# 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(fa,fb){
  area <-0.5*(125)*(fb-fa)+fa*125
  return(area)
}

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

C = capacitance
integrand <- data.frame(
  gain[2]/(1+(2*pi*C*vin1$x*short)^2),
  gain[2]/(1+(2*pi*C*vin1$x*k1)^2),
  gain[2]/(1+(2*pi*C*vin1$x*k10)^2),
  gain[2]/(1+(2*pi*C*vin1$x*k20)^2),
  gain[2]/(1+(2*pi*C*vin1$x*k35)^2),
  gain[2]/(1+(2*pi*C*vin1$x*k48)^2),
  gain[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))
{
    for(l in 1:398)
    {
      if(is.na(integrand[l+1,i]))
      {
        break
      }
      else
      {
        area[i] <- area[i]+ riemanSum(integrand[l,i],integrand[l+1,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

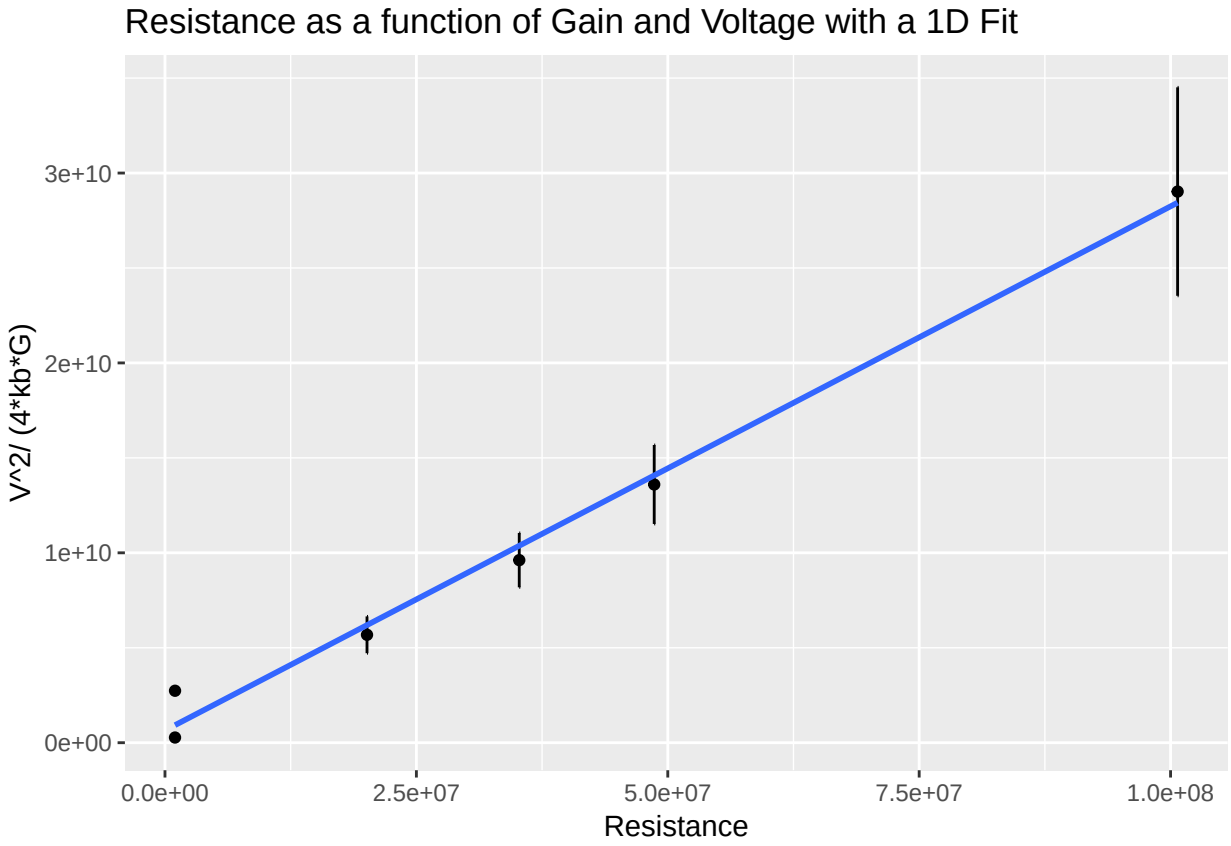
```
kb<- 1.38064852 *10^-23 #m2 kg s-2 K-1

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)
```

```
#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] 273.7115 273.9131 282.8623 272.9220 279.5173 288.2244
```

```
#
#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)
```

