In[2]:=
```
SetDirectory[NotebookDirectory[]];
```

In[3]:=
```
Import["../General.m"];
```

In[4]:=
```
temperatureData =
  Import["/home/nathan/olin/fall2016/qEAFall2016Homework/bset4/BostonTempData.mat",
   "Data"];
```

In[5]:=
```
Dimensions@temperatureData
```

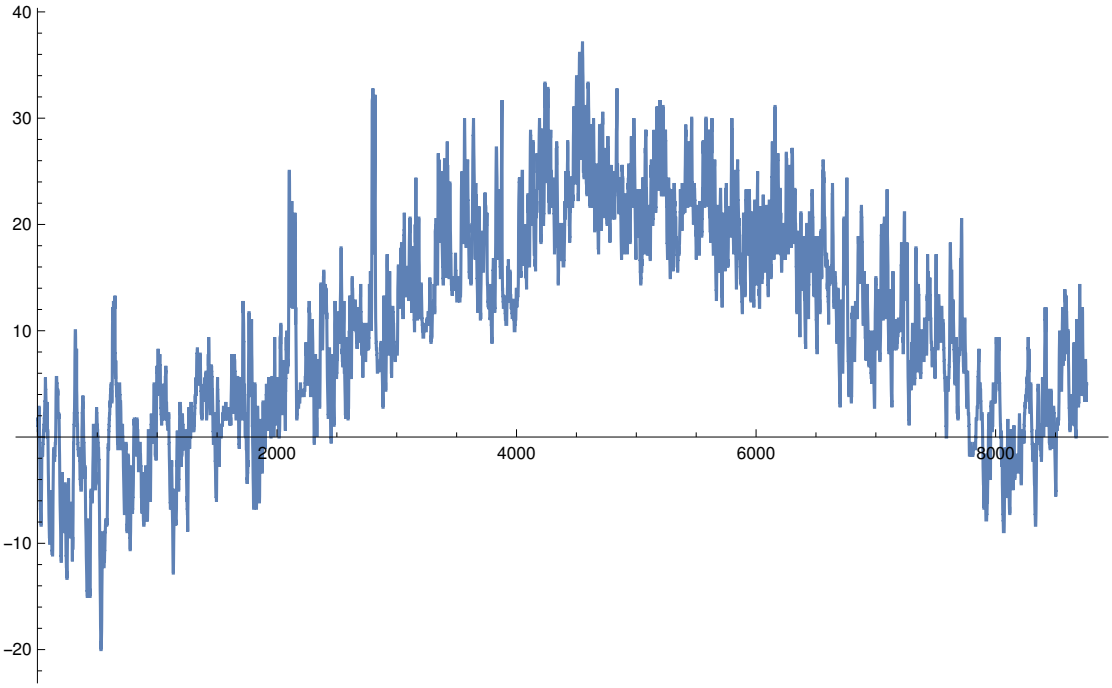
Out[5]=
```
{3, 8760, 1}
```

In[6]:=
```
dni = Flatten[temperatureData[[1]]];
hour = Flatten[temperatureData[[2]]];
temp = Flatten[temperatureData[[3]]];
```

Plot of temperature vs hours for the entire year. Highest temp is 36c or 96f. Lowest temp is -20c or -4f.

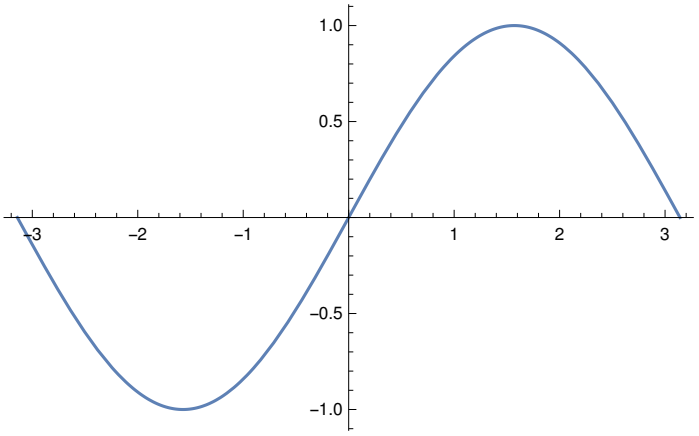
In[9]:=
```
ListLinePlot[temp, ImageSize → Large]
```

Out[9]=



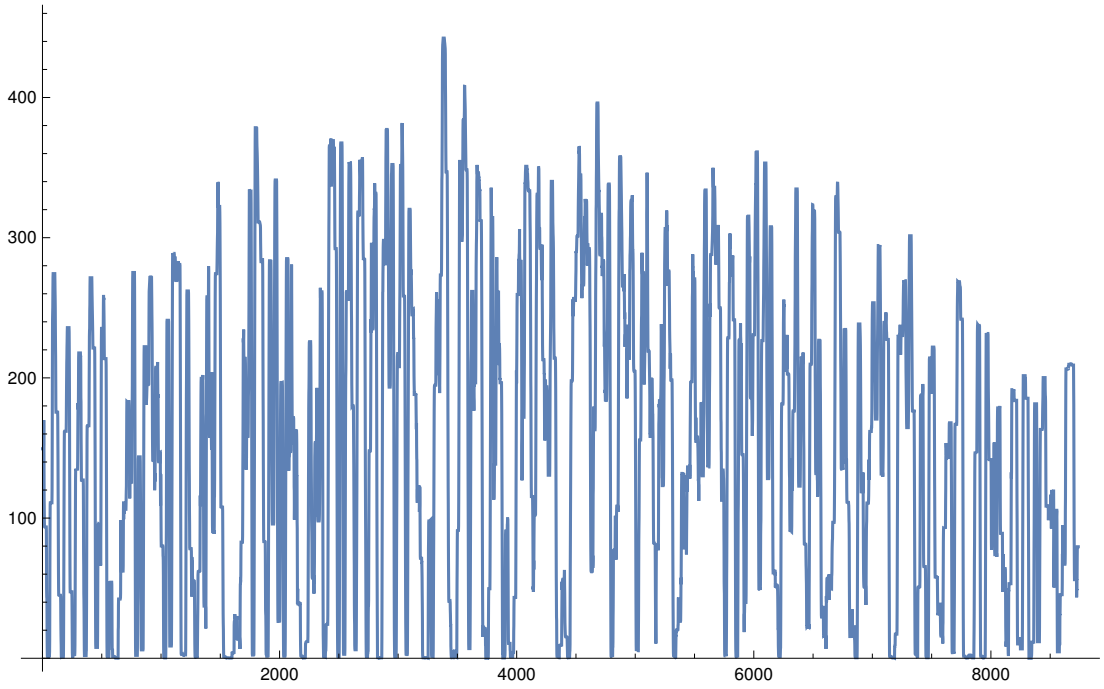
In[10]:=
```
Plot[Sin[θ], {θ, -Pi, Pi}]
```

