In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
'''Random readings of integers for testing purpose... For actual run, please comment
df = []
for i in range(1000):
    df.append(np.random.randint(1, 15))

#Comment above for actual run'''
```

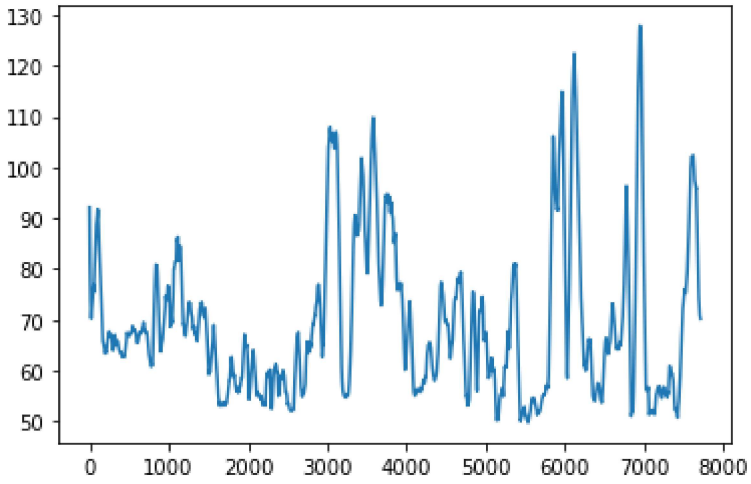
Out[2]:
```
'Random readings of integers for testing purpose... For actual run, please comment t
his section\ndf = []\nfor i in range(1000):\n    df.append(np.random.randint(1, 15))
\n\n#Comment above for actual run'
```

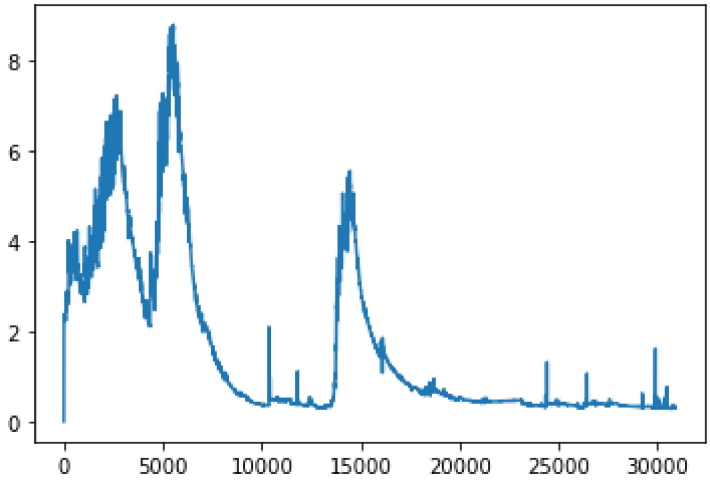
In [5]:
```
#The dataset must be preprocessed and scaled as per the given 'error_threshold' valu
#This snippet is taking all the datasets and then making numpy datasets

heart_rate = "HR.csv"
eda = "EDA.csv"
acc = "ACC.csv"
ibi = "IBI.csv"
temp = "TEMP.csv"
dia = "diabeties.csv"
pulse = "pulse.csv"
spo2 = "SpO2.csv"

#d = np.fromfile(filepath)

df_hr_ = pd.read_csv(heart_rate)
df_eda_ = pd.read_csv(eda)
df_ibi_ = pd.read_csv(ibi)
df_acc_ = pd.read_csv(acc)
df_temp_ = pd.read_csv(temp)
df_dia_ = pd.read_csv(dia)
df_pulse_ = pd.read_csv(pulse)
df_spo2_ = pd.read_csv(spo2)


df_list_ = [df_hr_, df_eda_, df_ibi_, df_acc_, df_temp_, df_dia_, df_pulse_, df_spo2



df_hr = df_hr_.to_numpy()
df_eda = df_eda_.to_numpy()
df_ibi= df_ibi_.iloc[:, [1]].to_numpy()
df_acc = df_acc_.iloc[:, [0]].to_numpy() #Accelerometer data only in x-axis
df_acc[:] += 200
df_temp = df_temp_.to_numpy()
df_dia = df_dia_.to_numpy()
df_pulse = df_pulse_.to_numpy()
df_spo2 = df_spo2_.to_numpy()


df_list = [df_hr, df_eda, df_ibi, df_acc, df_temp, df_dia, df_pulse, df_spo2]



