AP Statistics
Unit 08 – HW #2
Chi Square: Homogeneity & Independence Test
(2-Way Table Inference)

Name Key
Period ____

indep (all from one sample)

1. This data is showing who survived the sinking of the Titanic based on whether they were crew members, or passengers booked in first-, second-, or third-class staterooms:

	Crew	First	Second	Third	**Total**
Alive	212	202	118	178	**710**
Dead	673	123	167	528	**1491**
Total	**885**	**325**	**285**	**706**	**2201**

Is the survival rate of the boat passengers the same across the types of staterooms?

State: H_0: There is no association between a person's status on the Titanic and their survival.
$\alpha = 0.05$ H_A: There is an association between a person's status on the Titanic and their survival.

Plan: random: census ✓
10% condition: census ✓
Large counts: expected counts: all expected counts ✓ are greater than or equal to 5.

	Crew	1st	2nd	3rd
alive	285.48	104.84	91.935	227.74
dead	599.52	220.16	193.06	478.26

Because our conditions are met, we will perform a χ^2 test for independence.

DO: $\chi^2 = \frac{(212-285.48)^2}{285.48} + \frac{(202-104.84)^2}{104.84} + \frac{(118-91.935)^2}{91.935} + \dots$

test statistic = 187.79
df = 3
p-value = 1.8293×10^{-40}

Conclude: Because our p-value is less than our significance level $\alpha = 0.05$, we reject the null. There is convincing evidence that there is an association between a person's survival and their status on the Titanic.

homog 2. Two different teachers teach a stats class. The table shows the distribution of final grades they reported. We wonder whether one of these professors is an "easier" grader.

Grade	Teacher 1	Teacher 2	**Total**
A	5	9	14
B	11	12	23
C	14	10	24
D	9	8	17
F	7	9	10
Total	$n_1 = 46$	$n_2 = 48$	94

a. Will you test goodness of fit, homogeneity, or independence? Explain.

2 samples so we will test homogeneity.

b. Determine if one of the teachers is an "easier" grader.

State: H_0: There is no difference in the distribution of test grades between Teacher 1 and Teacher 2. Grades are independent.

$\alpha = 0.05$ H_A: There is a difference in the distribution of test grades between Teacher 1 and Teacher 2.

Plan: random: independent census of student grades for each teacher ✓

10% condition: $n_1 = 46$ 460 < all students ever taught by Teacher 1

$n_2 = 48$ 480 < all students ever taught by Teacher 2 ✓

Large counts: expected counts are all ≥ 5. ✓

	Teacher 1	Teacher 2
A	6.8511	7.1489
B	11.255	11.745
C	11.745	12.255
D	8.3191	8.6809
F	7.8298	8.1702

Because our conditions are met, we will perform a χ^2 test for homogeneity.

Do: $\chi^2 = \frac{(5-6.8511)^2}{6.8511} + \frac{(9-7.1489)^2}{7.1489} + \frac{(11-11.255)^2}{11.255} + \ldots$

test statistic = 2.120

df = 4

p-value = 0.7137

Conclude. Because our p-value 0.7137 is greater than our significance level $\alpha = 0.05$, we fail to reject the null. There is not convincing evidence that the distribution of grades differs between the 2 teachers or that one teacher is easier.

indep.

3. A recent study looked into the relationship between political views and opinions about nuclear energy. A survey administered to 100 randomly selected adults asked their political leanings as well as their approval of nuclear energy. The results are below:

	Liberal	Conservative	Independent	**TOTAL**
Approve	10	15	20	45
Disapprove	9	2	16	27
No Opinion	8	2	18	28
TOTAL	27	19	54	100

Do these data provide convincing evidence that political leanings and views on nuclear energy are associated in the larger population of adults from which the sample was selected?

State: H_0: There is not an association between political leanings and views on nuclear energy.
$\alpha = 0.05$ H_A: There is an association between political leanings and views on nuclear energy.

Plan: random: 100 randomly selected adults with views that are independent of one another ✓
10% condition: $n = 100$ 1000 < all adults ✓
Large counts: expected counts are all ≥ 5 ✓

	liberal	conservative	independent
approve	12.15	8.55	24.3
disapprove	7.29	5.13	14.58
no opinion	7.56	5.32	15.12

Because our conditions are met, we will perform a χ^2 test for independence.

Do: $\chi^2 = \frac{(10-12.15)^2}{12.15} + \frac{(15-8.55)^2}{8.55} + \frac{(20-24.3)^2}{24.3} + \dots$

test statistic: 11.102
df = 4
p-value = 0.02544

Conclude: Because our p-value = 0.02544 is less than our significance level $\alpha = 0.05$, we reject the null. There is convincing evidence that there is an association between political leaning and views on nuclear energy.

indep.

4. In a nationwide telephone poll of 1000 adults representing Democrats, Republicans, and Independents, respondents were asked two questions: their party affiliation and if their confidence in the US banking system had been shaken by the savings and loan crisis. The answers, cross-classified by party affiliation, are given in the following contingency table:

Observed	Yes	No	No Opinion
Democrats	175	220	55
Republicans	150	165	35
Independents	75	105	20

Test the null hypothesis that shaken confidence in the banking system is independent of party affiliation. Use a 10% significance level.

State: H_0: shaken confidence in the banking system is independent of party affiliation.

$\alpha = 0.10$ H_A: shaken confidence in the banking system is not independent of party affiliation.

Plan: Random: nationwide telephone poll assumed random ✓

10% condition: 10000 < all adults representing different political parties ✓
$n = 1000$

Large Counts: expected counts all ≥ 5 ✓

	yes	no	no opinion
dem	180	220.5	49.5
rep	140	171.5	38.5
indep	80	98	22

Because our conditions are met, we will perform a χ^2 test for independence.

Do: $\chi^2 = \frac{(175-180)^2}{180} + \frac{(220-220.5)^2}{220.5} + \frac{(55-49.5)^2}{49.5} + \ldots$

test statistic = 3.0243
df = 4
p-value = 0.5538

Conclude: Because our p-value = 0.5538 is greater than our significance level $\alpha = 0.05$, we fail to reject the null. There is not convincing evidence that shaken confidence in the banking system is not independent of party affiliation.