PROBLEM #1

Problem #1, part a.

- The three data points that are errors, and removed from the sample list:

"person"	"hours"
101	70
157	50
250	-5

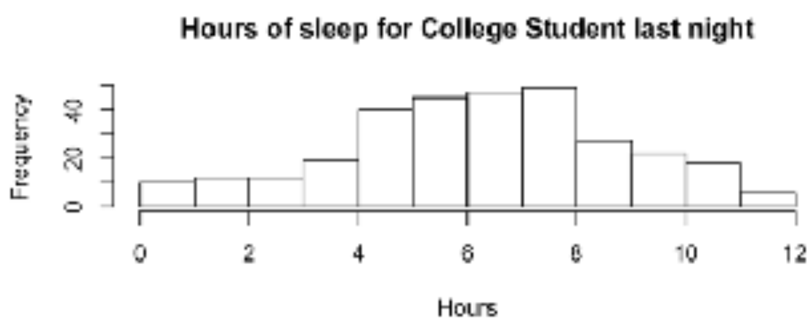
- A total sample of 307 college students remains, instead of 310.

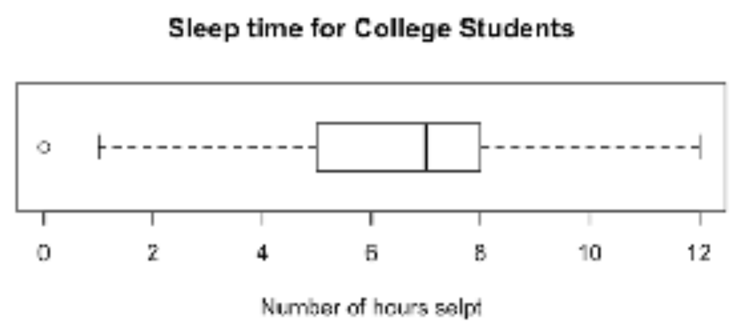
Problem #1, part b.

coding:

```
sleepData <- read.table("sleepData.txt", header = T)

par(mfrow=c(2,1))
hist(sleepData[,2], breaks = 12, main ="Hours of sleep for College Student last night", xlab ="Hours")
boxplot(sleepData[,2], horizontal = TRUE, xlab="Number of hours selpt", main="Sleep time for College Students")
```





- The histogram shows that a student typically slept 5 to 8 hours, with the highest percentage of the student receiving 7 hours of sleep. The histogram does not show the student which didn't sleep at all. With the boxplot, it shows the zero hours slept as well as the median and mean (though they are very closely related). It also shows the "middle 50%" between the 1st and 3rd quartile range.

Problem #1, part c.

coding:

```
summary(sleepData)
```

output:

```
person              hours
Min.   :  1.0       Min.   : 0.000
1st Qu.: 77.5       1st Qu.: 5.000
Median :155.0       Median : 7.000
Mean   :155.4       Mean   : 6.739
3rd Qu.:232.5       3rd Qu.: 8.000
Max.   :310.0       Max.   :12.000
```

- A value that initially sticks out immediately is the max value of 310, which is incorrect since there is only 307 data values after removing the 3 errors. Though the main information desired is the data based around the hours of sleep. The mean is more specific hear as it was difficult to see on the boxplot. It also confirms the whole number values for which the boxplot portrayed. While the histogram showed the frequency "at-a-glance", the boxplot provided more visual information which more mimics the summary information above.

Problem #1, part d.

The sleep hours of 0 most likely is not a data entry error, since a student could have not slept at all the night before the study was conducted. Therefore, it is plausible for the 0 hours to be within the data set.

Problem #2

Before proceeding, I believe it's fair to assume that there is no traffic jams and the flow of traffic does not slow during the rush hour times. Other factors such as wrecks, construction, or other delays are also ignored.

Looking at the chance that the cars may go over 325 during different times of the day:

coding:

```
#chance of having more than 325 vehicles per 30 min, during rush hour (7AM-10AM, 4PM-7PM)
#the average is 10/min, the chances of having more than 325 in a 30 minute period:
ppois((325/30), lambda = 10, lower=FALSE)

#chance of having more than 325 vehicles per 30 min, during non-rush hour (10AM-4PM)
#the average is 3/min, the chances of having more than 325 in a 30 minute period
ppois((325/30), lambda = 3, lower=FALSE)

#chance of having more than 325 vehicles per 30 min, during all other hours
#the average is 8/hr, the chances of having more than 325 in a 30 minute period
ppois((325/30), lambda = 8/60, lower=FALSE)
```

output:

```
> ppois((325/30), lambda = 10, lower=FALSE)
        [1] 0.4169602
> ppois((325/30), lambda = 3, lower=FALSE)
        [1] 0.000292337
> ppois((325/30), lambda = 8/60, lower=FALSE)
        [1] 5.249437e-18
```

PROBLEM #2

Problem #2, part a.

- The code for this was lengthly, so I placed it at the end in Appendix A.
- The price paid ended up being $3.828294 (or $3.83) per daily average.

Problem #2, part b.

