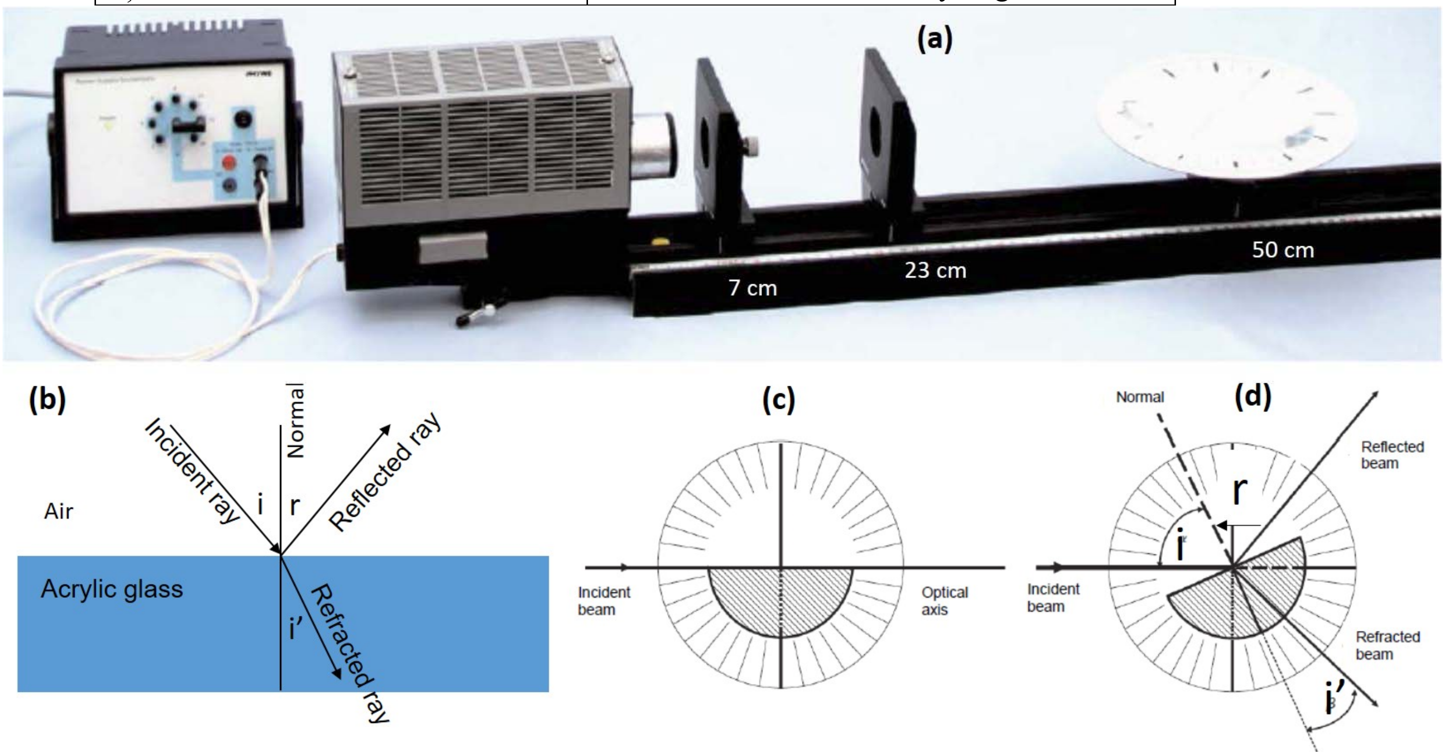
Name: ………………………………………….. **KSU ID:** ………………………. **Date:** ……./ …./201..

Objective (1): Verification of law of reflection and determination of refractive index of Acrylic glass

Required Equipment: (i) Optical bench, (ii) Glass lens, mounted, $f = +100$ mm, (iii) Diaphragm with slit, (iv) Optical disc, (v) Semicircular acrylic glass, and (vi) Light source.

