EXERCISES 1.A
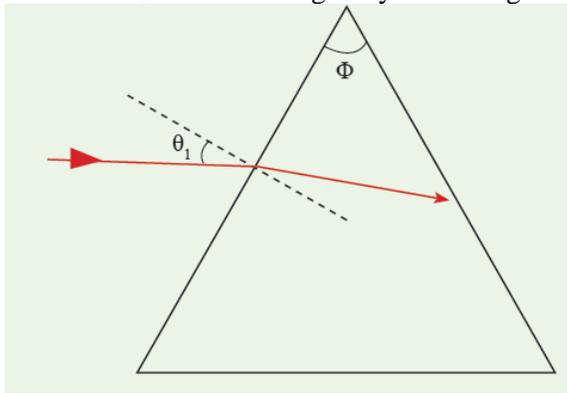
1. A ray of light incident at an angle i on a prism of angle, A, passes through it symmetrically. Write an expression for the deviation, d, of the ray in terms of i and A. Hence find the value of d, if the angle of the prism is $60°$ and the refractive index of the glass is 1.48.

2. A beam of monochromatic light in incident normally on the refracting surface of a $60°$ glass prism of refractive index 1.62. Calculate the deviation caused by the prism.

3. a) Define the critical angle of a medium.

   b) One side of a triangular glass prism put in a pool of water of refractive index 4/3 and the other side was left open to air. A ray of light from water was incident on the prism at an angle i =21.7°. The light just grazes as it emerges out of the prism. Given that the refractive index of glass 1.52, determine the refracting angle A of the prism.

4. A monochromatic light is incident at an angle of $45°$ on a glass prism of refracting angle $70°$ in air. The emergent ray grazes the boundary of the other refracting surface of the prism. Find the refractive index of the material of glass.

5. A prism of diamond has a refracting angle of $60°$. A ray of yellow light is incident at an angle of $60°$ on one face. Find the angle of emergence if the refractive index of diamond for yellow light is 2.42.

6. A ray of light just undergoes total internal reflection at the second face of a prism of refracting angle 60o and refractive index 1.5. What is its angle of incidence on the first face?

7. A sharp image is located 78.0mm behind a 65mm-focal-length converging lens. Find the object distance
a) using a ray diagram, b) by calculation.

8. What is: a) the position, b) the size of the image of a 7.6cm high flower placed 1m from a 50mm focal length camera lens?

9. An object is placed 10cm from a lens of 15m of focal length. Determine the image position.

10. Two converging lenses A and B, with focal lengths $f_A=20$cm and $f_B = -25$cm, are placed 80cm apart, as shown in the figure (1). An object is placed 60cm in front of the first lens as shown in figure
   (2). Determine (a) the position, and (b) the magnification, of the final image formed by the combination of the two lenses.
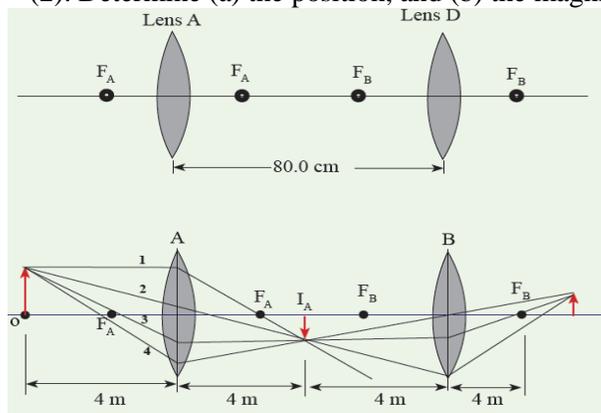

11. Where must a small insect be placed if a 25cm focal length diverging lens is to form a virtual image 20cm in front of the lens?

12. Where must a luminous object be placed so that a converging lens of focal length 20cm produces an image of size four times bigger than the object (Consider the case of a real image and the case of a virtual)

13. From a real object AB we want to obtain an inverted image four times bigger than the object. We place a screen 5m away the object. Specify the kind, the position and the focus of the lens to use. Give the graphical and the algebraic.

