Annotated Bibliography

https://mathshistory.st-andrews.ac.uk/DSB/Al-Kashi.pdf

Annotation: This resource gave a lot of biographical and historical information on Al-Kashi. It gave more context to his early life and the contrasting opinions on Al-Kashi's role at the Samarkand Observatory.

http://www.jphogendijk.nl/arabsci/Kashi-Aaboe.pdf/

Annotation: This was the first resource I found when I was researching Al-Kashi's method. It provided an explanation of Al-Kashi's method using sexagesimal notation and gave context for why he used sexagisimal notation.

https://mathshistory.st-andrews.ac.uk/Biographies/Al-Kashi/

Annotation: This provides more biographical and historical data. The most important being characterizations of his work from his contemporary Ulugh Beg. This resource also gives more context for the formation of the fractional decimal notation, i.e. Al-Kashi wrote the first methodical approach to the notation.

https://www2.clarku.edu/faculty/djoyce/trig/compute.html

Annotation: This resource recounts how Ptolemy produced his trig table in The Almagest. Interestingly I found this before our trigonometry lab and it made the last part a lot easier to understand, and relatable.

https://forumgeom.fau.edu/FG2015volume15/FG201523.pdf

Annotation: At the end of this document the author provides a decimal explanation of Al-Kashi's method. This was very helpful and provided the majority of the technical content for my presentation. I would also say that without this resource it would have been a lot more difficult to code Al-Kashi's method in Matlab.

https://mathematicalstamps.eu/news/71?ln=en-gb

Annotation: This is the depiction I chose to use for Al-Kashi. I think bringing up the fact that Al-Kashi is on a stamp lightens the tone of the presentation.

NOTE: The rest of this document is the Matlab demonstration I had planned

```
function [Hist,x] = Kashi(n, xg)
%This function takes the number of iterations n, and
%an initial guess at sind(1) and returns the steps in the
%Kashi iteration and the best approximation of sind(1)


%init Hist variable and base case.
Hist = [ ];
Hist(1) = xg;


 for i = 2:n+1
        %Evaluating the right hand side of the iteration step.
        y = ((sind(3) + 4*(Hist(i-1)^3))/3) - Hist(i-1);

        %Digit manipulation to pull first non-zero integer.
        z = floor(abs(y) ./ 10.^floor(log10(abs(y)))).*(10.^floor(log10(abs(y))));

        %Adding newest digit to approximation.
        Hist(i) = Hist(i-1)+z;
 end

 %Returning x
 x = Hist(n+1);
```

```
function [Hist,xp] = PowerSeries(n,x)
%This function takes a degree x and number of iterations n
%and returns the nth(2n+1) degree power series approximation for sin(x)

%Convert to radians.
Hist(1) = (pi/180)*x;

%Power series for loop
for i = 2:n
        Hist(i) = Hist(i-1) + ((-1)^(i-1)*((pi/180)^((2*i)-1)*(x)^((2*i)-1))/factorial((2*i) - 1));
end
```

```
%Run Al-Kashi Method for 16 digits...
[HistK, xk] = Kashi(14,.01);
HistK'
ErrorK = abs(HistK - sind(1))'

%Run Power series for 1 degree. Explain what I think is happening...
[HistP, xP] = PowerSeries(15,1);
HistP'
ErrorP = abs(HistP - sind(1))'

%Explain and run worst case Power Series...
[HistP, xP] = PowerSeries(15,89);
HistP'
ErrorP = abs(HistP - sind(89))'

%Compare convergence on loglog plot...
loglog([1:15], ErrorP,'o','Color','b')
hold on
loglog([1:15], ErrorK,'o','Color','r')
legend('Power Series','Al-Kashi','Location','northeast')
ylabel('Absolute Error')
xlabel('nth iteration')
```