HW1

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Contents

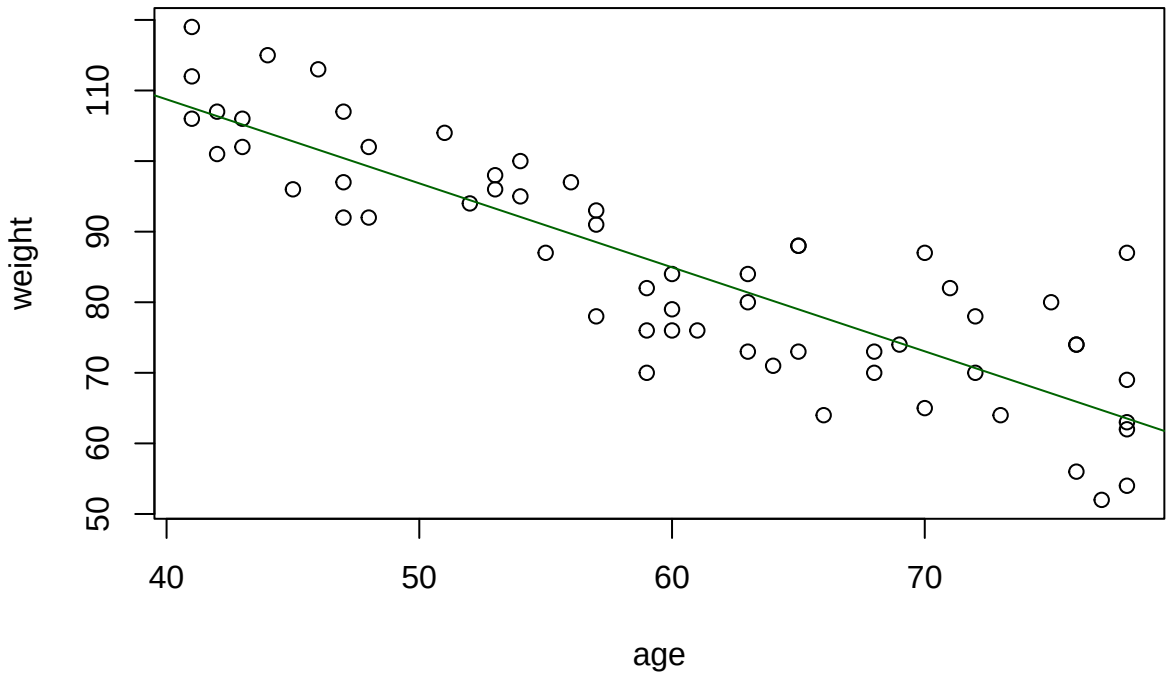
Problem 1

a

```
my_data <- read.delim("CH01PR27.txt", sep = "",header=FALSE)
colnames(my_data)<- c("Y", "X")
my_ordereddata<-my_data[order(my_data$X, decreasing = FALSE), ]
reg<-lm(Y ~ X, data=my_data)
reg
```

```
##
## Call:
## lm(formula = Y ~ X, data = my_data)
##
## Coefficients:
## (Intercept)            X
##      156.35        -1.19
```

```
plot(Y ~ X, data=my_data, xlab="age", ylab="weight")
abline(reg, col = "darkgreen")
```



The regression function is y=156.35-1.19x. The regression function that I found does appear to fit well to the data. The data supports the anticipation that as age increases muscle mass decreases.

b

1

```
count=0
difference=0
for(i in 1:nrow(my_ordereddata)) {   # for-loop over rows
  for(j in i:nrow(my_ordereddata)){
    if (abs(my_ordereddata[i,2]-my_ordereddata[j,2])==1){
      count=count+1
```

```
      difference= difference+((my_ordereddata[i,1]-my_ordereddata[j,1]))
    }
  }
}
mean=difference/count
mean
```

```
## [1] 2.205128
```

Point estimate for women differing in age by one year is 2.205128

2

```
count60s=0
sum60s=0
for (i in 1:nrow(my_ordereddata)){
  if (my_ordereddata[i,2]==60){
    count60s=count60s+1
    sum60s=sum60s+my_ordereddata[i,1]
  }
}
sum60s/count60s
```

```
## [1] 79.66667
```

Point estimate for women aged X=60 years is 79.66667

3

the eighth data point in the data set is [41,112]

```
my_data[8,]
```

```
##     Y  X
## 8 112 41
```

According to the regression function at 41 years old, weight should be 107.56. Thus the residual is 4.44.

```
y=156.35-1.19*(41)
my_data[8,1]-y
```

```
## [1] 4.44
```

