OPTICS

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1. Light from sodium lamp passes through a tank of glycerin ($\mu = 1.47$) 20 m long in a time t_1. If it takes a time t_2 to traverse the same tank when filled with carbon disulfide ($\mu = 1.63$) determine $t_2 - t_1$
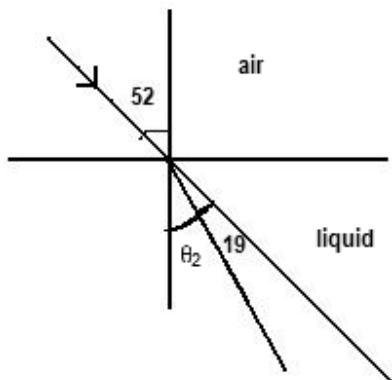
1) $t1 = 20/(c/n) = 20 \times (1.47) /c$

       $t2 = 20 \times (1.63) / c$

$t2-t1 = 20(1.63-1.47) / C$

$= 1.07 \times 10^{-8}$

2. Light passes from air into liquid and is deviated 19^0 when the angle of incidence is 52^0. What is the refractive index of liquid. 2)

$\theta_2 = 52-19 = 33$

$\mu = SIN\ 52/SIN\ 33 = 1.45$

3. What angle of incidence should a beam of light strike the surface of a still, pond if the angle between the reflected ray and refracted ray is to be 90^0.
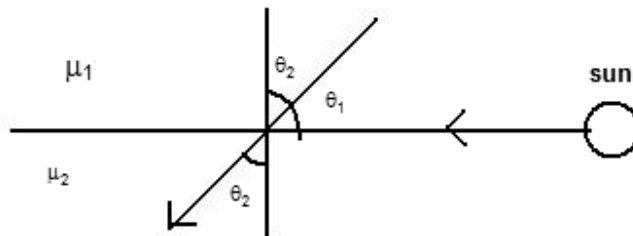
3) $\theta + \Phi = 90$

       $\Phi = 90 - \theta$

       $\theta = TAN^{-1}(\mu) = 53$

4. In what direction does the fish see the setting sun. The refractive index of water is 4/3 and air is 1.

4)

$\theta_2 = Sin^{-1}(3/4) = 48.6$

hence the fish perceives the sun at 90 – 48.6 = 41.4 above the horizontal

5. A layer of benzene ($\mu = 1.5$) floats on water. If the angle of incidence of the light entering the benzene from air is 60^0. What is angle of light makes with the vertical in the benzene and in the water.

5)
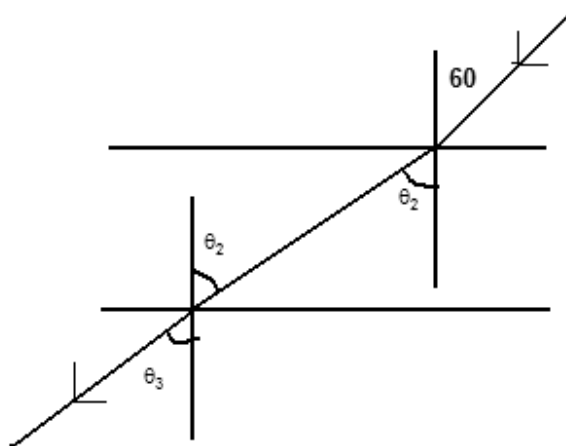
$$n_b = 1.5 = \sin 60 / \sin \theta_2 ; \quad \theta_2 = 35$$
$$n_w / n_b = \sin \theta_2 / \sin \theta_3 = 1.33/1.5$$

6.A man is shaving with his chin 0.4m from a concave magnifying mirror. If the linear magnification is 2.5. What is the radius of curvature of the mirror.

6) $1/0.4 + 1/-1 = 1/f$
      $f = 1/1.5$
      $R = 2f = 1.33m$

7A doctor looks through a small hole at the vertex of a cancave mirror to examine a sore throat. If the R of the mirror is 462mm and the light source is 1m from the mirror, how far from the throat should the mirror be if the light source is to be imagined on the inflamed area.

