Exercise 2.11

Introduction

This will work with the equation given in the book for the binomial coefficient. It helps calculate the probability.

In [8]:

```python
import numpy as np
import matplotlib.pyplot as plt

#Part A
def binomial(n,k):
    if k ==0:
        return 1
    else:
        return int(np.math.factorial(n)/np.math.factorial(k)/np.math.factorial(n-k))

#Part B
print("Pascal's Triangle")
for n in range(1,21):
    row = []
    for k in range(n+1):
        row.append(binomial(n,k))
    print(np.array(row))

print()

#Part C
num_tosses = 100
heads = 60

def probability(n,k):
    return binomial(n,k)/2**n

print(f'Probability of {heads} heads in {num_tosses} tosses: {probability(num_tosses,

total_probability = 0
for head in range(heads,num_tosses+1):
    total_probability += probability(num_tosses,head)

print(f'Probability of {heads} or more heads in {num_tosses} tosses: {total_probabili
```

```
Pascal's Triangle
[1 1]
[1 2 1]
[1 3 3 1]
[1 4 6 4 1]
[ 1  5 10 10  5  1]
[ 1  6 15 20 15  6  1]
[ 1  7 21 35 35 21  7  1]
[ 1  8 28 56 70 56 28  8  1]
[  1   9  36  84 126 126  84  36   9   1]
[  1  10  45 120 210 252 210 120  45  10   1]
[  1  11  55 165 330 462 462 330 165  55  11   1]
[  1  12  66 220 495 792 924 792 495 220  66  12   1]
[   1   13   78  286  715 1287 1716 1716 1287  715  286   78   13    1]
[   1   14   91  364 1001 2002 3003 3432 3003 2002 1001  364   91   14
    1]
[   1   15  105  455 1365 3003 5005 6435 6435 5005 3003 1365  455  105
   15    1]
[    1    16   120   560  1820  4368  8008 11440 12870 11440  8008  4368
  1820   560   120    16     1]
[    1    17   136   680  2380  6188 12376 19448 24310 24310 19448 12376
  6188  2380   680   136    17     1]
[    1    18   153   816  3060  8568 18564 31824 43758 48620 43758 31824
 18564  8568  3060   816   153    18     1]
[    1    19   171   969  3876 11628 27132 50388 75582 92378 92378 75582
 50388 27132 11628  3876   969   171    19     1]
[     1     20    190   1140   4845  15504  38760  77520 125970 167960
 184756 167960 125970  77520  38760  15504   4845   1140    190     20
      1]

Probability of 60 heads in 100 tosses: 1.084%
Probability of 60 or more heads in 100 tosses: 2.844%
```

Conclusion

This was not terrible. It took a second for me to understand how to do part b. I think I did the right thing for part c by adding the probabilities together, but I don't know.

Exercise 3.1

Introduction

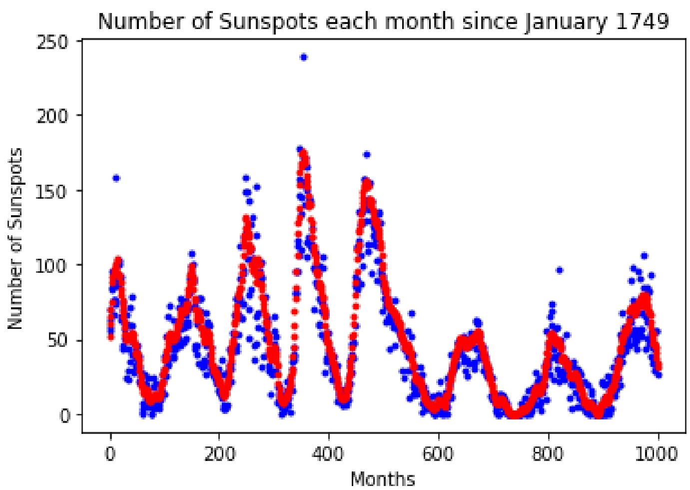
This will work with graphing from a data file.

In [31]:

```
#Parts A & B
data=np.loadtxt('sunspots.txt')
plt.plot(data[:1000,0],data[:1000,1],'b.')
plt.title('Number of Sunspots each month since January 1749')
plt.xlabel('Months')
plt.ylabel('Number of Sunspots')

#Part C
for idx in range(0,1001):
    r = 5
    yk_sum = 0
    for m in range(-r,r+1):
        yk_sum += data[idx+m][1]
    Yk = 1/2/r * yk_sum
    plt.plot(idx,Yk,'r.')

plt.show()
```



Conclusion

The hard part of this for me was understanding the math in the exercise. I couldn't do it at first. I think the graph of the running average makes sense.