4

```
var(my_data$Y)
```

```
## [1] 262.7446
```

Varince point estimate is 262.7446

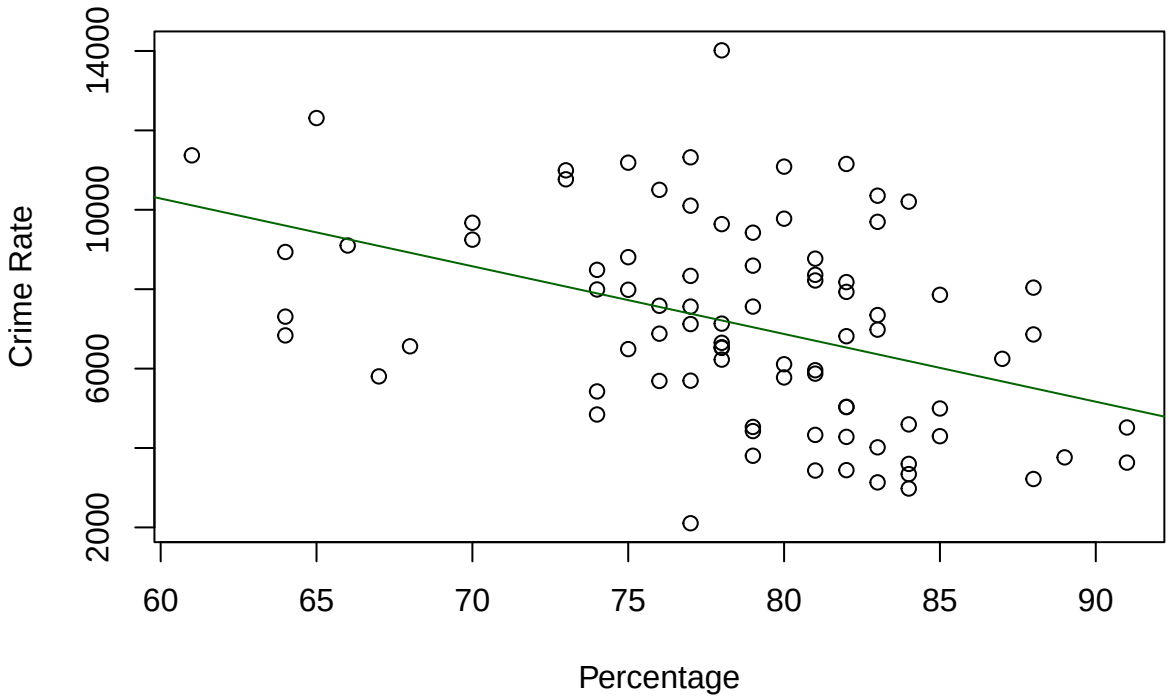
Problem 2

a

```
my_data2 <- read.delim("CH01PR28.txt", sep = "",header=FALSE)
colnames(my_data2)<- c("Y", "X")
my_ordereddata2<-my_data2[order(my_data2$X, decreasing = FALSE), ]
reg2<-lm(Y ~ X, data=my_data2)
reg2
```

```
##
## Call:
## lm(formula = Y ~ X, data = my_data2)
##
## Coefficients:
## (Intercept)            X
##     20517.6       -170.6
```

```
plot(Y ~ X, data=my_data2, xlab="Percentage", ylab="Crime Rate")
abline(reg2, col = "darkgreen")
```



While the line does seem to capture how the crime rate lowers as percentage of people with at least high-school diploma increases, it doesn't capture how packed data points are between 75-85 percentage, but very scarce and spread outside of that range.

b

1

The average difference in crime rate between counties that have a high school graduation rate separated by 1%

```
count2=0
difference2=0
for(i in 1:nrow(my_ordereddata2)) {    # for-loop over rows
  for(j in i:nrow(my_ordereddata2)){
    if (abs(my_ordereddata2[i,2]-my_ordereddata2[j,2])==1){
      count2=count2+1
      difference2= difference2+((my_ordereddata2[i,1]-my_ordereddata2[j,1]))
    }
  }
}
mean2=difference2/count2
mean2
```

```
## [1] 250.0081
```

The difference in crime rate between counties whose high school gradution differs by 1% is 250.0081

2

mean crime rate in counties when high school graduation is 80%

```
count80s=0
sum80s=0
for (i in 1:nrow(my_ordereddata2)){
  if (my_ordereddata2[i,2]==80){
    count80s=count80s+1
    sum80s=sum80s+my_ordereddata2[i,1]
  }
}
sum80s/count80s
```

```
## [1] 8187.25
```

Mean crime rate when high school graduation is 80% is 8187.25

3

```
reg2$residuals[10] #The residual of the 10th data point
```

```
##       10
## 1401.566
```

4

```
var(my_data2$Y) #Variance of the crime rate data
```

```
## [1] 6611278
```