7) $f = 462/2 = 231mm$
         $u = 1mm$
         $v = 300.4mm$

8.A object is placed infront of a concave mirror having a radius of curvature 0.3 m. If you want to produce first real and then virtual image 3 times as high as the object find the object distance in each case.

8)   Real image =0.200m, Virtual image   =0.100 m

9.Where must an object be placed in the case of the converging lens of focal length "f" if the image is to be virtual and 3 times as large as the object.

$3= h_i /h_o = -v/u$

$u= 2f/3$

10.A man who wears glasses of power 3D must hold a news paper at least 25cm away to see the print clearly. How far away would the news paper have to be if he took off the glasses and still wanted clear vision.

$3= h_i /h_o = -v/u$

$u= 2f/3$

11.If a beam of polarized has one tenth of its initial intensity after passing through an analyzer. What is the angle between the axis of the analyzer and initial amplitude of the beam.

$I = 0.1 I_0 = I_0 \cos^2 \theta$

$\cos\theta= 0.316$

$\theta=71.6$

12.Two wavelengths 1 and 2 are used in the double slit experiment . If one is 430nm what value must the other have for the fourth order bright fringe of one to fall on the sixth order bright fringe of the other.

$4\lambda_1/d=x/D$ $4\lambda_1=6\lambda_2$

$6\lambda_2/d=x/D$ if $\lambda_2=430$, $\lambda_1=645$nm

                        if $\lambda_1=430$, $\lambda_2 =287$nm

13.The amplitude of a beam of polarized light makes an angle of 65^0 with axis of a Polaroid sheet. What fraction of the beam is transm itted through the sheet.

$I^1/I=\cos^2\theta$, $\cos^2 65=0.179$

14 .What is the effect on the interference fringes in a Y. D .S experiment due to

       a) the screen is moved away from the plane of the slits.
       b) Source is replaced by another source of shorter wavelength.
       c) If the separation between is increased
       d) The source slit is moved closer to the double slit plane
       e) The width of the source slit is increased
       f) The width of the slits increased
       g) When monochromatic source is replaced by white light

    a. Angular separation of the fringes remains constant
      b. separation of the fringes decreases
       c. separation of the fringes decreases
    d. $S/D < \lambda/d$ otherwise no pattern is observed.
     e. if above condition is not satisfied interference pattern disappears.
     f. increases the brightness of the fringes.
    g. clear fringes are not observed.

15..When a low flying air craft passes over the head we some times notice slight shaking of the picture on our TV screen. Explain. .
interference of the direct signal received by the antenna with the signal reflected by the aircraft.

16...An object is placed between two plane parallel mirror. How many images do you expect to see)
N=(360/θ)-1

17 .A ray is incident on a plane mirror at an angle X with normal. Find the angle of deviation of the ray
the ray deviated by an angle 180-2x.

18.An equi convex lens of focal length 15cm is cut into two halves. What is the focal length of each half.
1/15=1/x-1/x , x=30cm

19.What is effect of temperature variation on the refractive index of a medium

19. as the temperature increases μ decreases.

20The surface of a goggle lens are curved, even though it does not have any power why? .

$R_1=R_2=R$, $P=1/f=(\mu-1)(1/r-1/r)$

$p=0$

21. A lens is made of two different transparent materials. How many images of a point object will be formed when the object is placed on the principal axis.

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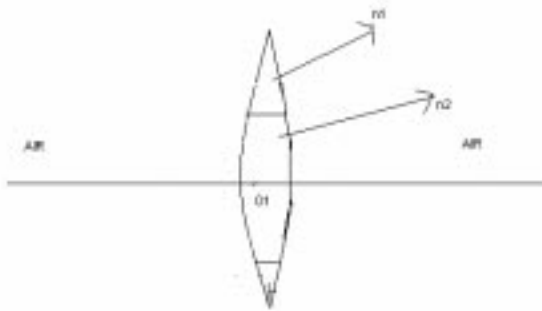
22 How does an air bubble behaves inside water.

behaves like concave lens.

23. What distance from the lens the image is formed when the object is placed at the focus of a concave lens.

.v=-F/2

24 What do you understand by the 'coma'.

optical defect in which point object of the optic axis focuses not in to a point image but

to a comet like surface.

