Answers to Hypothesis testing examples Using R Studio:

Note: In the first three problems, we test a claim about a population by using one sample data.
In the second part, problems IV to VI, we compare two populations using two samples data.
Additionally, we construct the corresponding confidence intervals: for one sample problems, when the confidence interval include the population parameter stated on the Null Hypothesis, implies that the samples belongs to the given population and therefore we fail to reject the Null; on the other hand, if the confidence interval does not include the population parameter, it suggests that the sample data describes a different population, so we reject the Null hypothesis.
For two samples intervals, whenever the interval negative and positive values, we say that the interval includes zero: it suggests that there is no difference between the two populations' parameters. If the interval includes only negative values or only positive values, it implies that the two population's parameters differ: one is always larger than the other (we reject the hypothesis of equality between the two populations: The Null.)

I.

H_0: $\mu = 60$
H1: $\mu \neq 60$

Note: the claim states a value; Temp (..) is equal to 60; it does not say greater or less, just a value. In this case the alternative is not equal to (≠).

The sample mean and standard deviations are given; therefore, this is a T-Test.
Level of significance is 0.01 ($\alpha = 0.01$); because the alternative hypothesis uses ≠, the test is a two tailed test.

```
> t.test.pvalue<-function(xbar, mu, s, n, tails){
+              t=(xbar-mu)*sqrt(n)/s
+      if (t<0) {pv=pt(t, n-1,lower.tail = T)} else {pv=pt(t, n-1,lower.tail = F)}
+                   t<-round(t,2)
+                   v1<-c(t, pv)
+                   v2<-c(t, 2*pv)
+                   if(tails==1) {return(v1)}
+                   if (tails==2) {return(v2)}
+ }
> t.test.pvalue(57,60,3.0,20,2)#example t test with summary
[1] -4.4700000000  0.0002611934
```

Conclusions: Reject the Null Hypothesis. There are two ways of drawing this conclusion: the t-stat absolute value is greater than the critical value or, the p-value is less than the stated value of alpha.
In technical terms: we have enough sample evidence to warrant rejection of the claim that the mean temperature is 60 degrees Fahrenheit.
Notice that the interval (55.1, 58.9) does not include the stated population parameter of 60.
That fact is consistent with the conclusion of rejecting H0: the sample describes a population whose mean is between 55.1 and 58.9, range of values that exclude 60.

II

H_0: p = 0.60
H1: p > 0. 60

One proportion Z-Test. α = 0.05; right tailed test.

```
> #Z test proportions
> z.test.prop.pvalue<-function(x, n, p, tails){
+                                z=(x/n - p)/sqrt(p*(1-p)/n)
+                                if (z<0) {pv=pnorm(z, lower.tail = T)} else {pv=pnorm(z,lo
wer.tail = F)}
+                                z<-round(z, 2)
+                                v1<-c(z, pv)
+                                v2<-c(z, 2*pv)
+                                if(tails==1) {return(v1)}
+                                if(tails==2) {return(v2)}
+ }
> z.test.prop.pvalue(130,200,0.60, 1)
[1] 1.44000000 0.07445734
```

Notice that p value 0.074 > alpha (0.01).

Conclusions: We fail to reject the Null hypothesis.
In technical terms: there is no sufficient evidence to support the claim that over 60% of the citizens approve the mayor's job.

The confidence interval includes 0.60 (0.59, 0.71); that is, the sample data is consistent with the Null hypothesis; therefore, the is no support for the claim that indeed the proportion is greater than 60%.

III.

H_0: μ = 5
H1: μ > 5

Significance level, α =0.05; right tailed test.
Since the problem states that *the standard deviation of all women was 7.*1; that is, sigma (σ) is given, so we use a Z-Test.

```
> z.test.pvalue<-function(xbar, mu, sigma, n, tails){
+                                                   z=(xbar-mu)*sqrt(n)/sigma
+                                                   if (z<0) {pv=pnorm(z, lower.tail = T)
} else {pv=pnorm(z,lower.tail = F)}
+                                                   z<-round(z,2)
+                                                   v1<-c(z, pv)
+                                                   v2<-c(z, 2*pv)
+                                                   if(tails==1) {return(v1)}
+                                                   if (tails==2) {return(v2)}
+                                                   }
> z.test.pvalue(6.7,5,7.1,29,1)
[1] 1.29000000 0.09862855
```

Conclusions: Fail to reject the Null hypothesis. According to the sample data there is no sufficient evidence to support the claim that the average weight gain per woman was over five pounds.
Notice that the confidence interval includes five; therefore, the true value of the population parameter may be five, not a value significantly greater than five. This fact is consistent with the decision of not rejecting the Null hypothesis (μ = 5).