for df in df_list_:
    print("Size of Dataframe " + str(df.shape))
    #print(df.head())
    print(df.describe())
```

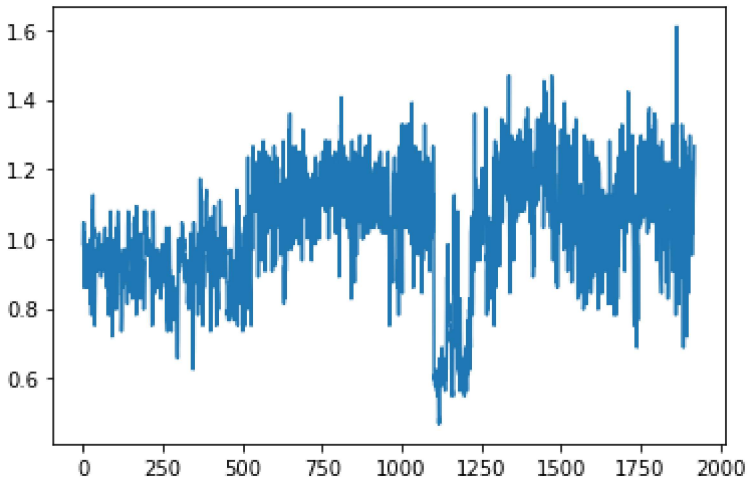
```
Size of Dataframe (7709, 1)
            97.20
count  7709.000000
mean     69.407696
std      15.195030
min      49.800000
25%      57.630000
50%      65.770000
75%      75.600000
max     127.900000
Size of Dataframe (30894, 1)
          4.000000
count  30894.000000
mean       1.603237
std        1.850925
min        0.000000
25%        0.387206
50%        0.526931
75%        2.525280
max        8.792326
Size of Dataframe (1919, 2)
         10.672364     0.953169
count  1919.000000  1919.000000
mean   3165.581938     1.034685
std    2233.886305     0.175950
min      19.454015     0.468771
25%     973.372680     0.921917
50%    2586.259008     1.046923
75%    5243.099374     1.171929
max    7541.204569     1.609449
Size of Dataframe (247151, 3)
                -27              4             57
count  247151.000000  247151.000000  247151.000000
mean      -43.416854       9.337122      14.762724
std        16.492503      33.430062      25.268635
min      -128.000000    -128.000000    -128.000000
25%       -57.000000     -12.000000      -3.000000
50%       -44.000000       2.000000      10.000000
75%       -31.000000      45.000000      38.000000
max       106.000000     127.000000     127.000000
Size of Dataframe (30883, 1)
             31.41
count  30883.000000
mean      31.682476
std        0.911279
min       30.330000
25%       30.930000
50%       31.290000
75%       32.590000
max       33.470000
Size of Dataframe (999, 1)
              135
count  999.000000
mean   114.101101
std     20.238230
min     80.000000
25%     97.000000
50%    114.000000
75%    131.000000
max    150.000000
Size of Dataframe (999, 1)
           58.285
count  999.000000
mean    56.785000
std      1.117027
min     55.288000
25%     55.787500
50%     56.287000
75%     57.286000
```

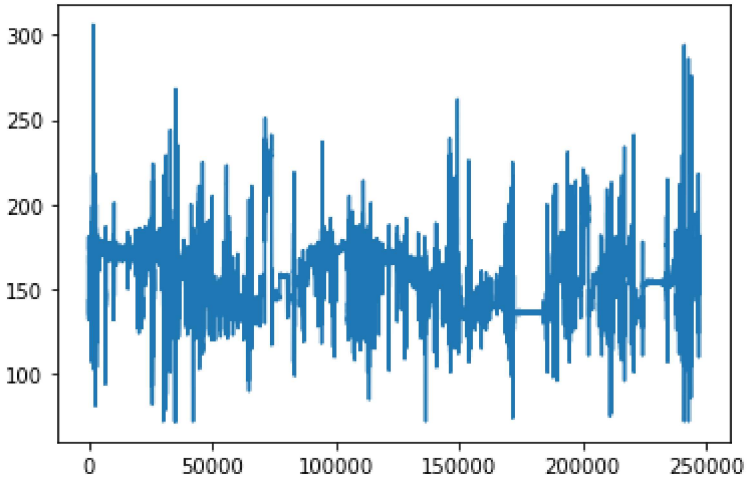
```
max     58.285000
Size of Dataframe (999, 1)
           96.011
count  999.000000
mean    96.261000
std      0.432941
min     96.011000
25%     96.011000
50%     96.011000
75%     96.510500
max     97.010000
```

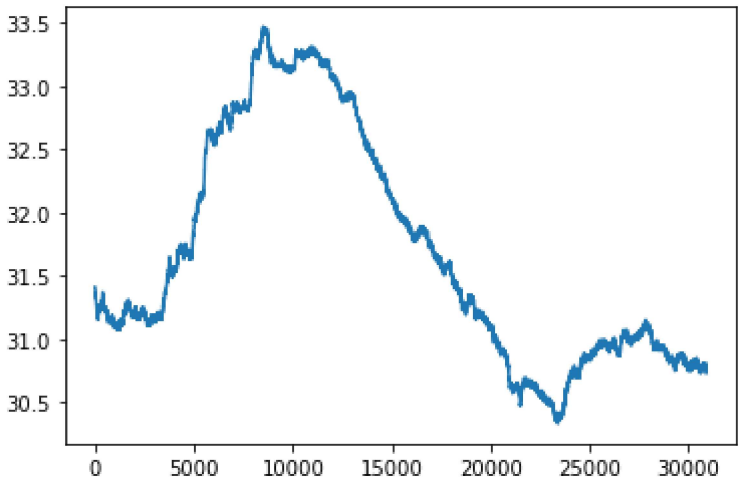
In [6]:
```
for df in df_list:
    plt.plot(df)
    plt.show()
```

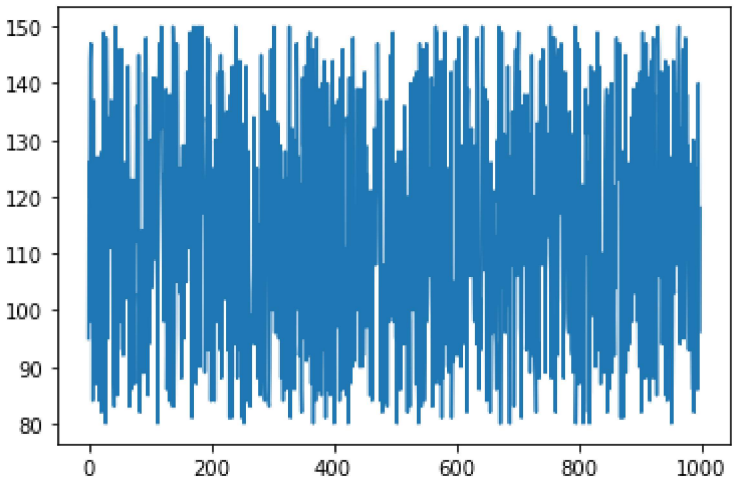


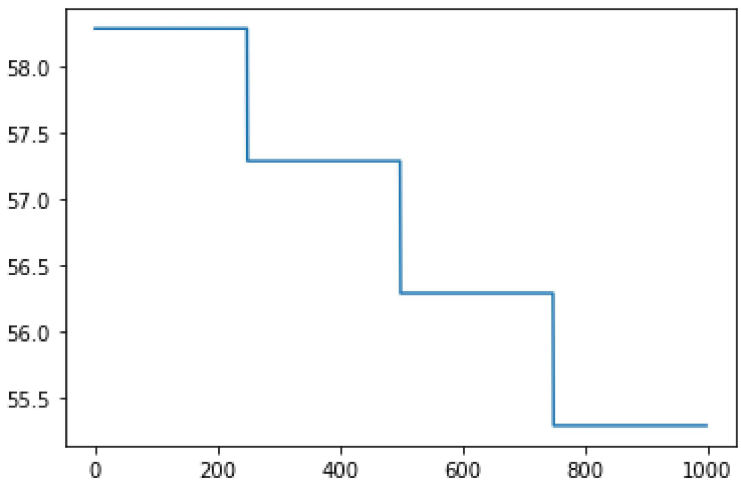


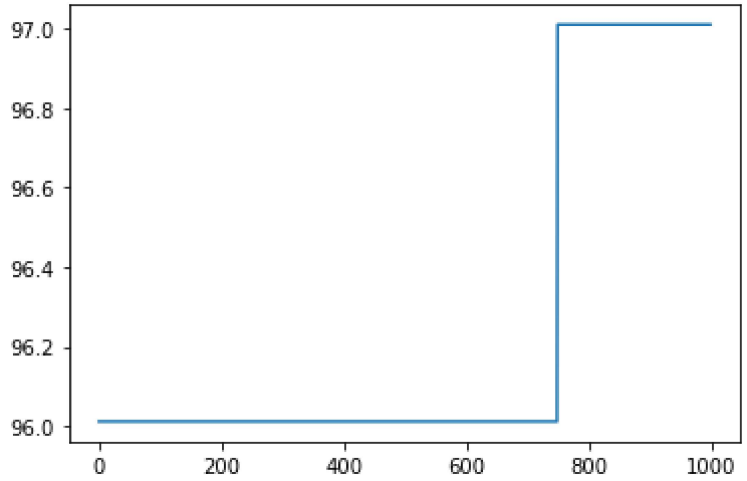



300
250
200
150
100
0
50000
100000
150000
200000
250000


33.5
33.0
32.5
32.0
31.5
31.0
30.5
0
5000
10000
15000
20000
25000
30000


150
140
130
120
110
100
90
80
0
200
400
600
800
1000


58.0
57.5
57.0
56.5
56.0
55.5
0
200
400
600
800
1000



In [109…
```
#df_list[2]
```

In [7]:
```
for df in df_list:
    print(len(df))
```

```
7709
30894
1919
247151
30883
999
999
999
```

In [8]:
```
k_arr = [20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80] # Various values for 'k

#error_thresholds = [e1, e2, e3] # Different threshold values for ECG Signal as per

send = [] # Will store the values which are sent for reference.
```

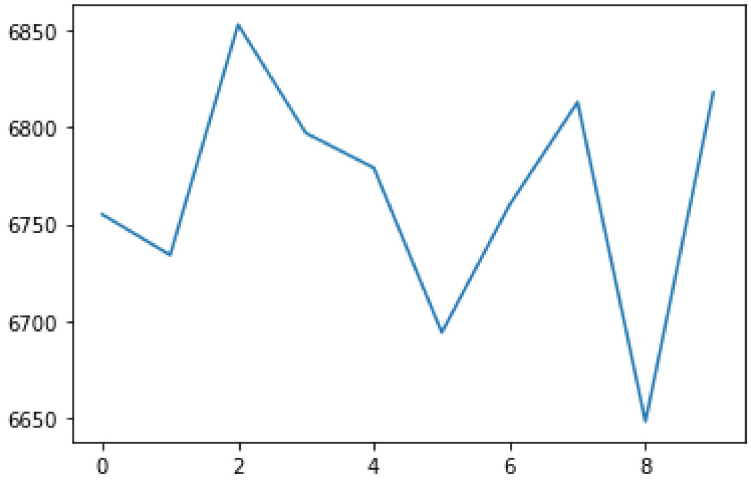
In [9]:
```
#Random fixed sum generator.

def get_ai_arr(l):
    ai_arr = []
    for t in range(10):      # Generating 10 sets of 'k' random values whose sum equ
        a = np.random.rand(l)
        a = a/np.sum(a, axis=0)
        ai_arr.append(a)
    #print(ai_arr)
    return ai_arr
```

In [10]:
```
# This method will return the prediction failure value.

def get_pred_fail(ai, df, k, e_th):
    pred_fail = 0

    for i in range(k, len(df)):

        yi = df[i]
        yi_pred = 0
        for j in range(0, k):
            yi_pred += ai[j] * df[i - j - 1]

        ei = yi_pred - yi

        yi_pred += ei
```

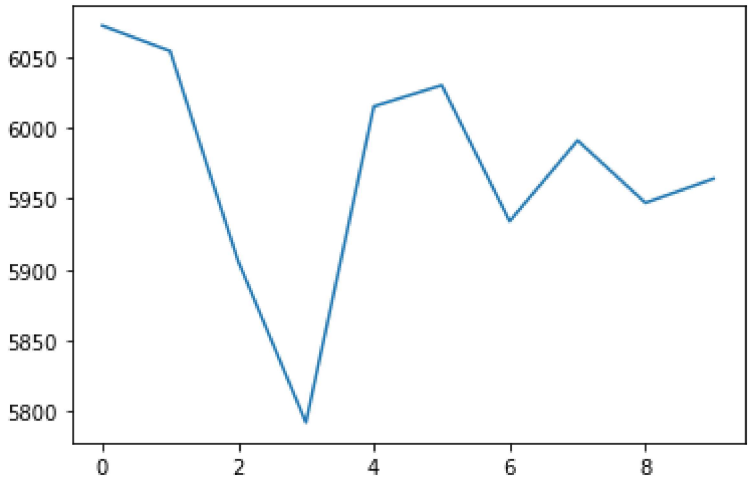
```
        rel_dev = ((abs(yi - yi_pred))/yi) * 100

        if rel_dev > e_th:
            pred_fail += 1
            yi_pred = yi
            send.append(yi)
    return pred_fail
    #print(len(send))
```

In [13]:
```
# List to store Prediction Faliures for different combinations of 'ai' and 'k'


#This method will find the set of 'ai' which give the optimal value.
#Run this code only for single sensor data..that must be in specific column of datas
def sampling_frequency_train(df, k, e_th):
    pred_fail_list = []

    ai_arr = get_ai_arr(k)


    for ai in ai_arr:             # Checking for different 'ai' combinations
        send = []

        for i in range(k):
            send.append(df[i])    # Sending initial K packets

        pred_fail_list.append(get_pred_fail(ai, df, k, e_th))

    #print(min(pred_fail_list))
    min_pt = np.argmin(np.array(pred_fail_list))
    p_trans = min_pt/len(df)
    ai_optimal = ai_arr[min_pt]
    #print("Optimal 'ai' Values are: ", ai_optimal)
    return ai_arr, ai_optimal, pred_fail_list
```

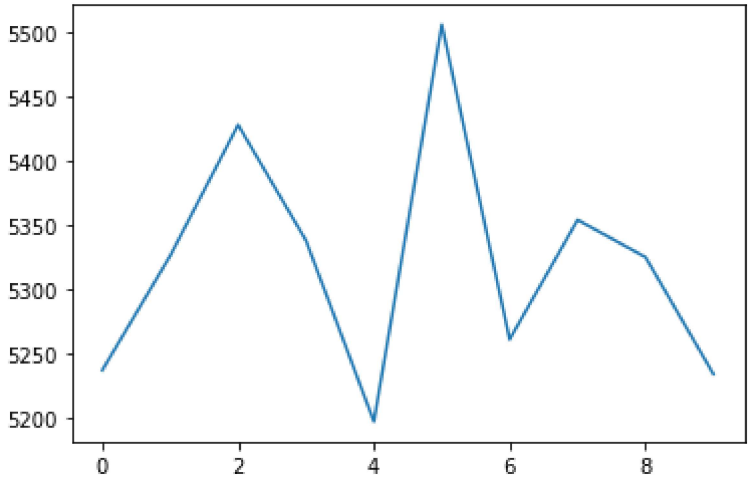
In [15]:
```
hr_th = [1, 2, 3, 4]

for th in hr_th:
    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[0], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[0], 30, th)
    print("Prediction failures For Heart Rate with Error Threshold {} : {}".format(t


    p_trans = pf/len(df_list[0])
    print("Transmission Probability ", p_trans)
```



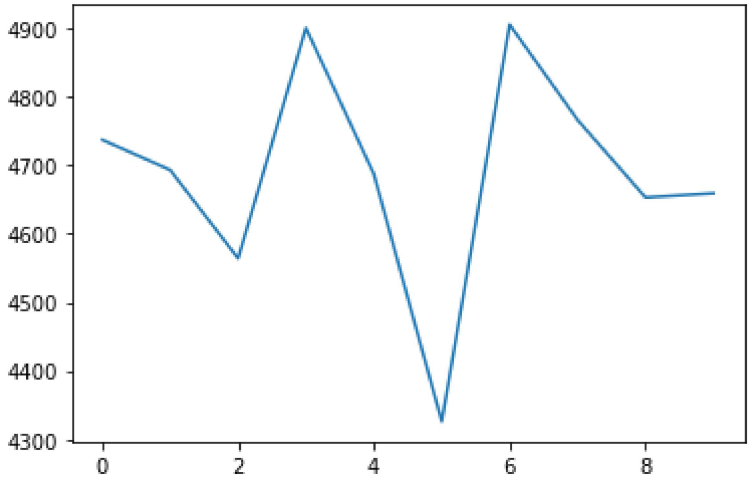

```
Prediction failures For Heart Rate with Error Threshold 1 : 6648
Transmission Probability  0.8623686600077831
```




```
Prediction failures For Heart Rate with Error Threshold 2 : 5792
Transmission Probability  0.7513296147360228
```

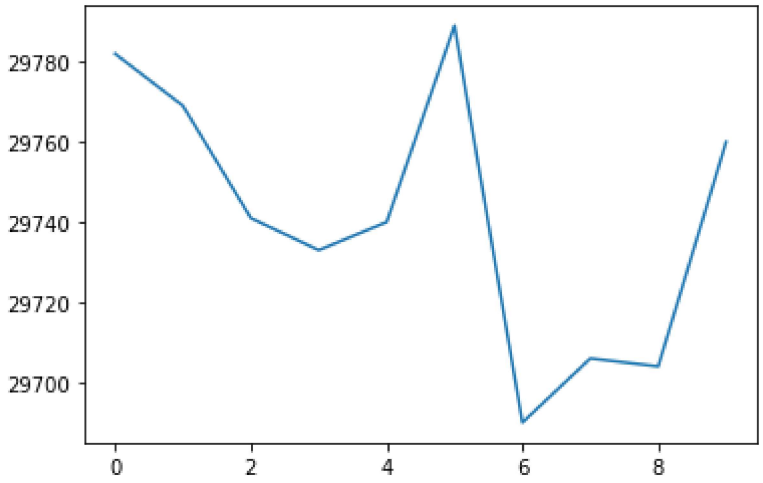



