In [39]:
```
import numpy as np
import matplotlib.pyplot as plt
```

In [25]:
```
# Read the input
spectX = np.loadtxt("spectX.txt")
spectY = np.loadtxt("spectY.txt")
```

In [26]:
```
T = 267
n = 23
numIterations = 257
requiredIteration = [0,1,2,4,8,16,32,64,128,256]

# Get the Ti array for M-step to update pi
Ti = np.zeros(n)
for i in range(n):
    Ti[i] = np.sum(spectX[:,i])
```

In [27]:
```
# P(Y|X)
# given arrays x and p, and y = 0 or 1
def likelihood(p, x, y):
    prod = np.prod((1-p)**x)
    ret = (1-y)*prod + y*(1-prod)
    return ret

# E-step of EM algorithm
# given arrays x and p, and y = 0 or 1
def eStep(p, x, y):
    numer = y*x*p
    denom = 1-np.prod((1-p)**x)
    return numer/denom
```

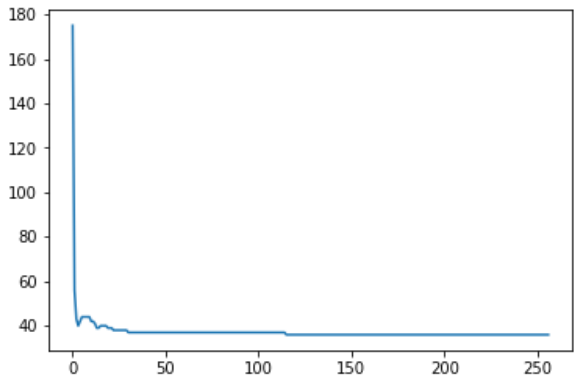
In [37]:
```
def EM(xData, yData):
    mistakes = []  # mistakes in each iteration
    L = []         # log-likelihood in each iteration
    params = np.full(n, 0.05) # initialize each pi with 0.05

    for i in range(numIterations):
        logLikelihood = 0
        numMistakes = 0
        eStepSum = 0

        for t in range(T):
            p_yx = likelihood(params, xData[t], yData[t])
            logLikelihood += np.log(p_yx)
            eStepSum += eStep(params, xData[t], yData[t])

            if p_yx <= 0.5:
                numMistakes += 1

        # Update pi
        params = eStepSum/Ti

        mistakes.append(numMistakes)
        L.append(logLikelihood/T)

        if i in requiredIteration:
            print('iteration: %d \t number of mistakes M %d \t log-likelihood L %.5f' % (i, numMi
stakes, logLikelihood/T))
    return mistakes, L
```

In [38]:
```
mistakes_list, log_likelihoods = EM(spectX, spectY)
```

```
iteration: 0     number of mistakes M 175        log-likelihood L -0.95809
iteration: 1     number of mistakes M 56         log-likelihood L -0.49592
iteration: 2     number of mistakes M 43         log-likelihood L -0.40822
iteration: 4     number of mistakes M 42         log-likelihood L -0.36461
iteration: 8     number of mistakes M 44         log-likelihood L -0.34750
iteration: 16    number of mistakes M 40         log-likelihood L -0.33462
iteration: 32    number of mistakes M 37         log-likelihood L -0.32258
iteration: 64    number of mistakes M 37         log-likelihood L -0.31483
iteration: 128   number of mistakes M 36         log-likelihood L -0.31116
iteration: 256   number of mistakes M 36         log-likelihood L -0.31016
```

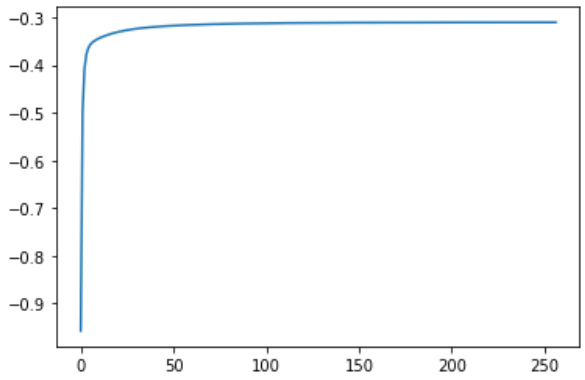
In [40]:
```
plt.plot(mistakes_list)
```

Out[40]:
```
[<matplotlib.lines.Line2D at 0x111c30290>]
```



In [41]:
```
plt.plot(log_likelihoods)
```

Out[41]:
```
[<matplotlib.lines.Line2D at 0x1144c3890>]
```



In [ ]: