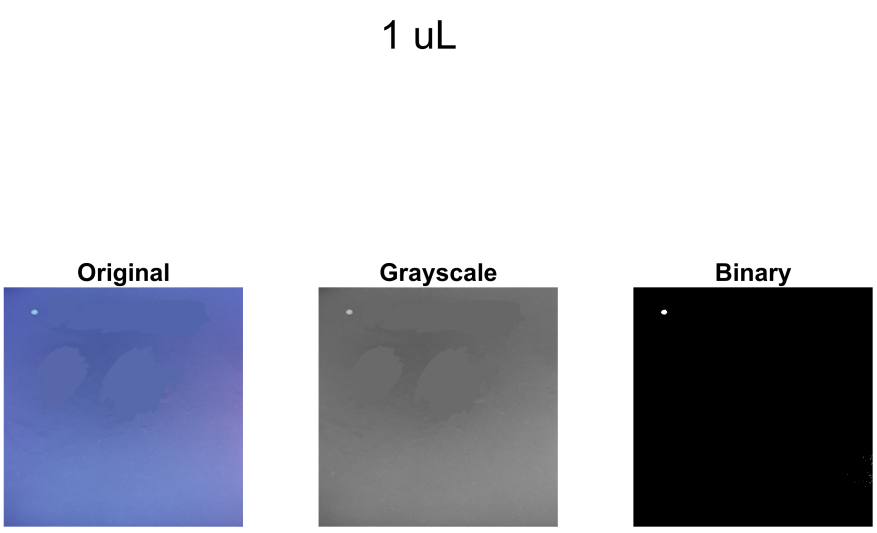
Standard Curve Formulas: 2nd Trial

Pixels to Cm^2 and Cm^2 to uL

Anderson 1/4/23

```
%retouch image to get rid of handwritten label
%crop images to pixel size 2200x2200
%rotate image as needed to fit in 2200x2200 square
%optional: change brightness
    %%anomarkbrighter=anomark+20
%optional: change contrast:
    %anomarkcontrast=localcontrast(anomarkbrighter,0.4,0.7);

oneul=imread("M:\Documents\stdcurveimages2\stdcurve1uL.jpg");
oneulgray=rgb2gray(oneul);
oneulbinary=oneulgray>150;
figure
subplot(1,3,1); imshow(oneul); title('Original')
subplot(1,3,2); imshow(oneulgray); title('Grayscale')
subplot(1,3,3); imshow(oneulbinary); title('Binary')
sgtitle('1 uL')
```




```
props1ul=regionprops(oneulbinary,'Area');
sortarea=sort([props1ul.Area],'descend');
oneulcounted=bwareaopen(oneulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numOneul]=bwlabel(oneulcounted,8);
```

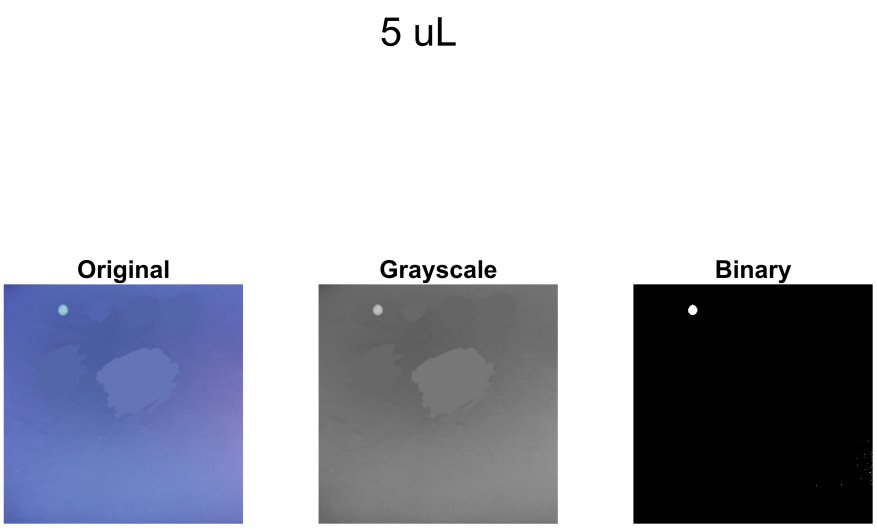
```
fprintf('MATLAB found %d shapes in 1uL.\n',numOneul)
```

```
MATLAB found 1 shapes in 1uL.
```

```
oneularea=bwarea(oneulbinary);
fprintf('Total area of voiding is %d pixels in 1uL.\n',oneularea)
```

```
Total area of voiding is 2.404250e+03 pixels in 1uL.
```

```
fiveul=imread("M:\Documents\stdcurveimages2\stdcurve5uL.jpg");
fiveulgray=rgb2gray(fiveul);
fiveulbinary=fiveulgray>150;
figure
subplot(1,3,1); imshow(fiveul); title('Original')
subplot(1,3,2); imshow(fiveulgray); title('Grayscale')
subplot(1,3,3); imshow(fiveulbinary); title('Binary')
sgtitle('5 uL')
```




```
props5ul=regionprops(fiveulbinary,'Area');
sortarea=sort([props5ul.Area],'descend');
fiveulcounted=bwareaopen(fiveulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numFiveul]=bwlabel(fiveulcounted,8);
fprintf('MATLAB found %d shapes in 5uL.\n',numFiveul)
```