```
Prediction failures For Heart Rate with Error Threshold 3 : 5197
Transmission Probability  0.6741471007912829
```

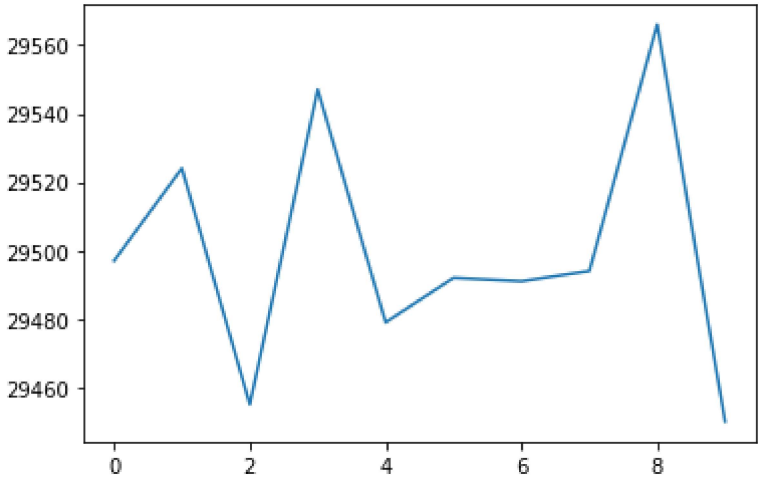



```
Prediction failures For Heart Rate with Error Threshold 4 : 4326
Transmission Probability  0.5611622778570502
```

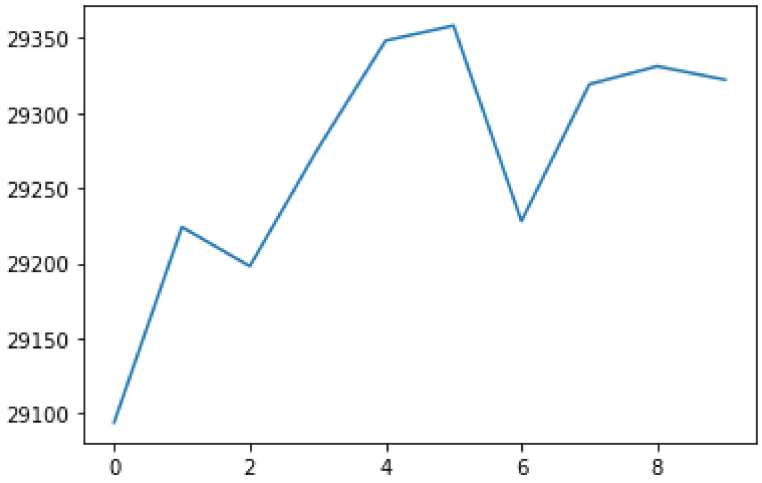
In [29]:
```
eda_th = [.10, .12, .14, .15]

for th in eda_th:
    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[1], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[1], 30, th)
    print("Prediction failures For electrodermal activity with Error Threshold {} :


    p_trans = pf/len(df_list[1])
    print("Transmission Probability ", p_trans)
```



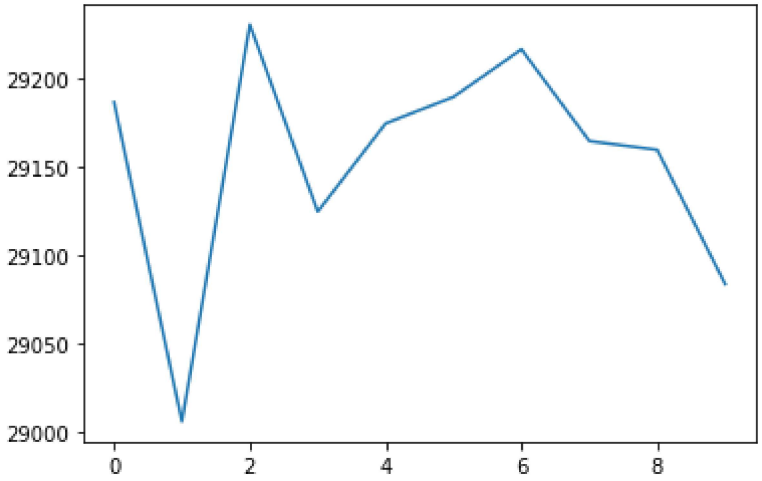

```
Prediction failures For electrodermal activity with Error Threshold 0.1 : 29690
Transmission Probability  0.9610280313329449
```




```
Prediction failures For electrodermal activity with Error Threshold 0.12 : 29450
Transmission Probability  0.9532595325953259
```



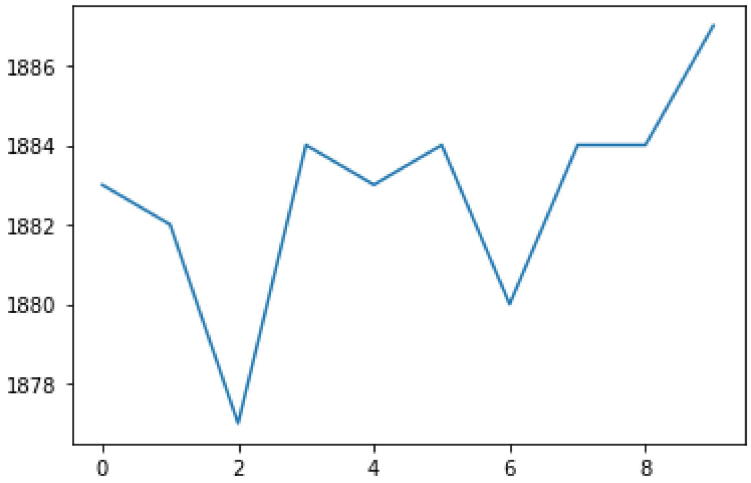

```
Prediction failures For electrodermal activity with Error Threshold 0.14 : 29094
Transmission Probability  0.9417362594678579
```



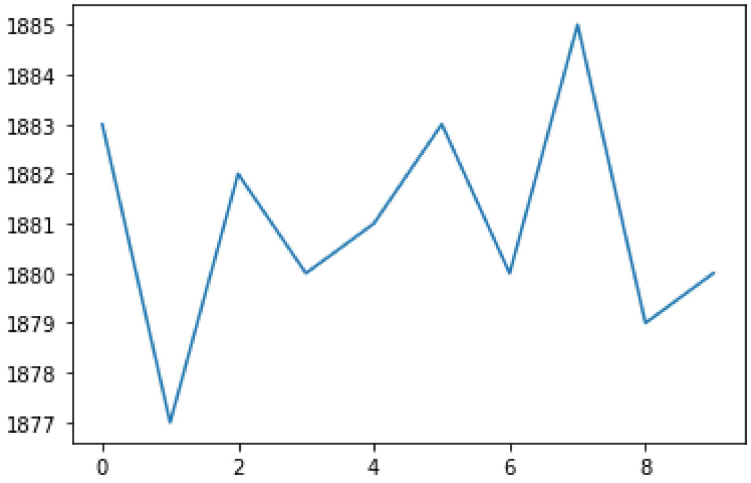

