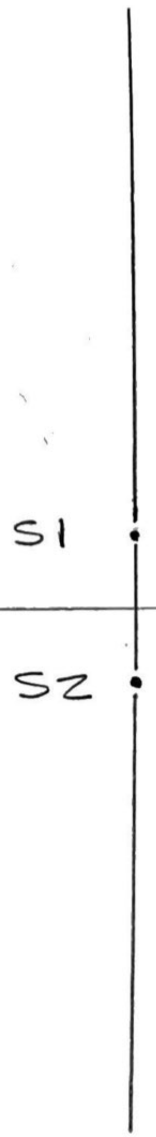
Problem Set 2 Problem 1

S1 and S2 are 20 mm apart



You can see the situation is very symmetrical. Once we have analyzed points A–P, it is trivial to predict what happens for Q–AE.

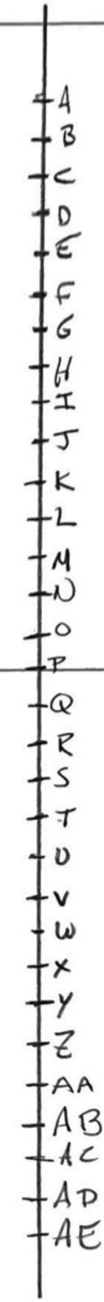


TABLE TO FILL IN

	DISTANCE FROM S2 (mm)	DISTANCE FROM S1 (mm)	DIFFERENCE (mm)
A	153	141	12
B	150	139	11
C	148	138	10
D			
E			
F			
G			
H			
I			
J			
K			
L			
M			
N			
O			
P			

Using $\lambda = 6mm$

$\frac{12mm}{6mm} \cdot 2\pi$

$\frac{11mm}{6mm} \cdot 2\pi$

	$\Delta\varphi$	I
A	4π	
B	$11\pi/3$	
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		
O		
P		

Using $\lambda = 4mm$

$\frac{12mm}{4mm} \cdot 2\pi$

$\frac{11mm}{4mm} \cdot 2\pi$

	$\Delta\varphi$	I
A	6π	
B	$11\pi/2$	
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		
N		
O		
P		

IN RADIANS

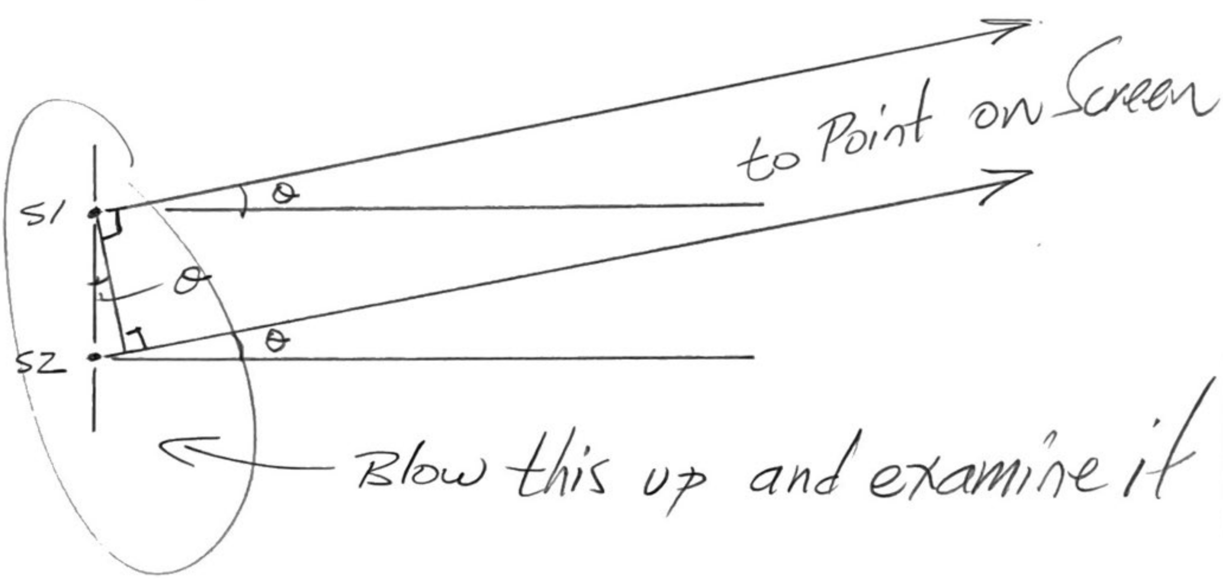
$$\Delta\varphi = \frac{\text{PATH DIFFERENCE}}{\lambda} \cdot 2\pi$$

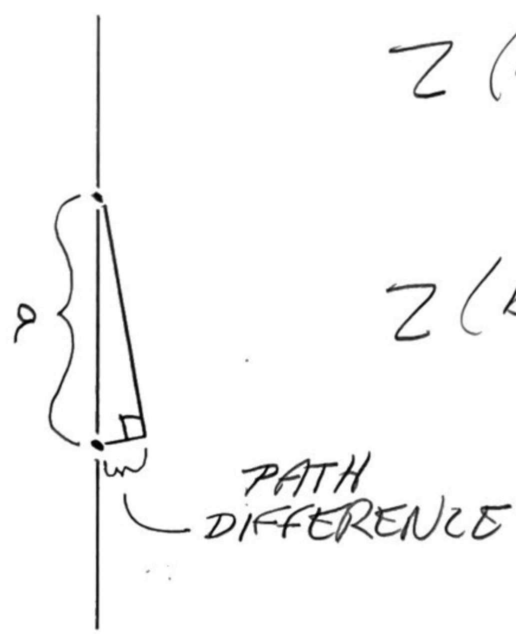
$$I = 2\cos^2\frac{\Delta\varphi}{2}$$

$$= 1 + \cos\Delta\varphi$$

Problem Set 2 Problem 2

An approximation often made is that the points A, B, C, ..., AD, AE are very far away and all that matters is the angle toward them:





2 (a) Using trig, what is the path difference

2 (b) Assuming $\frac{a}{\lambda} = \frac{10}{3}$ Convert path difference to radians (just as in problem 1).

In the solution, I changed the plot ranges to $-\pi/4$ to $\pi/4$ to better match what was done in problem 1.

2(c) Graph

$\Delta\varphi$ as a function of θ from $\theta = -\frac{\pi}{2}$ to $\theta = +\frac{\pi}{2}$

2(d) Graph

$I = 1 + \cos\Delta\varphi$ as a function of θ from $\theta = -\frac{\pi}{2}$ to $\frac{\pi}{2}$

2(e), 2(f), 2(g)

Repeat 2(b), 2(c), 2(d), but assume $\frac{a}{\lambda} = 5$

Problem 3

Far from a circular aperture a star which you wish would focus to a point actually focuses to a diffraction pattern called the Airy disk. The first minimum of the Airy disk is a circle of radius given by

$$\sin \theta = 1.22 \frac{\lambda}{A}$$

in radians

for very small angles $\sin \theta \approx \theta$

or $\sin\theta \approx \theta \cdot \frac{2\pi}{360^\circ}$

in degrees

If θ is in degrees and you use the approximation just given, then

$$\theta \cdot \frac{2\pi}{360^\circ} = 1.22 \frac{\lambda}{A}$$

Solve for $\theta = \frac{360^\circ}{2\pi} 1.22 \frac{\lambda}{A}$

(a) Plug in $A = 254mm$ and $\lambda = 550nm$
What is θ?

(b) Convert to arc-seconds.