Problem 3

a

Problem 4

a

b

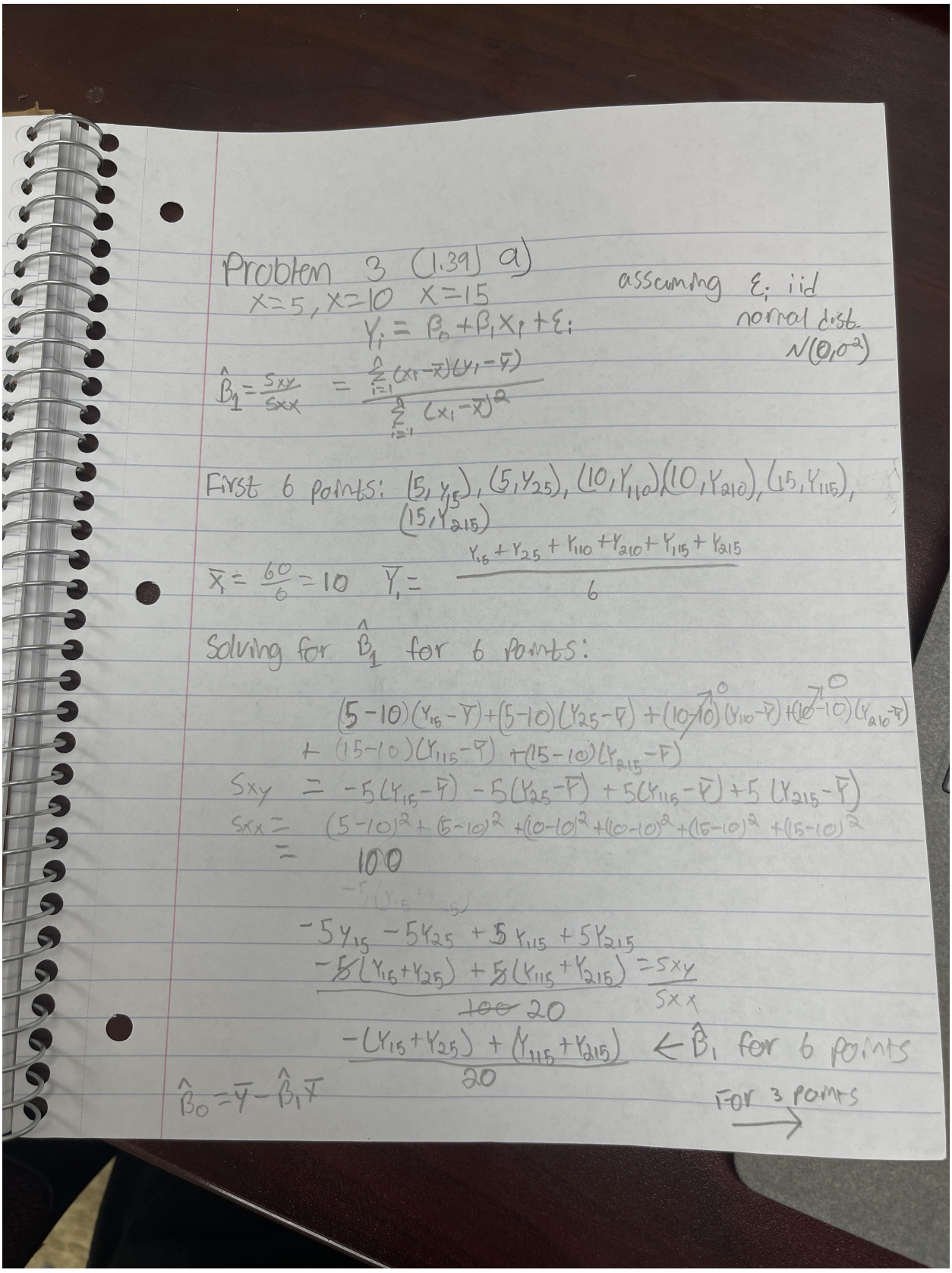


Figure 1: Written solution to problem 3a- part 1

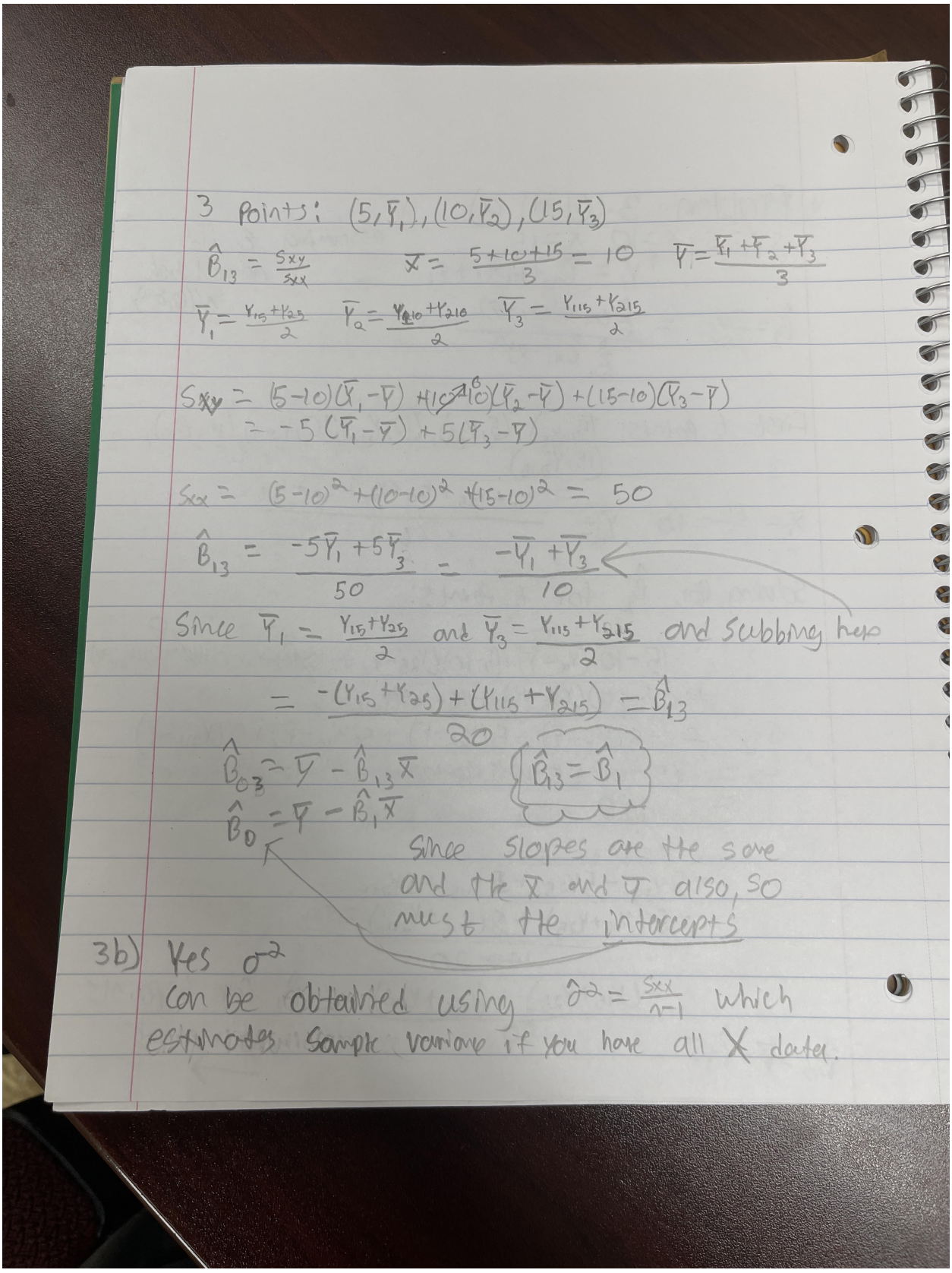


Figure 2: Written solution to the rest of 3a and 3b

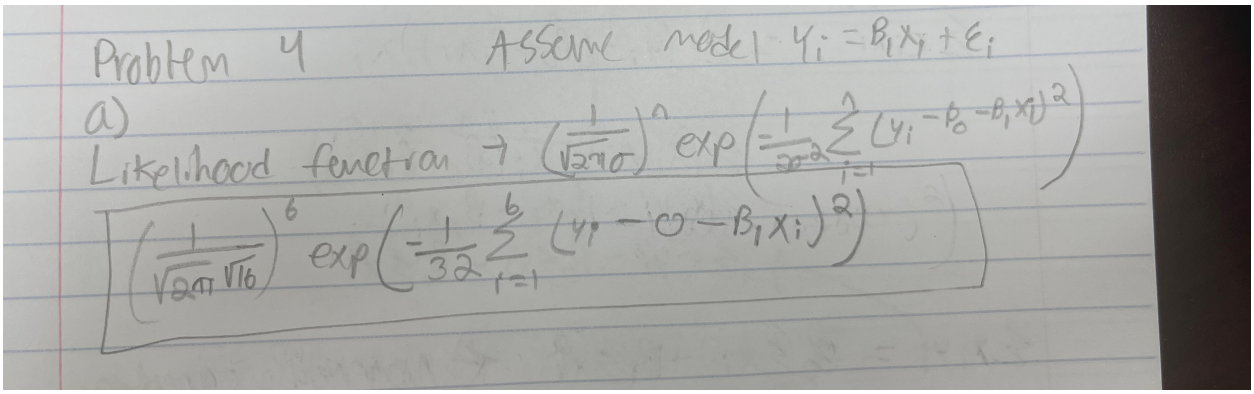


Figure 3: Written solution to 4a

```
my_data3 <- read.delim("CH01PR42.txt", sep = "",header=FALSE)
colnames(my_data3)<- c("Y", "X")
slopes<-c(17,18,19)
sum17=0
for (i in 1:nrow(my_data3)){
  sum17=sum17+((my_data3[i,1]-(slopes[1]*my_data3[i,2]))^2)
}

((1/(sqrt(16)*sqrt(2*pi)))^6)*exp(sum17*(-1/32))
```

```
## [1] 9.45133e-30
```

```
sum18=0
for (i in 1:nrow(my_data3)){
