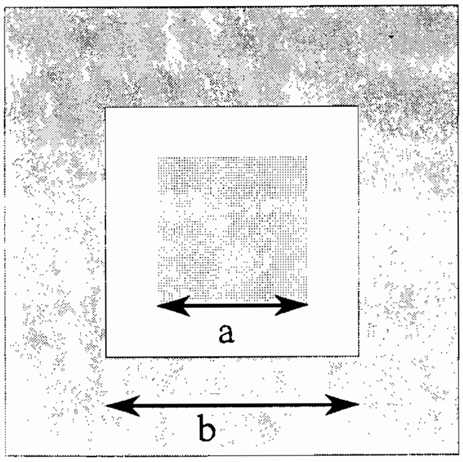
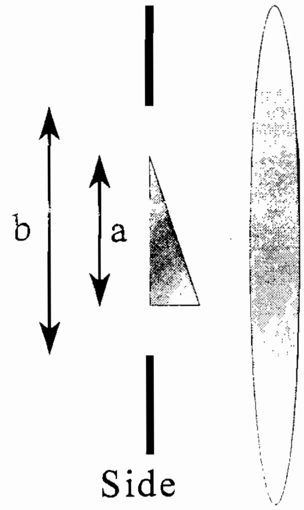
Completely Answer 5 of 6 Questions

(1) Briefly describe spatial and temporal coherence and their origins. What classical experiments are done to measure the two quantities? Analyze each experiment and determine under what conditions the experiments actually measure the temporal and spatial coherence independently. What are the key features measured in each experiment?

(2) A glass wedge of index n and wedge angle θ is in the shape of a square with sides "a". The wedge is centered and centrally mounted over a square hole with sides "b", in an opaque optical mount, with b>a, as in the figure below. This is followed by a lens of focal length *f*. The arrangement is then illuminated with plane parallel monochromatic light of wavelength λ. Write down the phase delay the light experiences passing through the wedge. Write down the transmission function for the wedge and mount combination. Calculate the field irradiance distribution at the rear focal plane of the lens. Compare your result with that expected applying geometrical optics principles.



Front



Side

(3) Two monochromatic right-handed circularly-polarized (rhcp) plane waves are propagating generally in the z-direction in free space (vacuum) with a small angle between their propagation vectors ($\Delta\underline{K}=\underline{K}_1-\underline{K}_2$) and with slightly different phases.

(A) Write down equations for the complex amplitude of the two electric fields and give explicit definitions **and relationships** for all important quantities (i.e. polarization direction, wavevector, wavelength, etc.)

(B) Sum the two fields. If the resulting wave is then detected, calculate the irradiance pattern variation with x & y at a plane whose normal is in the z-direction.

(C) What is meant by fringe visibility? Write down the expression for visibility.

(D) What is happens to the irradiance pattern if the phase difference is varied?

(E) What happens to the irradiance pattern if the angle between the two waves is varied? Does the fringe visibility change?

(F) Under what conditions will the fringe visibility be maximum?

(4) Chromatic aberrations are caused by the dependence of the index of refraction on wavelength for optical materials. An observable consequence is the variation of focal length with wavelength (*i.e.* Longitudinal Axial chromatic aberration LAch) for a simple bi-convex, thin lens. Using the "classical physics simple harmonic oscillator model" for optical materials, the dispersion can be derived. The lowest order dependence on λ is found to be $1/\lambda^2$. Write down an expression for n vs. λ and give a qualitative plot. Using the lensmaker's equation, derive an expression for $df/d\lambda$, the variation of focal length with wavelength. Suppose two identical lenses as described above are separated by a distance d. Write down the expression for the system's focal length. Can this system ever be completely free of LAch? If so, what is the condition?

(5) On Page 4 there is a diagram of a simple optical system composed of two thin lenses and an aperture stop. The lenses are identical having a focal length of 50mm and are 50mm apart. We place a 20mm high object 50mm in from of the first lens.

