Section 5

Q3) Alina gambles against Gina. Each night Alina draws a card from a deck (with replacement). If it is a spade or a queen, Alina wins $4. If not, Alina loses $1. What is Alina's total expected winnings after 30 nights?

A3) According to the question Alina wins when Either a SPADE or a QUEEN is drawn from a deck of cards (with replacement), therefore probability of obtaining either a SPADE or a QUEEN can be calculated as, (P=SUCCESS CASE)

$$P = \frac{{}^{13}C_1 + {}^{4}C_1 - 1}{{}^{52}C_1} = \frac{4}{13}$$

Where, ${}^{13}C_1$ is the combination of selecting a SPADE card.
${}^{4}C_1$ is the combination of selecting a QUEEN card.
1 is the QUEEN of SPADE card.

Also Q the probability of failure is

$$Q = 1 - P =$$

The Random Variable Considering the days she would win be X

For X=0

$$P(0) = {}^{30}C_0 \left(\frac{9}{13}\right)^{30}$$

For X=1

$$P(1) = {}^{30}C_1 \left(\frac{4}{13}\right) \left(\frac{9}{13}\right)^{29}$$

For X=2

$$P(2) = {}^{30}C_2 \left(\frac{4}{13}\right)^2 \left(\frac{9}{13}\right)^{28}$$

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For X=30

$$P(30) = {}^{30}C_{30} \left(\frac{4}{13}\right)^{30} \left(\frac{9}{13}\right)^0$$

The above can be calculated by using the following

```
from itertools import combinations
from math import factorial as f

def comb(a,b);
        return f(a)/(f(b)*f(a-b))

sum = [ ]

for i in range(31);
        sum.append((comb(30,1))*(pow((9/13),i)*pow((4/13),(30-i))))


print(sum)
```

Then we need to calculate the amount she wins in each of the following cases by using the following

```
a = [ ]
for i in range(31);
        a.append((30-i)*4 + (i)*(-1))

print(a)
```

In the end we need to multiply the amount array ‘a’ and ‘sum’ to calculate the expected amount she wins by repeatedly adding into it for various cases.

```
from itertools import combinations
from math import factorial as f

def comb(a,b);
        return f(a)/(f(b)*f(a-b))

sum = [ ]

for i in range(31);
        sum.append((comb(30,1))*(pow((9/13),i)*pow((4/13),(30-i))))


print(sum)

res = 0
for i in range(31);
        res = res + (sum[ i ] * a[ i])

print(res)
```

And finally we obtain the result as $16.153846.