Out[10]=

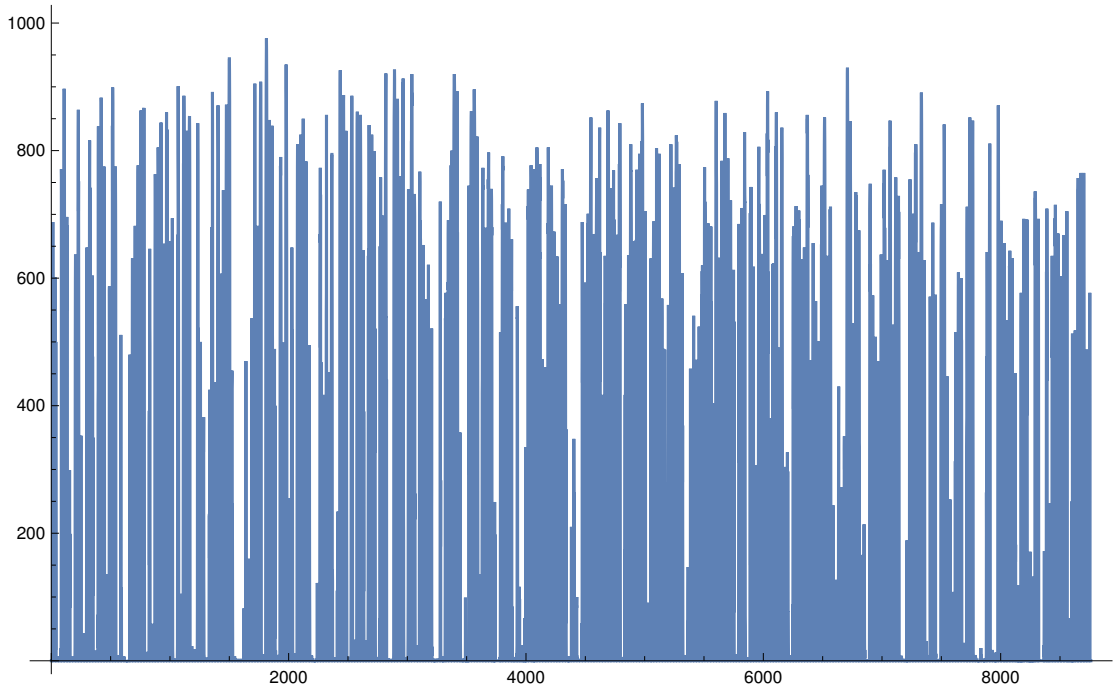


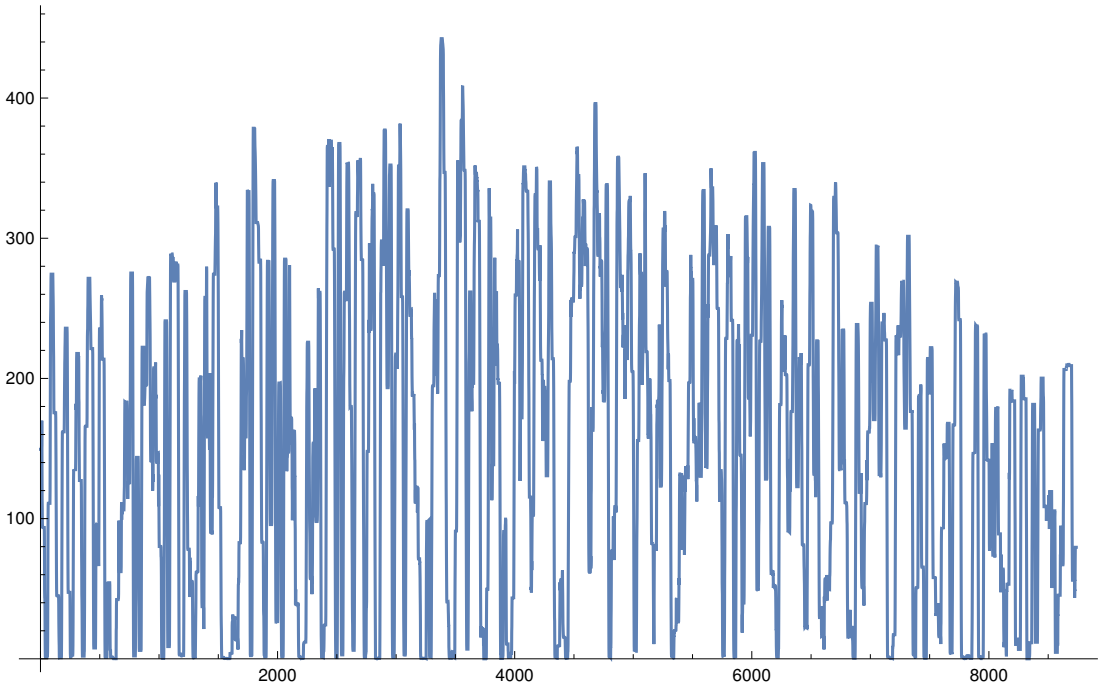
Plot of dni over the course of a year. You can see that some parts are more dense than others. I think this shows that some days in the summer get more sunlight than those in the winter.