25Why are images in toy telescope usually coloured.

lens are not achromatic lenses hence they possess chromatic aberration.

26.Parallel beam of light is incident on the system of two convex lenses of focal length 20 cm , 10cm . What should be the distance between the two lenses so that the rays after refraction from both the lenses pass undeviated.

27.A pipe 4m high driven into the bottom of a lake is 1m above the water. Determine the length of the shadow of the pipe on the bottom of the lake if the sun rays make an angle of 45^0 with water surface the refractive index of water is 4/3.

2.88m

28.A fish is rising up vertically inside a pond with a velocity 4 cm/s and notices a bird, which is diving downward and its velocity appears to be 16cm/s. What is the real velocity of diving bird if refractive of water is 4/3.

9 cm/s

29.Two thin converging lenses are placed on a common axis so that centre of one of them coincides with the focus of the other. An object is placed at a distance twice the focal length from the left hand lens. Where will its image be? What is the lateral magnification if the focal length of each lens is f.

Image is at distance of f/2 from the right hand lens and m=-0.5.

30.In an equilateral prism a ABC of $\mu = 1.5$ the condition for minimum deviation is fulfilled . If face AC is polished find a) Net deviation. b) if the system is placed in water what is net deviation. The refractive index of water is 4/3

a) 157.2   b) 128.4

31.Maximum intensity in YDS experiment is $I_0.$ Find the intensity at a point on the screen a) the phase difference between the two inferring beams is п/3. b) if path difference is one fourth of wave length.

31. a) ¾ xI_0 b) I_0/2

32.A thin glass lens of refractive index $\mu_2 = 1.5$ behaves as a interface between two media of refractive indices $\mu_{1 =} 1.4$ and

μ_3 =1.6 respectively. Determine the focal length of the lens if the radius of curvature of the both the surfaces is 20cm.
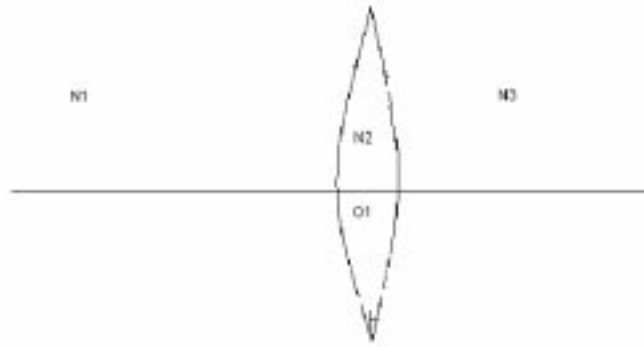
f=infinity

33. In YDSS experiment ,what should be the thickness of the glass slab μ= 1.5 which should be placed before the upper slit s_1 so that the central maxima now lies at a point where 5th bright fringe was lying earlier?(wave length of light is used is 5000A) (50000 A)

34. At what angle above the horizon is the sun when a person receiving its rays from calm water ($\mu = 1.327$) finds them linearly polarized ($Tan53^0 = 1.327$)
  (37)

35. In a single slit diffraction experiment the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band.
(Size reduce by half and intensity increases by 4 folds)

36. When a tiny circular obstacle is placed in the path of light form a distant source, a bright spot is seen at the centre of the shadow of the obstacle explain why.

(Waves diffracted from the edge of the circular obstacle interfere constructively at the centre of the shadow producing bright spot.)

37. The sun subtends an angle of 0.5^0 on earth. What should be the radius of curvature of the mirror which produces an image of the sun 2 cm in diameter.

   458 cm

38. What should be the angle between two mirrors sothat a ray parallel to one mirror may come out parallel to other mirror after one reflection from each mirror? How many images will be formed by the mirrors?

   60.5

39. One face of a prism of $\mu = 1.5$ and angle 75^0 is covered with a liquid of $\mu = 3\sqrt{2}/4$. What should be the angle of incidence of light on the clearface of prism for which the light is just totally reflected at the liquid covered face.

$\sin^{-1}(3/4)$

40. An astronaut photographs a bridge at a height of 1 km with a camera having a lens of focal length 50 cm. Size of the bridge on the photograph is 5 cm. Find the actual length of the bridge.

