

# Ciphertext

```
In [1]: from collections import Counter
file = open("ciphertext.txt", "r")

ciphertext = file.read()

ciphertext = ciphertext.replace("\n", "")

print(ciphertext)
```

hfcnkopw ahyplhp ya wznysgj hxzlvylv oxp qfwgs qyox lpq spdpqfncploa xznnplyl  
v pdpwj szj z wyvfwfka pskhzoyfl hfceylylv oxp oxpfwj fu ylufwczoyfl zls hfcn  
kozoyfl qyox xzlsaf1 ajaopca zls afuoqzwp spayvl ya oxp ipj of akhhpaa za flp  
fu oxp fgspao hfcnkopw ahyplhp spnzwocploa yl oxp hxyhzvf zwpx oxp ha spnzwoc  
plo zo yyo xza z gflv xyafwj fu cppoylv oxya hxzggplvp oxwfkvx mkzgyoj pskhz  
oyfl yl aczgg hgzaawffc pldywflcploa zgflv qyox ylopwlaxyn zls wpapzwhx fnnfw  
oklyoypa yl ylskaowj zls lzoyflzg gzefwzofwypayyo aoksploa qfwi qyox fkw uzkh  
goj fl qfwgshgzaa wpapzwhx yl zwpxa oxzo ylhgksp szoz ahyplhp syaowyekops aja  
opca ylufwczoyfl wpowypdzg hfcnkopw lpoqfwiylv ylopggyvplo ylufwczoyfl ajaopc  
a zls zgvfwyoxca oxp spnzwocplo fuupwa ezhxpgfw fu ahyplhp czaopw fu ahyplhp  
nwfupaayflzg czaopw zls nxs spvwppa ngka vwzskzop hpwoyuyhzopa zhhpqpwzops hf  
kwapa zls lflspvwpp aoks1 nzwooycp aoksploa hz1 ozip pdplylv hgzaapa zls gflv  
syaozlh1 aoksploa hz1 pzw1 czaopwa spvwppa flgylp aoksploa wzop fkw opzhxylv  
za zcflv oxp epao zo oxp klydpwayoj zls fkw uzkhgoj xzdp qfl lkcpwfka opzhxyl  
v zqzwsaoxp aphwpo aploplhp ya vffs bfe vkja

## Text frequencies

```
In [2]: pt_frequency = [('e', '12.7 %'), ('t', '9.1 %'), ('a', '8.2 %'), ('o', '7.5 %'), ('i', '7.0 %'), ('n', '6.7 %'), ('s', '6.3 %'), ('h', '6.1 %'), ('r', '6.0 %'), ('d', '4.3 %'), ('l', '4.0 %'), ('u', '2.8 %'), ('c', '2.8 %'), ('m', '2.4 %'), ('w', '2.4 %'), ('f', '2.2 %'), ('y', '2.0 %'), ('g', '2.0 %'), ('p', '1.9 %'), ('b', '1.5 %'), ('v', '1.0 %'), ('k', '0.8 %'), ('x', '0.2 %'), ('j', '0.2 %'), ('q', '0.1 %'), ('z', '0.1 %')]
ct_frequency = []
alphabets = 'abcdefghijklmnopqrstuvwxyz'
counter = 0
size = len(ciphertext.replace(" ", ""))

for a in alphabets:
    counter = 0
    for c in ciphertext:
        if not c == ' ':
            if a == c:
                counter += 1

    ct_frequency += [(str(a), float("%.2f" % ((counter/size)*100)))]

ct_frequency.sort(key = lambda x: x[1], reverse = True)
ct_frequency = [(key, str(value) + ' %') for key, value in ct_frequency]
print('Plaintext Frequency:\n', pt_frequency)
print('\n')
print('Ciphertext Frequency:\n', ct_frequency)
```

Plaintext Frequency:

```
[('e', '12.7 %'), ('t', '9.1 %'), ('a', '8.2 %'), ('o', '7.5 %'), ('i', '7.0 %'), ('n', '6.7 %'), ('s', '6.3 %'), ('h', '6.1 %'), ('r', '6.0 %'), ('d', '4.3 %'), ('l', '4.0 %'), ('u', '2.8 %'), ('c', '2.8 %'), ('m', '2.4 %'), ('w', '2.4 %'), ('f', '2.2 %'), ('y', '2.0 %'), ('g', '2.0 %'), ('p', '1.9 %'), ('b', '1.5 %'), ('v', '1.0 %'), ('k', '0.8 %'), ('x', '0.2 %'), ('j', '0.2 %'), ('q', '0.1 %'), ('z', '0.1 %')]
```