Formula Used: (i) i = r, and (ii) n sin i = n’ sin i’

i, Angle of incidence in degree	r, Angle of reflection in degree
i’, Angle of refraction in degree	
n, Refractive index of air ≈ 1	n’, Refractive index of acrylic glass = 1.49

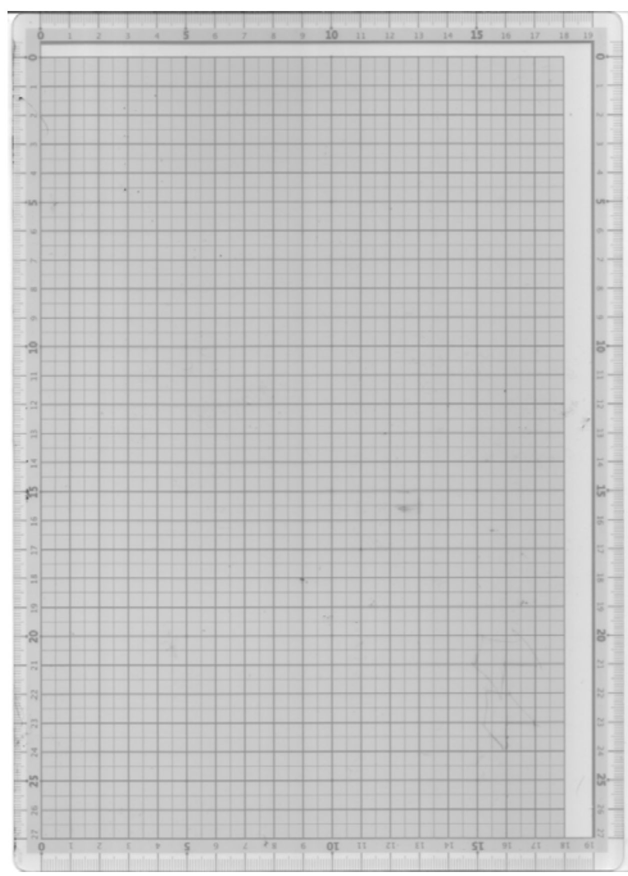


Method:

1. Arrange the set up as shown above in the Figure (**a**).
2. Mount the semicircular plastic modular on optical disc and arrange as shown in Figure (**c**).
3. Change the angle of incidence (i) and monitor the angle of reflection (r) and angle of refraction (i’), Figure (**d**).
4. Plot i versus r in the graph and also calculate refractive index (n’) of the acrylic glass.

Observation:

SN	i (°)	r (°)	i’ (°)	n'
1	10			
2	20			
3	30			
4	40			
5	50			
6	60			
7	70			
8	80			



Results: (i) A straight line between i and r verifies the law of reflection. (ii) The average value of n’ = …….

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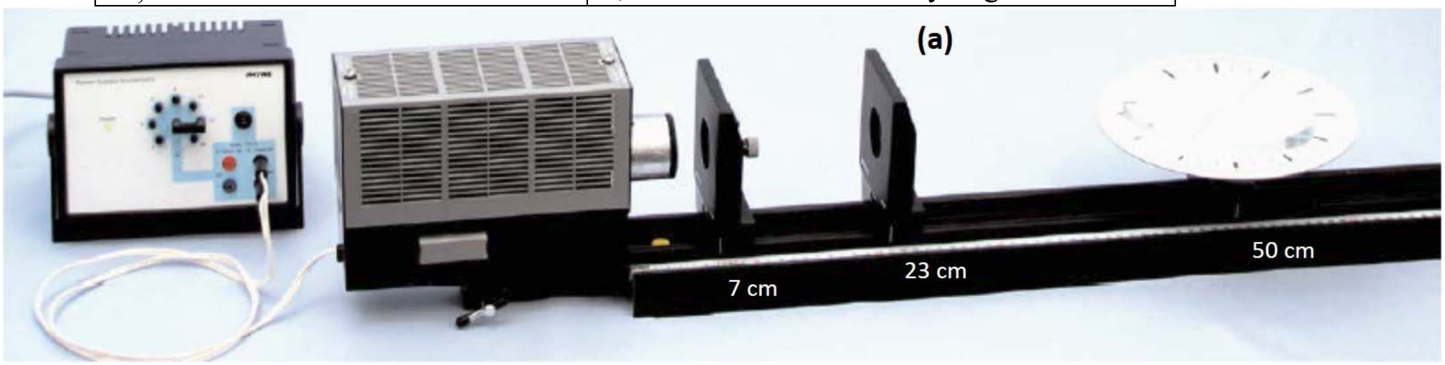
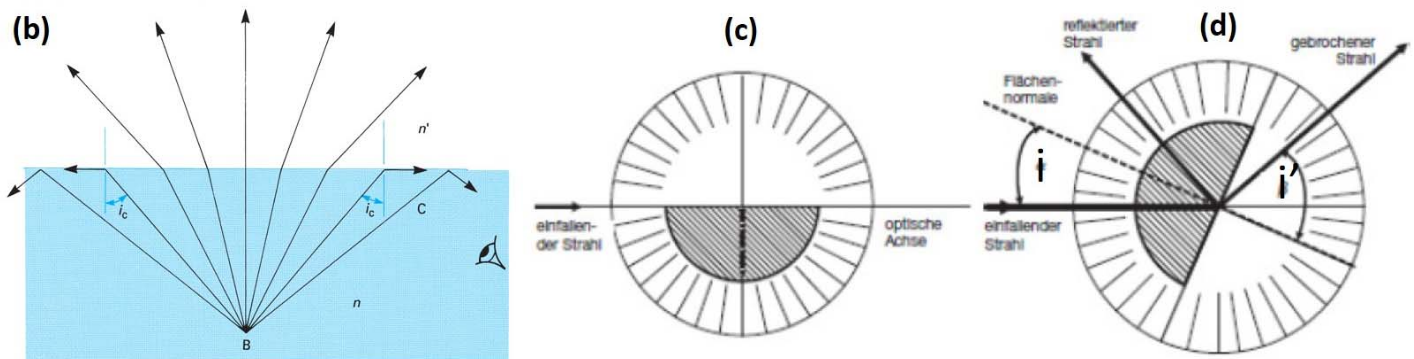
Objective (2): Estimation of critical angle (i_c) for acrylic glass and air boundary