Exercise 2.10 (cont.)

Intro

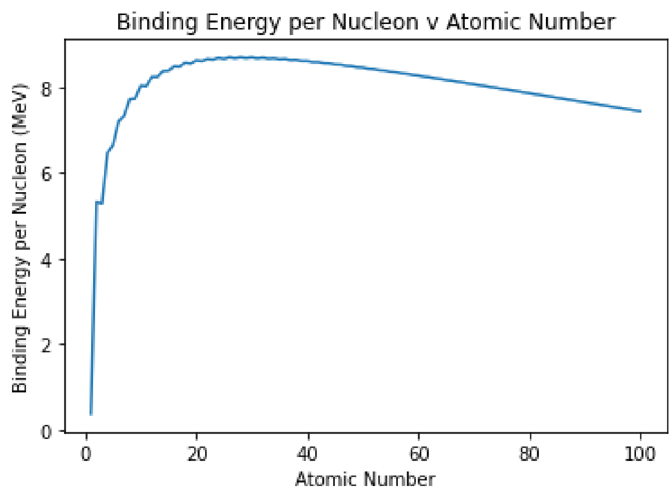
This code will calculate binding energy for input values. Then highest binding energy per nucleon. The highest binding per nucleon for a given atomic number will be calculated. Lastly, The highest binding energy per nucleon for elements 1-100 will be found.

$$B = a_1 A - a_2 A^{\frac{2}{3}} - a_3 \frac{Z^2}{A^{\frac{1}{3}}} - a_4 \frac{(A-2Z)^2}{A} + \frac{a_5}{A^{\frac{1}{2}}}$$

Now I am plotting binding energy per nucleon as a function of atomic number.

In [21]:

```
import numpy as np
import matplotlib.pyplot as plt
def binding_energy(Z,A):
    a1 = 15.8
    a2 = 18.3
    a3 = 0.714
    a4 = 23.2
    if A%2 ==0:
        if Z%2 == 0:
            a5 = 12  #a5 value depends on odd and even of A and Z
        else:
            a5 = -12
    else:
        a5 = 0
    return a1*A-a2*A**(2/3)-a3*Z**2 / A**(1/3)-a4*(A-2*Z)**2/A+a5/A**(1/2) #Equation
def maxBindingPerNucleon(Z):
    maxBpN = 0
    maxA = 0
    for A in range(Z,3*Z+1):
        BpN = binding_energy(Z,A)/A  #calculates binding energy and divides by # of n
        if BpN> maxBpN:  # If value calculated above is higher than max, it is the ne
            maxBpN=BpN
            maxA = A
    return maxA #Returns the mass number with the highest bnding energy per nucleon
#Part D
maxZ = []
for Z in range(1,101):
    #print(f'Z = {Z}, A= {maxBindingPerNucleon(Z)}, BpN= {binding_energy(Z,maxBinding
    maxZ.append(binding_energy(Z,maxBindingPerNucleon(Z))/maxBindingPerNucleon(Z)) #
#print()
#print(f'The maximum binding energy per nucleon occurs at Z = {maxZ.index(max(maxZ))+
plt.plot(range(1,101),maxZ)
plt.title('Binding Energy per Nucleon v Atomic Number')
plt.xlabel('Atomic Number')
plt.ylabel('Binding Energy per Nucleon (MeV)')
plt.show()
```



Conclusion

The graph is a lot like what is expected. There are some anomolies in nature that do not show up.

Ripples.py

In [26]:

```
from math import sqrt,sin,pi
from numpy import empty
from pylab import imshow,gray,show, colorbar

wavelength = 5.0
k = 2*pi/wavelength
xi0 = 1.0
separation = 20.0      # Separation of centers in cm
side = 100.0           # Side of the square in cm
points = 500           # Number of grid points along each side
spacing = side/points  # Spacing of points in cm


# Calculate the positions of the centers of the circles
x1 = side/2 + separation/2
y1 = side/2
x2 = side/2 - separation/2
y2 = side/2

# Make an array to store the heights
xi = empty([points,points],float)

# Calculate the values in the array
for i in range(points):
    y = spacing*i
    for j in range(points):
        x = spacing*j
        r1 = sqrt((x-x1)**2+(y-y1)**2)
        r2 = sqrt((x-x2)**2+(y-y2)**2)
        xi[i,j] = xi0*sin(k*r1) + xi0*sin(k*r2)

# Make the plot
imshow(xi,origin="lower",extent=[0,side,0,side])
show()
```