```
Prediction failures For electrodermal activity with Error Threshold 0.15 : 29006
Transmission Probability  0.9388878099307308
```

In [30]:
```
bib_th = [.12, .14, .16, .18]

for th in bib_th:
    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[2], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[2], 30, th)
    print("Prediction failures For Inter-Beat Interval with Error Threshold {} : {}"
```

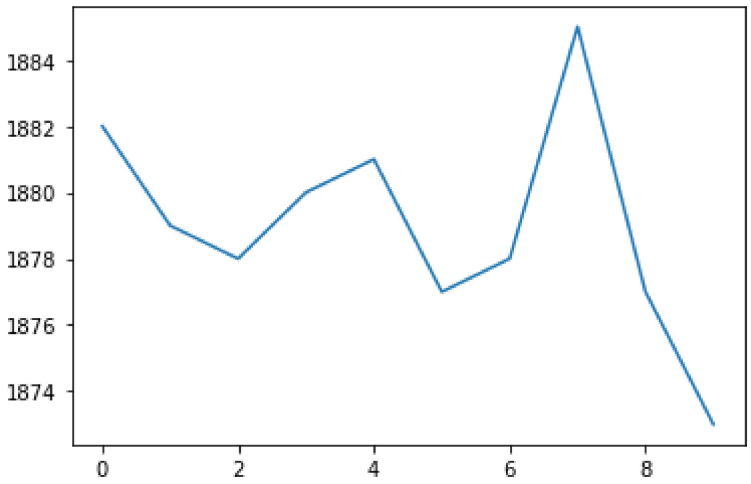
```
    p_trans = pf/len(df_list[2])
    print("Transmission Probability ", p_trans)
```



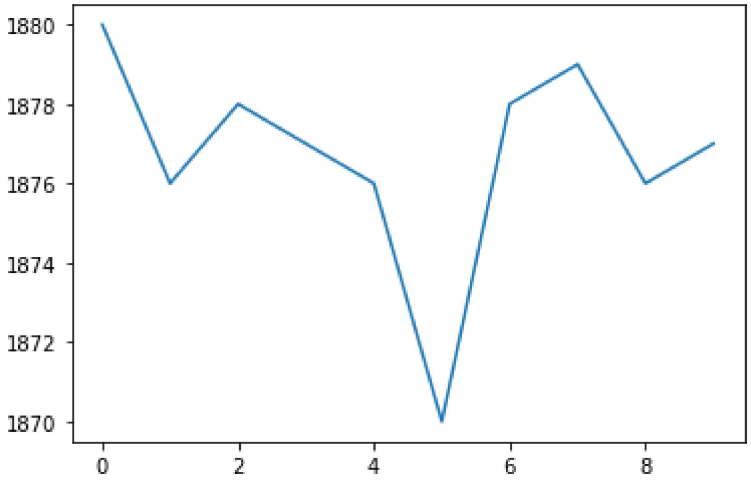

```
Prediction failures For Inter-Beat Interval with Error Threshold 0.12 : 1877
Transmission Probability  0.9781136008337676
```




```
Prediction failures For Inter-Beat Interval with Error Threshold 0.14 : 1877
Transmission Probability  0.9781136008337676
```

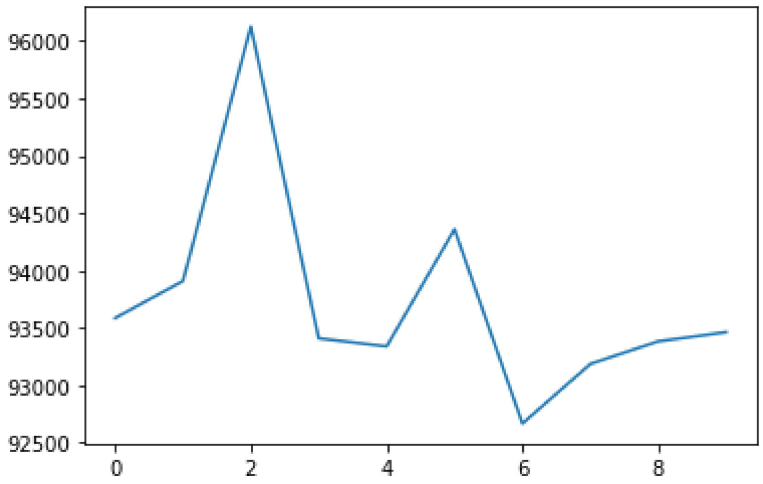



```
Prediction failures For Inter-Beat Interval with Error Threshold 0.16 : 1873
Transmission Probability  0.976029181865555
```

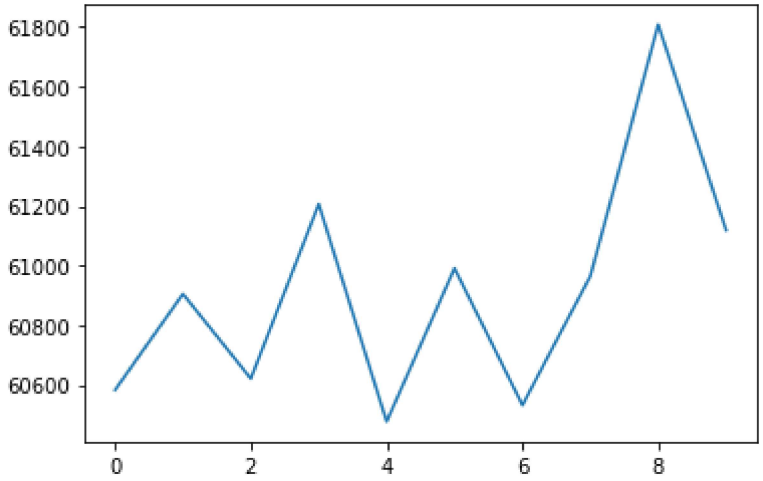



```
Prediction failures For Inter-Beat Interval with Error Threshold 0.18 : 1870
Transmission Probability  0.9744658676393955
```

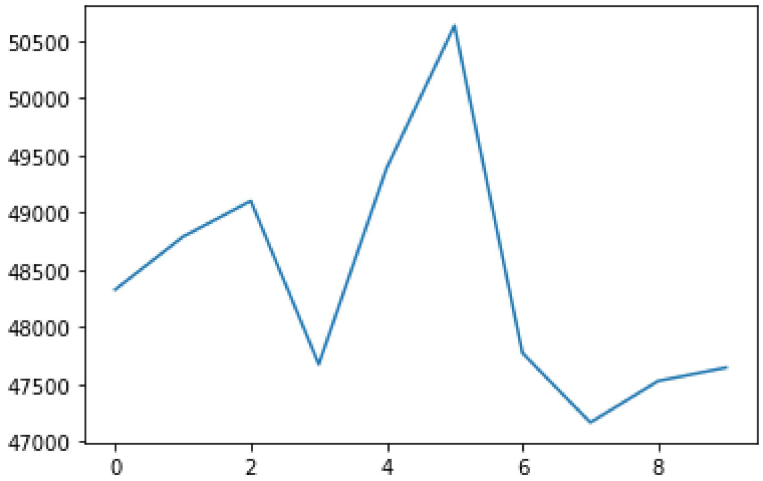
In [31]:
```
acc_th = [1, 2, 3, 4]

for th in acc_th:

