Experiment 3: kB

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Recording the resistor values measured during lab.

Experiment 3: Johnson Noise - Boltzmann Constant

```
experiment3data1<-read.csv("/Users/mallen/Documents/128AL/JohnsonNoise128AL/experiment3data1.csv")
```

Calculate Vmeas, V, and Vsystem

```
Vsys<- experiment3data1[1,7] #first row 7th column
VsysError <- experiment3data1[1,9]

Vmeask1<- (experiment3data1[2,7])
Vmeask10<-experiment3data1[3,7]
Vmeask20 <-experiment3data1[4,7]
Vmeask32<-experiment3data1[5,7]
Vmeask48<-experiment3data1[6,7]
Vmeask100<-experiment3data1[7,7]

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

VmeasError<-sqrt((sum(experiment3data1[2:7,9])^2))

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

Calculating G

```
gain <- data.frame(Frequency = vout1$x, Gain = (m_vout[2]/m_in))

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("experiment3data1.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])
      }
    }
}
```

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

```
#prepare the data for graphing
kb<- 1.38064852 *10^-23 #m2 kg s-2 K-1

area2<-area[2:7]/100 #take away the short's data
resistors2 <-resistors[1:6]
y_value2<- (V^2)/(4*resistors2*area2)
y2<- unlist(y_value2, use.names=FALSE)

#calculate the temperatures
Temperature<- ((V^2)/(4*kb*area2*resistors2))/100
Temperature2<-unlist(Temperature, use.names = FALSE)
fit <- lm(y2~Temperature2)
```

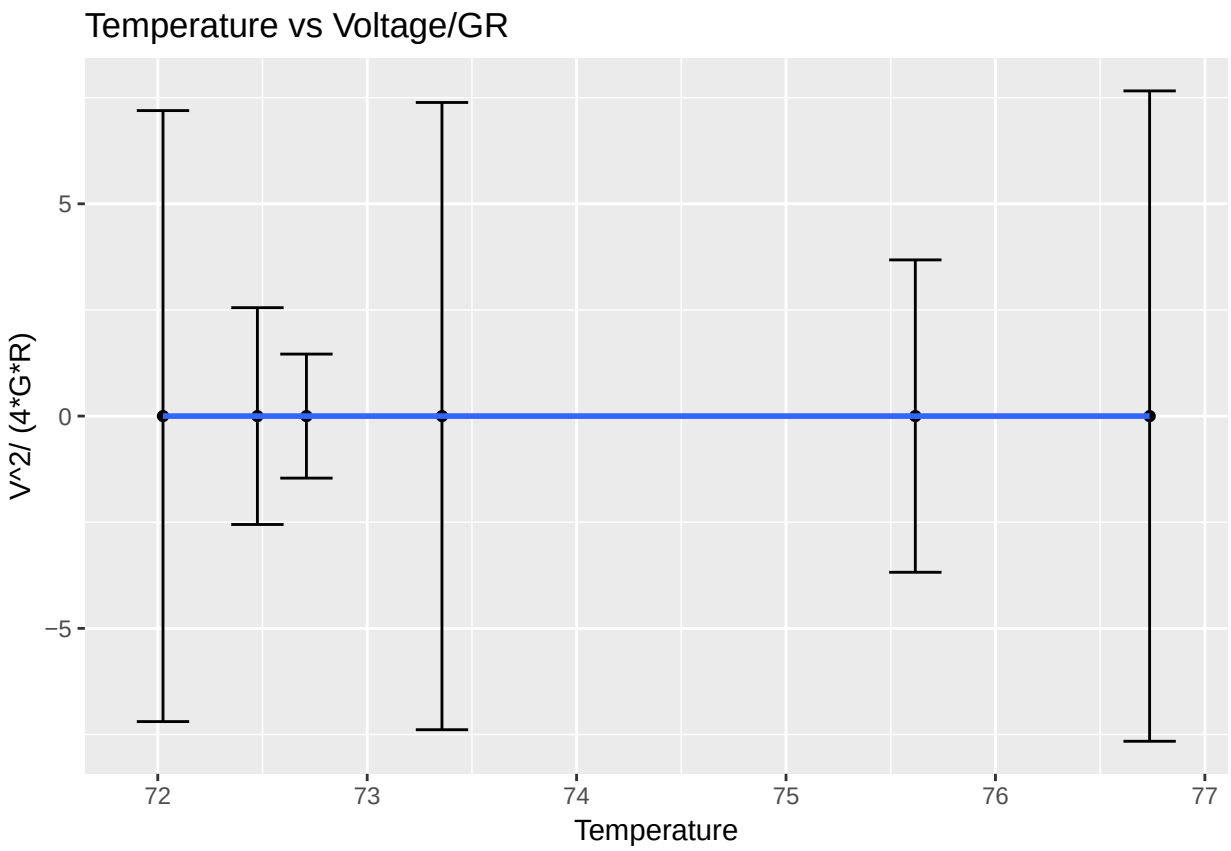
```
#Temperature<- ((V^2)/(4*kb*area2*resistors2))/100
#Temperature2<-unlist(Temperature, use.names = FALSE)