Required Equipment: (i) Optical bench, (ii) Glass lens, mounted, f = +100 mm, (iii) Diaphragm with slit, (iv) Optical disc, (v) Semicircular acrylic glass, and (vi) Light source.

Formula Used: $i_c = \sin^{-1}(n'/n)$

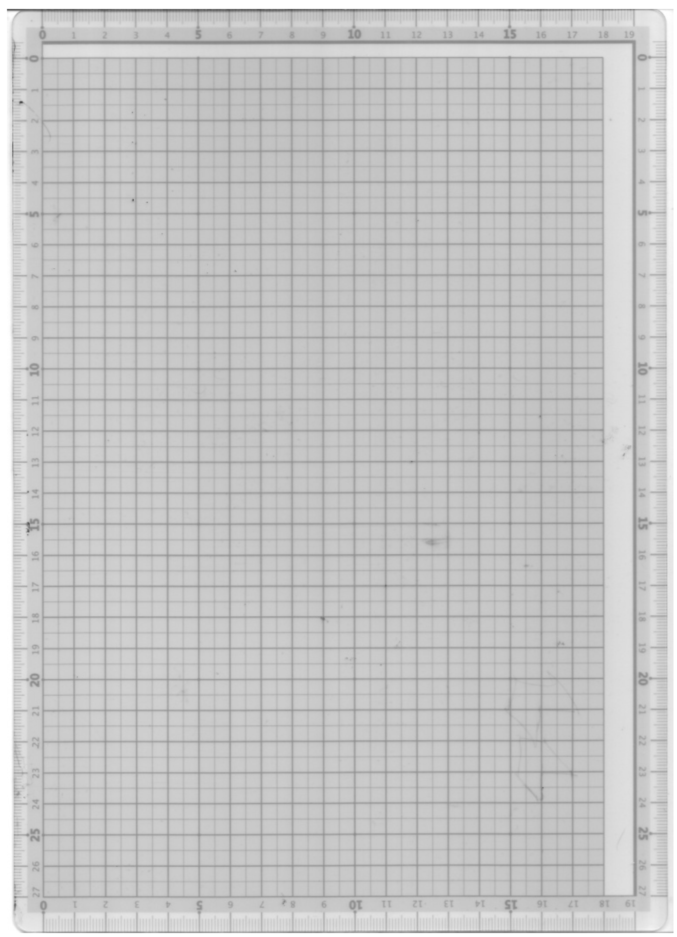
i, Angle of incidence in degree	i', Angle of refraction in degree
n', Refractive index of air ≈ 1	n, Refractive index of acrylic glass = 1.49





Method:

1. Arrange the set up as shown above in the Figure (**a**).
2. Mount the semicircular plastic modular on optical disc and arrange as shown in Figure (**c**).
3. Change the angle of incidence (i) and monitor the angle of refraction (i') as shown in Figure (**d**).
4. Plot i versus i' in the graph and estimate the critical angle (i_c). Compare it with the calculated value using its formulae.