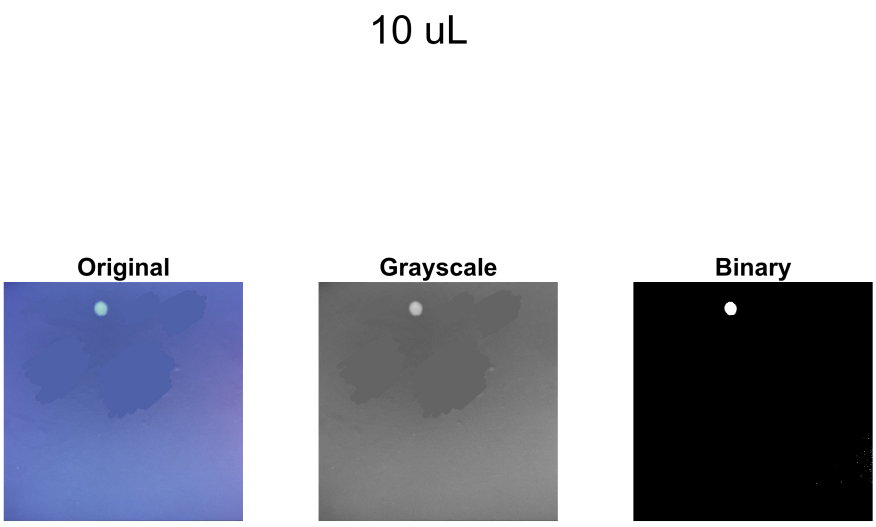
```
MATLAB found 1 shapes in 5uL.
```

```
fiveularea=bwarea(fiveulbinary);
```

```
fprintf('Total area of voiding is %d pixels in 5uL.\n',fiveularea);
```

```
Total area of voiding is 6.770875e+03 pixels in 5uL.
```

```
tenul=imread("M:\Documents\stdcurveimages2\stdcurve10uL.jpg");
tenulgray=rgb2gray(tenul);
tenulbinary=tenulgray>150;
figure
subplot(1,3,1); imshow(tenul); title('Original')
subplot(1,3,2); imshow(tenulgray); title('Grayscale')
subplot(1,3,3); imshow(tenulbinary); title('Binary')
sgtitle('10 uL')
```



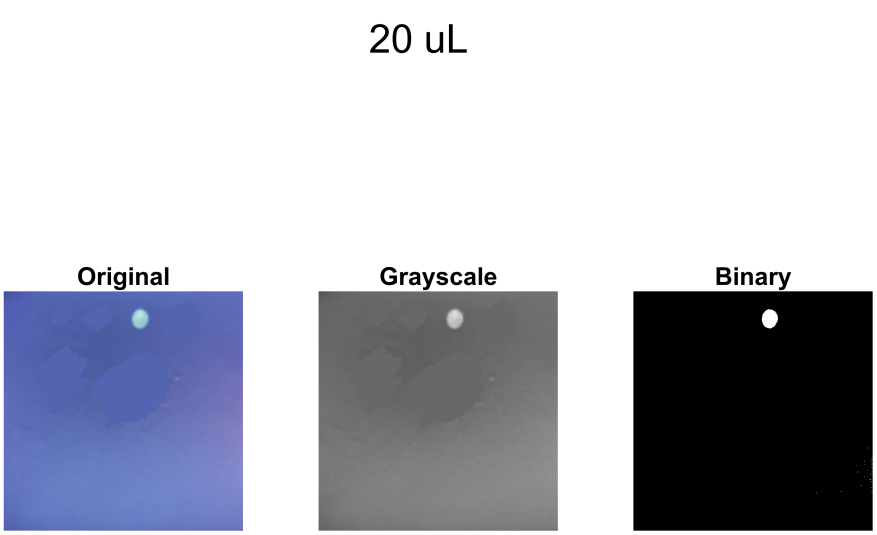

```
props10ul=regionprops(tenulbinary,'Area');
sortarea=sort([props10ul.Area],'descend');
tenulcounted=bwareaopen(tenulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numtenul]=bwlabel(tenulcounted,8);
fprintf('MATLAB found %d shapes in 10uL.\n',numtenul)
```

```
MATLAB found 1 shapes in 10uL.
```

```
tenularea=bwarea(tenulbinary);
fprintf('Total area of voiding is %d pixels in 10uL.\n',tenularea)
```

```
Total area of voiding is 1.158538e+04 pixels in 10uL.
```

```
twentyul=imread("M:\Documents\stdcurveimages2\stdcurve20uL.jpg");
twentyulgray=rgb2gray(twentyul);
twentyulbinary=twentyulgray>150;
figure
subplot(1,3,1); imshow(twentyul); title('Original')
subplot(1,3,2); imshow(twentyulgray); title('Grayscale')
subplot(1,3,3); imshow(twentyulbinary); title('Binary')
sgtitle('20 uL')
```




```
props20ul=regionprops(twentyulbinary,'Area');
sortarea=sort([props20ul.Area],'descend');
twentyulcounted=bwareaopen(twentyulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numtwentyul]=bwlabel(twentyulcounted,8);
fprintf('MATLAB found %d shapes in 20uL.\n',numtwentyul)
```