Ciphertext Frequency:

```
[('p', '12.07 %'), ('o', '9.68 %'), ('l', '8.84 %'), ('a', '8.43 %'), ('z', '8.22 %'), ('y', '7.08 %'), ('f', '6.66 %'), ('w', '6.35 %'), ('h', '4.68 %'), ('s', '4.27 %'), ('x', '3.64 %'), ('k', '3.23 %'), ('g', '3.12 %'), ('c', '2.71 %'), ('v', '2.71 %'), ('n', '1.87 %'), ('j', '1.66 %'), ('u', '1.56 %'), ('q', '1.25 %'), ('d', '0.73 %'), ('e', '0.62 %'), ('i', '0.42 %'), ('b', '0.1 %'), ('m', '0.1 %'), ('r', '0.0 %'), ('t', '0.0 %')]
```

## One letter word in ciphertext

```
In [3]: one_letter = []
words = ciphertext.split(" ")
for w in words:
    if len(w) == 1:
        one_letter += [w]

print(Counter(one_letter))
```

Counter({'z': 2})

## Double letters

```
In [4]: double_letter = []
for w in words:
    temp = ""
    for l in w:
        if temp == l:
            double_letter += [l]
        temp = l
print(Counter(double_letter))
```

Counter({'a': 5, 'p': 4, 'g': 3, 'n': 2, 'h': 2, 'y': 2, 'f': 2, 'u': 1, 'o': 1})

## Two letter word in ciphertext

```
In [5]: two_letter = []
for w in words:
    if len(w) == 2:
        two_letter += [w]
print(Counter(two_letter))
```

Counter({'fu': 5, 'yl': 4, 'ya': 3, 'za': 2, 'zo': 2, 'of': 1, 'ha': 1, 'fl': 1})

## Three letter word in ciphertext

```
In [6]: three_letter = []
for w in words:
    if len(w) == 3:
        three_letter += [w]
print(Counter(three_letter))
```

Counter({'oxp': 9, 'zls': 9, 'fkw': 3, 'hzi': 2, 'lpq': 1, 'szj': 1, 'ipj': 1, 'flp': 1, 'yyo': 1, 'xza': 1, 'nxs': 1, 'qfl': 1, 'bfe': 1})

## Frequent initial letters

```
In [7]: size = 0
initial_frequency = []
for a in alphabets:
    counter = 0
    for w in words:
        if len(w) > 1:
            if w[0] == a:
                counter += 1
    size += counter

    initial_frequency += [(str(a), float("%.2f" % counter))]

initial_frequency.sort(key = lambda x: x[1], reverse = True)
initial_frequency = [(key, str("%.2f" %(value/size)) + ' %') for key, value in
initial_frequency]

print(initial_frequency)
```

[('z', '0.12 %'), ('a', '0.11 %'), ('o', '0.11 %'), ('h', '0.09 %'), ('y', '0.09 %'), ('f', '0.09 %'), ('s', '0.06 %'), ('q', '0.05 %'), ('p', '0.04 %'), ('w', '0.04 %'), ('l', '0.03 %'), ('x', '0.03 %'), ('c', '0.02 %'), ('n', '0.02 %'), ('g', '0.02 %'), ('v', '0.02 %'), ('e', '0.01 %'), ('u', '0.01 %'), ('b', '0.01 %'), ('i', '0.01 %'), ('k', '0.01 %'), ('m', '0.01 %'), ('d', '0.00 %'), ('j', '0.00 %'), ('r', '0.00 %'), ('t', '0.00 %')]

