Student's Name: ________________________________ **Student's Name:** ________________________________

Lab day & time: ___________________ Date: __________________

Lenses (E7) - Data Sheets

Show all calculations and write all results on the data sheets in ink.

Activity 1: Focal Length of Converging and Diverging Lenses. *(3.5 p.)*

1.1. ***Converging (convex) lens***.

1.3. Place the object at distance s_{oc} and carefully measure s_{ic}. Calculate the focal length of the converging lens f_c from these measurements. Here "s_{oc}" indicates the object distance for the converging lens and "s_{ic}" indicates the image distance for the converging lens. When you measure the distance to the lens use the <u>center of the lens</u> as the position of the lens. Find the average focal length value.

s_{oc} (cm)	s_{ic} (cm)	f_c (cm)
15 cm		
20 cm		
25 cm		
30 cm		
40 cm		
Average focal length f_c		

1.4. Try to reduce the object distance to be smaller than the focal length ($s_{oc} < f_c$). Are you able to find a real image on the screen?

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1.5. Each converging lens could be used as a magnifying glass. Using the average focal length f_c and the usual value of the near-point distance s_N = 25 cm, calculate the angular magnification (Eq. (3b)) for this converging lens when used as the magnifying glass. Observe the enlarged image of the tip of your pen.

Magnification $\boldsymbol{m_\theta}$ = _____________

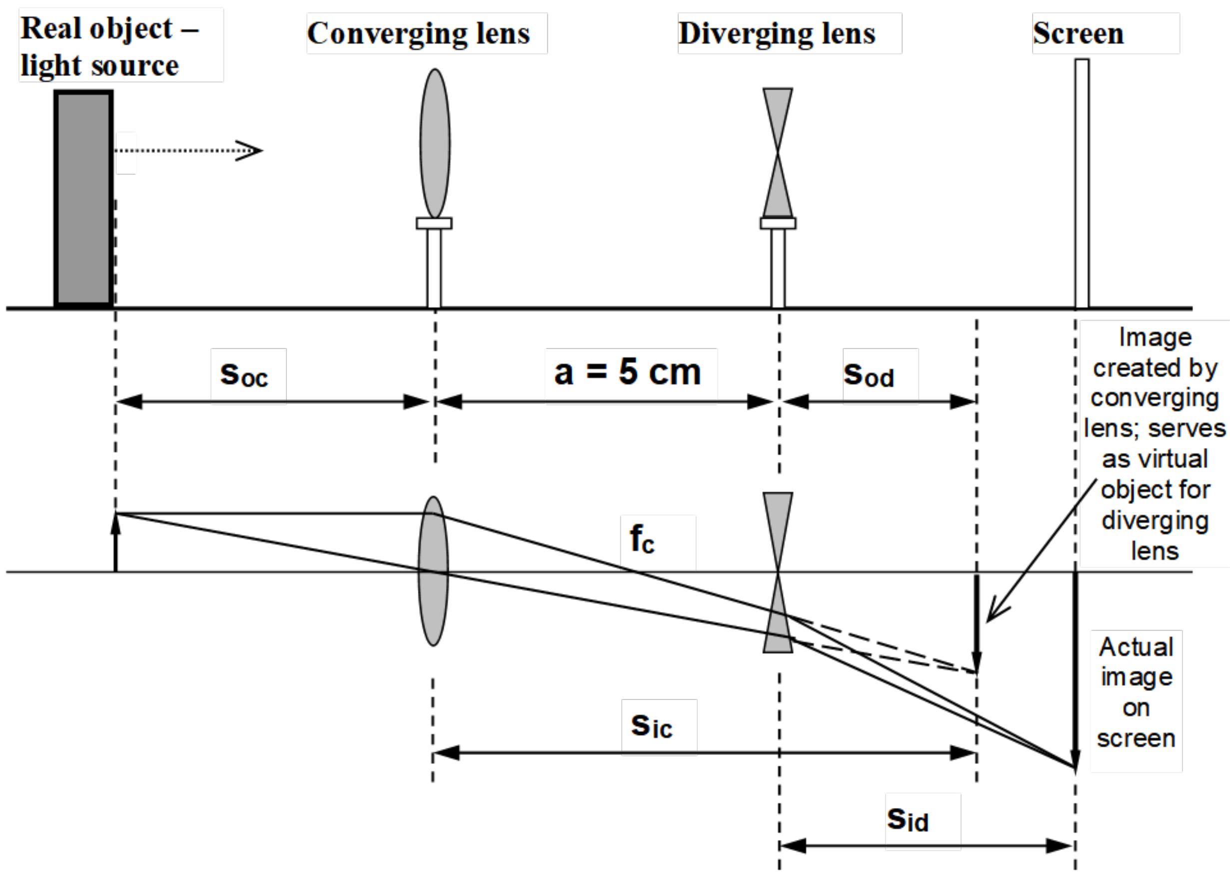
1.6. ***Diverging (concave) lens.***

1.7. Place the object at distance s_{oc} = 25 cm, 30 cm, 40 cm from the converging lens. Add the diverging lens a = 5 cm to the right of the converging lens and locate the sharp image of the crossed arrow object on the screen.

1.8. Copy the s_{ic} values for the converging lens alone from the data table in Activity 1.3. Use the lens separation a = 5 cm to calculate the object distance for the diverging lens

$s_{od} = a - s_{ic} = 5$ cm $- s_{ic}$ (which is given by Eq. (5)).

Measure the distance from the diverging lens to the position of the image - s_{id}. Here is the experimental setup (*the distance between lenses and the screen are schematic and are not accurate or proportional to the real setup*).



s_{oc} (cm)	s_{ic} (cm) (without the diverging lens)	a (cm)	s_{od} (cm)	s_{id} (cm)	f_d (cm)
25 cm		5 cm			
30 cm		5 cm			
40 cm		5 cm			
Average focal length f_d					

1.9. Use Eq. (6) to calculate the focal length of the diverging lens f_d. Keep in mind that the <u>focal length of a diverging lens should be negative</u>! Repeat calculations for the other distances between the object and the converging lens s_{oc}. Calculate the average focal length of the diverging lens.

Activity 2: Partially Covered Lenses *(1 p.)*

2.1. Use the converging lens and prepare the same type of setup as for Activity 1.2. Make sure that the crossed arrow object (part of the light source) faces the converging lens. Place the lens at the distance equal to 1.5 times the average focal length (1.5 * f_c from *Activity* 1) from the object. Move the screen to get a sharp image of the crossed arrow.

2.2. Cover one half of the lens (left or right). What has happened to the image? With the lens still partially covered, do you see a part of the image or a complete image? If you see a complete image, then please explain how it is possible.

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Activity 3: Index of Refraction of a Cylindrical Lens. *(2 p.)*

3.4. Identify incident ray, reflected ray and refracted ray. Rotate the ray table until the light ray emerging from the cylindrical lens disappears. Hold a piece of white paper next to the edge of the ray table so you can see the light ray. Measure the total angle between the incident and reflected rays. Note that this total angle is **twice the critical angle** θ_c because the angle of reflection equals the angle of incidence.

$\theta_{incident} + \theta_{reflected} = 2\theta_c =$ _____________ (˚)

Critical angle $\theta_c =$ _____________ (˚)

$n =$ _____________

3.5. When finished, please **remove the light source** from the track and make sure that it is turned off.

Complete the lab report and return it to the lab TA.