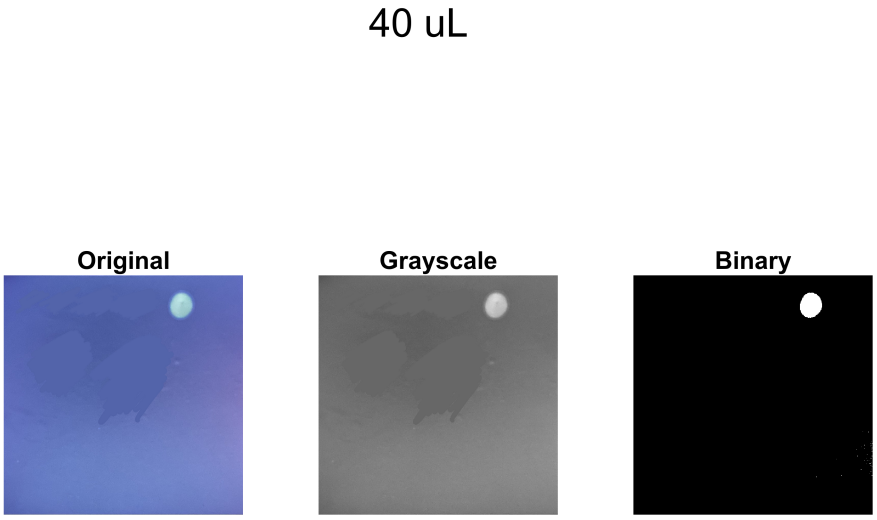
```
MATLAB found 1 shapes in 20uL.
```

```
twentyularea=bwarea(twentyulbinary);
fprintf('Total area of voiding is %d pixels in 20uL.\n',twentyularea)
```

```
Total area of voiding is 2.071475e+04 pixels in 20uL.
```

```
fortyul=imread("M:\Documents\stdcurveimages2\stdcurve40uL.jpg");
fortyulgray=rgb2gray(fortyul);
fortyulbinary=fortyulgray>150;
figure
subplot(1,3,1); imshow(fortyul); title('Original')
```

```
subplot(1,3,2); imshow(fortyulgray); title('Grayscale')
subplot(1,3,3); imshow(fortyulbinary); title('Binary')
sgtitle('40 uL')
```




```
props40ul=regionprops(fortyulbinary,'Area');
sortarea=sort([props40ul.Area],'descend');
fortyulcounted=bwareaopen(fortyulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numfortyul]=bwlabel(fortyulcounted,8);
fprintf('MATLAB found %d shapes in 40uL.\n',numfortyul)
```

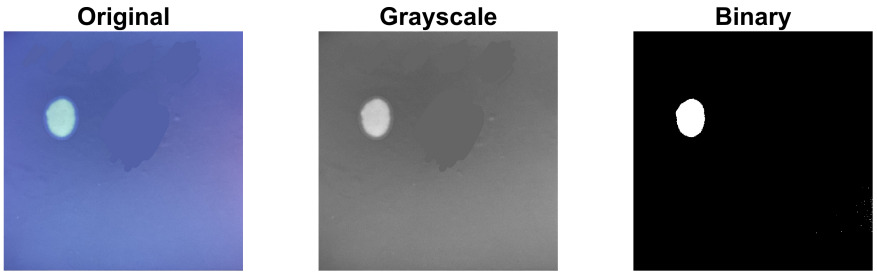
```
MATLAB found 1 shapes in 40uL.
```

```
fortyularea=bwarea(fortyulbinary);
fprintf('Total area of voiding is %d pixels in 40uL.\n',fortyularea)
```

```
Total area of voiding is 3.724738e+04 pixels in 40uL.
```

```
eightyul=imread("M:\Documents\stdcurveimages2\stdcurve80uL.jpg");
eightyulgray=rgb2gray(eightyul);
eightyulbinary=eightyulgray>150;
figure
subplot(1,3,1); imshow(eightyul); title('Original')
subplot(1,3,2); imshow(eightyulgray); title('Grayscale')
subplot(1,3,3); imshow(eightyulbinary); title('Binary')
sgtitle('80 uL')
```

80 uL




```
props80ul=regionprops(eightyulbinary,'Area');
sortarea=sort([props80ul.Area],'descend');
eightyulcounted=bwareaopen(eightyulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numeightyul]=bwlabel(eightyulcounted,8);
fprintf('MATLAB found %d shapes in 80uL.\n',numeightyul)
```

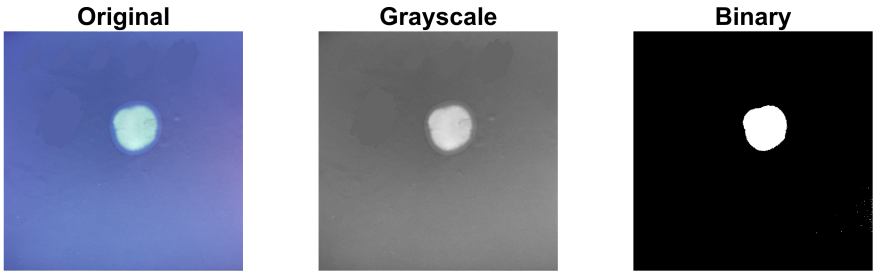
```
MATLAB found 1 shapes in 80uL.
```

```
eightyularea=bwarea(eightyulbinary);
fprintf('Total area of voiding is %d pixels in 80uL.\n',eightyularea)
```

```
Total area of voiding is 73703 pixels in 80uL.
```

```
onesixtyul=imread("M:\Documents\stdcurveimages2\stdcurve160uL.jpg");
onesixtyulgray=rgb2gray(onesixtyul);
onesixtyulbinary=onesixtyulgray>150;
figure
subplot(1,3,1); imshow(onesixtyul); title('Original')
subplot(1,3,2); imshow(onesixtyulgray); title('Grayscale')
subplot(1,3,3); imshow(onesixtyulbinary); title('Binary')
sgtitle('160 uL')
```

160 uL




```
props160ul=regionprops(onesixtyulbinary,'Area');
sortarea=sort([props160ul.Area],'descend');
onesixtyulcounted=bwareaopen(onesixtyulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numonesixtyul]=bwlabel(onesixtyulcounted,8);
fprintf('MATLAB found %d shapes in 160uL.\n',numonesixtyul)
```

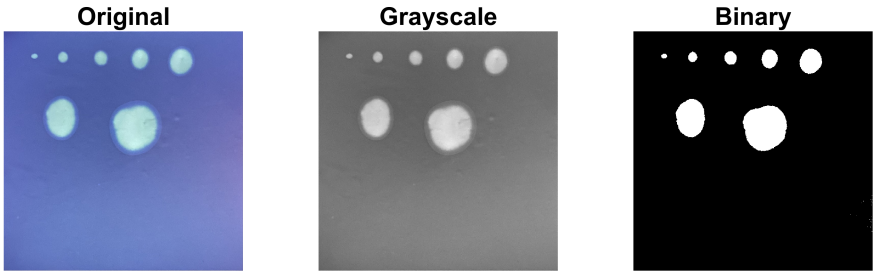
```
MATLAB found 1 shapes in 160uL.
```

```
onesixtyularea=bwarea(onesixtyulbinary);
fprintf('Total area of voiding is %d pixels in 160uL.\n',onesixtyularea)
```

```
Total area of voiding is 1.320394e+05 pixels in 160uL.
```

```
totalul=imread("M:\Documents\stdcurveimages2\stdcurve316uL.jpg");
totalulgray=rgb2gray(totalul);
totalulbinary=totalulgray>150;
figure
subplot(1,3,1); imshow(totalul); title('Original')
subplot(1,3,2); imshow(totalulgray); title('Grayscale')
subplot(1,3,3); imshow(totalulbinary); title('Binary')
sgtitle('316 uL')
```

316 uL



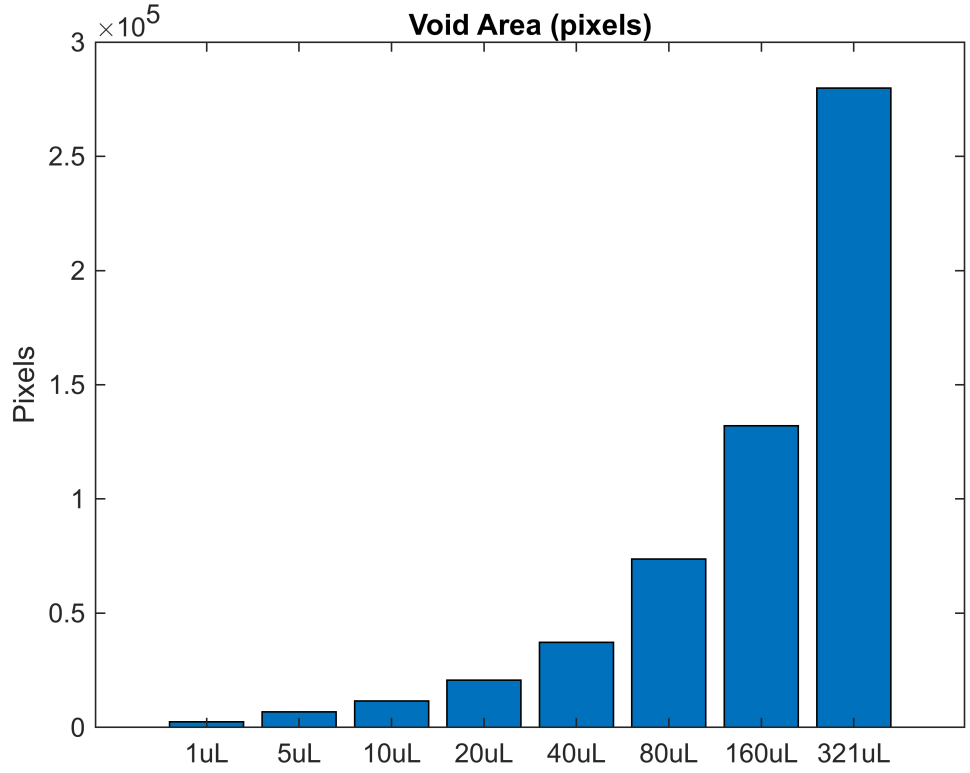

```
propstotalul=regionprops(totalulbinary,'Area');
sortarea=sort([propstotalul.Area],'descend');
totalulcounted=bwareaopen(totalulbinary,50); %CAN CHANGE PIXEL FILTERING
[label,numTotalul]=bwlabel(totalulcounted,8);
fprintf('MATLAB found %d shapes in 316uL.\n',numTotalul)
```

```
MATLAB found 7 shapes in 316uL.
```

```
totalularea=bwarea(totalulbinary);
fprintf('Total area of voiding is %d pixels in 316uL.\n',totalularea)
```

```
Total area of voiding is 2.799016e+05 pixels in 316uL.
```

```
%Will be making two sets of standard curves: 1. pixels to cm2 and 2. cm2 to
%uL. With conversion factors for both, we will be able to calculate volume of
%voiding in uL given only pixels.
areaVoidforbar=[oneularea fiveularea tenularea twentyularea fortyularea eightyularea onesixtyul
figure
bar(areaVoidforbar)
set(gca,'xticklabel',{'1uL','5uL','10uL', '20uL', '40uL','80uL','160uL','321uL'})
ylabel('Pixels')
title('Void Area (pixels)')
```




```
%convert pixels to cm^2
%images are sized at 2200x2200 pixels
%total pixels=4,840,000
%dimenions of paper used is 7inx7in or 17.78cmx17.78cm
%paper has total area 316.128cm^2
%need to calculate percentage of total pixels and multiply by percentage of
%total cm^2 to get cm^2 of voiding
totalpixels=4840000;
totalcm2=316.128
```

```
totalcm2 = 316.1280
```

```
oneulareacm=(oneularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 1uL.\n',oneulareacm)
```

```
Total area of voiding is 1.570353e-01 sq cm in 1uL.
```

```
fiveulareacm=(fiveularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 5uL.\n',fiveulareacm)
```

```
Total area of voiding is 4.422445e-01 sq cm in 5uL.
```

```
tenulareacm=(tenularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 10uL.\n',tenulareacm)
```

```
Total area of voiding is 7.567069e-01 sq cm in 10uL.
```

```
twentyulareacm=(twentyularea ./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 20uL.\n',twentyulareacm)
```

```
Total area of voiding is 1.352998e+00 sq cm in 20uL.
```

```
fortyulareacm=(fortyularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 40uL.\n',fortyulareacm)
```

```
Total area of voiding is 2.432838e+00 sq cm in 40uL.
```

```
eightyulareacm=(eightyularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 80uL.\n',eightyulareacm)
```

```
Total area of voiding is 4.813963e+00 sq cm in 80uL.
```

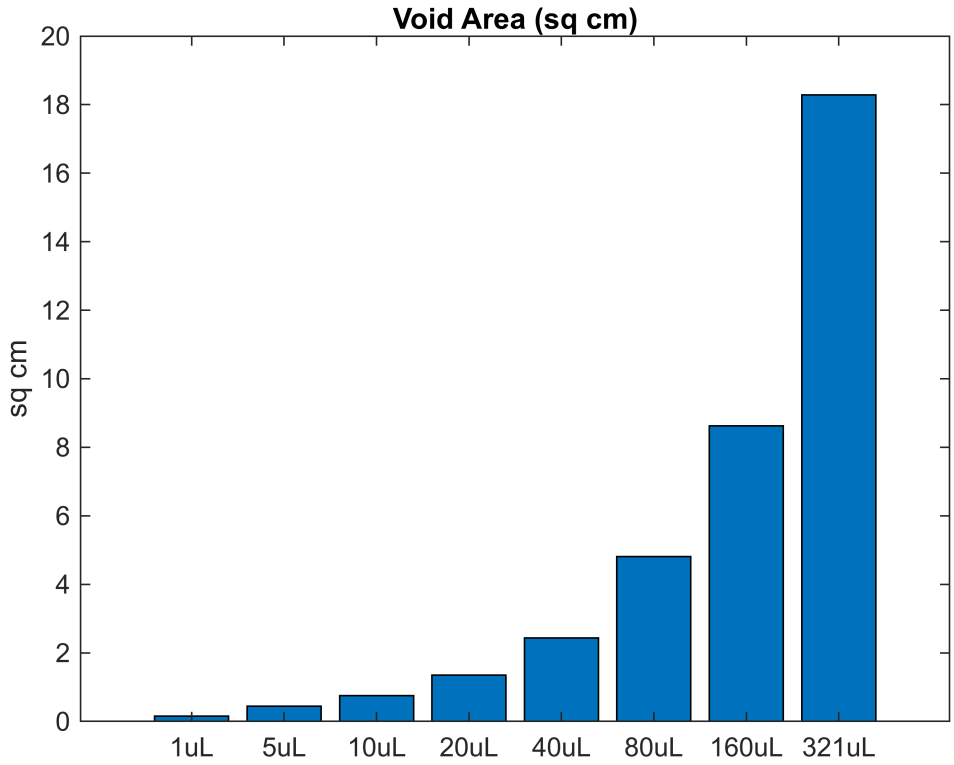
```
onesixtyulareacm=(onesixtyularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 160uL.\n',onesixtyulareacm)
```

```
Total area of voiding is 8.624245e+00 sq cm in 160uL.
```

