8. Let the number of wires $N = 5$

9. since each wire has double ends

10. $\Rightarrow 2N = 10$

11. Let X be the number of loops formed

12.

13. Case 1: One Long Loop

the possibility of this happening is when all 10 ends are paired together

$$Pr(\text{case 1}) = \frac{1}{\binom{10}{2}}$$
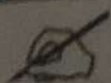
14.

15. the number of loops for case 1 is one (1)

16.

17. Case 2: Two loops

18. this is possible when 8 ends are paired together

19. leaving 2 loose end that form a separate loop

20. $$Pr(\text{case 2}) = \frac{\binom{10}{2}\binom{8}{2}}{\binom{10}{4}}$$

[8] Case 3: there could be 3 loops

[9] this is possible when 6 ends are paired together

[10] leaving 4 loose end that form separate loops

[11]

[12] $$Pr(case\ 3) = \frac{\binom{10}{2} \cdot \binom{8}{2} \cdot \binom{6}{2}}{\binom{10}{6}}$$

[13]

Case 4: Four Loops

[14]

[15] $$Pr(case\ 4) = \frac{\binom{10}{2} \cdot \binom{8}{2} \cdot \binom{6}{2} \cdot \binom{4}{2}}{\binom{10}{8}}$$

[16]

[17]

[18] Case 5: Five Loops

[19]

[20] $$Pr(case\ 5) = \frac{\binom{10}{2} \cdot \binom{8}{2} \cdot \binom{6}{2} \cdot \binom{4}{2} \cdot \binom{2}{2}}{\binom{10}{10}}$$

$$E(x) = 1 \cdot Pr(x=1) + 2 \cdot Pr(x=2) + 3 \cdot Pr(x=3)$$
$$+ 4 \cdot Pr(x=4) + 5 \cdot Pr(x=5)$$

$$\Rightarrow = 1 \cdot \frac{1}{\binom{10}{2}} + 2 \cdot \frac{\binom{10}{2} \cdot \binom{8}{2}}{\binom{10}{4}} + 3 \cdot \frac{\binom{10}{2} \binom{8}{2} \cdot \binom{6}{2}}{\binom{10}{6}}$$

$$+ 4 \cdot \frac{\binom{10}{2} \cdot \binom{8}{2} \binom{6}{2} \binom{4}{2}}{\binom{10}{8}} + 5 \cdot \frac{\binom{10}{2} \cdot \binom{8}{2} \binom{6}{2} \cdot \binom{4}{2} \binom{2}{2}}{\binom{10}{10}}$$

$$\Rightarrow \frac{1}{45} + 2 \frac{45 \times 28}{210} + 3 \cdot \frac{45 \times 28 \times 15}{210} +$$

$$4 \cdot \frac{45 \times 28 \times 15 \times 6}{45} + 5 \cdot \frac{45 \times 28 \times 15 \times 6 \times 1}{1}$$

$$\Rightarrow \frac{1}{45} + 12 + 63 + 504 + 3780$$

$$\Rightarrow 4860 + \frac{1}{45} \approx 4857.8$$

The expected Number of loops For
Five wires is approximately 4857.8