14. In cinematography the film is located at 30m from the screen and the image has a magnification of 100. Determine the focal length of the lens used in projection.

15. An object AB of 1cm is placed at 8cm from a converging lens of focal length 12cm. Find its image (Position, nature and the size).

16. An object of 2cm is placed at 50cm from a diverging lens of focal length 10cm. Determine its image.

17. An object located 32cm infront of a lens forms an image on a screen 8cm behind the lens.
a) Find the focal length of the lens.
b) Determine the magnification.
c) Is the lens converging or diverging?

18. A movie star catches the reporter shooting pictures of her at home. She claims the reporter was trespassing. To prove her point, she gives as evidence the film she seized. Her 1.72m height is 8.25mm high on the film and the focal length of the camera lens was 210mm. How far away from the subject was the reporter standing?

19. A lighted candle is placed 33cm in front of a converging lens of focal length $f_1=15$cm, which in turn is 55cm in front of another converging lens of focal length $f_2=12$cm.
a) Draw a ray diagram and estimate the location and the relative size of the final image.
b) Calculate the position and relative size of the final image

$f_1 = 15\text{cm}$

$f_2 = 12\text{cm}$

candle

33cm

55cm
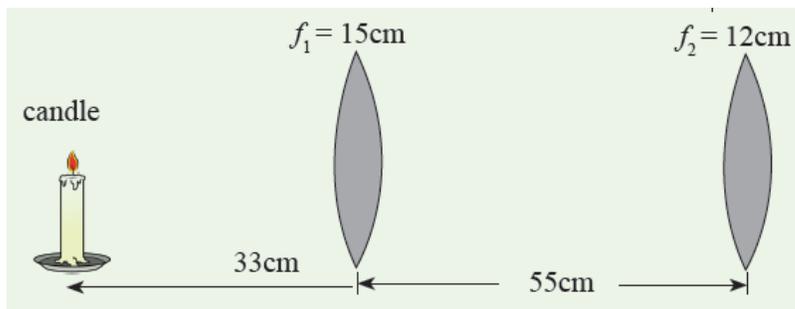
20. When an object is placed 60cm from a certain converging lens, it forms a real image. When the object is moved to 40cm from the lens, the image moves 10cm farther from the lens. Find the focal length of this lens.

21. A converging glass lens (n=1.52) has a focal length of 40cm in air. Find its focal length when it is immersed in water, which has an index of refraction of 1.33.

22. Verify that the focal length f of a symmetrical biconvex lens which the two faces have a radius of curvature R and refractive index 1.5 is $f_{meter}=R_{meter}$.

23. We put in contact a converging lens of focal length 20cm and a diverging lens of focal length 50cm. What are the nature, the power and the focal length of the constituted lens?

24. To a converging lens of focal length 20cm we put in contact a second lens so that the constituted system has the power of 4 diopters. Determine the nature of the second lens and calculate the focal length.

25. In a physics lab students want to determine the focal length x of a thin diverging lens. They stick to it a converging lens of 5 diopters and they use the system to have a real and inverted image A'B' of size equal to the one of the object AB. The distance from the object AB to the screen where they watch the image is 4m. Calculate x.

26. A thin glass lens n = 1.5 has a focal length +10cm in air. Compute its focal length in water n = 1.33.

27. A prism which has a refracting angle equals $60°$ and refractive index 1.5 receives a ray at an angle of incidence $45°$; calculate the angle of emergence and the deviation of the ray.

28. Calculate for the same prism (Question 1) the value of minimum deviation as well as the value of $i = i'$.

29. Let consider a prism made in glass of refracting angle A=$59°$ and the refractive index 1.52.
a) Calculate the deviation that makes an emerging ray with the extension of the incident ray for an incidence equal to $35°$.
b) Calculate the angle of minimum deviation and specify the value of the angle of the corresponding angle of incidence and refraction inside the prism.