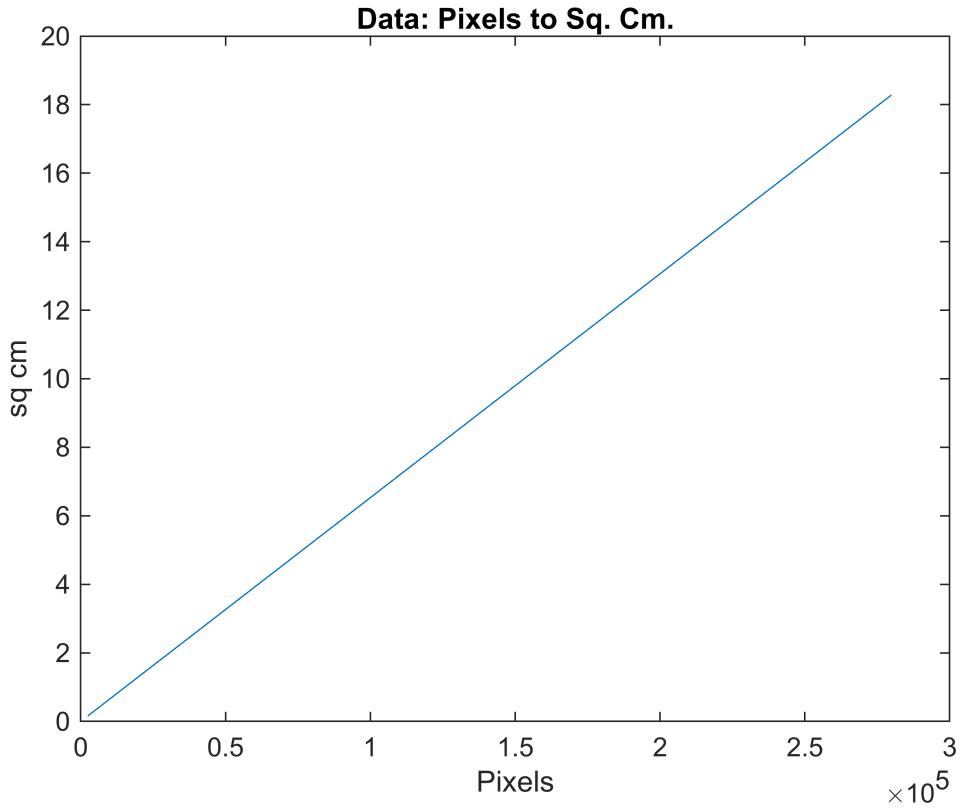
```
totalulareacm=(totalularea./totalpixels)*totalcm2;
fprintf('Total area of voiding is %d sq cm in 316uL.\n',totalulareacm)
```

```
Total area of voiding is 1.828197e+01 sq cm in 316uL.
```

```
areacmVoidforbar=[oneulareacm fiveulareacm tenulareacm twentyulareacm fortyulareacm eightyulare
figure
bar(areacmVoidforbar)
set(gca,'xticklabel',{'1uL','5uL','10uL', '20uL', '40uL','80uL','160uL','321uL'})
ylabel('sq cm')
title('Void Area (sq cm)')
```




```
table1=table(areaVoidforbar,areacmVoidforbar);
plot(table1,"areaVoidforbar","areacmVoidforbar")
xlabel('Pixels'),ylabel('sq cm'),title('Data: Pixels to Sq. Cm.')
```




```
x=areaVoidforbar;
y=areacmVoidforbar;
p1=polyfit(x,y,1)
```

```
p1 = 1×2
10^-4 ×
    0.6532   -0.0000
```

```
m1=p1(1)
```

```
m1 = 6.5316e-05
```