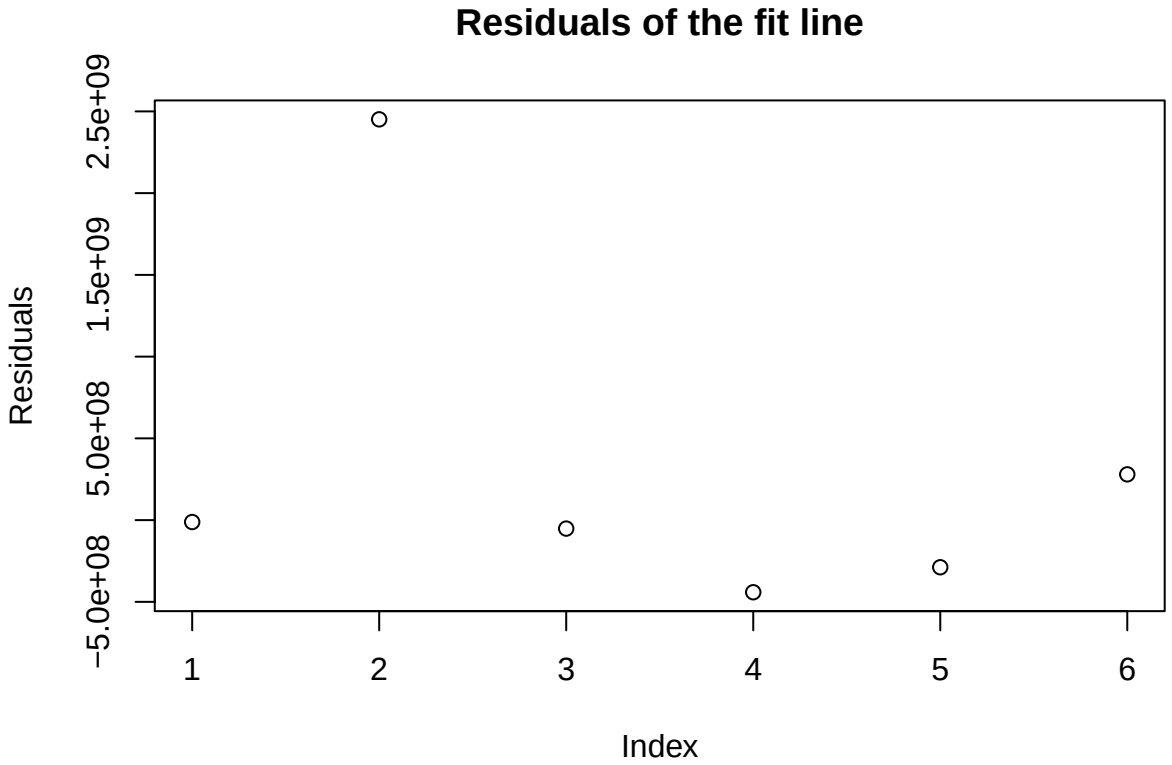
```
library(ggplot2)
qplot(unlist(resistors3),unlist(y))+geom_errorbar(aes(x=unlist(resistors3), ymin=unlist(y-resistors3erro
  geom_smooth(method="lm", se=FALSE, fullrange=TRUE, level=0.95)+labs(title = "Resistance as a function
```




```
summary(fit)
```

```
##
## Call:
## lm(formula = y ~ 0 + resistors3)
##
## Residuals:
##          1          2          3          4          5          6
##  -11712456 2451354901  -51896125 -441199967 -288402464  279836274
##
## Coefficients:
##            Estimate Std. Error t value Pr(>|t|)
## resistors3  285.445      9.486   30.09  7.6e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.129e+09 on 5 degrees of freedom
## Multiple R-squared:  0.9945, Adjusted R-squared:  0.9934
## F-statistic: 905.5 on 1 and 5 DF,  p-value: 7.603e-07
```

```
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.