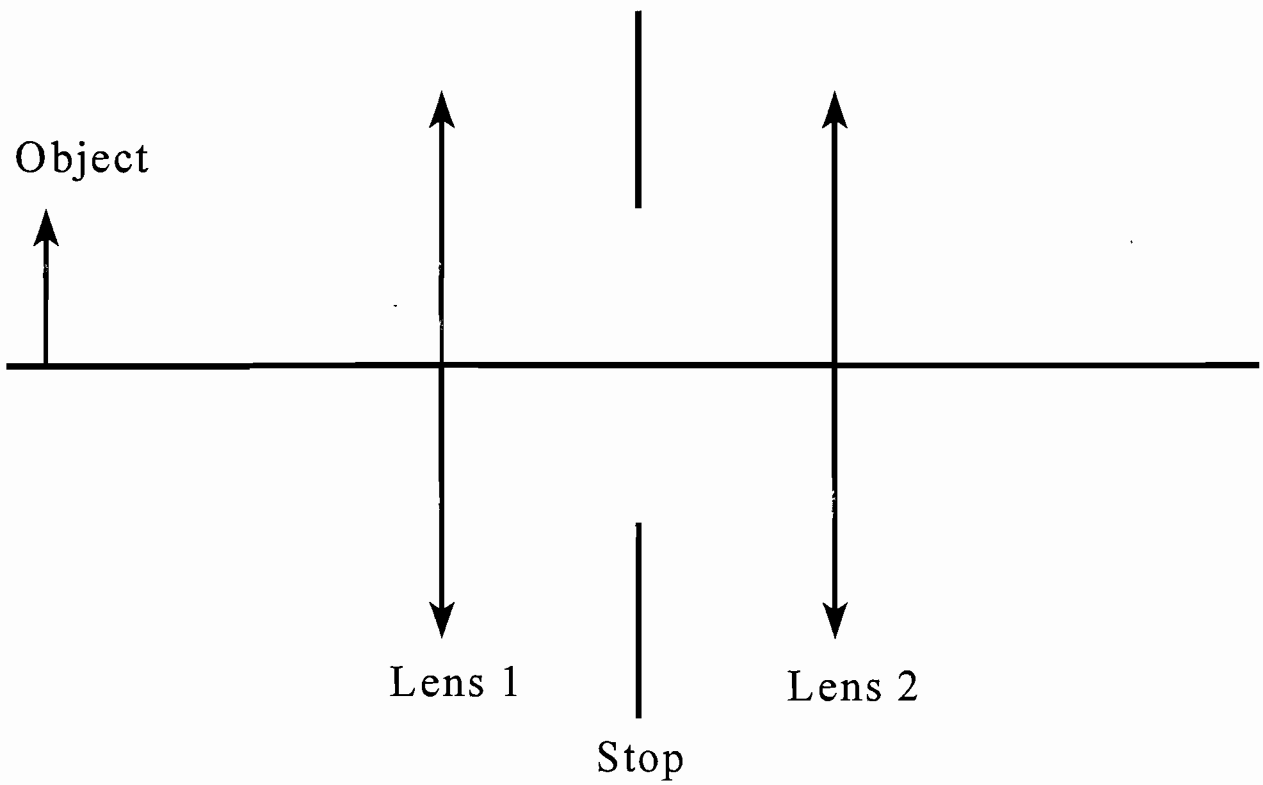
(A) Use the ray chart and trace conditional a-ray and b-ray through the system (as given). Find the image location.

(B) Find the chief and marginal ray and trace them through the system. Draw them on the figure (which is to scale).

(C) On the figure locate and label: the image, the chief ray, the marginal ray, the principal planes, the focal points, the exit pupil and the entrance pupil. Supply the data requested on page 4.

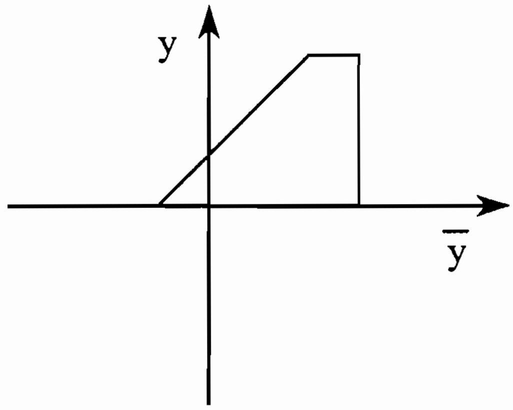
Surface #	Object	1	2-stop	3	4-Image
$-\phi_j$	0		0		0
t_j/n_j	50mm	25mm	25mm		
y_A	0mm				
nu_A					
y_B	20mm				
nu_B	0				
Marginal Ray					
y	0		2.5		
nu					
Chief Ray					
$\bar{y}$	5		0		
$\bar{n}\bar{u}$					

Front Principal Plane:	S#1→P_1 =	________
Rear Principal Plane;	P_1→S#3 =	________
Entrance Pupil:	S#1→E_1 =	________
	Diam of E_1 =	________
Exit Pupil:	E_2→S#3 =	________
	Diam of E_2 =	________
Focal Length:	f=	________



(6) The figure below shows a y-$\bar{y}$ diagram for a thick lens. The lens system has an Optical Invariant of $\mathcal{K}=0.01$ and a refractive index $n=2$. The coordinates for the system are listed below

Surface #	y	$\bar{y}$	
0	0	-1	object
1	3	2	1st-surface
2	3	3	2nd-surface
3	0	3	image



(a) What is the transverse magnification of this system? What is the diameter of the aperture stop?

(b) On the y-$\bar{y}$ diagram, mark the locations of the entrance pupil, E_1, and the principal planes P_1 and P_2.

(c) The system is telocentric in image space. Where is the exit pupil located?

(d) Determine the distance from E_1 to the first surface, surface #1 to P_1, P_2 to surface #2, and the thickness of the lens..

(e) Make a scale drawing of the system. Trace the chief and marginal rays through the system. Using the ynu and $\overline{ynu}$ data verify the results of part (c). Indicate the position of the pupils and stops on your drawing.