  sum18=sum18+((my_data3[i,1]-(slopes[2]*my_data3[i,2]))^2)
}

((1/(sqrt(16)*sqrt(2*pi)))^6)*exp(sum18*(-1/32))
```

```
## [1] 2.649043e-07
```

```
sum19=0
for (i in 1:nrow(my_data3)){
  sum19=sum19+((my_data3[i,1]-(slopes[3]*my_data3[i,2]))^2)
}

((1/(sqrt(16)*sqrt(2*pi)))^6)*(exp(1)^(-1/32))
```

```
## [1] 9.539569e-07
```

The largest value is when B1=18 with the value 2.649e-7

c

```
xy=0
x_square=0
for (i in 1:nrow(my_data3)){
  xy=xy+(my_data3[i,2]*my_data3[i,1])
}
for (i in my_data3[,2]){
  x_square=x_square+i^2
}
xy/x_square
```

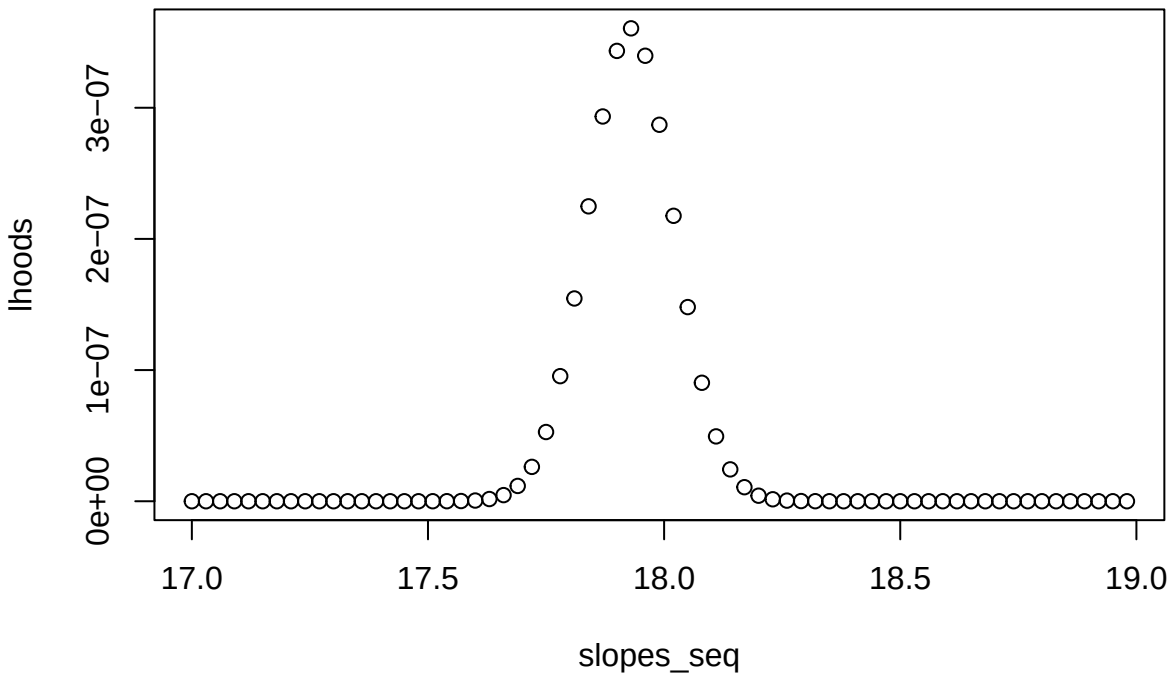
```
## [1] 17.9285
```

The value is very close to 18, which the likelihood function in part b also was the highest for

d

```
slopes_seq<-seq(17,19,0.03)
sums<-c(rep(0,length(slopes_seq)))
lhoods<-c(rep(0,length(slopes_seq)))
for (i in 1:length(sums)){
for (j in 1:nrow(my_data3)){
  sums[i]=sums[i]+((my_data3[j,1]-(slopes_seq[i]*my_data3[j,2]))^2)
}
}
for(i in 1:length(sums)){
lhoods[i]<-((1/(sqrt(16)*sqrt(2*pi)))^6)*exp(sums[i]*(-1/32))
}

plot(x=slopes_seq,y=lhoods)
```




```
max(lhoods)
```

```
## [1] 3.605343e-07
```

```
which.max(lhoods)
```

```
## [1] 32
```

```
slopes_seq[32]
```

```
## [1] 17.93
```

the likelihood plot shows that indeed the point from part c is where the likelihood was the greatest