41. Two coherent monochrometic light beams of intensities I and 4I are superimposed. What is the maximum and minimum possible intensities in the resulting beam

   9I,I ; $I_{max}/I_{min} = ((I_1)^{1/2} + (I_2)^{1/2})^2 / ((I_1)^{1/2} - (I_2)^{1/2})^2$

42. In a double slit experiment two coherent sources have slightly different intensities I and I+dI such that dI < I. Show that resultant intensity at maxima is nearly 4I while that at the minima is nearly $(dI)^2/4I$

43. Following data was recorded for values of object distance and the corresponding values of image distance in lthe

experiment on study of real image formation by a convex lens of power +5D. One of these observations is incorrect Identify and give reason.

|	I	II	III	IV	V	VI
Object distance	25	30	35	45	50	55
Image distance	97	6	37	35	32	30

f=1/p=0.20m=20cm   Sr no. 3 is incorrect

43.PQR is right angled prism with other angles as 60 and 30 refractive index of prism is 1.5. PQ has a thin layer of liquid . Light falls normally on the face PR . Calculate the max refractive index of the medium TIR.

i should be greater than C
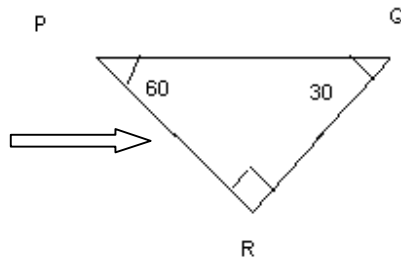
=> C<60° i.e, C max=60°

44.Consider coaxial system of two thin convexlenses of focal length f each separated by a distance d. Draw a ray diagram for image formation corresponding to an object at infinity placed on the principal axis in the following cases. (i) d< f (ii) d=f (ii) f<d<2f (iv) d=2f (v) d>2f.
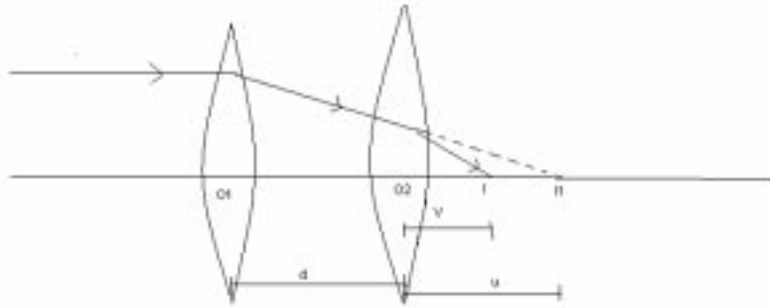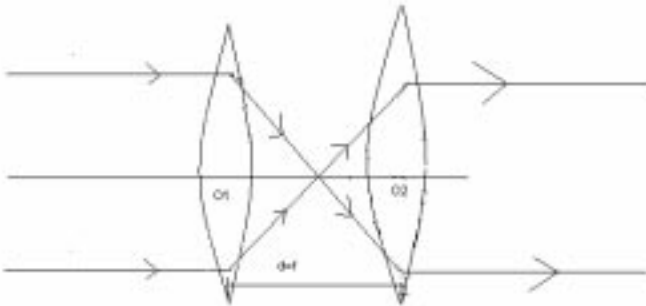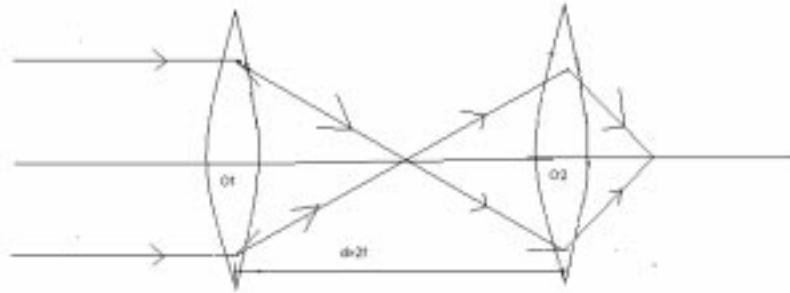
2)d=f
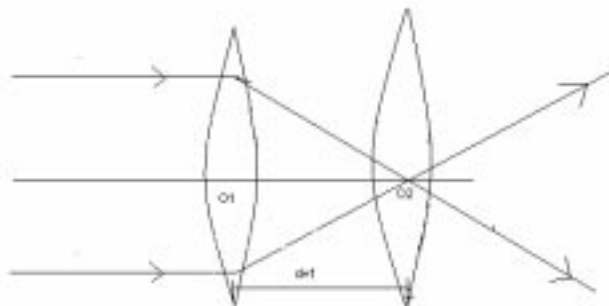
3)f<d<2f
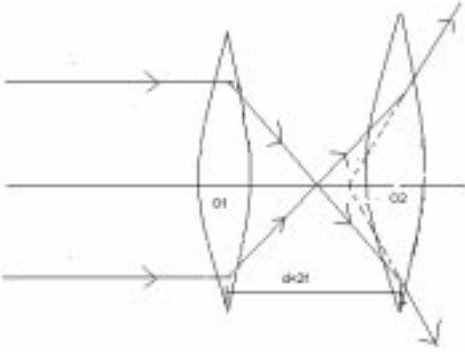
4)d=2f