In[11]:=
```
ListLinePlot[dni, ImageSize → Large]
```



Out[11]=

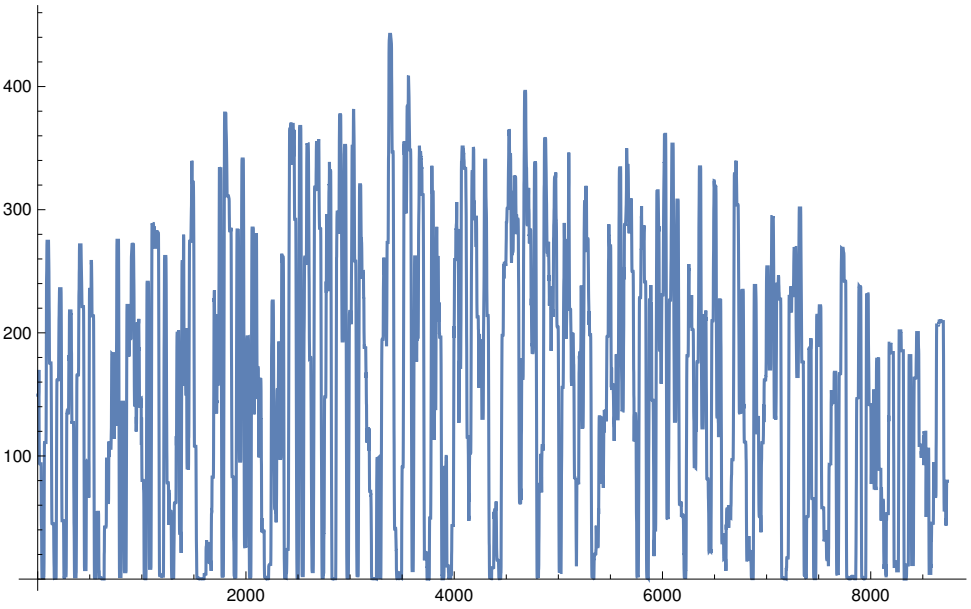

1000
800
600
400
200
2000
4000
6000
8000


400
300
200
100
2000
4000
6000
8000

Moving average half a year long cyclic convolutions. Here we can see the lowest frequency. This is how the sun behaves over the course of year.

In[12]:=
```
ListLinePlot[ListConvolve[ConstantArray[1/24, 24], dni]]
```

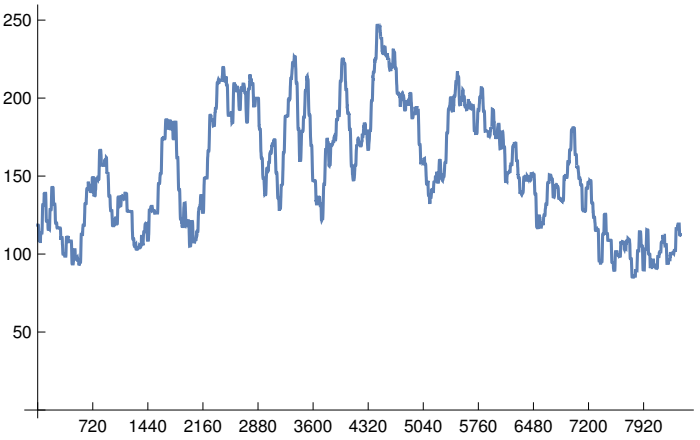
Out[12]=



Moving averages over the course a month

In[13]:=
```
ListLinePlot[ListConvolve[ConstantArray[1/360, 360], dni],
 Ticks → {Range[0, 8760, 24 * 30], Range[0, 250, 50]}]
```