30. Given that a prism of refracting angle A = $60°$ and refractive index $n=\sqrt{3}$

31.Let consider a ray of light falling on a prism through an angle i=$90°$.If it goes out the prism through an angle i',calculate i'

32. Through what angle i must fall on the prism a ray to go out through an emergence i =$90o$.

33. Find the refractive index of a prism A = $60°$ producing a minimum deviation equal to $40o$.

34. A triangular glass prism with apex angle $60°$ has an index of refraction of 1.50.
a) Show that if its angle of incidence on the first surface is θ_1=$48.6°$, light will pass symmetrically through the prism,
b) Find the angle of deviation D_{min} for θ_1= $48.6°$.
c) What If? Find the angle of deviation if the angle of incidence on the first surface is $45.6°$.
d) Find the angle of deviation if $\theta_1 = 51.6°$.

35. A triangular glass prism with apex angle $\Phi = 60°$ has an index of refraction n= 1.5. What is the smallest angle of incidence θ_1 for which a light ray can emerge from the other side?

36. A triangular glass prism with apex angle Φ has index of refraction n. What is the smallest angle of incidence $\theta1$ for which a light ray can emerge from the other side?

37. Place a triangular glass prism on a white sheet of paper and draw its outline.

Glass prism
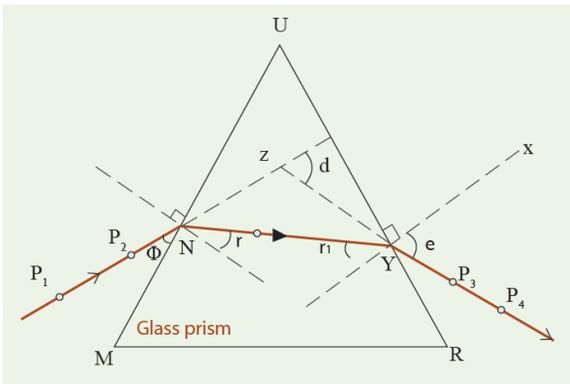
i) Remove the prism and label the outline as MUR
(ii) Draw a perpendicular line to the face MU of the prism at N.
(iii) Draw a line TN so that it makes a relatively small angle with normal at N.
(iv) Replace the prism in its outline.
(v) Place pins P_1 and P_2 along TN and perpendicular to the paper. While looking through the other face UR of the prism, fix pins P_3 and P_4 so that they are in line with images of P_1 and P_2.
(vi) Remove the prism and draw a line through P_3 and P_4.
(vii) Repeat the above procedures with the same prism but turned upside down so that its refracting angle is facing upwards. What do you notice? Can you see that the rays are coming to a point?
38. Copy the diagram below and fill in the names and use of other optical instruments you know.
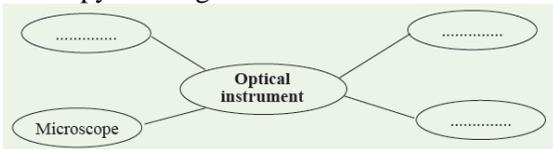
39. Use the concept obtained from unit 1 and write the definition and main function in the table below in your notebook.

Table: Definition and functions of optical terms

Term	Definition and function
Cornea	
Pupil and Iris	
Lens	
Retina	
Rods and cones	

40. Match the following statements with corresponding name of vision problems in the table below in your notebook.

Table: Vision problems

Vision problems	Name corresponding to vision
The rays focus before the retina	
Distant objects appear blurry	Near sightedness
Occur either because the cornea is too curved or the eye ball is too long.	
It can be corrected using diverging (concave) lens.	Far sightedness
Near images appear blurry	
Occur either because a cornea is not curved enough or an eyeball is too short.	
Distant objects appear clearly	

LENSES AND PRISM

1. An object is placed 40cm away from a diverging lens of focal length 20cm. If it is 2cm high, determine graphically the position, size and nature of the image. (Instruction: Let 1cm on the paper represent 10cm on the horizontal axis and 1cm on the vertical axis of the actual distance.)
2. An object is placed 20cm from a converging lens of focal length 15 cm. Find the nature, position and magnification of the image.
3. An object is placed 12cm from a converging lens of focal length 18cm. Find the nature and the position of the image.
4. Find the nature and position of the image of an object placed 15cm from a diverging lens of focal length 15cm.
5. Find the focal length of a combination of a converging lens and a diverging lens of focal lengths 5cm and 10cm respectively.