#Temperature3Error<-Temperature3*sqrt((V^2/Verror^2)+(resistors2/resistorserror)^2)


#1st degree fit
Temperature2<-Temperature2/100
Temperature2[2]<- Temperature2[2]/10
```

```
print(Temperature2)
```

```
## [1] 76.73625 72.02486 72.70978 72.47577 75.61742 73.35707
```

```
Temperature2Error<-Temperature2*sqrt((V^2/Verror^2)+(resistors2/resistorserror)^2)
```

```
library(ggplot2)
qplot((Temperature2),(y2))+geom_errorbar(aes(x=(Temperature2), ymin=(y2-Temperature2Error), ymax=(y2+Te
  geom_smooth(method="lm", se=FALSE, fullrange=TRUE, level=0.95)+labs(title = "Temperature vs Voltage/G
```



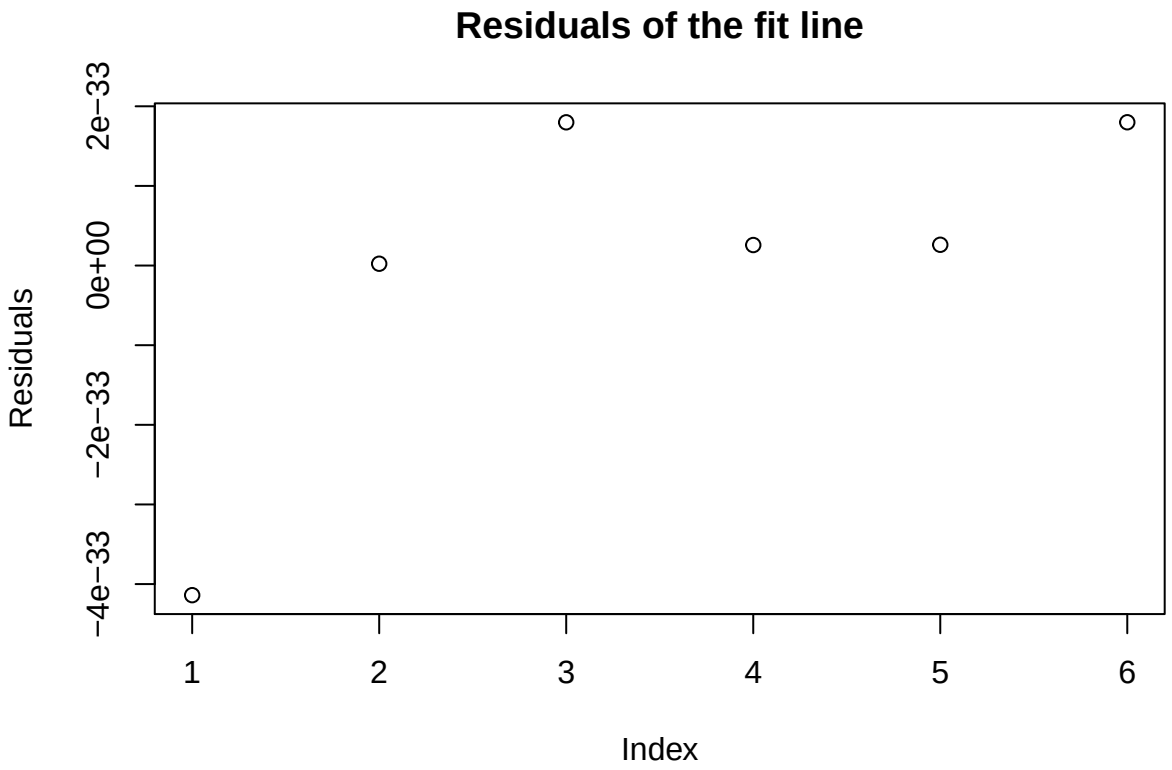

```
summary(fit)
```

```
## Warning in summary.lm(fit): essentially perfect fit: summary may be
## unreliable
```

```
##
## Call:
## lm(formula = y2 ~ Temperature2)
##
## Residuals:
##          1          2          3          4          5          6
## -4.139e-33  2.286e-35  1.799e-33  2.576e-34  2.609e-34  1.799e-33
##
## Coefficients:
##                Estimate Std. Error   t value Pr(>|t|)
## (Intercept)  0.000e+00  1.246e-33 0.000e+00        1
## Temperature2 1.381e-21  4.131e-38 3.343e+16   <2e-16 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.436e-33 on 4 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 1.117e+33 on 1 and 4 DF,  p-value: < 2.2e-16
```

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



You have to divide by 100 for some reason in all of the results. Our result for the slope was 1.381*10^-21 but dividing by 100 gives us: 1.381*10^-23 with an error of