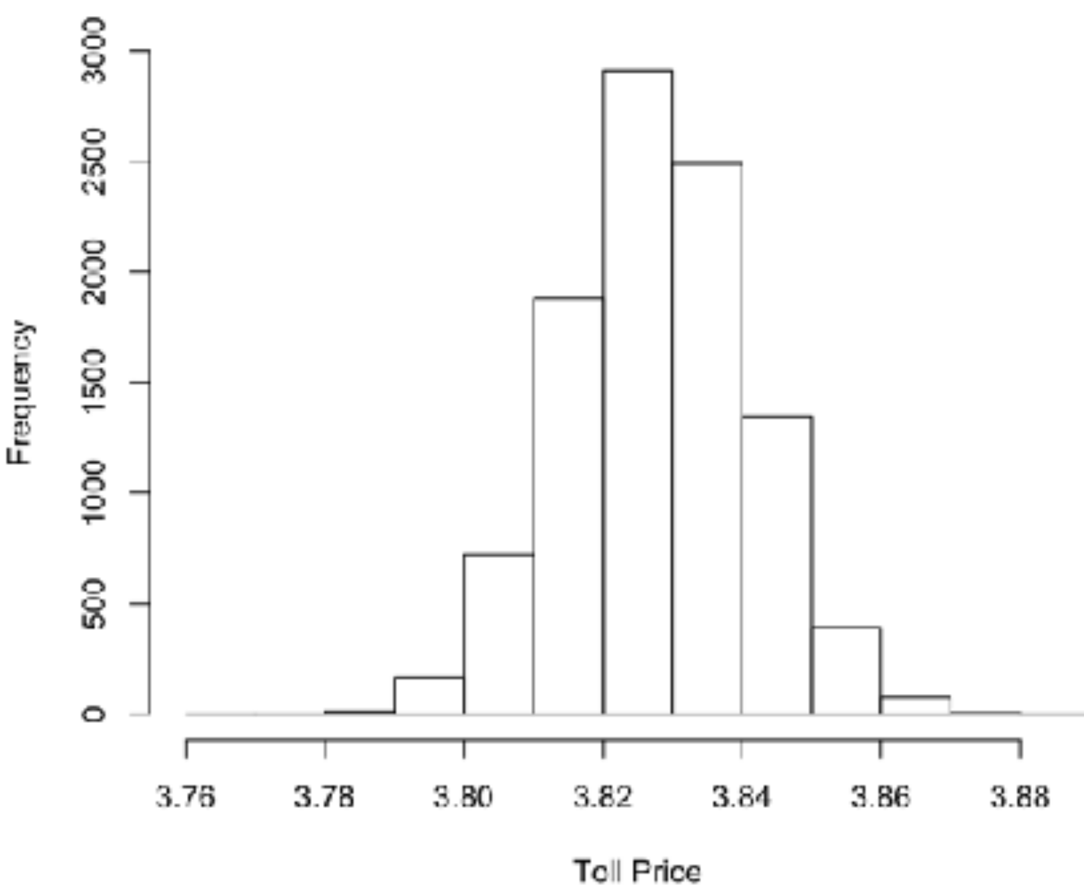
- The calculated standard deviation is: 0.01317745 (or about 1 cent)

Problem #2, part c.

- I sampled a random set given the averages of 10/min vehicles during rush hour, 3/min during between 10AM and 4PM, and 3/hr otherwise. For the 3/hr, I simply factored it over an hour instead of 30 minutes since it is *extremely* unlikely that there will be more than 325 cars in 30 minutes. I did this for only one day, not for 5 times to consider 5 days. If I did this, the other prices resulted in:

  $3.83, $3.83, $3.85, $3.84, $3.82, $3.83, $3.84, etc.

  For this, a for loop was placed to run the code and store it into an array. These numbers resemble each other very closely. Rough example below:



Problem #2, part d.

coding:

```
#For rush hours
(ppois((350/30), lambda = 10))-(1-(ppois((325/30), lambda = 10, lower=FALSE)))
#For 10AM to 4PM
(ppois((350/30), lambda = 3))-(1-(ppois((325/30), lambda = 3, lower=FALSE)))
```

output:

```
> (ppois((350/30), lambda = 10))-(1-(ppois((325/30), lambda = 10, lower=FALSE)))
    [1] 0.1137364
> (ppois((350/30), lambda = 3))-(1-(ppois((325/30), lambda = 3, lower=FALSE)))
    [1] 0.0002209503
```

- With this data, 11.37% of the rush hour traffic will pay when greater than 325 but less than 350. While 0.022% of those traveling between 10AM and 4PM will pay.
- Concluding:
  - An array was added to the appendix coding to count the random cars in the sample of 10000

```
VEHSUMAVE[i] = (VEHSUM)
VHNRSUMAVE[i] = (VHNRSUM)
```

- For the output:

```
> mean(VEHSUMAVE)
    [1] 3599.048
> mean(VHNRSUMAVE)
    [1] 1079.734
```

- With results:

  11.37% of 3599.048 = 409.212 (~)

  0.022% of 1079.734 = .2375 (~)

  **The 8 vehicles/hour was not factored since it's nearly impossible to occur.

-Thus:

  About a total of 410 cars per day, on average, will pay extra even if the total amount in 30 minutes is less than 350.