    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[3], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[3], 30, th)
    print("Prediction failures For Accelerometer with Error Threshold {} : {}".forma


    p_trans = pf/len(df_list[3])
    print("Transmission Probability ", p_trans)
```



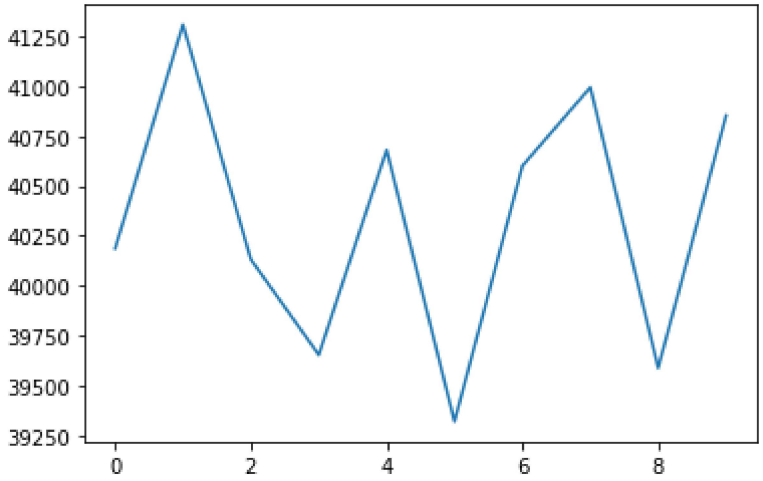

```
Prediction failures For Accelerometer with Error Threshold 1 : 92667
Transmission Probability  0.3749408256490971
```




```
Prediction failures For Accelerometer with Error Threshold 2 : 60477
Transmission Probability  0.2446965620207889
```



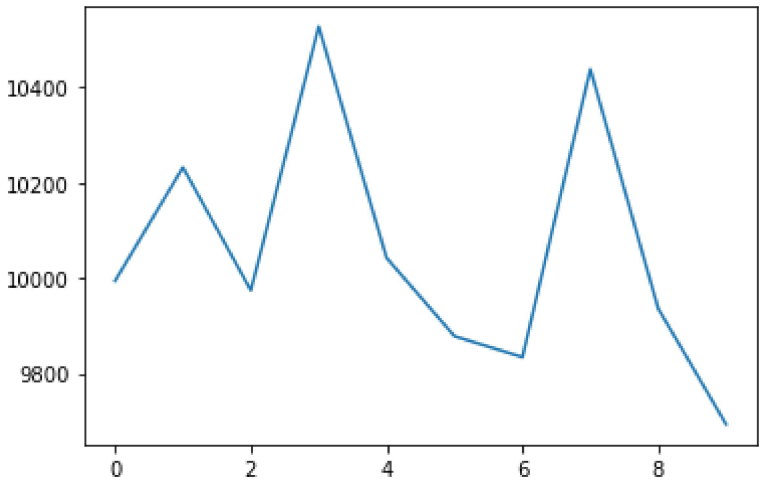

```
Prediction failures For Accelerometer with Error Threshold 3 : 47163
Transmission Probability  0.19082666062447654
```



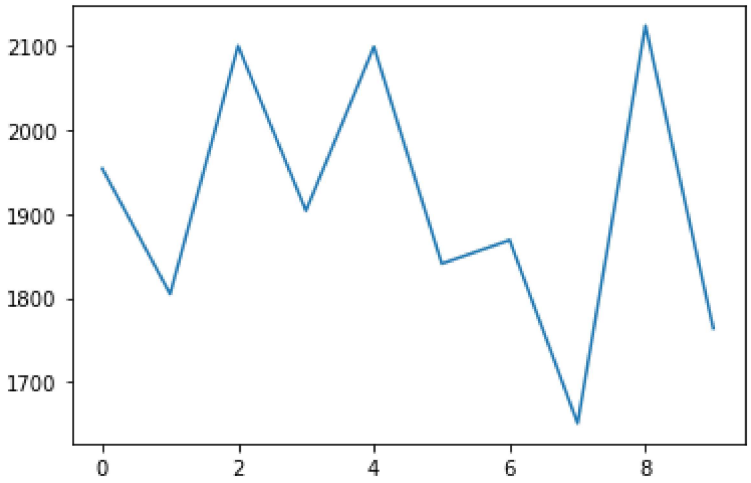

```
Prediction failures For Accelerometer with Error Threshold 4 : 39321
Transmission Probability  0.1590970702121375
```

In [20]:
```
temp_th = [.05, .1, .15, .2]

for th in temp_th:

    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[4], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[4], 30, th)
    print("Prediction failures For Body Temprature with Error Threshold {} : {}".for
```

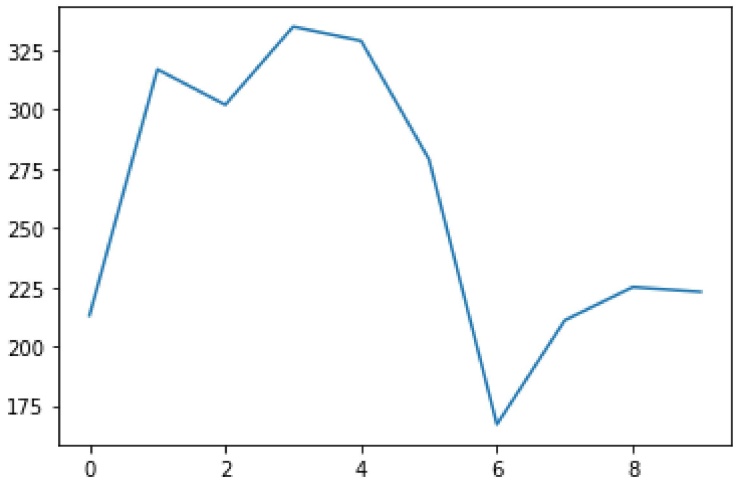
```
    p_trans = pf/len(df_list[4])
    print("Transmission Probability ", p_trans)
```



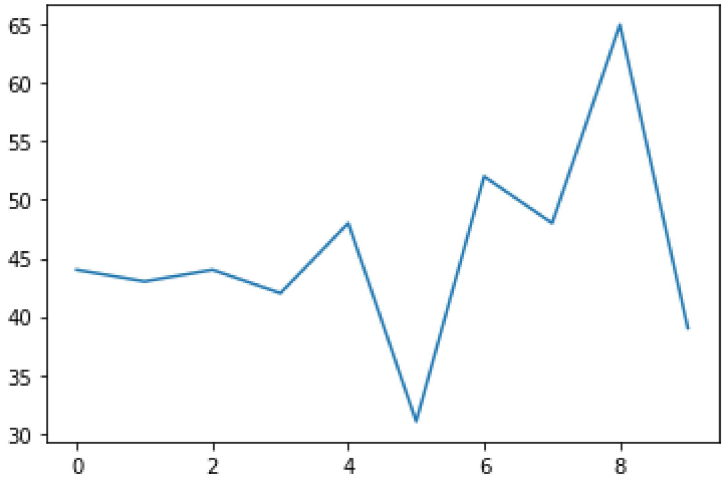

```
Prediction failures For Body Temprature with Error Threshold 0.1 : 9693
Transmission Probability  0.31386199527248
```