Problem 5

Problem 6

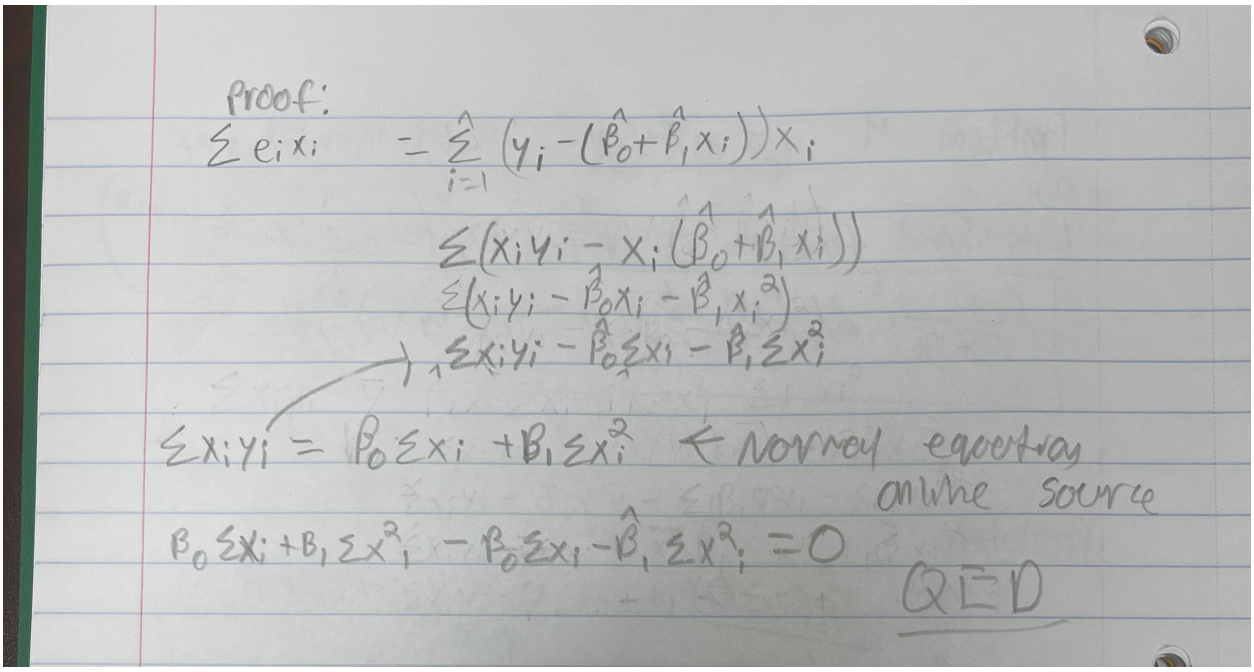


Figure 4: Problem 5- Written solution to prove sum of product of xi and ei equals 0