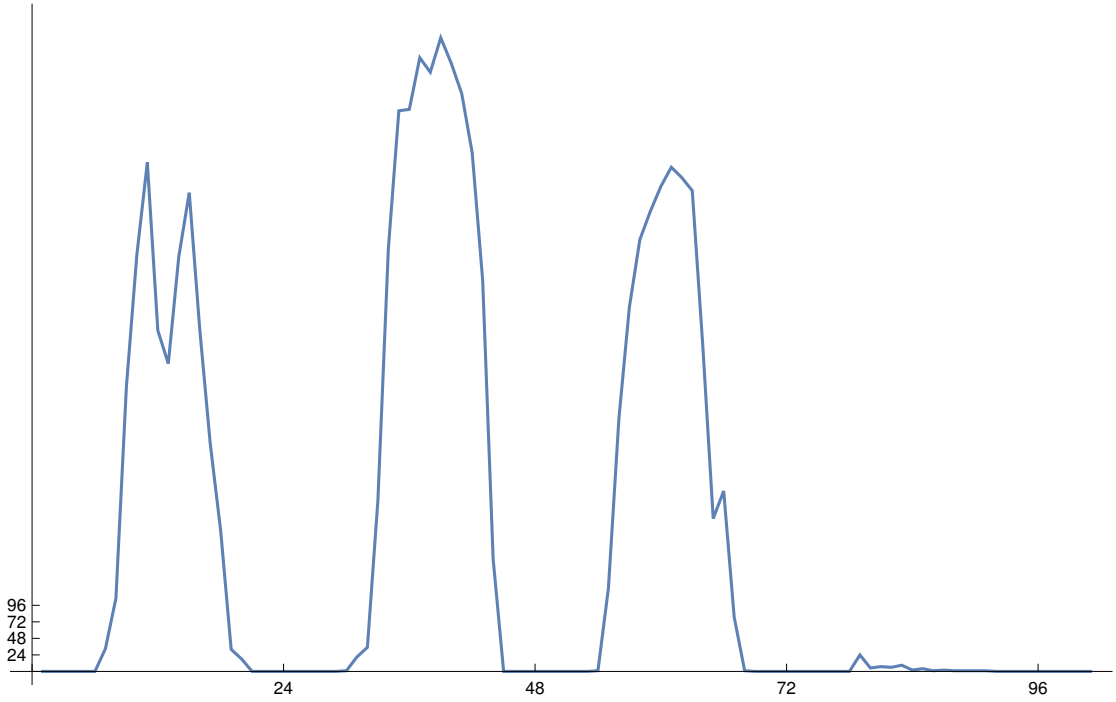
Out[13]=



Plot of dni for 5 random days. I'm interested why hours 35 to 70 have zero sunlight. Maybe there was a full day solar eclipse.

In[14]:=
```
ListLinePlot[dni[[3000 ;; 3100]], ImageSize → Large,
 PlotRange → Full, Ticks → {Range[0, 100, 24]}]
```