## Frequent final letters

```
In [8]: size = 0
final_frequency = []
for a in alphabets:
    counter = 0
    for w in words:
        if len(w) > 1:
            if w[-1] == a:
                counter += 1
    size += counter

    final_frequency += [(str(a), float("%.2f" % counter))]

final_frequency.sort(key = lambda x: x[1], reverse = True)
final_frequency = [(key, str("%.2f" %(value/size)) + ' %') for key, value in final_frequency]

print(final_frequency)

[('a', '0.21 %'), ('p', '0.17 %'), ('l', '0.11 %'), ('s', '0.09 %'), ('j', '0.07 %'), ('o', '0.07 %'), ('v', '0.07 %'), ('w', '0.06 %'), ('x', '0.04 %'), ('u', '0.03 %'), ('g', '0.02 %'), ('f', '0.01 %'), ('z', '0.01 %'), ('c', '0.01 %'), ('e', '0.01 %'), ('i', '0.01 %'), ('n', '0.01 %'), ('q', '0.01 %'), ('b', '0.00 %'), ('d', '0.00 %'), ('h', '0.00 %'), ('k', '0.00 %'), ('m', '0.00 %'), ('r', '0.00 %'), ('t', '0.00 %'), ('y', '0.00 %')]
```

## Substitution

```
In [9]: cipher_to_plain = {}
```

## One Letter Frequency (z)

```
In [10]: cipher_to_plain['z'] = 'A'
ciphertext = ciphertext.replace('z', 'A')
ciphertext
```

```
Out[10]: 'hfcnkopw ahypplhp ya wAnysgj hxAlvyllv oxp qfwgs qyox lpq spdpgfncploa xAnnply
lv pdpwj sAj A wyvfwfka pskhAoyfl hfceylylv oxp oxpfwj fu ylufwcAoyfl Als hfc
nkoAoyfl qyox xAlsafl ajaopca Als afuoqAwspayvl ya oxp ipj of akhhpaa Aa fl
p fu oxp fgspao hfcnkopw ahypplhp spnAwocploa yl oxp hxyhAvf Awpa oxp ha spnAw
ocplo Ao yyo xAa A gflv xyafwj fu cppoylv oxya hxAggplvp oxwfkvx mkAgyoj psk
hAoyfl yl acAgg hgAaawffc pldywflcploa Agflv qyox ylopwlaxyn Als wpapAwhx fnn
fwoklyoypa yl ylskaowj Als lAoyflAg gAefwAofwypayyo aoksploa qfwi qyox fkw uA
hkgoj fl qfwgshgAaa wpapAwhx yl AwpaAa oxAo ylhgksp sAoA ahypplhp syaowyekops a
jaopca ylufwcAoyfl wpowypdAg hfcnkopw lpoqfwyylv ylopogyvplo ylufwcAoyfl ajao
pca Als Agvfwyoxca oxp spnAwocplo fuupwa eAhxpgfw fu ahypplhp cAapw fu ahypplh
p nwfupaayflAg cAapw Als nxs spvwppa ngka vwAskAop hpwoyuyhAopa AhhpgpwAops
hfkwapA Als lflspvwpp aoksj nAwooycp aoksploa hAl oAip pdplylv hgAaapa Als gf
lvsyaoAlhp aoksploa hAl pAwl cAapwa spvwppa flgylp aoksploa wAop fkw opAhxyl
v Aa Acflv oxp epao Ao oxp klydpwayoj Als fkw uAhkgoj xAdp qfl lkcpwfka opAhx
ylv AqAwsaexp aphwpo aploplhp ya vffs bfe vkja'
```

## Double Letter + Final Letter Frequency (aa)

```
In [11]: cipher_to_plain['a'] = 'S'
          ciphertext = ciphertext.replace('a','S')
          ciphertext
```

```
Out[11]: 'hfcnkopw Shyplhp yS wAnysgj hxAlvyllv oxp qfwgs qyox lpq spdpqgncploS xAnnply
lv pdpwj sAj A wyvfwfkS pskhAoyfl hfceyllylv oxp oxpfwj fu ylufwcAoyfl Als hfc
nkoAoyfl qyox xAlsSfl SjSopcS Als SfuoqAwP spSyvl yS oxp ipj of SkhhpSS AS fl
p fu oxp fgspSo hfcnkopw Shyplhp spnAwocploS yl oxp hxyhAvf AwPA oxp hS spnAw
ocplo Ao yyo xAS A gflv xySofwj fu cppoylv oxyS hxAggplvp oxwfkvx mkAgyoj psk
hAoyfl yl ScAgg hgASSwffc pldywflcploS Agflv qyox ylopwlSxyn Als wpSpAwhx fnn
fwoklyoyPS yl ylskSowj Als lAoyflAg gAefwAofwypSyoy SoksplOS qfwi qyox fkw uA
hkgoj fl qfwgshgASS wpSpAwhx yl AwPAS oxAo ylhgksp sAoA Shyplhp sySowyekops S
jSopcS ylufwcAoyfl wpowypdAg hfcnkopw lpoqfwilylv ylopggyvplo ylufwcAoyfl SjSo
pcS Als AgvfwyoxcS oxp spnAwocplo fuupwS eAhxpgfw fu Shyplhp cASopw fu Shyplh
p nwfupSSyflAg cASopw Als nxs spvwppS ngkS vwAskAop hpwoyuyhAopS AhhpgpwAops
hfkWspS Als lflspvwpp SoksJ nAwooycp SoksplOS hAl oAip pdplylv hgASSpS Als gf
lvSySoAlhp SoksplOS hAl pAwl cASopwS spvwppS flgylp SoksplOS wAop fkw opAhxyl
v AS Acflv oxp epSo Ao oxp klydpwSyoy Als fkw uAhkgoj xAdp qfl lkcpwfkS opAhx
ylv AqAwsSoxp Sphwpo Sploplhp yS vffs bfe vkjS'
```

