Chi squared

Chi-square test χ^2

Determines how likely the result you got was significant

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

Do not solve for X!!! The value you want is calculated as given.
NEVER TAKE THE SQUARE ROOT OF ANYTHING in a chi-square calculation!

The chi-squared test is to see if your data are a good fit to a random distribution. Formally, your *null hypothesis* should be something like: "this is just variations of a random distribution…there is no real pattern." Remember, most of the time your *actual* hypothesis is that there is some preference or pattern. You are asking the chi square test to *DISPROVE* the null hypothesis. Possible outcomes:

1. Chi squared value is small, less than would give you a p-value of 0.05 or 0.01 or so. In this case you have failed to disprove the null hypothesis. You **cannot** conclude that there is no pattern or preference (in the case below). You can only conclude that you don't have enough data to show a pattern.
2. Chi-squared value is high, resulting in a p-value less than 0.05 or 0.01 (depending on the requirements given). This allows you to conclude that the null hypothesis is extremely unlikely. You therefore conclude that a pattern other than random does exist.

Using a choice chamber to measure preferences of mosquitos, a student compares the relative attractiveness of different strips of cotton cloth taken from undershirts, either brand new or worn by one of 4 different individuals (2 male, 2 female) for 3 hours during their day. She counts how many times mosquitos land on the cloth per minute, for 5 separate trials. She finds the following:

Trial	New Undershirt	F1	F2	M1	M2	Total landings	Expected for each	χ^2
1	1	18	15	28	20	82	16.4	23.73
2	2	22	16	25	19	84	16.8	37.05
3	1	17	14	29	22	83	16.6	48.32
4	0	25	14	31	22	92	18.4	51.00
5	3	20	12	30	18	83	16.6	40.72
sum	7	102	71	143	101	417	83.4	169.10
average	1.4	20.4	14.2	28.6	20.2			
Sums	7	417						

a. It seems from the last row that mosquitos prefer cloth from shirts worn by humans. What would be a good "null hypothesis," to test by a chi-squared method?

i. First note that I added another column and some more rows and included calculations. The null hypothesis might be: "The flies show no preference for worn clothing and the deviations from random distribution is not significant."
If this is true, the expected number of landings on all cloths, assuming they are equal in size, should be the same, 0.2x the total.

b. determine whether the null hypothesis is disproved or not using chi-squared.

i. You can conclude for each trial that the χ^2 value is easily high enough to exceed a p-value lower than 0.01 (much lower—in fact, I should have picked less dramatic numbers). Summing all the experiments gives an even more dramatic result. However, maybe summing the experiments introduces a variable for which I didn't control? I don't think so since each trial looks pretty similar.

c. The data may suggest a slight preference for men's clothing. Propose an experiment to test that.

i. There are lots of things we discussed for which you would need to control. Assuming you got all the controls right, you could test whether there really is a preference by comparing them directly.
Looking at the data, perhaps we could get an idea just from those shown. Let's say we ignore the unworn cotton and just compare the human-worn cloth. So, ½ of those landings should be on those worn by women and the other ½ on those worn by men.
I did some calculations below and the $\chi 2$ value is shown. For 1 degree of freedom, the

Table 1-1

F1	F2	M1	M2	Expected	χ^2
18	15	28	20	40.5	2.78
22	16	25	19	41	0.44
17	14	29	22	41	4.88
25	14	31	22	46	2.13
20	12	30	18	40	3.20
102	71	143	101	208.5	12.09

individual trials don't rise to the level of significance. I cannot rule out the null hypothesis that this is random scatter around the expected 50:50 distribution. However, assuming that I can add all the trials, the last row suggests there is a significant preference for male clothing.
Again, there are lots of caveats.