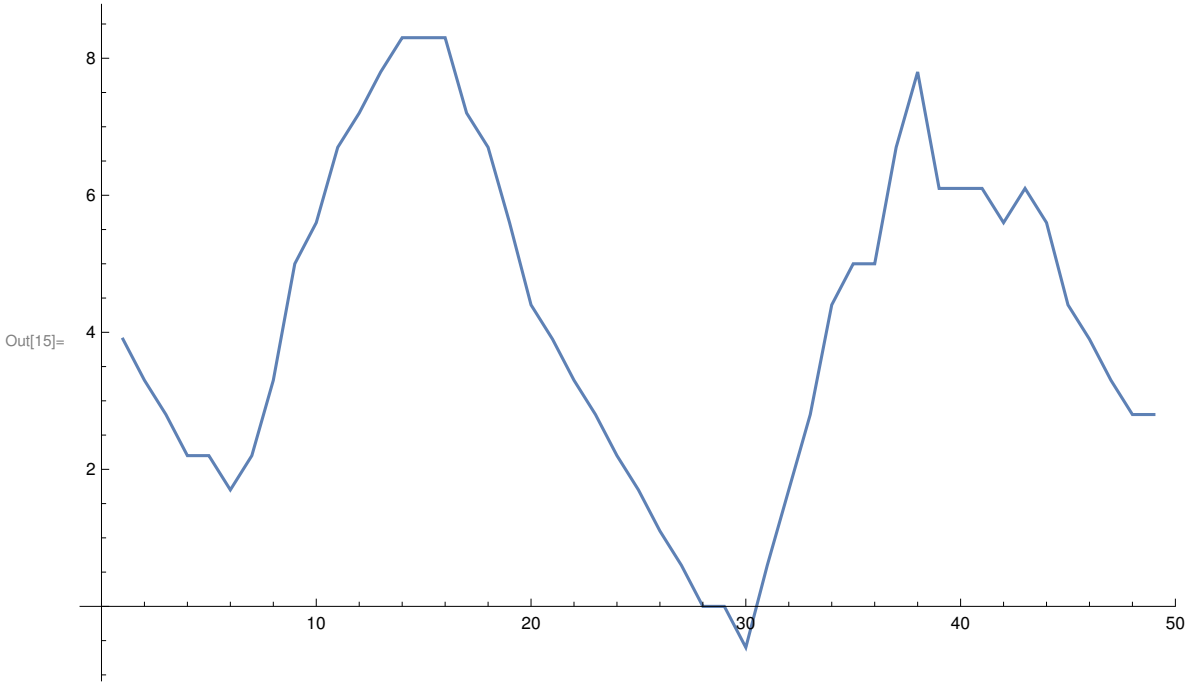
Out[14]=



Two random days during the year. The plot starts during the night and it gets colder. During daytime, the temperature increases.