## Most Frequent Letter (p)

```
In [12]: cipher_to_plain['p'] = 'E'
          ciphertext = ciphertext.replace('p','E')
          ciphertext
```

```
Out[12]: 'hfcnkoEw ShyElhE yS wAnysgj hxAlvyllv oxE qfwgs qyox lEq sEdEgfnCEloS xAnnEly
lv EdEwj sAj A wyvfwfkS EskhAoyfl hfceyllylv oxE oxEfwj fu ylufwcAoyfl Als hfc
nkoAoyfl qyox xAlsSfl SjSoEcS Als SfuoqAwE sESyvl yS oxE iEj of SkhhESS AS fl
E fu oxE fgSESo hfcnkoEw ShyElhE sEnAwocEloS yl oxE hxyhAvf AwEA oxE hS sEnAw
ocElo Ao yyo xAS A gflv xySofwj fu cEEoylv oxyS hxAggElvE oxwfkvx mkAgyoj Esk
hAoyfl yl ScAgg hgASSwffc EldywflCEloS Agflv qyox yloEwlSxyn Als wESEAwHx fnn
fwoklyoyES yl ylskSowj Als lAoyflAg gAefwAofwyESyoy SoksEloS qfwi qyox fkw uA
hkgoj fl qfwgshgASS wESEAwHx yl AwEAS oxAo ylhgkSE sAoA ShyElhE sySowyekoEs S
jSoEcS ylufwcAoyfl wEowEdAg hfcnkoEw lEoqfwilylv yloEggyvElo ylufwcAoyfl SjSo
EcS Als AgvfwyoxcS oxE sEnAwocElo fuuEwS eAhxEgfw fu ShyElhE cASoEw fu ShyElh
E nwfUESSyflAg cASoEw Als nxs sEvwEES ngkS vwAskAoE hEwoyuyhAoES AhhEgEwAoEs
hfkWSES Als lflSEvwEE SoksJ nAwooyCE SoksEloS hAl oAiE EdElylv hgASSES Als gf
lvSySoAlhE SoksEloS hAl EAwl cASoEwS sEvwEES flgylE SoksEloS wAoE fkw oEAHxyl
v AS Acflv oxE eESo Ao oxE klydEwSyoy Als fkw uAhkgoj xAdE qfl lkCEwfkS oEAHx
ylv AqAwsSoxE SEhWEo SEloElhE yS vffs bfe vkjS'
```