6. A thin converging lens of focal length 8cm is placed in contact with a diverging lens of focal length 12cm. Calculate the focal length of the combination.

7. An object O is placed 12cm from a thin converging lens P of focal length 10cm and an image is formed on a screen S on the other side of the lens. A thin diverging lens, Q is now placed between the converting lens and S, 50cm from the converging lens. Find the position and nature of the final image if the focal length of the diverging lens is 15cm.

8. An object is placed 6.0cm from a thin converging lens A of focal length 5.0cm. Another thin converging lens B of focal length 15cm is placed co-axially with A and 20cm from it on the side way from the object. Find the position, nature and magnification of the final image.

9. A ray of light falls from air to a prism of refracting angle 60° at an angle of 30°. Calculate the angle of emergence on the second face of the prism (Take refractive index of the material of glass, ng = 1.5).

10. A prism of refracting angle of 67° and index of refraction of 1.6 is immersed in a liquid of refractive index 1.2. If a ray travelling through a liquid makes an angle of incidence of 53°. Calculate the angle of emergence of the ray from the second face of prism.

11. A glass prism of refracting angle 60° has a refractive index of 1.5. Calculate the angle of minimum deviation for a parallel beam of light passing through it.

12. A glass prism of refracting angle 72° and index of refraction 1.66 is immersed in a liquid of refractive index 1.33. What is the angle of minimum deviation for a parallel beam of light passing through the prism?

13. Light is incident at a small angle on a thin prism of refracting angle 5° and refractive index 1.52^{o}. Calculate the deviation of the light by the prism.

14. A mono chromatic light is incident on one refracting surface of a prism of refracting angle 60o, made of glass of refractive index 1.50. Calculate the least angle of incidence for the ray to emerge through the second refracting surface.

15. A ray of light incident at an angle i on a prism of angle, A, passes through it symmetrically. Write an expression for the deviation, d, of the ray in terms of i and A. Hence find the value of d, if the angle of the prism is $60°$ and the refractive index of the glass is 1.48.

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      Determine (a) the position, and (b) the magnification, of the final image formed by the combination of the two

Lens A   Lens D

F_A F_A F_B F_B

————80.0 cm————
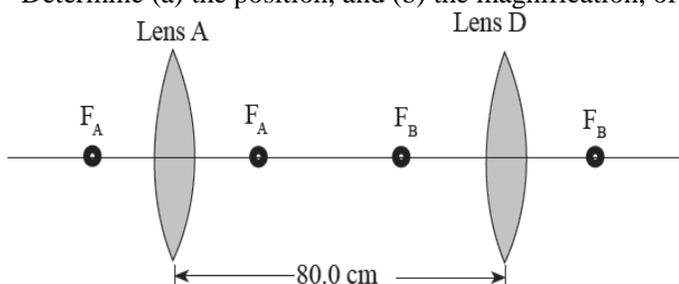
lenses.

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41. A thin glass lens n = 1.5 has a focal length +10cm in air. Compute its focal length in water n = 1.33.

42. A prism which has a refracting angle equals 60° and refractive index 1.5 receives a ray at an angle of incidence 45°; calculate the angle of emergence and the deviation of the ray.

43. Calculate for the same prism (Question 1) the value of minimum deviation as well as the value of $i = i$'.

44. Let consider a prism made in glass of refracting angle A=59° and the refractive index 1.52

a) Calculate the deviation that makes an emerging ray with the extension of the incident ray for an incidence equal to 35°.
b) Calculate the angle of minimum deviation and specify the value of the angle of the corresponding angle of incidence and refraction inside the prism.