Observation:

SN	i (°)	i' (°)
1	10	
2	20	
3	30	
4	40	
5	41	
6	42	
7	43	

Results: Using the graph critical angle is . …….
Standard value of the critical angle is i_c = 42.15°.

Name: ……………………………………….. **KSU ID:** ………………………. **Date:** ……./ …./201…

Objective (3): Determination of refractive index of a glass slab using a travelling microscope

Required Equipment: (i) Travelling microscope (TM) and (ii) Glass slab.

Formula Used: $n = (R_3 – R_1) / (R_3 – R_2)$

where, n = Refractive index of a glass slab,

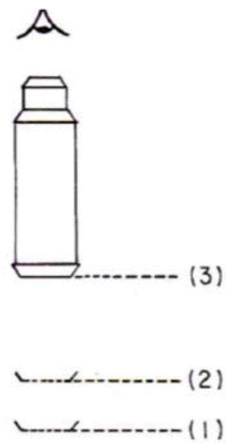
R_1 = TM reading at position 1 (in mm),

R_2 = TM reading at position 2 (in mm),

R_3 = TM reading at position 3 (in mm).

Method:

1. Focus the microscope on **+** marked on the center of the TM bench. It gives $\mathbf{R_1}$.
2. Place the glass slab on it. It results in upward shift of **+**. Focus again the microscope on **+ through travelling screw only**. It gives $\mathbf{R_2}$.
3. There is a **+** on the top of the glass slab. Now focus the microscope on **+ through travelling screw only**. It gives $\mathbf{R_3}$.
4. Use the formula to calculate refractive index (*n*) of the glass slab.



Calculation:

Least count (LC) of TM = $\dfrac{\textit{minimum distance in mm that can be determined by the Main scale}}{\textit{Total number of divisions in Vernier scale}}$

$= \dfrac{\ldots\ldots}{\ldots\ldots}$ = …………. (mm)

R (in mm) = MSR in mm + (LC in mm × VSR), where MSR is main scale reading of the TM and VSR is Vernier scale reading of the TM		
R_1 (mm) = ……. mm + (………. mm × …….) = ………….. (mm)	R_2 (mm) = ……. mm + (………. mm × …….) = ………….. (mm)	R_3 (mm) = ……. mm + (………. mm × …….) = ………….. (mm)

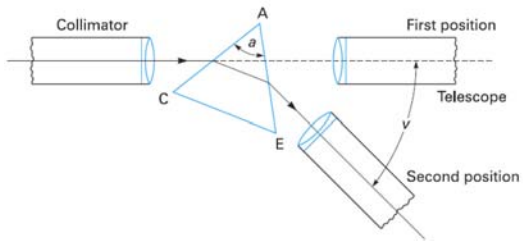
n = ---

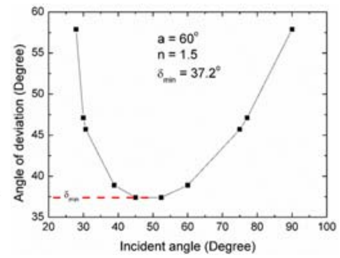
Result: Refractive index of glass slab is ……………

Standard value of refractive index of glass slab is …1.52.

Name: ……………………………………….. **KSU ID:** ………………………. **Date:** ……../ …../201..