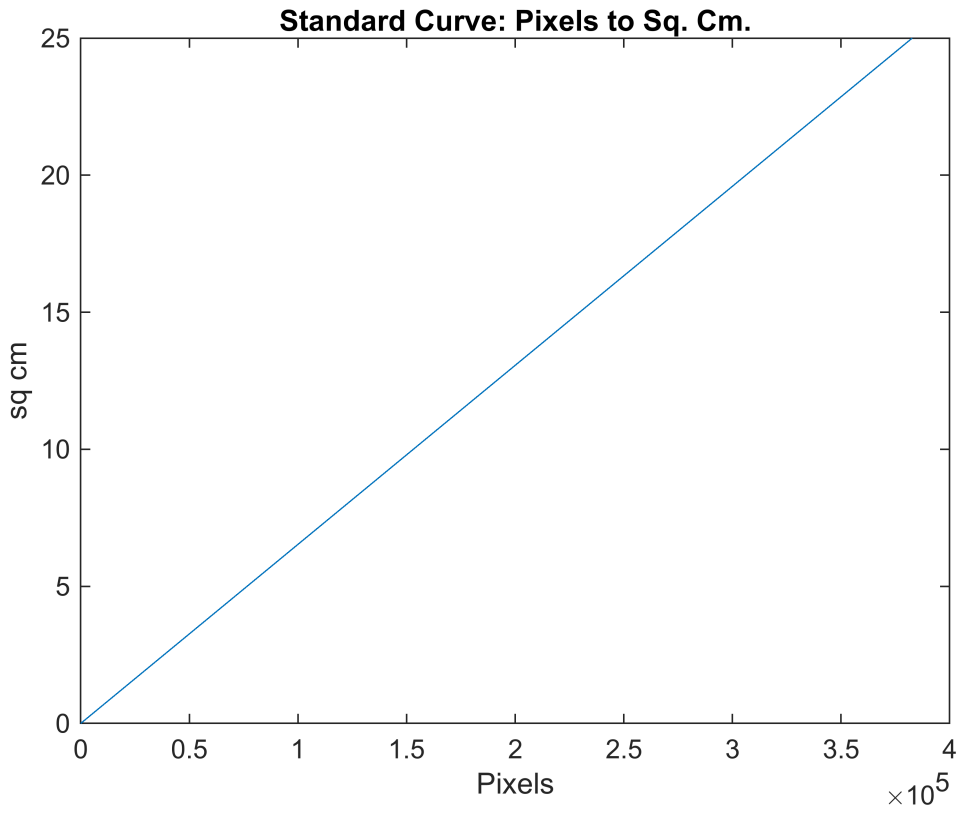
```
b1=p1(2)
```

```
b1 = -4.0538e-15
```

```
f1=@lineartrendline %Pixels to sq cm function
```

```
f1 = function_handle with value:
    @lineartrendline
```

```
array1=linspace(0,400000);
f1array=f1(array1);
plot(array1,f1array);title('Standard Curve: Pixels to Sq. Cm.');xlabel('Pixels'),ylabel('sq cm
```




```
fprintf('Linear trendline formula to convert pixels to sq cm is %d * x + %d.\n',m1,b1)
```

```
Linear trendline formula to convert pixels to sq cm is 6.531570e-05 * x + -4.053775e-15.
```

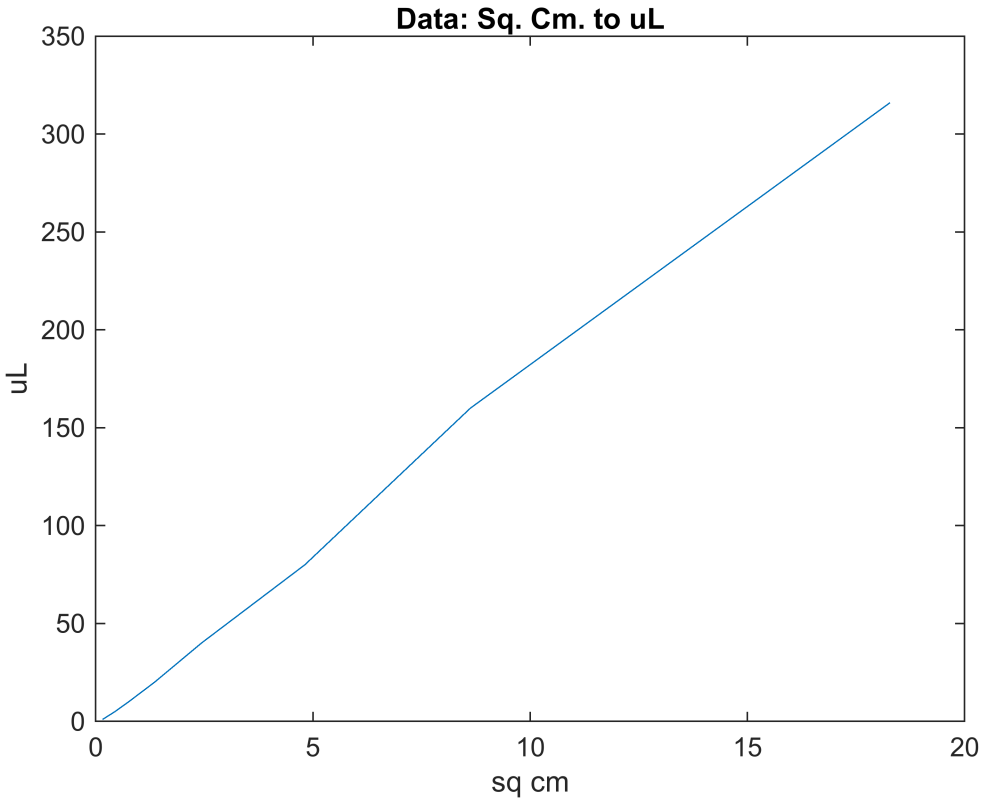
```
volumeuL=[1, 5, 10, 20, 40, 80, 160, 316];
table2=table(areacmVoidforbar,volumeuL)
```

```
table2 = 1×2 table
```