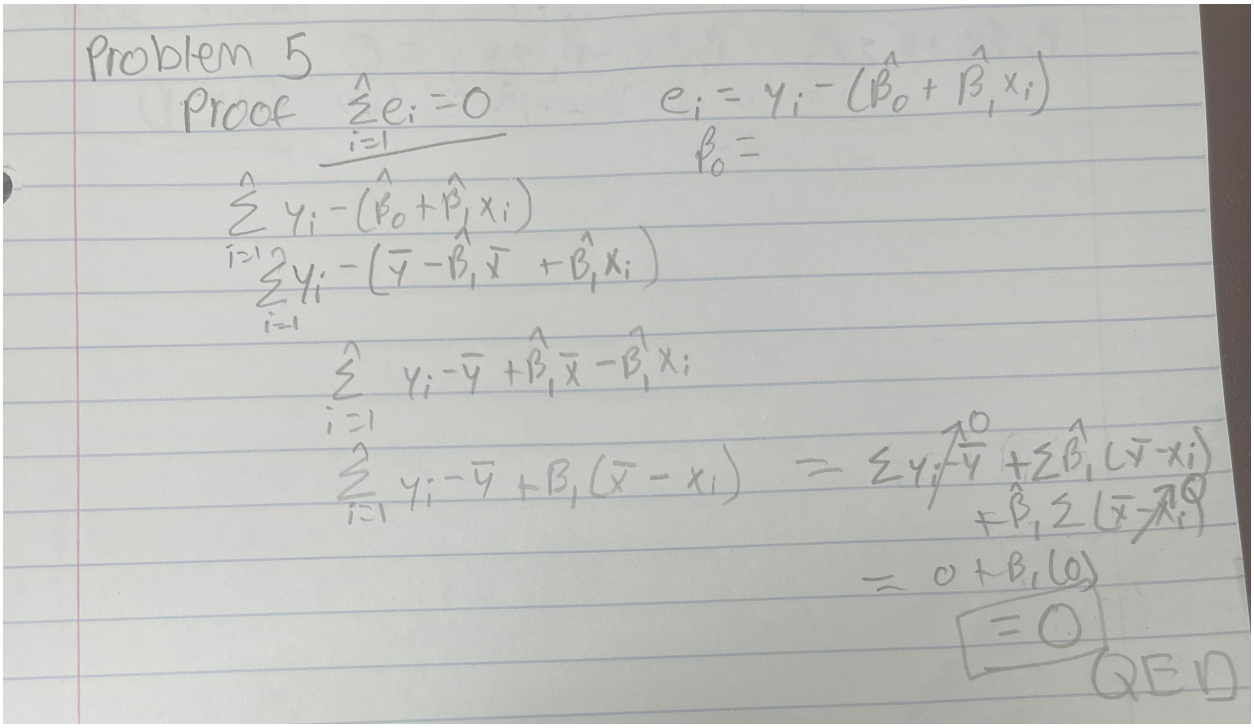


Figure 5: Problem 5- Written solution to prove sum of ei equals 0

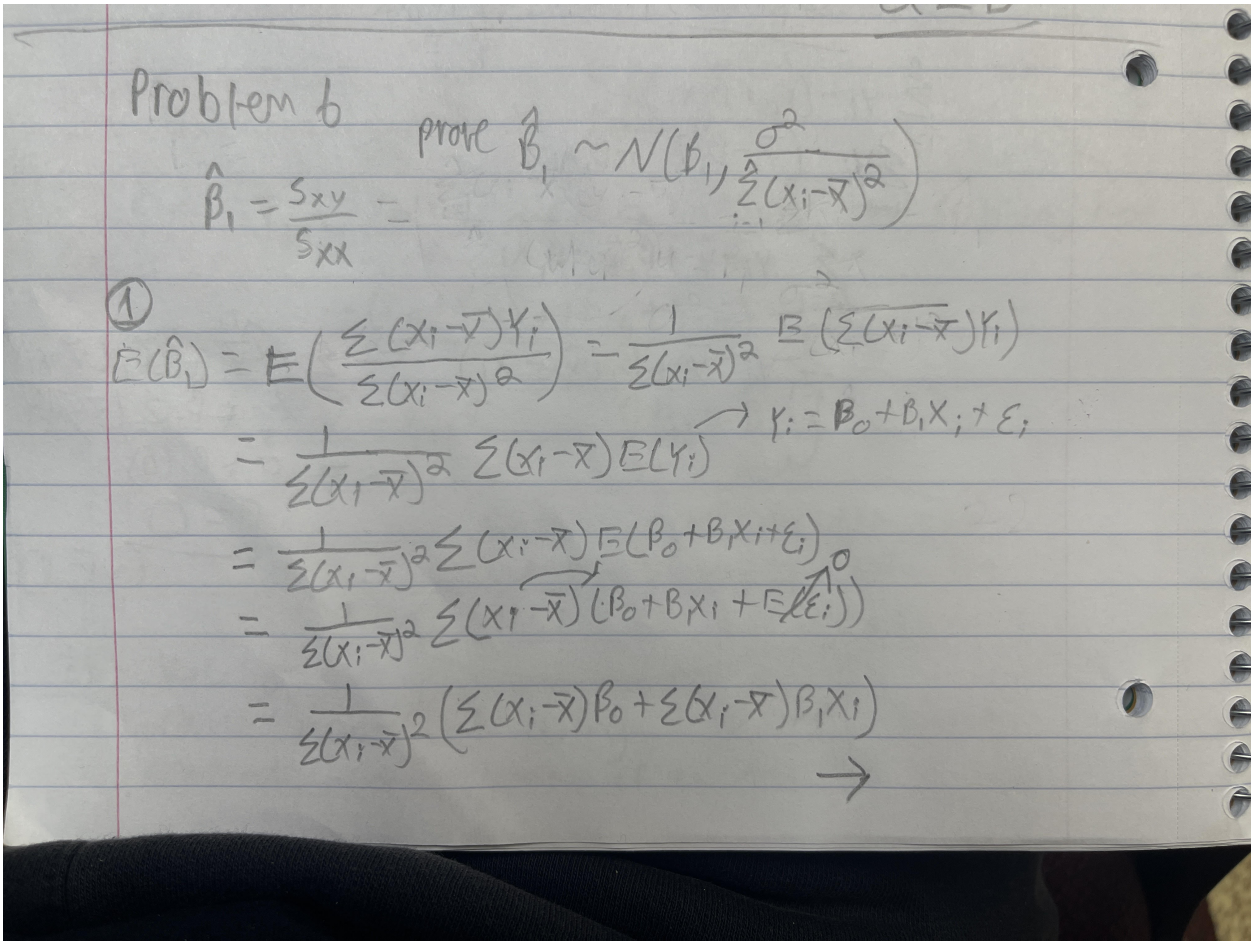


Figure 6: Problem 6 - Written solution to prove B1 hat has mean B1 and Variance:sigmaˆ2/(S_xx)

