

Name Key Hr _____

1. Decide whether each of the following statements is true or false. If false, explain why.

- T a) When the number of categories is small, the shape of the χ^2 distribution is skewed right.
- T b) In a chi-square goodness-of-fit test, you use the test to assess how well a given probability model fits your data.
- F c) In a chi-square goodness-of-fit test, the expected frequencies ~~are always positive integers.~~ *Can be decimals*
- F d) As the number of categories increases, the shape of the χ^2 distribution gradually becomes ~~more skewed and less mound-shaped.~~ *less more*

2. The table below lists the actual percent of traffic stops by age groups in 2002 for the Las Vegas Metropolitan Police Department¹. (Note: Age is the officer's perception of the age of the driver.) Suppose that in a random sample of 1000 traffic stops for the following year, the distribution was as shown in the table below.

Age	Percent Stopped in 2002	Age	Number Stopped in 2003
Younger Than 18	3.0	Younger Than 18	40
18-29	40.5	18-29	435
30-39	27.4	30-39	280
40-49	16.5	40-49	150
50 and Older	12.6	50 and Older	95

If you test the goodness of fit of the 2003 sample to the 2002 distribution, the expected frequency for the 18-29 age group in 2003 is

- a) 40.5
- b) 81
- c) 200
- d) 405
- e) 435

$1000(.405)$

¹ Source: State of Nevada, Office of the Attorney General, January 29, 2003, http://ag.state.nv.us/Hottopics/AB500/AB500_Complete.pdf.

3. Mrs. Sapp runs an experiment to determine whether three flavors of Jolly Ranchers are equally preferred among MHS students. In the experiment, 150 students are individually presented with three Jolly Ranchers, each a different flavor, and their choice is noted. Tabulations show that 62 students prefer Green Apple, 43 prefer Grape, and 45 prefer Cherry. Is there sufficient evidence to say that students have preferences among the flavors? Test at the 10% significance level.

χ^2 GOF

- a) No, with $\chi^2 = 2.09$, there is not sufficient evidence even at the 25% significance level.
 b) No, with $\chi^2 = 4.36$, there is not sufficient evidence even at the 10% significance level.
 c) No, with $\chi^2 = 19.0$, there is not sufficient evidence even at the .1% significance level.
 d) Yes, with $\chi^2 = 4.36$, there is sufficient evidence at the 10% significance level.
 e) Yes, with $\chi^2 = 19.0$, there is sufficient evidence even at the 0.1% significance level.
4. Which of the following statements is *not* true for a chi-square goodness-of-fit test?
- a) The test may be used to check whether a die is fair. ↳ one variable
 b) The test may be used to check whether observed frequencies follow a given theoretical distribution.
 c) The test is used when we are measuring two or more variables.
 d) You can reject the null hypothesis when the P -value is smaller than α , the level of significance.
 e) The alternate hypothesis states that the observed counts are different than the expected counts.
5. Decide whether each of the following statements is **true** or **false**. If false, explain why.
- F a) To determine whether there is an association between voting and subscribing to a newspaper, an investigator takes an independent random sample of registered voters and asks them if they voted in the last election and then asks each person whether he or she subscribes to a newspaper. The investigator concluded the appropriate chi-square test has ~~4~~ degrees of freedom. df = 1
- F b) In a chi-square test of independence, independent random samples are taken from ~~two or more~~ one populations.
- T c) Chi-square tests of independence and homogeneity both are usually right-tailed tests.
- T d) The null hypothesis for a chi-square test of homogeneity is that the proportion that falls into each category is the same for every population.

Questions 6–7 refer to the following data.

The two-way table shown next presents data about the race and gender, per thousand, of persons stopped for traffic violations in 2002 by the Las Vegas Metropolitan Police Department. These data cannot reasonably be considered a random sample from any well-defined population because this is the entire population of traffic stops. (*Note:* the “Other” column for race was removed because of its very small rate.)

		Race (per thousand)				Total
		White	Black	Hispanic	Asian	
Gender (per thousand)	Male	372	107	184	33	696
	Female	186	50	49	19	304
	Total	558	157	233	52	1000

6. What is the expected number of Hispanic males per thousand persons stopped for traffic violations in 2002, assuming race and gender are independent?
- A. $\frac{233}{1000}$ B. $\frac{696}{1000}$ C. $696 \cdot \frac{1000}{233}$ D. $233 \cdot \frac{1000}{696}$ E. $233 \cdot \frac{696}{1000}$
7. Suppose you use a chi-square test in order to test the claim that there is an association between race and gender among those stopped for traffic violations. You compute $\chi^2 = 13.02$. Assuming that the data can be considered a random sample of drivers stopped for traffic violations, which of the following is an appropriate conclusion at the 5% significance level?
- a) If you use a chi-square test of homogeneity, the P -value is less than .05. This is sufficient evidence to reject the null hypothesis that race and gender are not related.
- b) If you use a chi-square test of homogeneity, the P -value is greater than .05. This is insufficient evidence to reject the null hypothesis that race and gender are not related.
- c) If you use a chi-square test of independence, the P -value is less than .05. This is sufficient evidence to reject the null hypothesis that race and gender are not related.
- d) If you use a chi-square test of independence, the P -value is greater than .05. This is insufficient evidence to reject the null hypothesis that race and gender are not related.
- e) A chi-square test cannot be used because at least one of the expected values is too small.