In[15]:=
```
ListLinePlot[temp[[2424 ;; 2472]], ImageSize → Large]
```

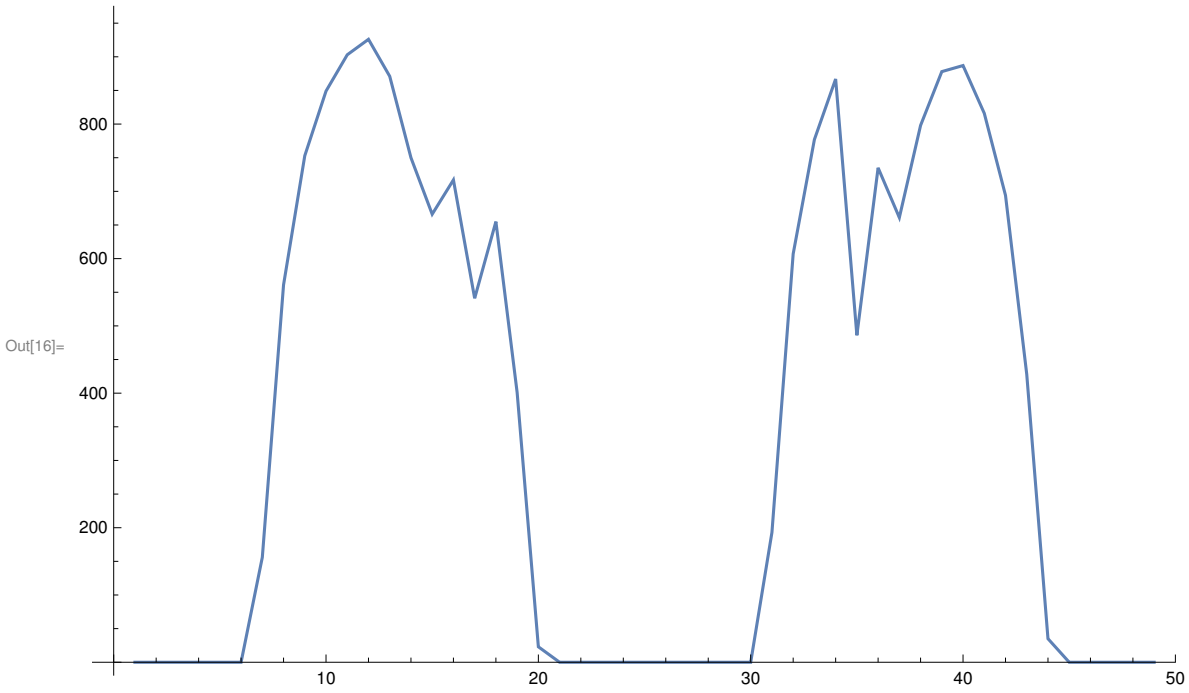
Out[15]=



Plot of dmi vs hour for the two random days. We can see daylight hours give us sunlight which increases temperature.

In[16]:=
```
ListLinePlot[dni[[2424 ;; 2472]], ImageSize → Large]
```

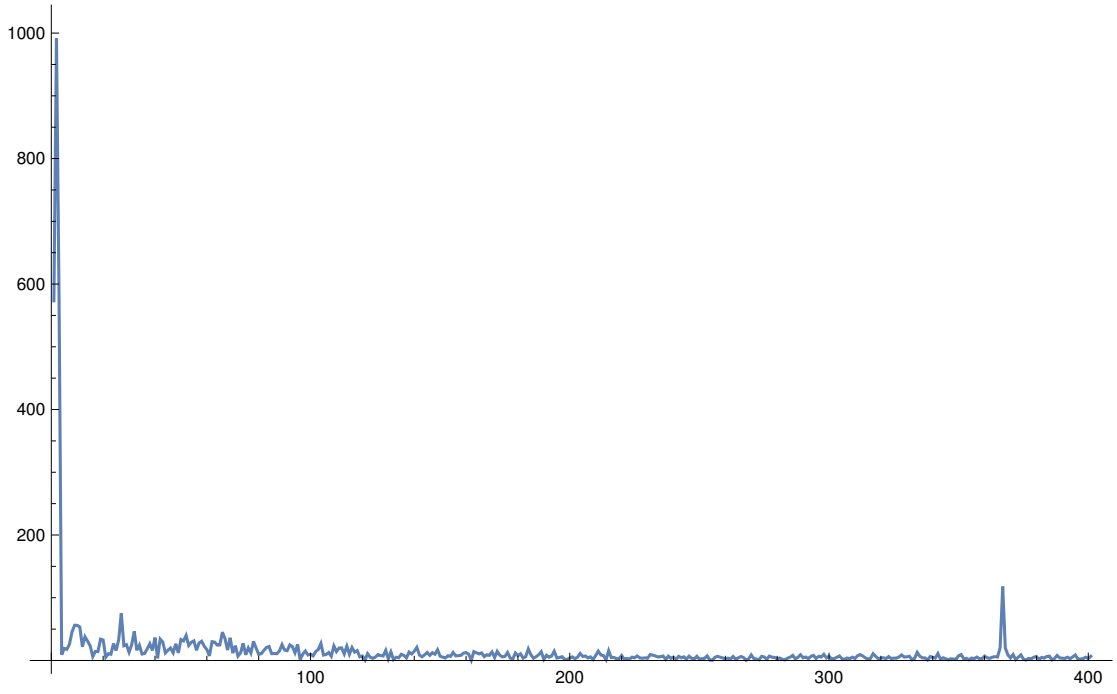
Out[16]=



A zoomed in view of the temperature fft. The huge peak at the low frequency (peaks at 1000), represents the overall trend for the year. The peak at index 365ish represents the temperatures over a 24 hour period.

