Spherical Lens

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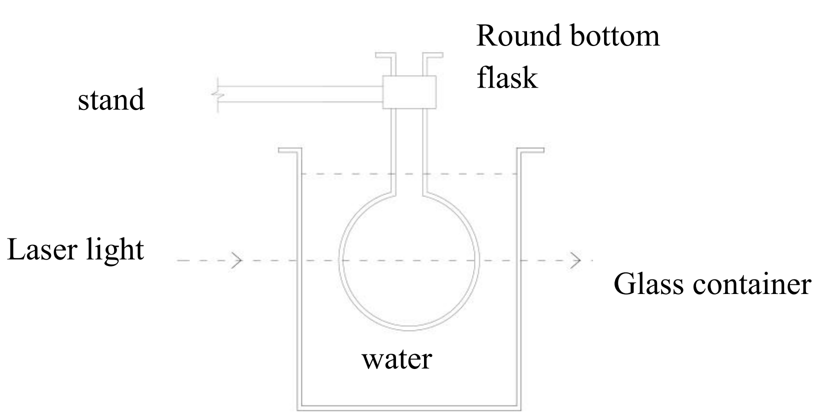
Introduction:

When a lens (glass refractive index μ=1.5 or water μ=1.33) is placed on a stand and light is incident on the spherical surface from air (μ=1) the bending effects on the light due to the spherical surface are well known. But it is more interesting to see how the light behaves when light is incident from a denser material, whose refractive index μ=1.33, on to a less-dense medium with μ=1.0.

This experiment deals with the methodology to calculate μ when light is incident from optically denser medium (μ>1) on to an optically less dense medium (μ=1).

Apparatus: Thread, scale, round bottom flask, glass container (larger than the round bottom flask), water, laser pointer (used during power point presentations), graph paper. **If higher power laser is used then safety precautions have to be taken.**

Theory: When a round bottom flask is carefully inserted inside a large glass container containing water, then any light incident on the surface of the round bottom flask will be moving from medium of high optical density to medium of low optical density. For most of the students, the bending of light will be counter-intuitive and hence a very interesting experiments for students.



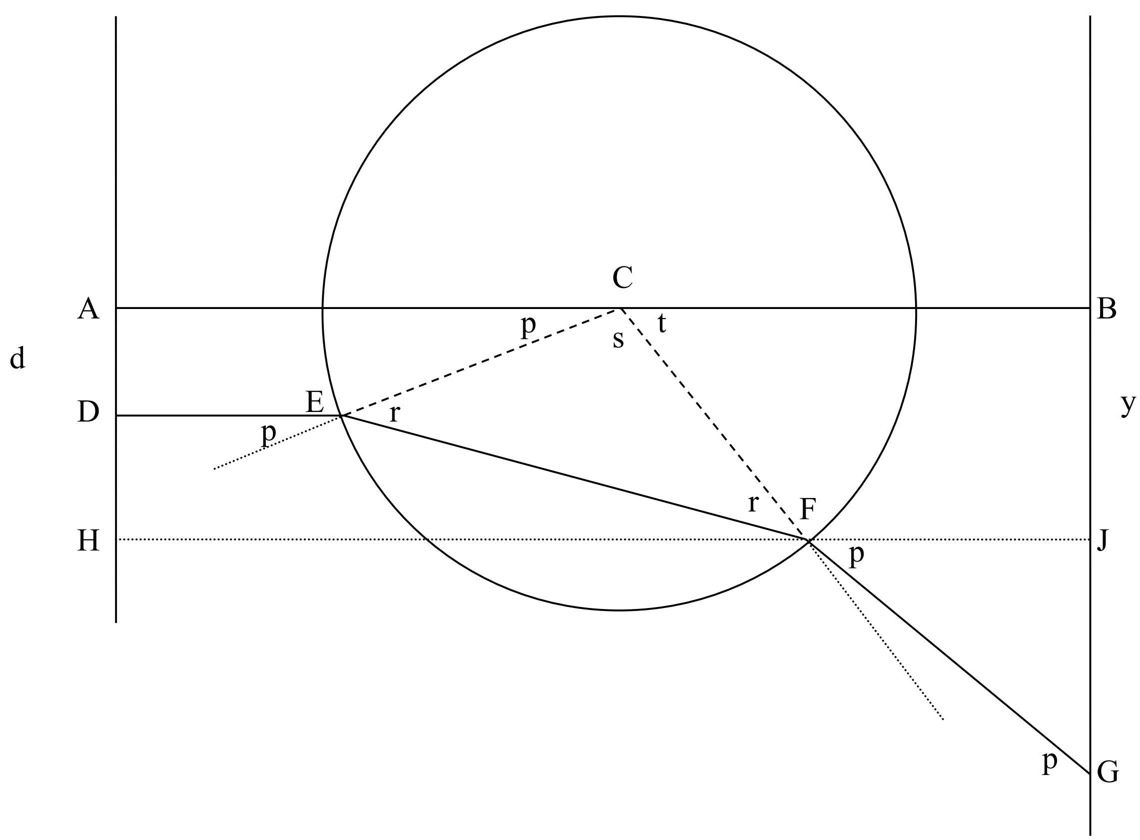
Procedure :

