Help with page 18 of the lecture notes

Setting and Question

A roulette wheel lands on each of the digits 0, 1, 3, 4, 5, 6, 7, 8, and 9 with probability = 0.10. Write down an expression for the calculation of the following: "the probability of "5 or " 6" exactly 3 times in 20 spins"

This setting is appropriately modeled using the Binomial distribution

Each spin of roulette wheel qualifies as a separate trial.
N = # trials = 20

The outcomes of the separate spins are mutually independent.
The outcome of each spin has no influence on the outcome of other spins.

There is a "yes/no" event of interest.
We say event has occurred if the wheel lands on a "5 or 6"
Probability [event] = π = 0.20

So we can define our Binomial random variable X as
X = # occurrences of event of "5 or 6" in 20 trials where π = 0.20

The desired probability is "5 or 6" exactly 3 times in 20 spins"

Translation: Probability [X = 3] = $\binom{20}{3} \pi^3 (1-\pi)^{20-3}$

Solution for $\binom{20}{3}$

$$\binom{20}{3} = \frac{20!}{3!\ 17!} = \frac{(20)(19)(18)\,17!}{3!\ 17!}$$ by a little unravelling of the 20!

$$= \frac{(20)(19)(18)}{3!}$$ by canceling the 17! top and bottom

$$= \frac{(20)\,(19)\,(18)}{(3)(2)(1)} \text{ by unravelling the 3!}$$

$= 1140$

Solution for π^3

$$\pi^3 = .20^3 = .008$$

Solution for $(1 - \pi)^{20\text{-}3}$

$$(1\text{-}\pi)^{20\text{-}3} = (1\text{-}.20)^{17} = .80^{17} = 2.2517998 \text{ x } 10^{-2} = .02252$$

The desired probability is thus

$$\binom{20}{3} \pi^3 \, (1\text{-}\pi)^{20\text{-}3}$$

$$= (1140)(.008)(.02252)$$

$$= .2054$$