```
Prediction failures For Body Temprature with Error Threshold 0.2 : 1651
Transmission Probability  0.05345983227018101
```

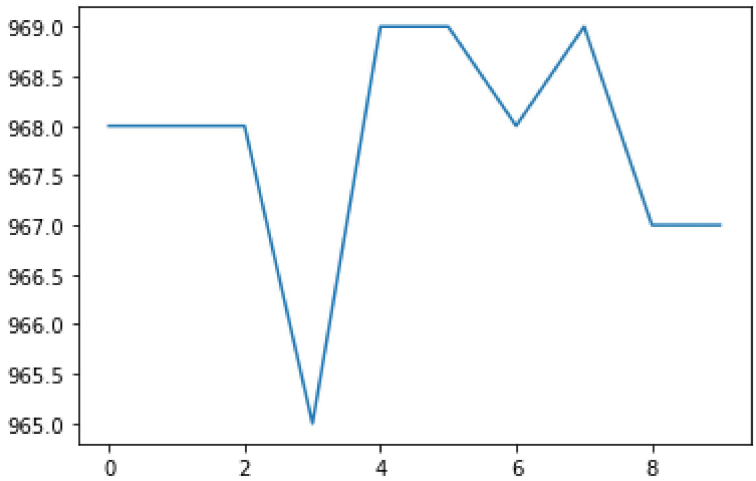



```
Prediction failures For Body Temprature with Error Threshold 0.3 : 167
Transmission Probability  0.005407505747498624
```

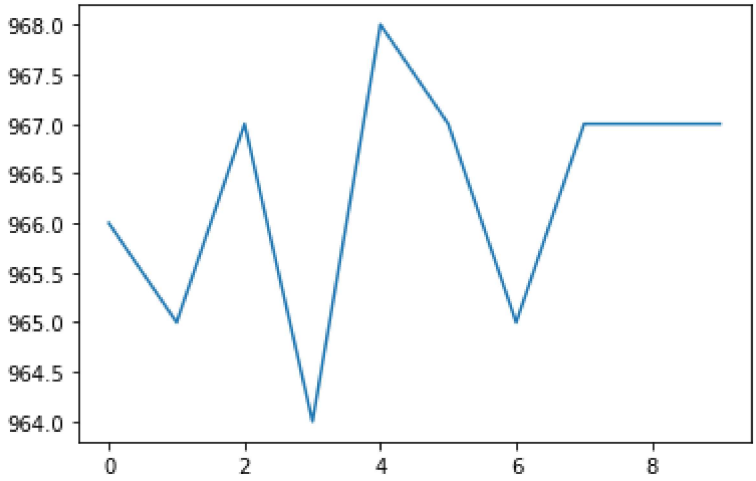



```
Prediction failures For Body Temprature with Error Threshold 0.4 : 31
Transmission Probability  0.0010037884920506427
```

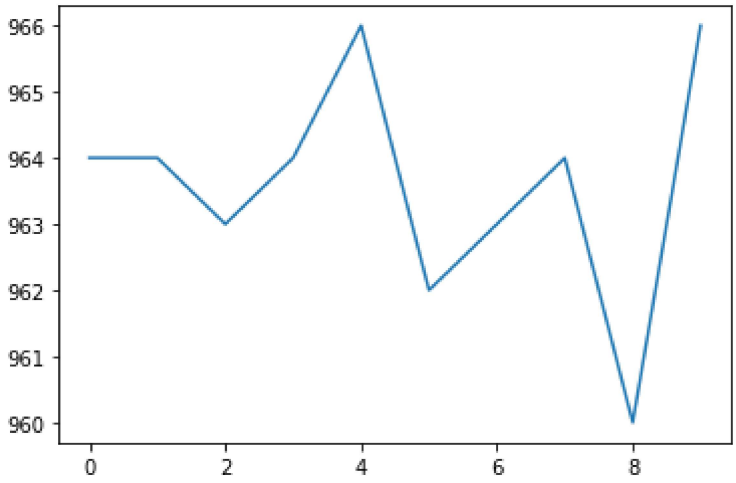
In [22]:
```
dia_th = [2, 5, 8, 10]

for th in temp_th:

    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[5], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[5], 30, th)
    print("Prediction failures For Diabeties with Error Threshold {} : {}".format(th


    p_trans = pf/len(df_list[5])
    print("Transmission Probability ", p_trans)
```



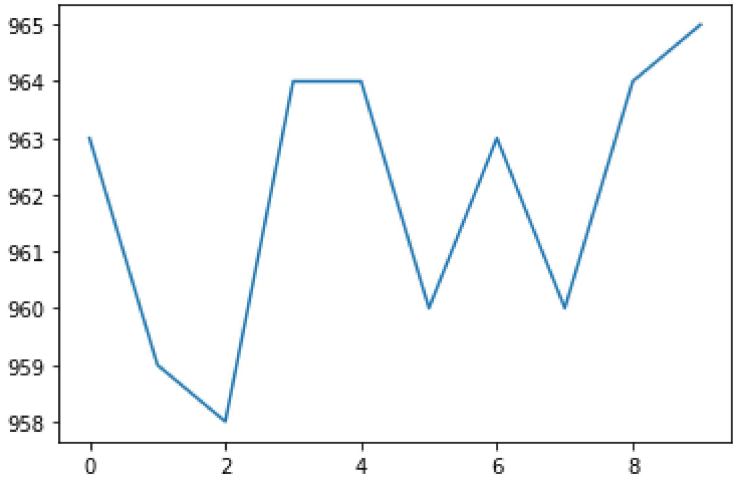

```
Prediction failures For Diabeties with Error Threshold 0.1 : 965
Transmission Probability  0.965965965965966
```




```
Prediction failures For Diabeties with Error Threshold 0.2 : 964
Transmission Probability  0.964964964964965
```



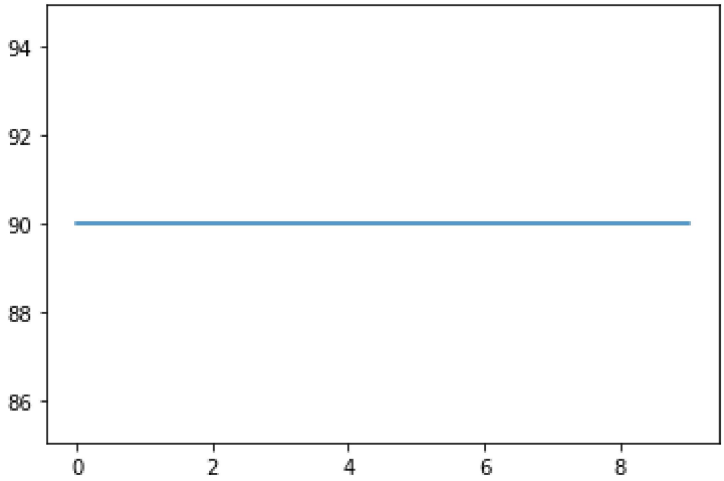