...

	areacmVoidforbar			
1	0.1570	0.4422	0.7567	1.3530

```
plot(table2,"areacmVoidforbar","volumeuL")
xlabel('sq cm'),ylabel('uL'),title('Data: Sq. Cm. to uL')
```




```
a=areacmVoidforbar;
b=volumeuL;
p2=polyfit(a,b,1)
```

```
p2 = 1×2
   17.6147   -2.1641
```

```
m2=p2(1)
```

```
m2 = 17.6147
```

```
b2=p2(2)
```

```
b2 = -2.1641
```

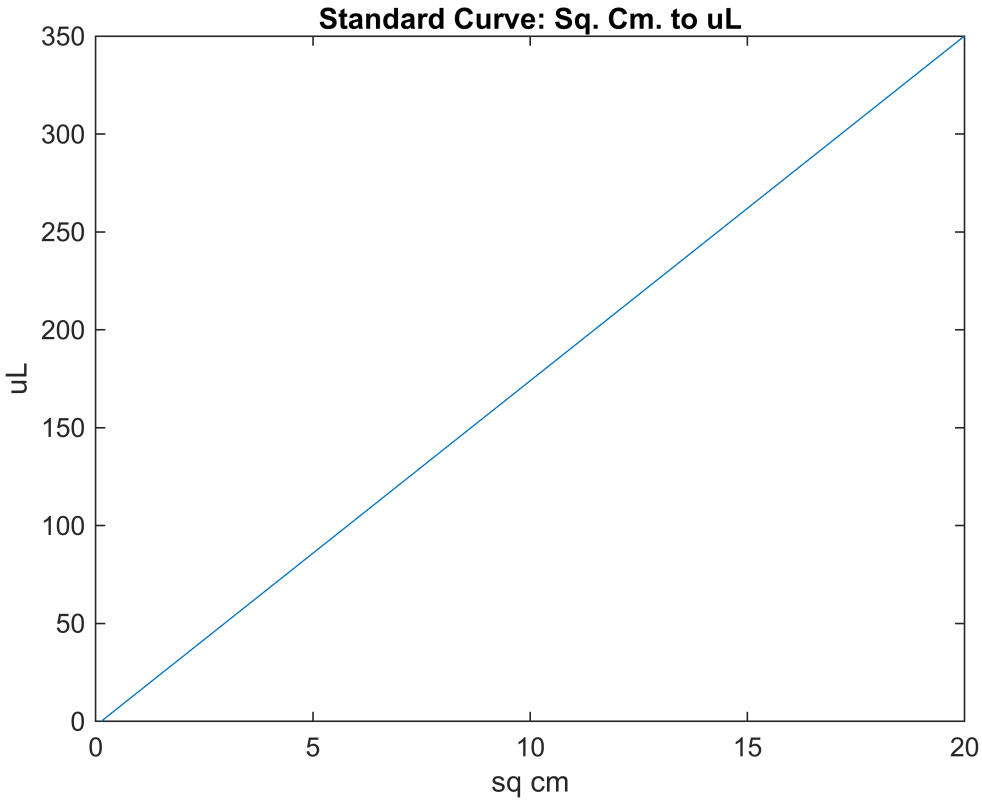
```
f2=@lineartrendline2 %sq cm to uL function
```

```
f2 = function_handle with value:
    @lineartrendline2
```

```
fprintf('Linear trendline formula to convert sq cm to uL is %d * x + %d.\n',m2,b2)
```

```
Linear trendline formula to convert sq cm to uL is 1.761470e+01 * x + -2.164125e+00.
```

```
array2=linspace(0,25);
f2array=f2(array2);
plot(array2,f2array);title('Standard Curve: Sq. Cm. to uL');xlabel('sq cm'),ylabel('uL');ylim(
```




```
function f1=lineartrendline(x)
m1 = 6.5316e-05;
b1 = -4.0538e-15;
f1=m1*x+b1; %where f1 is sq cm and x is pixels
end
function f2=lineartrendline2(x)
m2 = 17.6147;
b2 = -2.1641;
f2=m2*x+b2; %where f2 is uL and x is sq cm
end
%Now, if calculated # of pixels, can put in f1 to calculat sq cm, and then
%put output as input in f2 to calculate volume. WOuld you like to see out
%put in sq cm or go directly to pixels?
```