Objective (4): Determination of refractive index of a glass prism using a spectrometer





Required Equipment: (i) Spectrometer, (ii) Glass prism, and (iii) Mercury light source

Formula Used: $n = \frac{sin\left(\frac{A+\delta m}{2}\right)}{sin\left(\frac{A}{2}\right)}$ where, n = Refractive index of a glass prism,

A = Apex angle of prism (in degree), and

δ_m = Minimum angle of deviation (in degree)

Method:

1. Illuminate the slit at the collimator with mercury light. Adjust the slit with minimum opening using micrometer and sharp light beam at the telescope.
2. Place a prism on the prism table, so that light rays incident on surface of the prism. Collect the refracted light beam via rotating telescope and prism table. Get the sharp image of green line on the cross-wire of the telescopic eye piece.
3. Turn the prism table and telescope slowly until angle of minimum deflection is obtained, i.e. until the green line shifts to one side only independent of the turning direction of the prism table.
4. Lock telescope and prism table in that position by means of locking screws and read the value of the circular scale. It gives R_1.
5. Remove the prism from the Prism table and collect the white beam of the collimator directly on the cross-wire of the telescope. It gives R_2. The difference of R_1 and R_2 is δ_m.
6. Use the formula to calculate refractive index (*n*) of the glass prism.

Calculation:

Apex angle (A) = …50°

Least count (LC) of spectrometer

$$= \frac{minimum\ angle\ in\ degree\ that\ can\ be\ determined\ by\ the\ circular\ scale}{Total\ number\ of\ divisions\ in\ Vernier\ scale}$$

= ……………………… / ………… = ………… °

R (in degree) = CSR in degree + (LC in degree × VSR), where CSR is circular scale reading and VSR is Vernier scale reading	
R_1 = ……….... ° + (……..…….° × ………..) = …………... °	R_2 = ……….... ° + (……..…….° × ………..) = …………... °
$\delta_m = R_2 - R_1$ = …………………………………………………………………………………..	

n = -----------------------------------° = ---------------°

Result: Refractive index of glass prism is …………… (Standard value: …1.52)

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Objective (5): Determination of power of a convex lens.

Required Equipment: (i) Optical bench, (ii) Lens holder, (iii) Convex lens, (iv) Hg light source, (v) Objective, and (vi) Screen.

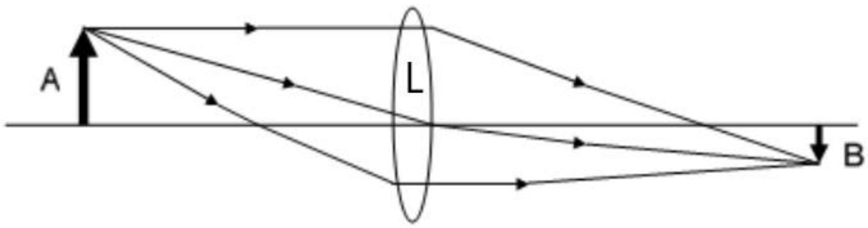
Formula Used: $\frac{1}{l'(cm)} = \frac{1}{l\ (cm)} + \frac{1}{f\ (cm)}$ and $F(in\ diopter) = \frac{100}{f(cm)} m^{-1}$

where, f = Focal length of lens

l = Distance between objective and lens

l' = Distance between image (screen) and lens

F = Power of lens.



Method

1. Put the convex lens (L) at a distance (*l*) from the objective (A). Take *l*-value with negative sign with respect to the lens.
2. Move the screen (B) behind the lens to form a clear image of the objective on it.
3. Measure the distance between the lens and the screen. It gives *l'*.
4. Calculate focal length and power of lens using the formula.

Observation:

Position A (cm)	Position L (cm)	Position B (cm)	*l* (cm) = L - A	*l'* (cm) = B - L	*f* (cm)	*F* (D)

Results:

The average value of the power of the convex lens is …………

Standard value of *f* = +10 cm

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Objective (6): Determination of concave lens power using a convex lens

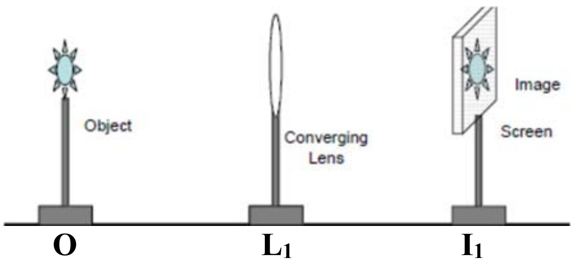
Required Equipment: (i) Optical bench, (ii) Lens holders, (iii) Convex lens, (iv) Concave lens, (v) Light source, (vi) Objective, and (vii) Screen.

