(1) Pete Zaria owns the Papa's Pizza chain. Recently, Pete hired a new chef. A random sample of ten pepperoni pizza's made by Pete's old chef and pepperoni pizza made by his new chef yielded the following number of slices of pepperoni per pizza.

New Chef	Old Chef
32, 36, 39, 28, 25, 26, 28, 32, 34, 35	28, 36, 38, 42, 36, 34, 31, 32, 40, 33

a. Find the sample mean and standard deviation for both types of crust

$\bar{x}_{New\ Chef}$ = 31.5 pepperoni slices $\bar{x}_{Old\ Chef}$ = 35 pepperoni slices

$s_{New\ Chef}$ = 4.62 pepperoni slices $s_{New\ Chef}$ = 4.27 pepperoni slices

b. Use a 90% confidence interval to estimate the difference between the average slices of pepperoni per pizza for the old and new chef.

State: μ_{old} = true mean # of pepperoni slices per pizza by the old chef

μ_{new} = true mean # of pepperoni slices per pizza by the new chef

We want to estimate $\mu_{old} - \mu_{new}$ with 90% Confidence level

Plan: Two sample t-interval for $\mu_{old} - \mu_{new}$

1) These are two independent, random samples of pizzas form each chef.

2) DRAW THE BOXPLOTS Each sample size is only 10; however, the boxplots of both samples are reasonably symmetric with no serious non-normal features. The normality condition has been met.

3) Because the samples were chosen without replacement, assume that there were at least 10(10) = 100 pizzas made by the new chef and at least 10(10) = 100 pizzas made by the old chef in the population from which Pete selected the sample.

Calculate:

$\bar{x}_{Old}$ = 35 s_{old} =4.27 n_{old} = 10

$\bar{x}_{new}$ = 31.5 s_{new} =4.62 n_{new} =10

df = 17.886 (with technology)

(0.0476, 6.952)

We are 90% confident that the difference in the true mean number of pepperoni slices per pizza (old-new chef) is between 0.0476 and 6.952 slices.

OR We are 90% confident that the true mean number of pepperoni slices per pizza placed by the old chef is between 0.0476 and 6.952 slices more than the true mean number of pepperoni slices per pizza placed by the new chef.

c. In an effort to keep his pizza consistent, Pete wants to ensure that the average amount of pepperoni per slice has not changed with the hiring of his new chef. Using the confidence interval constructed in part (c), what would you tell Pete? Justify your answer.

H0: $\mu old = \mu new$ HA: $\mu old \neq \mu new$

Because the interval does not contain 0, Pete could reject the null hypothesis. There is evidence that the true mean # of pepperoni slices placed by the new chef is **not equal** to the true mean # of pepperoni slices placed by the old chef.

(Not required for full points)

(2) Pete starts paying more attention to his new chef and notices that he seems to be dropping a lot of pizzas while tossing them. He looks at his records from his old chef and discovers that, in a simple random sample of 100 pizzas, the old chef dropped 10 pizzas. Pete finds that in an SRS of 100 pizzas the *new* chef dropped 20 pizzas.

a. Pete decides that he will fire his new chef if this difference is significant at the 5% level. Should the new chef file for unemployment? (Don't forget to do a full process here!)

State: p_{new} = true proportion of pizzas dropped by the new chef

p_{old} = true proportion of pizzas dropped by the old chef

H0: $p_{new} = p_{old}$ HA: $p_{new} > p_{old}$

$\alpha = 0.05$

Plan: Two sample z-test for $p_{new} - p_{old}$

1) The problem uses two, independent samples of pizzas from the old and new chef.

2) $n_{new}\,\hat{p}_{new} \geq 10$ $n_{new}\,(1-\hat{p}_{new}) \geq 10$ $n_{new}\,\hat{p}_{old} \geq 10$ $n_{new}\,(1-\hat{p}_{old}) \geq 10$

(100)(.2) ≥10 (100)(.8) ≥10 (100)(.1) ≥10, (100)(.9) ≥10

20≥10 80≥10 10≥10 90≥10

The large counts condition for Normality has been met.

3) Because the samples were chosen without replacement, assume that there were at least 10(100) = 1000 pizzas made by the new chef and at least 10(100) = 1000 pizzas made by the old chef in the population from which Pete selected the sample.

Calculate:

$\hat{p}_{new}$= .1 n_{new} = 100 $\hat{p}_{old}$ = .2 n_{old} =100 $\hat{p}_c$=0.15

z = 1.98

SKETCH **← p-value = 0.023**

Because our p-value (0.023) is less than than our significant level (0.05), we reject the null hypothesis. We have sufficient evidence that the true proportion of pizzas dropped by the new chef is greater than the true proportion of pizzas dropped by the old chef. Pete will be firing his new chef!

(3) The Panther Prowler just published the results of a recent student poll asking an SRS of 10 girls and 10 boys if they like Justin Bieber. Eight girls reported that they like Justin while 2 boys reported that they were Beliebers. Is there a significant difference in opinions between boys and girls?

a. What procedure would you use to answer this question?

