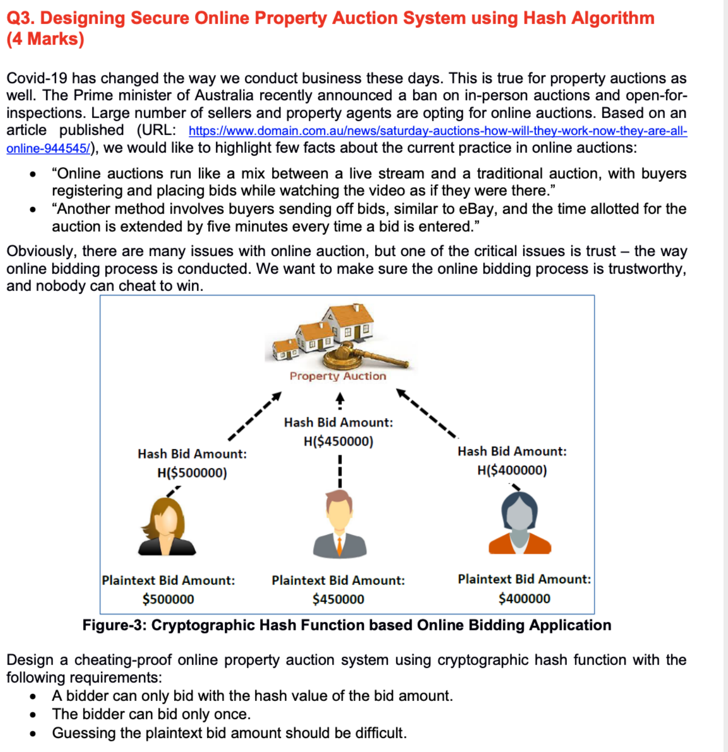


The frequencies of the intercept are:

A	B	C	E	F	D	G	I	H	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
23	20	18	16	16	15	15	10	9	7	7	7	6	6	5	5	4	3	3	2	0	0	0	0	0	0
11.7	10.2	9.1	8.1	8.1	7.6	7.6	5.1	4.6	3.6	3.6	3.6	3.0	3.0	2.5	2.5	2.0	1.5	1.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0
e	a	o	t	h	n	i	r	l	d	s	w	y	g	b	m	f	c	u	p						

Finally,we type the missing letter in the passage we got :
The battle has been raging all day in the distance and I am unable to ascertain whether anything has been gained or not. How i long for this war to end. How I long for peace. How will i hail the day when I return to the bosom of my family. My dear I hope to see you.

Q3



Q3. Designing Secure Online Property Auction System using Hash Algorithm (4 Marks)

Covid-19 has changed the way we conduct business these days. This is true for property auctions as well. The Prime minister of Australia recently announced a ban on in-person auctions and open-for-inspections. Large number of sellers and property agents are opting for online auctions. Based on an article published (URL: https://www.domain.com.au/news/saturday-auctions-how-will-they-work-now-they-are-all-online-944545/), we would like to highlight few facts about the current practice in online auctions:

- "Online auctions run like a mix between a live stream and a traditional auction, with buyers registering and placing bids while watching the video as if they were there."
- "Another method involves buyers sending off bids, similar to eBay, and the time allotted for the auction is extended by five minutes every time a bid is entered."

Obviously, there are many issues with online auction, but one of the critical issues is trust – the way online bidding process is conducted. We want to make sure the online bidding process is trustworthy, and nobody can cheat to win.