## Two Word Frequency (at)

```
In [13]: cipher_to_plain['o'] = 'T'
cipher_text = cipher_text.replace('o', 'T')
cipher_text
```

```
Out[13]: 'hfcnkTEw ShyElhE yS wAnysgj hXAlvylv TxE qfwgs qyTx lEq sEdEgfnCElTS xAnnEly
lv EdEwj sAj A wyvfwfkS EskhATyfl hfceyllylv TxE TxEfwj fu ylufwcATyfl Als hfc
nkTATyfl qyTx xAlsSfl SjSTEcS Als SfuTqAwE sESyvl yS TxE iEj Tf SkhhESS AS fl
E fu TxE fgsEST hfcnkTEw ShyElhE sEnAwTcElTS yl TxE hxyhAvf AWEA TxE hS sEnAw
TcElT AT yyT xAS A gflv xySTfwj fu cEETylv TxyS hxAggElvE Txwfkvx mkAgyTj Esk
hATyfl yl ScAgg hgASSwffc EldywflCElTS Agflv qyTx ylTEwlSxyn Als wESEAwHx fnn
fwTklyTyES yl ylskSTwj Als lATyflAg gAefwATfwyESyyT STksElTS qfwi qyTx fkw uA
hkgTj fl qfwgshgASS wESEAwHx yl AWEAS TxAT ylhgksE sATA ShyElhE sySTwyekTEs S
jSTEcS ylufwcATyfl wETwyEdAg hfcnkTEw lETqfwilylv ylTEggyvElT ylufwcATyfl SjST
EcS Als AgvfwyTxcS TxE sEnAwTcElT fuuEwS eAhxEgfw fu ShyElhE cASTEw fu ShyElh
E nwfueSSyflAg cASTEw Als nxs sEvweES ngkS vwAskATE hEwTyuyhATES AhhEgEwATES
hfkWSES Als lfIsEvweE STksj nAwTTyce STksElTS hAl TAiE EdElylv hgASSES Als gf
lvSySTAlhE STksElTS hAl EAwl cASTEWS sEvweES flgylE STksElTS wATE fkw TEAhxyl
v AS Acflv TxE eEST AT TxE klydEwSyTj Als fkw uAhkgTj xAdE qfl lkcEwfkS TEAhx
ylv AqAwSSTxE SEhwET SElTElHE yS vffs bfe vkjS'
```

## Three Word Frequency (the)

```
In [14]: cipher_to_plain['x'] = 'H'
cipher_text = cipher_text.replace('x', 'H')
cipher_text
```

```
Out[14]: 'hfcnkTEw ShyElhE yS wAnysgj hHAlvylv THE qfwgs qyTH lEq sEdEgfnCElTS HAnnEly
lv EdEwj sAj A wyvfwfkS EskhATyfl hfceyllylv THE THEfwj fu ylufwcATyfl Als hfc
nkTATyfl qyTH HAlsSfl SjSTEcS Als SfuTqAwE sESyvl yS THE iEj Tf SkhhESS AS fl
E fu THE fgsEST hfcnkTEw ShyElhE sEnAwTcElTS yl THE hHyhAvf AWEA THE hS sEnAw
TcElT AT yyT HAS A gflv HySTfwj fu cEETylv THyS hHAggElvE THwfkVh mkAgyTj Esk
hATyfl yl ScAgg hgASSwffc EldywflCElTS Agflv qyTH ylTEwlSHyn Als wESEAwHh fnn
fwTklyTyES yl ylskSTwj Als lATyflAg gAefwATfwyESyyT STksElTS qfwi qyTH fkw uA
hkgTj fl qfwgshgASS wESEAwHh yl AWEAS THAT ylhgksE sATA ShyElhE sySTwyekTEs S
jSTEcS ylufwcATyfl wETwyEdAg hfcnkTEw lETqfwilylv ylTEggyvElT ylufwcATyfl SjST
EcS Als AgvfwyTHcS THE sEnAwTcElT fuuEwS eAhHEgfw fu ShyElhE cASTEw fu ShyElh
E nwfueSSyflAg cASTEw Als nHs sEvweES ngkS vwAskATE hEwTyuyhATES AhhEgEwATES
hfkWSES Als lfIsEvweE STksj nAwTTyce STksElTS hAl TAiE EdElylv hgASSES Als gf
lvSySTAlhE STksElTS hAl EAwl cASTEWS sEvweES flgylE STksElTS wATE fkw TEAhHy1
v AS Acflv THE eEST AT THE klydEwSyTj Als fkw uAhkgTj HAdE qfl lkcEwfkS TEAhH
ylv AqAwSSTHE SEhwET SElTElHE yS vffs bfe vkjS'
```