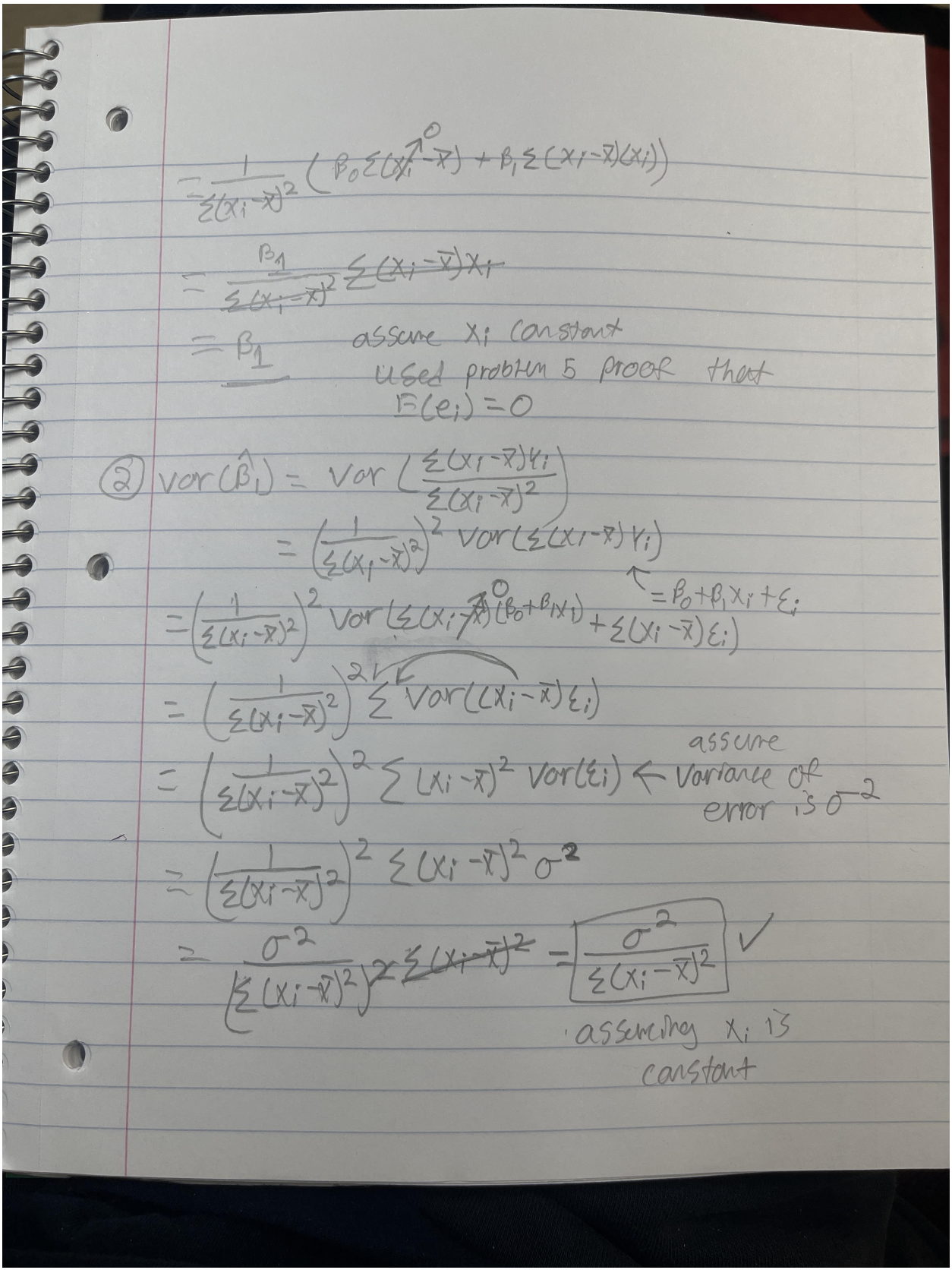


Figure 7: Problem 6 - Continuation of written solution to prove B1 hat has mean B1 and Variance:sigma^2/(S_xx)