5)d>2f

45. When a ray of light enters a glass slab from air. How its
wavelength is affected ?
λ=ʋ/f   λ should decreases since   ʋ   decreases.

46.A partially plane polarized beam of light is passed through a
Polaroid. Show graphically the variation of transmitted light with
angle of rotation of Polaroid.
47. Give conditions in which a thin lens has a lateral magnification
of -1?
If the object is lying at a distance of double the focal length (2f) of a lens from the
        lens.
48.Why scratches on the lens of a photographic camera do not
appear on the photograph.
.A camera has to photograph only those objects whose image is focused on
the photographic film by the lens .The scratches on the lens do not satisfy this
condition so they do not appear on the film.
49.How can you produce dispersion without deviation.Violet
light is incident on the thin convex lens. If this light is replaced

by the red light. Explain with reason how the power of the lens would change?

50. A convex lens and concave lens, each having focal length 50cm are placed in contact. What is the focal length and power of combination.

51 We have right angled isosceles prism, $\mu = 1.5$. If we make incident ray of light normally on the two perpendicular surfaces. Name the phenomenon which occurs?

52. A parallel beam is incident on a convex lens of focal length f. It is then put in contact with a concave lens of focal length f/2. What will happen to its image.

53. The satellite takes 12h to rotate once about its axis . How much time does the sun take to shift by 1^0 when viewed from the satellite.

$360^0 = 12$ h , $1^0 = 360/ 12$, 8 minutes

54. How does the resolving power of microscope affects when (a)wave length of illuminating radiation decreased. (b)the diameter of the objective lens is decreased.

55. A Cassegrain telescope two mirrors such telescope is built with the mirror 20mm apart. If the radius of curvature of larger mirror is 220 mm and smaller mirror is 140 mm. Where will be final image of an object at infinity be? 1.5 m

54. A concave mirror and concave lens are held in water. What happens, in their respective focal length as compared to their values in air.

55. Two plane mirrors are arranged at right angled to each other. A ray of light is incident on the horizontal mirror at an angle θ. What value of θ the ray emerges parallel to the incoming ray after reflection from the vertical mirror.
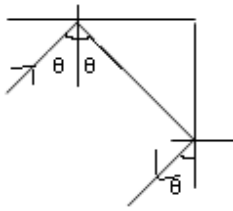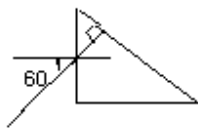
makes same angle

56.The refractive index of the prism is 2. Find maximum refracting angle of the prism.

$\theta =\sin^{-1}(1/ \mu) = 30^0$

   If A>2 θ, the ray does not emerge from the prism .Hence max. angle= 60^0

57.One of the refracting surfaces of a prism of angle 30 is silvered. A ray of light incident at an angle of 60 retraces its path. Find the refractive index of the prism.