## 'SECRET' Substitution

```
In [15]: cipher_to_plain['h'] = 'C'
cipher_to_plain['w'] = 'R'
ciphertext = ciphertext.replace('h','C')
ciphertext = ciphertext.replace('w','R')
ciphertext
```

```
Out[15]: 'CfcnkTER SCyElCE yS RAnysgj CHAlvylv THE qfRgs qyTH lEq sEdEgfnCElTS HAnnEly
lv EdERj sAj A RyvfrfKS EskCATyfl Cfceylylv THE THEfRj fu yluFRcATyfl Als Cfc
nkTATyfl qyTH HAlSsf1 SjSTEcS Als SfuTqARE sESyvl yS THE iEj Tf SkCCCESS AS fl
E fu THE fgsEST CfcnkTER SCyElCE sEnARTcElTS yl THE CHyCAvf AREA THE CS sEnAR
TcElT AT yyT HAS A gflv HySTfRj fu cEETylv THyS CHAggElvE THRfkvh mkAgyTj Esk
CATyfl yl ScAgg CgASSRffc EldyRflcElTS Agflv qyTH ylTERlSHyn Als RESEARCH fnn
fRTklyTyES yl ylskSTRj Als lATyflAg gAefRATfRyESyyT STksElTS qfRi qyTH fKR uA
CkgTj fl qfRgsCgASS RESEARCH yl AREAS THAT ylcgksE sATA SCyElCE sySTRyekTEs S
jSTEcS yluFRcATyfl RETryEdAg CfcnkTER lETqfRiylv ylTEggyvElT yluFRcATyfl SjST
EcS Als AgvfRyTHcS THE sEnARTcElT fuuERS eACHEgFR fu SCyElCE cASTER fu SCyElC
E nRfuESSyflAg cASTER Als nHs sEvREES ngkS vRASKATE CERTyuyCATES ACCEgERATES
CfKRSES Als lflsEvREE STksj nARTTyce STksElTS CA1 TAiE EdElylv CgASSES Als gf
lvSYSTAlCE STksElTS CA1 EARl cASTERS sEvREES flgylE STksElTS RATE fKR TEACHyl
v AS Acflv THE eEST AT THE klydERSyTj Als fKR uACKgTj HAdE qfl lkCErfKS TEACH
ylv AqARsSTHE SECRET SElTElCE yS vffs bfe vkjS'
```

## 'TEACHING' Substitution

```
In [16]: cipher_to_plain['y'] = 'I'
cipher_to_plain['l'] = 'N'
cipher_to_plain['v'] = 'G'
ciphertext = ciphertext.replace('y','I')
ciphertext = ciphertext.replace('l','N')
ciphertext = ciphertext.replace('v','G')
ciphertext
```

```
Out[16]: 'CfcnkTER SCIENCE IS RAnIsgj CHANGING THE qfRgs qITH NEq sEdEgfnCEnts HAnnENI
NG EdERj sAj A RIGfRfKS EskCATIfN CfceINING THE THEfRj fu INufRcATIfN ANs Cfc
nkTATIfN qITH HANsSfN SjSTEcS ANs SfuTqARE sESIGN IS THE iEj Tf SkCCCESS AS fN
E fu THE fgsEST CfcnkTER SCIENCE sEnARTcENTS IN THE CHICAGf AREA THE CS sEnAR
TcENT AT IIT HAS A gfNG HISTfRj fu cEETING THIS CHAggENGEnE THRfkGH mkAgITj Esk
CATIfN IN ScAgg CgASSRffc ENdIRfNcENTS AgfNG qITH INTERNSHIn ANs RESEARCH fnn
fRTKNITIES IN INskSTRj ANs NATIfNAg gAefRATfRIESIIT STksENTS qfRi qITH fKR uA
CkgTj fN qfRgsCgASS RESEARCH IN AREAS THAT INCgksE sATA SCIENCE sISTRIekTEs S
jSTEcS INufRcATIfN RETRIEdAg CfcnkTER NETqfRiING INTEggIGENT INufRcATIfN SjST
EcS ANs AgGfRITHcS THE sEnARTcENT fuuERS eACHEgFR fu SCIENCE cASTER fu SCIENC
E nRfuESSIfNAg cASTER ANs nHs sEGREES ngkS GRASKATE CERTIuICATES ACCEgERATES
CfKRSES ANs nFNsEGREE STksj nARTTIce STksENTS CAN TAiE EdENING CgASSES ANs gf
NGsISTANCE STksENTS CAN EARN cASTERS sEGREES fNgINE STksENTS RATE fKR TEACHIN
G AS AcfNG THE eEST AT THE kNIdeRSITj ANs fKR uACKgTj HAdE qfN NkcERfKS TEACH
ING AqARsSTHE SECRET SENTENCE IS Gffs bfe GkjS'
```