Two sample z test for proportions

b. State the appropriate hypotheses.

H_0: $p_{girls} = p_{boys}$ $\qquad$ H_0: $p_{girls} \neq p_{boys}$

c. Check the conditions required to carry out the procedure you chose in part (a). Have we satisfied the necessary conditions to carry out the procedure?

1) The Prowler staff asked two independent SRS's of girls and boys.

2) $n_{girls}\, \hat{p}_{girls} \geq 10$ $\qquad$ $n_{girls}\, (1 - \hat{p}_{girls}) \geq 10$ $\qquad$ $n_{girls}\, \hat{p}_{boys} \geq 10$ $\qquad$ $n_{girls}\, (1 - \hat{p}_{boys}) \geq 10$

$(10)(.8) \geq 10$ $\qquad$ $(10)(.2) \geq 10$ $\qquad$ $(10)(.2) \geq 10$, $\qquad$ $(10)(.8) \geq 10$

$8 \geq 10$ $\qquad$ $2 \geq 10$ $\qquad$ $2 \geq 10$ $\qquad$ $8 \geq 10$

The condition for normality is NOT MET. We did not have at least 10 successes and failures in each sample.

3) Because the samples were chosen without replacement, assume that there are at least 10(10) = 100 girls and 10(10) = 100 boys in the population.

This was an SRS, the samples were independent, and we met the 10% condition, but we failed to meet the condition for Normality/large counts.

(4) Mrs. Skaff believes that printing tests on colored paper improves test scores. To test this theory, the randomly assigns half of her AP Statistics student to take a test on colored paper and gives the other half of her students a test on boring white paper. The results are listed below.

	n	$\bar{x}$	s
Colored Paper	24	82.5	5.2
White Paper	25	78.3	6.1

a. State the appropriate procedure to test Mrs. Skaff's claim, then state the parameters and appropriate hypotheses.

Two sample t test for means

μ_C = the true mean score of all students when given this test on colored paper

μ_W = the true mean score of all students when given this test on white paper

H_0: $\mu_C = \mu_W$ $\qquad$ H_0: $\mu_C > \mu_W$

b. Check the conditions required to carry out the procedure you chose in part (a). Have we satisfied the necessary conditions to carry out the procedure?

1) The subjects were randomly assigned to treatment groups (colored and white paper)

2) Although we do not know the shapes of the populations, the sample sizes are fairly large (24 for colored and 25 for white). Assuming that the shape of one (or both) of the populations is not **very** strongly skewed and that there were no outliers in our sample data, we can state that the Normality condition has been met.

c. Describe how you could make this a matched pairs experiment. What procedure would you use in this case?
   Answers may vary somewhat…ex: pair students based on current test average. Flip a coin to randomly assign one student in each pair to take the test on colored paper and have the other student take the test on white paper. After giving the test, compare the differences in the scores for all pairs of students to see if testing on colored paper improves test scores (on average).

(5) An SRS of 45 male employees at a large company found that 36 felt that the company was supportive of female and minority employees. An independent SRS of 40 female employees found that 24 felt that the company was supportive of female and minority employees. Let p_1 represent the proportion of all male employees members at the company and p_2 represent the proportion of all female employees members at the company who hboys this opinion. We wish to test the hypotheses $H_0: p_1 - p_2 = 0$ *vs.* $H_a: p_1 - p_2 > 0$

a. Write the appropriate formula for a 99% confidence interval and make the correct substitutions.

$$\hat{p}_1 - \hat{p}_2 \pm z^* \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}} = .8 - .6 \pm 2.756\sqrt{\frac{.8(1-.8)}{45} + \frac{.6(1-.6)}{40}}$$

(6) Some researchers have conjectured that stem-pitting disease in peach tree seedlings might be controlled with weed and soil treatment. An experiment was conducted to compare peach tree seedling growth with soil and weeds treated with one of two herbicides. In a field containing 20 seedlings, 10 were randomly selected from throughout the field and assigned to receive Herbicide A. The remaining 10 seedlings were to receive Herbicide B. Soil and weeds for each seedling were treated with the appropriate herbicide, and at the end of the study period, the height (in centimeters) was recorded for each seedling. A box plot of each data set showed no indication of non-Normality. The following results were obtained:

	$\bar{x}$(cm)	*S* (cm)
Herbicide A	94.5	10
Herbicide B	109.1	9

a. Write the appropriate formula for the test statistic and make the correct substitutions.

$$t = \frac{(\bar{x}_A - \bar{x}_B) - (\mu_A - \mu_A)}{\sqrt{\frac{s^2{}_A}{n_A} + \frac{s^2{}_B}{n_B}}} = \frac{(94.5 - 109.1) - 0}{\sqrt{\frac{100}{10} + \frac{81}{10}}}$$