1. Use a thread to measure the circumference of the spherical lens. Ignore the thickness of the glass wall as it can be considered thin for all the optical purposes. The value of circumference measured can be used to calculate the radius **R** of the round bottomed flask.
2. Attach a graph paper on the longer side of glass container from where the light is going to emerge.
3. Make the laser light as horizontal as possible, making sure that you do not look directly into the laser beam.
4. Use the horizontal and vertical movement to align the laser beam in such a way that it is perpendicular to the face of the glass container.
5. Now make the laser light fall on the equator of the glass spherical container. This can be tested by the fact that in case it is above or below the equator, the emergent ray of light will be below or above the height at which laser light is incident.
   [This aspect tests the skill of the students to align the objects and light sources. When the light is incident in the equatorial plane, which is also horizontal, the emergent light may bend but still not leave the horizontal plane. This alignment is very essential for the rest of the experiment. If the light leaves the horizontal plane, then the distance measurement is very complicated.
   This is the aspect that teachers need to check when students are carrying out this experiment]
6. Now ensure that light travels along a path that is undeflected from the other end of the glass container. This will ensure that it is travelling the maximum distance available inside the spherical glass container.
7. [The light source cannot be placed inside the water as it may have technical problems: the laser will stop working!. So if the light is incident perpendicular to the glass container walls from outside, it can be simulated as a source inside the water.]
   Light will therefore pass perpendicular to the glass container wall; it will then be perpendicular to the wall of the round bottom flask, and will continue along straight line. Light will emerge from the other end of the flask, and since it is perpendicular, it will continue moving along the straight line till it hits the other wall of the glass container, also oriented perpendicular.
8. Note down the emergent position on the glass wall by marking it on the graph paper. Record that reading as x_0 = __________ . This represents line AB in the figure.
9. Now move the laser light horizontally by a distance d_1 and note the position of the emergent ray on graph paper as x_1. d_1 is the distance AD and x_1 is the distance BG.

d_1= ___________ x_1 = ______________

10. Take a plastic ruler and keep it as parallel as possible to line AB over the glass container so that it passes over point F, connecting points HFJ. Record the distance between B and J as y_1= ___________

11. Angle p is $\sin^{-1}(d_1/R)$. p = _____________
12. angle $t = \sin^{-1}(y_1/R)$
13. angle $s = 180 - p - t$
14. angle $r = (180-s)/2$
15. refractive index $\mu = \sin(r) / \sin(p)$
16. Keep increasing distance AD (d) and measure the corresponding values of y in order to calculate μ. It is possible to calculate x and y when the light emerges from the walls of glass container, but only up to a point. When the light is incident on the glass walls at an angle greater than the critical angle, it will not emerge from the glass container. This restricts the range of values of distance d.
17. When light does not emerge on the outside of container the refractive index μ of water is calculated by the formula for critical angle.



ANSWER SHEET FOR SPHRICAL LENS

No.	D_1	Y_1	P	T	S	R	μ
1							
2							
3							
4							
5							

d_1 = ___________ for which light does not emerge from the glass container. For this d_1, calculate the refractive index μ.