## 'TEACHING' Substitution



```
In [17]: cipher_to_plain['f'] = 'O'
cipher_to_plain['c'] = 'M'
cipher_to_plain['n'] = 'P'
cipher_to_plain['k'] = 'U'
ciphertext = ciphertext.replace('f','O')
ciphertext = ciphertext.replace('c','M')
ciphertext = ciphertext.replace('n','P')
ciphertext = ciphertext.replace('k','U')
ciphertext
```

```
Out[17]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENING EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COMPUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ONE OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPARTMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDUCATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPPORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIES IIT STUDENTS QUALIFY WITH OUR FACULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED SYSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYSTEMS AND ALGORITHMS THE DEPARTMENT OFFERS BACHELOR OF SCIENCE MASTER OF SCIENCE PROFESSIONAL MASTER AND PHD DEGREES PLUS GRADUATE CERTIFICATES ACCELERATED COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LONGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHING AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACHING AWARDS THE SECRET SENTENCE IS GOOD BOE GUYS'
```

## 'RAPIDLY' Substitution

```
In [18]: cipher_to_plain['s'] = 'D'
cipher_to_plain['g'] = 'L'
cipher_to_plain['j'] = 'Y'
ciphertext = ciphertext.replace('s','D')
ciphertext = ciphertext.replace('g','L')
ciphertext = ciphertext.replace('j','Y')
ciphertext
```

```
Out[18]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENING EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COMPUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ONE OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPARTMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDUCATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPPORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIES IIT STUDENTS QUALIFY WITH OUR FACULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED SYSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYSTEMS AND ALGORITHMS THE DEPARTMENT OFFERS BACHELOR OF SCIENCE MASTER OF SCIENCE PROFESSIONAL MASTER AND PHD DEGREES PLUS GRADUATE CERTIFICATES ACCELERATED COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LONGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHING AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACHING AWARDS THE SECRET SENTENCE IS GOOD BOE GUYS'
```

## 'WORLD' Substitution

```
In [19]: cipher_to_plain['q'] = 'W'
         ciphertext = ciphertext.replace('q','W')
         ciphertext
```

```
Out[19]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENING EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COMPUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ONE OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPARTMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDUCATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPPORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIES IIT STUDENTS WORK WITH OUR FACULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED SYSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYSTEMS AND ALGORITHMS THE DEPARTMENT OFFERS BACHELOR OF SCIENCE MASTER OF SCIENCE PROFESSIONAL MASTER AND PHD DEGREES PLUS GRADUATE CERTIFICATES ACCELERATED COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LONGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHING AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACHING AWARDS THE SECRET SENTENCE IS GOOD BOE GUYS'
```

## 'EVERY' Substitution

```
In [20]: cipher_to_plain['d'] = 'V'
         ciphertext = ciphertext.replace('d','V')
         ciphertext
```

```
Out[20]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENING EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COMPUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ONE OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPARTMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDUCATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPPORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIES IIT STUDENTS WORK WITH OUR FACULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED SYSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYSTEMS AND ALGORITHMS THE DEPARTMENT OFFERS BACHELOR OF SCIENCE MASTER OF SCIENCE PROFESSIONAL MASTER AND PHD DEGREES PLUS GRADUATE CERTIFICATES ACCELERATED COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LONGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHING AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACHING AWARDS THE SECRET SENTENCE IS GOOD BOE GUYS'
```

## 'FACULTY' Substitution

```
In [21]: cipher_to_plain['u'] = 'F'
         ciphertext = ciphertext.replace('u','F')
         ciphertext
```

```
Out[21]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENI
NG EVERY DAY A RIGOROUS EDUCATION COMeINING THE THEORY OF INFORMATION AND COM
PUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE iEY TO SUCCESS AS ON
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COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAiE EVENING CLASSES AND LO
NGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHIN
G AS AMONG THE eEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACH
ING AWARDSTHE SECRET SENTENCE IS GOOD bOe GUYS'
```

## 'TAKE' Substitution

```
In [22]: cipher_to_plain['i'] = 'K'
         ciphertext = ciphertext.replace('i','K')
         ciphertext
```

```
Out[22]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENI
NG EVERY DAY A RIGOROUS EDUCATION COMeINING THE THEORY OF INFORMATION AND COM
PUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ON
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COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LO
NGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHIN
G AS AMONG THE eEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACH
ING AWARDSTHE SECRET SENTENCE IS GOOD bOe GUYS'
```