   $r_2 = 0$, $r_1 =A=30^0$, i=60, μ=sin 60/sin 30= $\sqrt{3}$

58,angle of minimum deviation is equal to the angel of prism A of an equilateral glass prism Find the angle of incidence at which minimum deviation occurs.

$A=\delta_M=60$ $I=(a+\delta_m)/2 - 60$

59.A plane mirror is made of glass slab u= 1.5 , 2.5 cm thickness and silvered on back. A point object is placed 5 cm infront of the unsilvered   face of the mirror. What will be the position of the final image. .
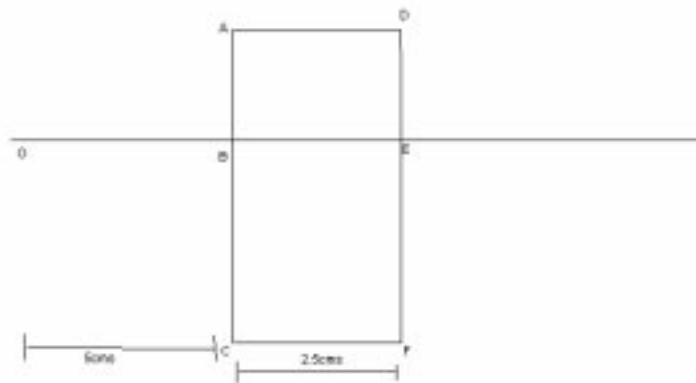
i_1, i_2, i_3 be image formed by
1) refraction from ABC.
2) refraction from DEF.
3) again refraction from AB.
$BI_1 = 5 \mu g = 7.5$, $EI_1 = 2.5 + 7.5 = 10$
$EI_2 = 10$cm behind the mirror
$BI_2 = 10 + 2.5 = 12.5$
$BI_3 = 12.5/1.5 = 8.3$

60. A 2 cm diameter coin rest flat on the bottom of a bowl in which water is 20cm deep, $\mu = 4/3$ If the coin is viewed directly above . What is the apparent diameter.

61. Parallel beam of light is incident on the system of two convexlenses of $f_1 = 20$ cm. $f_2 = 10$ cm . What should be the distance between the two lenses so that the rays after refraction from both the lenses pass undeviated.
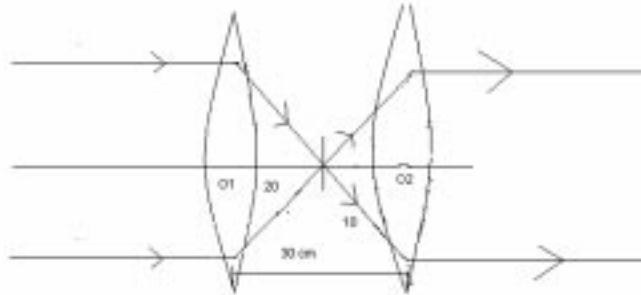
62 A point object is placed at a distance of 25 cm from a convex lens of f = 20 cm. If the glass slab of thickness t , μ = 1.5 is inserted between the object and lens, the image is formed at infinity, what is thickness? shift, 25-20=(1-1/μ)t   t=15cm

63. A plano convexlens fits exactly in to a plano concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2 , R is radius of curvature then what is the focal length of the combination.
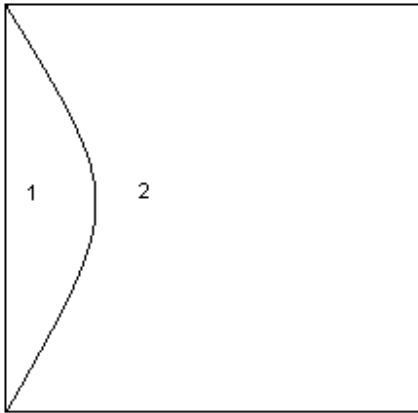
$1/f=1/f_1+1/f_2=(\mu_1-1)(1/\infty+/r)+(\mu_2-1)((1/-r)-1/\infty)$
$f=r/(\mu_1-\mu_2)$