APPENDIX A

```
tollPriceList<-0

for(i in 1:10000){

#random number of vehicles in a 30 minutes window, during rush hours
VEH1 = sum(rpois(30, 10))
VEH2 = sum(rpois(30, 10))
VEH3 = sum(rpois(30, 10))
VEH4 = sum(rpois(30, 10))
VEH5 = sum(rpois(30, 10))
VEH6 = sum(rpois(30, 10))
VEH7 = sum(rpois(30, 10))
VEH8 = sum(rpois(30, 10))
VEH9 = sum(rpois(30, 10))
VEH10 = sum(rpois(30, 10))
VEH11 = sum(rpois(30, 10))
VEH12 = sum(rpois(30, 10))
VEHSUM = sum(VEH1+VEH2+VEH3+VEH4+VEH5+VEH6+VEH7+VEH8+VEH9+VEH10+VEH11+VEH12)

#random number of vehicles in a 30 minutes window, during non rush hours
VHNR1 = sum(rpois(30, 3))
VHNR2 = sum(rpois(30, 3))
VHNR3 = sum(rpois(30, 3))
VHNR4 = sum(rpois(30, 3))
VHNR5 = sum(rpois(30, 3))
VHNR6 = sum(rpois(30, 3))
VHNR7 = sum(rpois(30, 3))
VHNR8 = sum(rpois(30, 3))
VHNR9 = sum(rpois(30, 3))
VHNR10 = sum(rpois(30, 3))
VHNR11 = sum(rpois(30, 3))
VHNR12 = sum(rpois(30, 3))
VHNRSUM =
sum(VHNR1+VHNR2+VHNR3+VHNR4+VHNR5+VHNR6+VHNR7+VHNR8+VHNR9+VHNR10+VHNR11+VHNR12)

#random number of vehicles in a 30 minutes window, during other hours outside 7AM to 7PM
VHELSE1 = sum(rpois(60, 8/60))
VHELSE2 = sum(rpois(60, 8/60))
VHELSE3 = sum(rpois(60, 8/60))
VHELSE4 = sum(rpois(60, 8/60))
VHELSE5 = sum(rpois(60, 8/60))
VHELSE6 = sum(rpois(60, 8/60))
```

```
VHELSE7 = sum(rpois(60, 8/60))
VHELSE8 = sum(rpois(60, 8/60))
VHELSE9 = sum(rpois(60, 8/60))
VHELSE10 = sum(rpois(60, 8/60))
VHELSE11 = sum(rpois(60, 8/60))
VHELSE12 = sum(rpois(60, 8/60))
VHOTHERSUM =
sum(VHELSE1+VHELSE2+VHELSE3+VHELSE4+VHELSE5+VHELSE6+VHELSE7+VHELSE8+VHELSE9+VHELSE10+VHELSE11+VH
ELSE12)


#1-4wheels, 2-semi (more than 4 wheels)
fourWheelRushHour = sample(0:1, size=VEHSUM, replace=TRUE, prob=c(.25,.75))
sum(fourWheelRushHour)
semiTruckRushHour = VEHSUM - sum(fourWheelRushHour)

fourWheelNonRushHour = sample(0:1, size=VHNRSUM, replace=TRUE, prob=c(.25,.75))
sum(fourWheelNonRushHour)
semiTruckNonRushHour = VHNRSUM - sum(fourWheelNonRushHour)

fourWheelOtherHour = sample(0:1, size=VHOTHERSUM, replace=TRUE, prob=c(.25,.75))
sum(fourWheelOtherHour)
semiTruckOtherHour = VHOTHERSUM - sum(fourWheelOtherHour)

totalCars=sum(fourWheelRushHour)+
  semiTruckRushHour+
  sum(fourWheelNonRushHour)+
  semiTruckNonRushHour+
  sum(fourWheelOtherHour)+
  semiTruckOtherHour

totalTollPaid=(sum(fourWheelRushHour)*3*(1-.417))+(sum(fourWheelRushHour)*(3*1.25)*(.417))+
(sum(semiTruckRushHour)*5*(1-.417))+(sum(semiTruckRushHour)*(5*1.25)*(.417))+
(sum(fourWheelNonRushHour)*3*(1-.417))+(sum(fourWheelNonRushHour)*(3*1.25)*(.417))+
(sum(semiTruckNonRushHour)*5*(1-.0003))+(sum(semiTruckNonRushHour)*(5*1.25)*(.0003))+
(sum(fourWheelOtherHour)*3)+
(sum(semiTruckOtherHour)*5)

#average price
tollPriceList[i] = (totalTollPaid/totalCars)

}

mean(tollPriceList)
sd(tollPriceList)
```

OUTPUT VALUES:

```
> mean(tollPriceList)
    [1] 3.828294
> sd(tollPriceList)
    [1] 0.01317745
```