$$\chi^2 \text{cdf}(13.02, 1E99, 3) = .0046$$

8. A grocery store sells four different sizes of a popular brand of corn flakes. For the past few years the proportion of boxes they sell of each size has been quite stable: 10% Small, 15% Medium, 60% Large, and 15% Jumbo. They decide to change the pricing of the four sizes and want to see if this changes the proportion of boxes they sell of each size. To test this, a few weeks after changing the prices they take a simple random sample of 120 transactions involving corn flakes and count how many boxes of each size were sold. Here are the results.

Observed number of boxes sold for each box size

Small	Medium	Large	Jumbo
8	24	61	27

- a) We wish to carry out a test of significance to see if the distribution of sizes of cereal boxes sold has changed. State the null and alternative hypotheses for this test.

Exp H_0 : The proportion of boxes sold remains stable

H_a : The proportion of boxes sold does not remain stable

- b) Find the expected counts for each size box under the assumption that the null hypothesis is true.

See above

- c) Discuss whether the conditions for this test have been met.

Random Sample ✓ Expected values > 5 ✓ Counts at least 1 ✓

- d) Conduct the appropriate hypothesis test and make the appropriate conclusion. Use $\alpha = 0.05$.

$$\chi^2 = 9.514 \quad p\text{-val} = .023 \quad df = 3$$

Since $p\text{-value} < \alpha$, there is sufficient evidence to suggest that the prop. of boxes sold does not remain stable.

- e) Based on your answer to (d), which error is it possible that you have made: Type I or Type II? Describe that error in the context of the problem.

Type I

(The prop. of boxes sold does remain stable, but we say it doesn't.)

9. In some countries, people believe that blood type has a strong impact on personality. For example, Type B blood is thought to be associated with passion and creativity. A statistics student at a large U.S. university decides to test this theory. Reasoning that people involved in the arts should be passionate and creative, she takes a simple random sample of students majoring or minoring in arts at her university and asks them for their blood type. Here are her results:

-State Assump.

Observed number of performing arts majors with each blood type

Type A	Type B	Type AB	Type O	Total
50	23	10	67	150

63 15 6 66

Assume the distribution of blood type among all U.S. residents is as follows: Type A: 42%; Type B: 10%; Type AB: 4%; Type O: 44%.

Conduct an appropriate hypothesis test to determine if blood type has an impact on personality.

H_0 : Blood types for arts students follow the US distribution

H_a : ... do not ...

$\chi^2 = 9.631$ $df = 3$ $p\text{-value} = .02197$ $\alpha = .05$

Since $p\text{-val} < \alpha$, there is suff. evidence to suggest the blood types for arts students do not follow the typical US distribution.

10. A person studying fathers' involvement in their children's education interviews a simple random sample of fathers of school-age children. One question concerns regularly scheduled parent-teacher conferences. Here is a two-way table of the results:

-State Assump.

	Attended all	Attended some	Attended none	Total
Fathers in two-parent families	109	132	203	444
Fathers in single-parent families	15	10	13	38
Non-resident fathers	11	5	82	98
Total	135	147	298	580

Conduct an appropriate hypothesis test to determine if there is an association between fathers' household role and attending conferences.

χ^2
Independence

H_0 : there is no association between fathers role and attending conferences.

H_a : there is an assoc...

$\chi^2 = 54.77$

$p\text{-val} = 0$ $\alpha = .05$

$df = 4$

Since $p\text{-val} < \alpha$ there is suff. evidence...

11. A large company planning to install drink vending machines in its office building selects simple random samples of both the professional staff and the administrative support staff and asks people to choose between two brands of drink machines—Coca-Cola or Pepsi. Here are the results.

χ^2 Homogeneity

-State assump.

Drink Brand	Coca-cola	Professional Staff	Support Staff	Total		
		10.1	14		33.8	30
	Pepsi	11.8	8	39.1	43	51
	Total	22	73	95		

- a) Do these data provide evidence that there is a difference in the brand preferences of the professional and administrative support staffs? Use a chi-square test to support your conclusion.

H_0 : the drink preference is the same for professional and support staff.
 H_a : ... not the same...

$$\chi^2 = 3.45 \quad p\text{-val} = .06 \quad df = 1 \quad \alpha = .05$$

Since $p\text{-val} > \alpha$, there is insuff. evidence to suggest the drink preferences are not the same for professional and support staff.

- b) The company discovers that the original sample of professional staff members included six other subjects who didn't respond to the survey. Is it possible that the opinions of those people would change your conclusion? Explain.

Yes, if all 6 responded that they prefer Coke, the new p-value would be .006.