IV. Two Samples T Test

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 > \mu_2$

The question (claim) is: Does dieters lose more fat than the exercisers? Since we label first group (dieters) as 1, and exercisers as 2, the alternative hypothesis is symbolized: $\mu_1 > \mu_2$. It is a right tailed test.

```
> install.packages("BSDA")
> require(BSDA)
> #tsum.test(mean1,s1,n1,mean2,s2,n2,alt=" ",conf.level= )
> tsum.test(5.9,4.1,42,4.1,3.7,47, alt="greater",conf.level=.99)

        Welch Modified Two-Sample t-Test

data:  Summarized x and y
t = 2.1646, df = 83.143, p-value = 0.01664
alternative hypothesis: true difference in means is greater than 0
99 percent confidence interval:
 -0.1725248         NA
sample estimates:
mean of x mean of y
      5.9       4.1
```

Notice that the p-value is larger than alpha; also, the confidence interval includes zero. All this information suggests that the two populations' means are equal.
Conclusions: We fail to reject the Null Hypothesis. There is no sufficient evidence to answer yes to the question that dieters lose more weight than exercisers.

V. Two samples T Test.

Label treatment group as 1; and control group as 2 (it could be the other way and we will draw the same conclusions): the researcher test whether the treatment is effective, in that case the mean systolic blood pressure of group 1 would be lower than the mean for group two.

H_0: $\mu_1 = \mu_2$
H_1: $\mu_1 < \mu_2$

```
> tsum.test(150,30,13,180,50,15, alt="less",conf.level=.99)

        Welch Modified Two-Sample t-Test

data:  Summarized x and y
t = -1.9533, df = 23.347, p-value = 0.03144
alternative hypothesis: true difference in means is less than 0
99 percent confidence interval:
       NA 8.353074
sample estimates:
mean of x mean of y
      150       180
```

Test stat: t = -1.95; p-value: 0.0314
Notice that the test statistic absolute value is less than the critical value; accordingly, the p-value is of 0.0314 is greater than the stated significance level, and the confidence interval includes zero.

Conclusions: Fail to reject the Null. There is no sufficient evidence to support the researcher's claim that the treatment has been effective in lowering the systolic blood pressure.

VI: 2-Proportions Z Test:

H_0: $p_1 = p_2$
H_1: $p_1 \neq p_2$

The research consists of testing whether there is a difference or not between the two medications. That is the reason why we choose the symbols to be equal and not equal to (Is there a difference or not?).
This is a two-tailed test with significance level of 0.01

```
> prop.test(x=c(20,12),n=c(200,200), alternative ="two.sided", correct = F)

	2-sample test for equality of proportions without continuity correction

data:  c(20, 12) out of c(200, 200)
X-squared = 2.1739, df = 1, p-value = 0.1404
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.0130278  0.0930278
sample estimates:
prop 1 prop 2
  0.10   0.06
```

Notice that the test statistic is less than the critical value, and the p-value is greater than alpha; accordingly, the corresponding confidence interval includes zero.

Conclusions: Fail to reject the Null hypothesis. There is no sufficient evidence to determine that indeed there is a difference in the percentage of adult patients' reactions.

VII:

H_0: $\mu = 7$
$H1$: $\mu \neq 7$

```
> x<-c(4.2,4.5,4.8,5,5,5,5.5,5.5,5.5,6,6,6,6,6.5,6.5,6.5,6.5,6.5,7.5,7.5,7.5,8,8,8.5,8.5,8.5,9)
> t.test(x, mu=7, alternative = "two.sided",conf.level = 0.90)
	One Sample t-test

data:  x
t = -2.0402, df = 26, p-value = 0.05161
alternative hypothesis: true mean is not equal to 7
90 percent confidence interval:
 6.013987 6.911939
sample estimates:
mean of x
 6.462963
```

Notice that the question asks us to find evidence if the number of sleep hours is *different from 7*; that is, not equal to seven.
A two tailed test.
A) 90% Conf interval is 6.013987 6.911939, which doesn't include 7.
B) At alpha = 0.10 there is evidence that the number of hours of sleep is different from 7, it is actually less than 7.