## 'QUALITY' Substitution

```
In [23]: cipher_to_plain['m'] = 'Q'
         ciphertext = ciphertext.replace('m','Q')
         ciphertext
```

```
Out[23]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENI
NG EVERY DAY A RIGOROUS EDUCATION COMeINING THE THEORY OF INFORMATION AND COM
PUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ON
E OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPAR
TMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDU
CATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPP
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COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LO
NGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHIN
G AS AMONG THE eEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACH
ING AWARDSTHE SECRET SENTENCE IS GOOD bOe GUYS'
```

## 'BEST' Substitution

```
In [24]: cipher_to_plain['e'] = 'B'
         ciphertext = ciphertext.replace('e','B')
         ciphertext
```

```
Out[24]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENI
NG EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COM
PUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ON
E OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPAR
TMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDU
CATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPP
ORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIESIIT STUDENTS WORK WITH OUR FA
CULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED S
YSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYST
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COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LO
NGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHIN
G AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACH
ING AWARDSTHE SECRET SENTENCE IS GOOD bOB GUYS'
```

## 'JOB' Substitution

```
In [25]: cipher_to_plain['b'] = 'j'
cipher_text = cipher_text.replace('b', 'j')
cipher_text
```

```
Out[25]: 'COMPUTER SCIENCE IS RAPIDLY CHANGING THE WORLD WITH NEW DEVELOPMENTS HAPPENING EVERY DAY A RIGOROUS EDUCATION COMBINING THE THEORY OF INFORMATION AND COMPUTATION WITH HANDSON SYSTEMS AND SOFTWARE DESIGN IS THE KEY TO SUCCESS AS ONE OF THE OLDEST COMPUTER SCIENCE DEPARTMENTS IN THE CHICAGO AREA THE CS DEPARTMENT AT IIT HAS A LONG HISTORY OF MEETING THIS CHALLENGE THROUGH QUALITY EDUCATION IN SMALL CLASSROOM ENVIRONMENTS ALONG WITH INTERNSHIP AND RESEARCH OPPORTUNITIES IN INDUSTRY AND NATIONAL LABORATORIESIIT STUDENTS WORK WITH OUR FACULTY ON WORLDCLASS RESEARCH IN AREAS THAT INCLUDE DATA SCIENCE DISTRIBUTED SYSTEMS INFORMATION RETRIEVAL COMPUTER NETWORKING INTELLIGENT INFORMATION SYSTEMS AND ALGORITHMS THE DEPARTMENT OFFERS BACHELOR OF SCIENCE MASTER OF SCIENCE PROFESSIONAL MASTER AND PHD DEGREES PLUS GRADUATE CERTIFICATES ACCELERATED COURSES AND NONDEGREE STUDY PARTTIME STUDENTS CAN TAKE EVENING CLASSES AND LONGDISTANCE STUDENTS CAN EARN MASTERS DEGREES ONLINE STUDENTS RATE OUR TEACHING AS AMONG THE BEST AT THE UNIVERSITY AND OUR FACULTY HAVE WON NUMEROUS TEACHING AWARDS'
THE SECRET SENTENCE IS GOOD JOB GUYS'
```

## Leftover

```
In [26]: missing_plain = list(alphabets)
for c in cipher_to_plain.items():
    missing_plain.remove(c[1].lower())
missing_plain = [m.upper() for m in missing_plain]

missing_cipher = list(alphabets)
for c in cipher_to_plain.items():
    missing_cipher.remove(c[0])

for m in missing_cipher:
    cipher_to_plain[m] = missing_plain
```

## KEY

```
In [27]: sorted(cipher_to_plain.items())
```

```
Out[27]: [('a', 'S'),  
          ('b', 'J'),  
          ('c', 'M'),  
          ('d', 'V'),  
          ('e', 'B'),  
          ('f', 'O'),  
          ('g', 'L'),  
          ('h', 'C'),  
          ('i', 'K'),  
          ('j', 'Y'),  
          ('k', 'U'),  
          ('l', 'N'),  
          ('m', 'Q'),  
          ('n', 'P'),  
          ('o', 'T'),  
          ('p', 'E'),  
          ('q', 'W'),  
          ('r', ['X', 'Z']),  
          ('s', 'D'),  
          ('t', ['X', 'Z']),  
          ('u', 'F'),  
          ('v', 'G'),  
          ('w', 'R'),  
          ('x', 'H'),  
          ('y', 'I'),  
          ('z', 'A')]
```