```
Prediction failures For Diabeties with Error Threshold 0.3 : 960
Transmission Probability  0.960960960960961
```



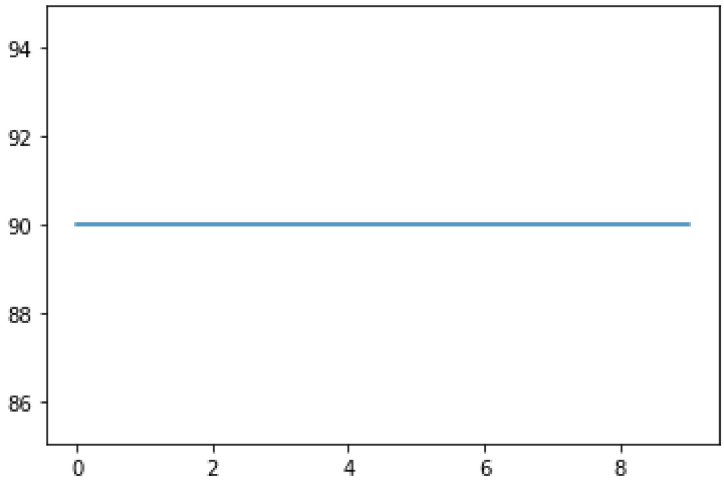

```
Prediction failures For Diabeties with Error Threshold 0.4 : 958
Transmission Probability  0.958958958958959
```

In [27]:
```
pulse_th = [.001, .002, .005, .01]

for th in pulse_th:

    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[6], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[6], 30, th)
    print("Prediction failures For Pulse Rate with Error Threshold {} : {}".format(t
```

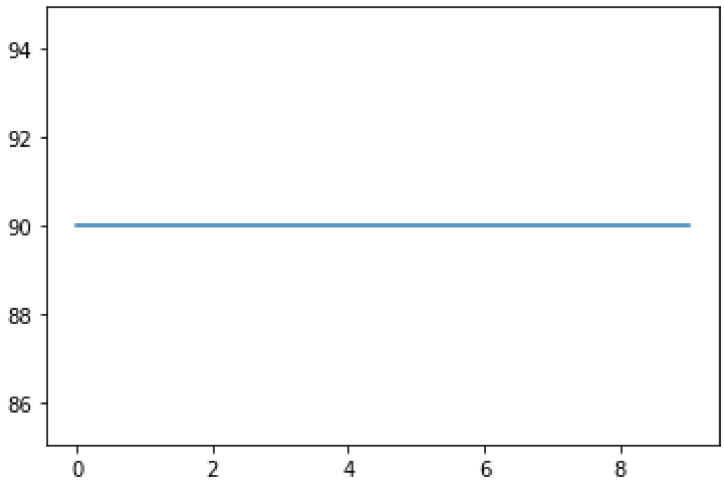
```
    p_trans = pf/len(df_list[6])
    print("Transmission Probability ", p_trans)
```



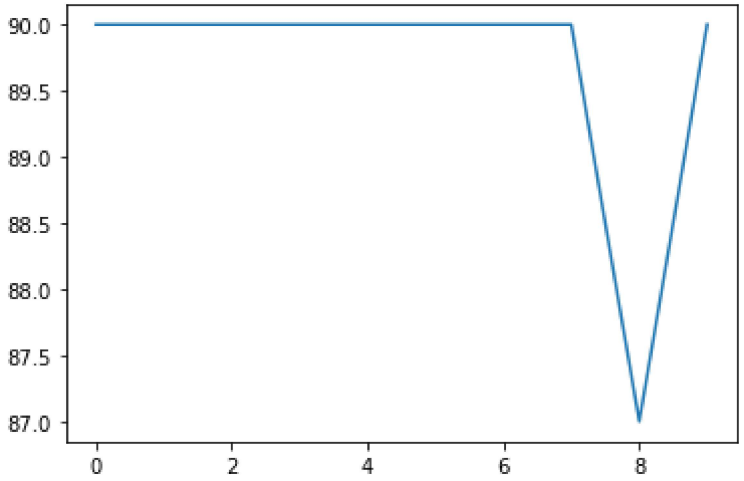

```
Prediction failures For Pulse Rate with Error Threshold 0.001 : 90
Transmission Probability  0.09009009009009009
```




```
Prediction failures For Pulse Rate with Error Threshold 0.002 : 90
Transmission Probability  0.09009009009009009
```

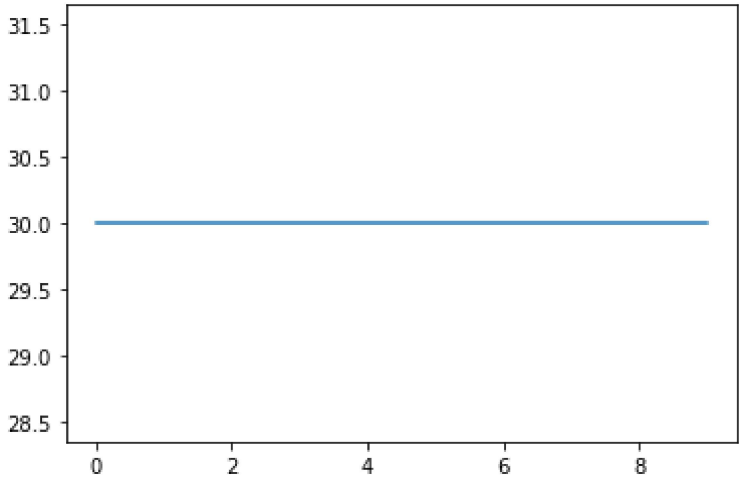



```
Prediction failures For Pulse Rate with Error Threshold 0.005 : 90
Transmission Probability  0.09009009009009009
```

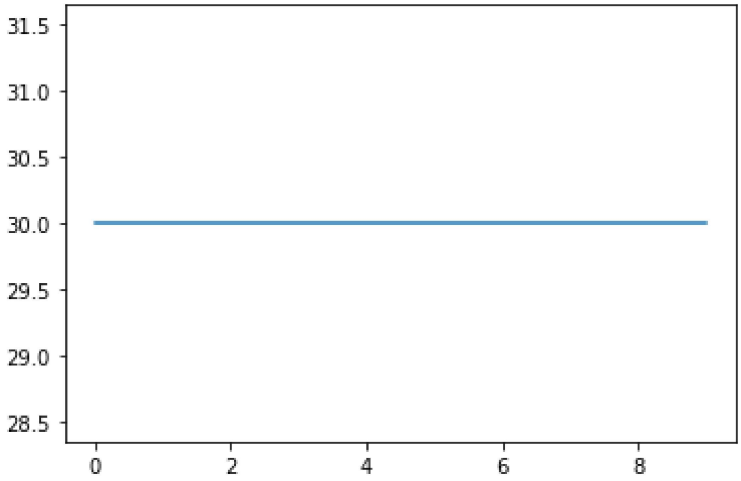



```
Prediction failures For Pulse Rate with Error Threshold 0.01 : 87
Transmission Probability  0.08708708708708708
```

In [28]:
```
spo2_th = [.001, .002]

for th in spo2_th:

    ai_arr, ai_optimal, pred_fail_list = sampling_frequency_train(df_list[7], 30, th

    plt.plot(pred_fail_list)
    plt.show()

    pf = get_pred_fail(ai_optimal, df_list[7], 30, th)
    print("Prediction failures For SpO2 with Error Threshold {} : {}".format(th, pf)


    p_trans = pf/len(df_list[7])
    print("Transmission Probability ", p_trans)
```




```
Prediction failures For SpO2 with Error Threshold 0.001 : 30
Transmission Probability  0.03003003003003003
```




```
Prediction failures For SpO2 with Error Threshold 0.002 : 30
Transmission Probability  0.03003003003003003
```

In [120…
```
'''Sampling frequency can be calculated by uncommenting this section of code.'''
#sampling_freq = packet_tras_rate * p_trans                    #----'packet_tras_
```

Out[120…
```
'Sampling frequency can be calculated by uncommenting this section of code.'
```

In [ ]:
```

```