64 A plano convexlens $\mu = 3/2$ and $R = 10$ cm is placed at a distance of b from a concave lens of focal length 20 cm . What should be the distance of a point object O from the plano convexlens sothat the position of final image is independent of b.
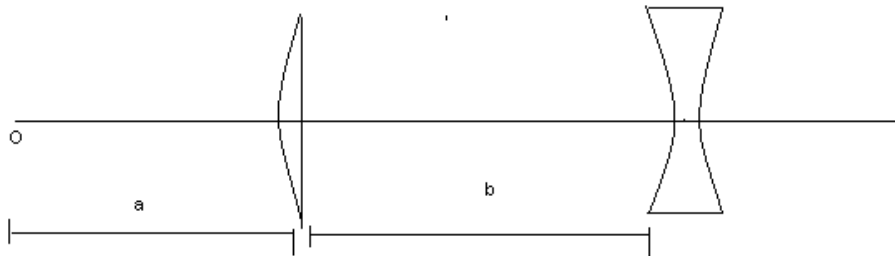
$1/f=(3/2-1)*(1/10-1/\infty)$
  $=20$cm

65.A convexlens of focal length 10 cm is painted black at the middle portion for 2 cm. An object is placed at a distance of 20 cm from the lens then how many images are formed.

2 cm

20 cm
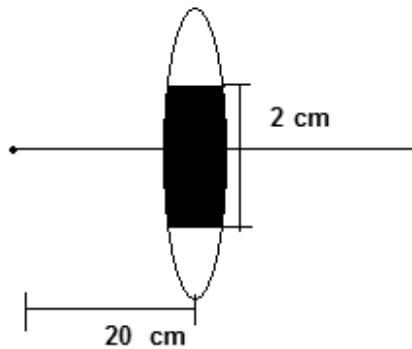
only one image will be formed because optic axis &both parts coincide. If optic axis are different two images would have formed

66. Two sources S_1 and S_2 are 24 cm apart where should a convex lens of focal length 9 cm be placed in between them sothat the images of both sources are formed at the same place?

if image of s1 is real and s2 is virtual

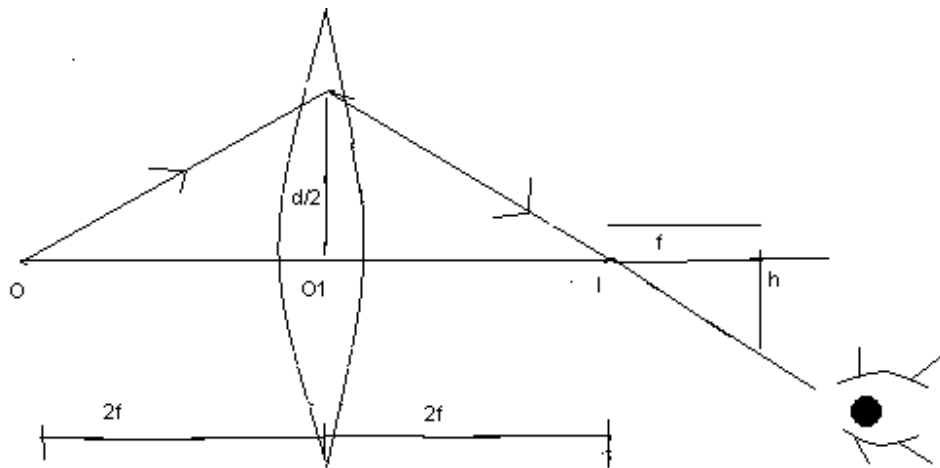for s1=1/y+1/x=1/9

for   s2=-1/y+1/(24-x)=1/9

x=6cm

67. The angle of incidence for equilateral prism is 60. What should be the μ of prism sothat the ray is parallel to the base inside the prism   at minimum deviation r₁=r₂=a/2=30

μ=sin60/sin30=√3

68. What is the minimum value of the refractive index for a 90 – 45 – 45 prism which is used to deviate a beam through 90 by TIR.

at AC

μ=1/sin45 =√2

69. A point object is placed on the optic axis of a convex lens of focal length f at a distance of 2f to the left of it. The diameter of the lens is d. An eye is placed at a distance of 3f to the right of the lens and distance h below the optic axis . What is the maximum value of h to see the image.

d/2

O

O1

f

h

2f

2f

I

$$h/(d/2)=f/2f$$
$$h=d/4$$