Figure-3: Cryptographic Hash Function based Online Bidding Application

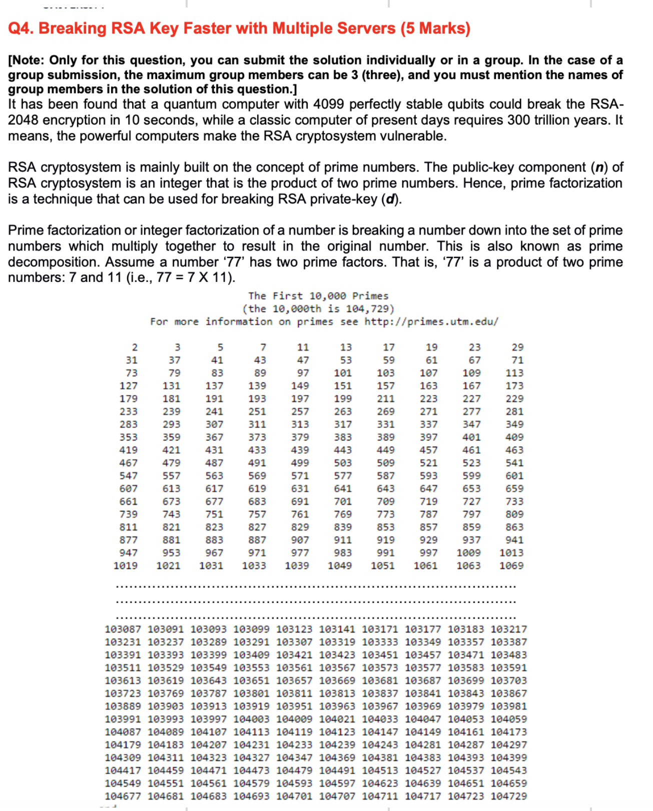
Design a cheating-proof online property auction system using cryptographic hash function with the following requirements:

- A bidder can only bid with the hash value of the bid amount.
- The bidder can bid only once.
- Guessing the plaintext bid amount should be difficult.

Firstly, every bidder will receive a 6-characters-long random string from sellers such as : adYsdw
we can use this website to get a random string:https://www.random.org/strings/
Then the bidder should combine the string they received with bid amount like 500000adYsdw
then submit h(500000adYsdw) using SHA-256, it will ensure the other bidder can not guess the price they submit because they do not know the 6 random string.
there is a example :
bidder A
6-characters-long string:ofAkKO
the bid amount:400000
combination of two value, we get: 400000ofAkKO

400000ofAkKO	c3f52fae80a8fa1d87841bf77646bbc741e923326750d83923917b8be26768e8

Q4



Q4. Breaking RSA Key Faster with Multiple Servers (5 Marks)

[Note: Only for this question, you can submit the solution individually or in a group. In the case of a group submission, the maximum group members can be 3 (three), and you must mention the names of group members in the solution of this question.]
It has been found that a quantum computer with 4099 perfectly stable qubits could break the RSA-2048 encryption in 10 seconds, while a classic computer of present days requires 300 trillion years. It means, the powerful computers make the RSA cryptosystem vulnerable.

RSA cryptosystem is mainly built on the concept of prime numbers. The public-key component (***n***) of RSA cryptosystem is an integer that is the product of two prime numbers. Hence, prime factorization is a technique that can be used for breaking RSA private-key (***d***).