In[17]:=
```
ListLinePlot[Abs[fftShift[temp]][[Round@Length[temp]/2 ;; Round@Length[temp]/2 + 400]],
 ImageSize → Large, PlotRange → All]
```

Out[17]=



In[18]:=
```
24 * 365
```

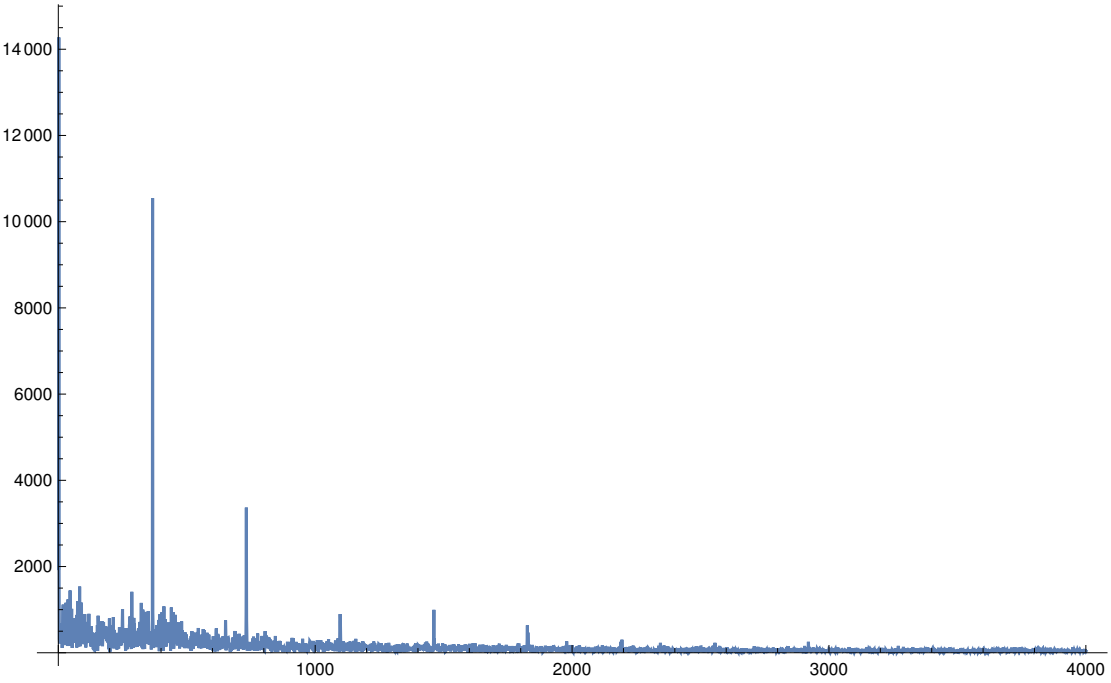
Out[18]= 8760

In[19]:=
```
plot
```

Out[19]= plot

In[20]:=
```
ListLinePlot[Abs[fftShift[dni]][[Round@Length[temp]/2 ;; Round@Length[temp]/2 + 4000]]],
 ImageSize → Large, PlotRange → All]
```

Out[20]=



3b - doing pre-work calculations

In[21]:=
```
r[t_] := A * Cos[2 Pi * v * t]/L
```

In[22]:=
```
r[t]
```

Out[22]=
$$\frac{A \text{Cos}[2 \pi t v]}{L}$$

In[23]:=
```
∂t A Cos[2 π t v]/L
```

Out[23]=
$$-\frac{2 A \pi v \text{Sin}[2 \pi t v]}{L}$$

In[24]:=
```
exportNotebookPDF[]
```

```
/home/nathan/olin/fall2016/qEAFall2016Homework/bset4/bset4Scrapbook.pdf
```