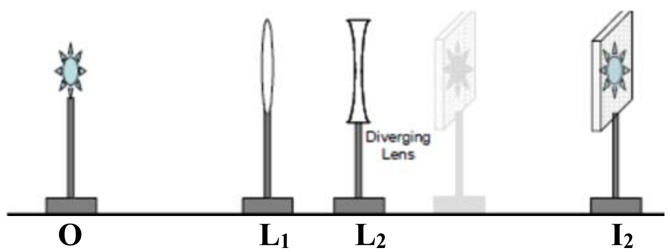
Formula Used: (1) $\frac{1}{l_1'\,(cm)} = \frac{1}{l_1\,(cm)} + \frac{1}{f_1\,(cm)}$

(2) $\frac{1}{l_2'\,(cm)} = \frac{1}{l_2\,(cm)} + \frac{1}{f_2\,(cm)}$ and $F(in\ diopter) = \frac{100}{f_2(cm)}\,m^{-1}$

where,

l = Distance between objective and lens
l' = Distance between image and lens
f = Focal length of the lens
F = Power of lens.





Method:
1. Put a convex lens (L_1; focal length f_1) in front of the objective (O) and get a clear image of it on the screen (I_1).
2. Record the positions of O, L_1 and I_1.
3. Calculate the differences: $L_1 - O = l_1$ and $I_1 - L_1 = l_1'$. Using the formulae (1) with negative value of l_1, calculate f_1.
4. Put a concave lens (L_2; focal length f_2; $|f_2| > |f_1|$) between the lens L_1 and the screen. It will blur the image. Get a clear new image, I_2 on the screen via adjusting the screen.
5. Record the positions of L_2 and I_2.
6. Calculate the differences: $I_1 - L_2 = l_2$ and $I_2 - L_2 = l_2'$.
7. Calculate the focal length and power of concave lens using the formula (2).

Observation:

With lens L_1				With Lenses L_1 and L_2					
O (cm)	L_1 (cm)	I_1 (cm)	f_1 (cm)	L_2 (cm)	I_2 (cm)	l_2 (cm)	l_2' (cm)	f_2 (cm)	F (D)

Results:

The average power of the concave lens is ………..

Standard values: $f_1 = +5$ cm; $f_2 = -15$ cm

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Objective (7): Determination of focal length of a concave mirror.

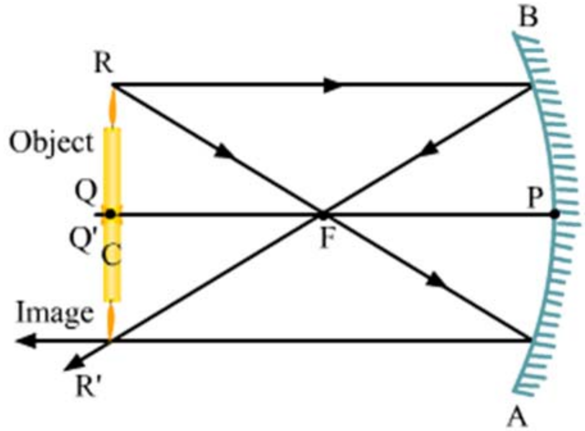
Required Equipment: (i) Optical bench, (ii) Mirror holder, (iii) Concave mirror and (v) Pencil as an objective

Formula Used: $-\frac{1}{l'(cm)} = \frac{1}{l\,(cm)} - \frac{1}{f'(cm)}$

where, f' = Focal length of mirror

l = Distance between objective and mirror

l' = Distance between image and mirror



Method

1. Put the concave mirror AB at a point P from the Objective (pencil) at a point Q. Get an inverted image of pencil. Make sure that the object, the image and the mirror are on the optical axis.
2. Move the mirror such a way that you get the inverted image of the pencil exactly at a point Q'. In this case, the tips of pencil and its image coincide to each other. Further, object and image both move together while moving the eye.
3. A difference of Q (or Q') and P positions results in a distance *l* (or *l'*). Both *l* and *l'* have negative values and hence *f'*-value is also negative.
4. Calculate focal length of the mirror using the formula.

Observation/ Calculation:

Position P (cm)	Positions Q & Q'(cm)	*l* (cm) = Q - P	*l'* (cm) = Q' – P	*f'* (cm)

Results: The average value of the focal length of the concave mirror is …………

Standard value of *f'* of concave mirror = -20 cm