In [15]:

```
import math
import matplotlib.pyplot as plt


T=5
sigma=0.3
r=0.05
K=105
S0=100
delta=T/20
delta_1=math.sqrt(delta)

def aux_put(Pri):
  if (Pri<=K):
    return (K-Pri)
  elif (Pri>K):
    return 0


def aux_call(Pri):
  if (Pri>=K):
    return (-K+Pri)
  elif (Pri<K):
    return 0

def fact(n):
  prod=1
  while n>1:
    prod=prod*n
    n=n-1
  return prod
def pric(i,a,b):
  pricc=S0
  pricw=pow(a,i)*pow(b,20-i)
  pricc=pricc*pricw
  return pricc

def combination(n,r):
  k_1=fact(n)
  k_2=fact(n-r)*fact(r)
  k_1=k_1/k_2
  return k_1

alpha=math.exp(sigma*delta_1+(r-(sigma*sigma)/2)*delta)
beta=math.exp(-sigma*delta_1+(r-(sigma*sigma)/2)*delta)
if (beta<math.exp(r*T/20)) and (alpha>math.exp(r*T/20)):
  print("The no arbitrage condition is verified")
  print(" ")

else :
  print("The calculations are invalid due to the violation of no arbitrage princ
iple")

M=[0, 2, 4, 6, 12, 18]


def main(f):
  a=math.exp(sigma*delta_1+(r-(sigma*sigma)/2)*delta)
  b=math.exp(-sigma*delta_1+(r-(sigma*sigma)/2)*delta)
```

```
  p=((math.exp(r*delta))-b)/(a-b)
  q=1-p
  rem=((20-f)*T)/20
  base=1/math.exp(r*rem)
  print("The present time: ", T-rem)
  print("The remaining time: ", rem)
  print(" ")
  if f>=0:
    call=[]
    put=[]
    for s in range(f+1):
      up=s
      down=f-s
      s_1=0
      s_2=0
      for j in range(21-f):
        price_ok=pric(j+s,a,b)
        price1=aux_call(price_ok)
        price1=price1*combination(20-f,j)
        price1=price1*pow(p,j)*pow(q,20-f-j)
        s_1=s_1+price1
        price2=aux_put(price_ok)
        price2=price2*combination(20-f,j)
        price2=price2*pow(p,j)*pow(q,20-f-j)
        s_2=s_2+price2
      s_1=s_1*base
      s_2=s_2*base
      call.append(s_1)
      put.append(s_2)

    print("The call option prices:")
    print("The first entry indicates 0 ups and all downs, the second 1 up and th
e rest downs and so on")
    print(" ")
    print(call)
    print(" ")
    print("The put option prices:")
    print("The first entry indicates 0 ups and all downs, the second 1 up and th
e rest downs and so on")
    print(" ")
    print(put)
    print(" ")

for k in M:
  main(k)
```

```
The no arbitrage condition is verified

The present time:  0.0
The remaining time:  5.0

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[33.85944948849383]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[15.633531710991278]

The present time:  0.5
The remaining time:  4.5

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[15.09587251387976, 31.89325322224638, 59.95876890092259]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[24.672817161536067, 15.487143431401382, 8.479204228539844]

The present time:  1.0
The remaining time:  4.0

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[5.154831129992468, 13.469716242796967, 29.803955121326933, 57.69999
468717516, 100.66266571336135]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[35.96530361639754, 24.98328656939406, 15.26943210857484, 8.00422345
974074, 3.5041738979719725]

The present time:  1.5
The remaining time:  3.5

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[1.1250032145209163, 4.121404621027413, 11.767496962598832, 27.57320
423638379, 55.29535567856726, 98.43886924880032, 160.61138775301708]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
```

```
he rest downs and so on

[48.30495083519326, 36.97007206651646, 25.270959639777367, 14.963371
872697078, 7.436262009137822, 2.998249745266072, 0.9424265244113356]

The present time:  3.0
The remaining time:  2.0

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[0.0, 0.0, 0.0, 0.1183301448516881, 1.2359711338578985, 6.1485204634
26525, 19.725206220102635, 46.97618778485102, 91.19343329629586, 15
4.84169905359852, 242.03018282001358, 359.93418379078935, 519.099688
850719]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[78.22822279375717, 72.35769482612885, 64.43331094390453, 53.8548417
1072243, 40.5333138464162, 25.955023925263937, 13.221828652306382,
4.958185582926971, 1.235702234238715, 0.17210275688518703, 0.0087052
81628291726, 0.0, 0.0]

The present time:  4.5
The remaining time:  0.5

The call option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 8.149173872616734, 36.
25149449124524, 83.95057683153273, 149.14960563525577, 237.159088911
3628, 355.9594650618289, 516.3231991518775, 732.791598029106, 1024.9
93372815408, 1419.4245121000376]

The put option prices:
The first entry indicates 0 ups and all downs, the second 1 up and t
he rest downs and so on

[95.53406311515671, 93.12931642139074, 89.88324791682146, 85.5015137
5593353, 79.58679130640233, 71.60275111353512, 60.82542413915251, 4
6.2775544006557, 26.639984302677387, 8.28121121914694, 0.60154616826
26716, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```

In [ ]: