Experiment 2: Temperatures for Gain 250

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Experiment 2: Johnson Noise 1

Recording the resistor values measured during lab.

```
#everything will be in ohms
short<- .03
shortError<-.001

k20<-20090
k20error<-1

k35 <- 35230 #secretly 35.2 but that would be an ugly variable name
k35error<-1

k100 <- 100700
k100error <- 1

k10 <- 999.05
k10error<- .01

k1 <- 998.17
k1error <- .01

k48 <- 48650 #secretly 48.7k but again that would be an ugly variable name
k48error<- 1

resistors<-c(k1,k10,k20,k35, k48,k100)
resistorserror<-c(k1error, k10error, k20error, k35error, k48error, k100error)
```

Import Band Voltage measurements from experiment 2

```
experiment2data<-read.csv("/Users/mallen/Documents/128AL/JohnsonNoise128AL/experiment2data2.csv")
```

Calculate Vmeas, V, and Vsystem

```
Vsys<- experiment2data[1,7] #first row 7th column
VsysError <- experiment2data[1,9]

Vmeask1<- (experiment2data[2,7])
Vmeask10<-experiment2data[3,7]
Vmeask20 <-experiment2data[4,7]
Vmeask32<-experiment2data[5,7]
Vmeask48<-experiment2data[6,7]
Vmeask100<-experiment2data[7,7]

Vmeas<-c(Vmeask1, Vmeask10, Vmeask20, Vmeask32, Vmeask48, Vmeask100)

#need to redo the error later (2/5)
```

```
VmeasError<-sqrt((sum(experiment2data[2:7,9])^2))

V<- sqrt(-Vsys^2+Vmeas^2)
Verror<- sqrt(VmeasError^2+ VsysError^2)
```

Calculating G

```
capacitance <-87.875*(10^-12)
capacitanceError <-.594*(10^-12)
#df is just the x componenent

riemanSum <- function(f){
  area<-(125/2)*(f[1]+2*sum(f[2:398])+f[399])
  return(area)
}

#resistors<-read.csv("experiment2data1.csv")

C = capacitance
integrand <- data.frame(
  gain[2]^2/(1+(2*pi*C*vin1$x*short)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k1)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k10)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k20)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k35)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k48)^2),
  gain[2]^2/(1+(2*pi*C*vin1$x*k100)^2)
  )
area <- data.frame(
  G1 =0,
  G2 =0,
  G3 =0,
  G4 =0,
  G5 =0,
  G6 =0,
  G7 =0

  )
for(i in 1:length(integrand))
{
        area[i] <- riemanSum(unlist(integrand[i]))
}

area2error=sqrt((capacitance/capacitanceError)^2+(resistors/resistorserror)^2)
```

So this returns a gain value G for each resistor (called “area”)

Plotting R as a function of V^2, kB, and G

```
kb<- 1.38064852 *10^-23 #m2 kg s-2 K-1
```

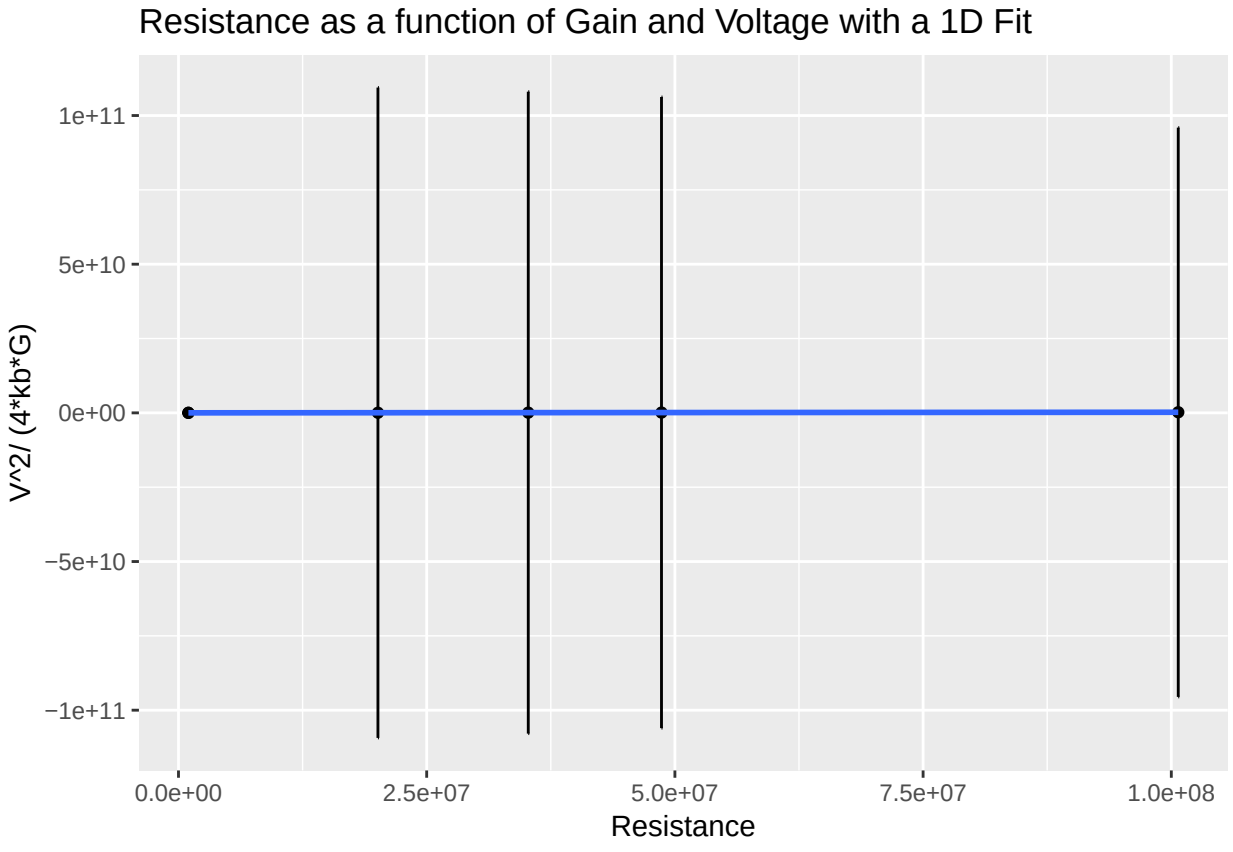
```r
area2<-area[2:7] #take away the short's data
y_value<- (V^2)/(4*kb*area2) #area is the vector that contains all G's

#prepare data for graphing
resistors2 <-resistors[1:6]
y<- unlist(y_value, use.names=FALSE)
```

```r
#I'll try finding temperatures

Temperature<- ((V^2)/(4*kb*area2*resistors2))/100

Temperature2<-unlist(Temperature, use.names = FALSE)/10
Temperature2[2]<-Temperature2[2]/10 #error in data inputting caused 2nd term to be 10* every other term
print(Temperature2) #these are the correct values
```

```
## [1] 2.047951 2.049459 2.105866 2.016544 2.048945 2.046911
```

```r
#
#resistor as the x axis and the other term as the y axis.
#

resistors3<-resistors2[1:6]*1000
resistors3error <- resistors3*sqrt((V^2/Verror^2)+((area2/area2error)^2))
fit  <- lm(y~0+resistors3)
```

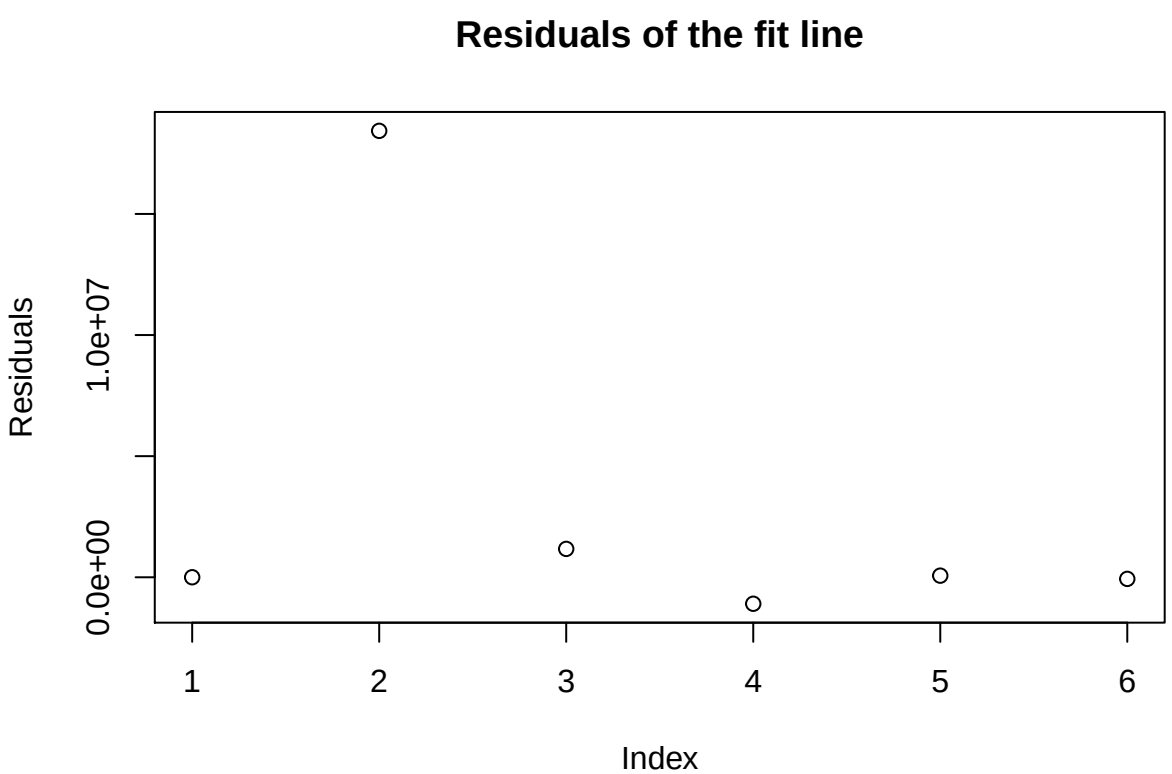
```r
library(ggplot2)
qplot(unlist(resistors3),unlist(y))+geom_errorbar(aes(x=unlist(resistors3), ymin=unlist(y-resistors3erro
  geom_smooth(method="lm", se=FALSE, fullrange=TRUE, level=0.95)+labs(title = "Resistance as a function
```



```r
summary(fit)
```

```
##
## Call:
## lm(formula = y ~ 0 + resistors3)
##
## Residuals:
##          1          2          3          4          5          6
##      379.6 18429496.9  1171153.0 -1093069.5    66891.2   -66397.7
##
## Coefficients:
##            Estimate Std. Error t value Pr(>|t|)
## resistors3  2.04757    0.06954   29.45 8.47e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8273000 on 5 degrees of freedom
## Multiple R-squared:  0.9943, Adjusted R-squared:  0.9931
## F-statistic:   867 on 1 and 5 DF,  p-value: 8.47e-07
```

```r
plot(fit$residuals, main = "Residuals of the fit line", ylab= "Residuals")
```



We see that the reported estimate for the temperatures of the resistors is 285.445, or 285 to our best estimates. If the room temperature was 20.5 as recorded, then the value for absolute 0 in Kelvin is -264.5.We expected to find -273.15.