Prime factorization or integer factorization of a number is breaking a number down into the set of prime numbers which multiply together to result in the original number. This is also known as prime decomposition. Assume a number '77' has two prime factors. That is, '77' is a product of two prime numbers: 7 and 11 (i.e., 77 = 7 X 11).

```
                    The First 10,000 Primes
                   (the 10,000th is 104,729)
        For more information on primes see http://primes.utm.edu/

      2      3      5      7     11     13     17     19     23     29
     31     37     41     43     47     53     59     61     67     71
     73     79     83     89     97    101    103    107    109    113
    127    131    137    139    149    151    157    163    167    173
    179    181    191    193    197    199    211    223    227    229
    233    239    241    251    257    263    269    271    277    281
    283    293    307    311    313    317    331    337    347    349
    353    359    367    373    379    383    389    397    401    409
    419    421    431    433    439    443    449    457    461    463
    467    479    487    491    499    503    509    521    523    541
    547    557    563    569    571    577    587    593    599    601
    607    613    617    619    631    641    643    647    653    659
    661    673    677    683    691    701    709    719    727    733
    739    743    751    757    761    769    773    787    797    809
    811    821    823    827    829    839    853    857    859    863
    877    881    883    887    907    911    919    929    937    941
    947    953    967    971    977    983    991    997   1009   1013
   1019   1021   1031   1033   1039   1049   1051   1061   1063   1069

    ..........................................................................
    ..........................................................................
    ..........................................................................
 103087 103091 103093 103099 103123 103141 103171 103177 103183 103217
 103231 103237 103289 103291 103307 103319 103333 103349 103357 103387
 103391 103393 103399 103409 103421 103423 103451 103457 103471 103483
 103511 103529 103549 103553 103561 103567 103573 103577 103583 103591
 103613 103619 103643 103651 103657 103669 103681 103687 103699 103703
 103723 103769 103787 103801 103811 103813 103837 103841 103843 103867
 103889 103903 103913 103919 103951 103963 103967 103969 103979 103981
 103991 103993 103997 104003 104009 104021 104033 104047 104053 104059
 104087 104089 104107 104113 104119 104123 104147 104149 104161 104173
 104179 104183 104207 104231 104233 104239 104243 104281 104287 104297
 104309 104311 104323 104327 104347 104369 104381 104383 104393 104399
 104417 104459 104471 104473 104479 104491 104513 104527 104537 104543
 104549 104551 104561 104579 104593 104597 104623 104639 104651 104659
 104677 104681 104683 104693 104701 104707 104711 104717 104723 104729
```

From the question, we know n =10772542097 and e = 95177

We can factorise n(10772542097) using wolframalpha to find p and q (link:https://www.wolframalpha.com/)

10772542097=103619*103963 these two numbers are also on the given table

then we knew the p and q, we should find out ϕ(n) because ϕ(n) = (p - 1) * (q - 1)

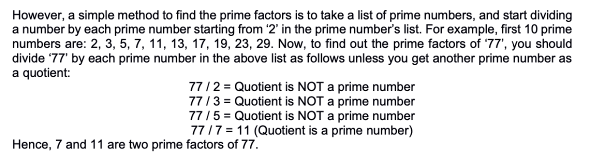
ϕ(n) = (103619-1)*(103963-1)=10772334516

then we should find out d because d = e^(-1) mod ϕ(n),

d=95177^(-1) mod 10772334516=3758212253

finally, we can decrypt C to get the value of M, M = C^d mod n

M=c^3758212253 mod 10772542097



However, a simple method to find the prime factors is to take a list of prime numbers, and start dividing a number by each prime number starting from '2' in the prime number's list. For example, first 10 prime numbers are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29. Now, to find out the prime factors of '77', you should divide '77' by each prime number in the above list as follows unless you get another prime number as a quotient:

77 / 2 = Quotient is NOT a prime number
77 / 3 = Quotient is NOT a prime number
77 / 5 = Quotient is NOT a prime number
77 / 7 = 11 (Quotient is a prime number)

Hence, 7 and 11 are two prime factors of 77.

As you know from Lecture-3 and Tutorial-3, the public-key component (n) of the RSA cryptosystems is an integer that has two prime numbers. Assume that you have found the RSA public-key as: **n = 10772542097 and e = 95177**. You want to find the **private-key (d)** for the above RSA public-key.

Say, you have the list of first 10000 prime numbers as partially shown in **Figure-4**. A complete list of first 10000 prime numbers can be found in the URL: https://primes.utm.edu/lists/small/10000.txt. Assume that you have **10 computers**. How can you take advantage of the 10 computers and perform the integer factorization tasks mentioned above to break RSA faster? Explain your algorithm and show detail steps. Please note that we are not interested in any established approach found in textbooks to find prime factors. A simple brute-force method should do the work.

[https://www.quintessencelabs.com/blog/breaking-rsa-encryption-update-state-art/]