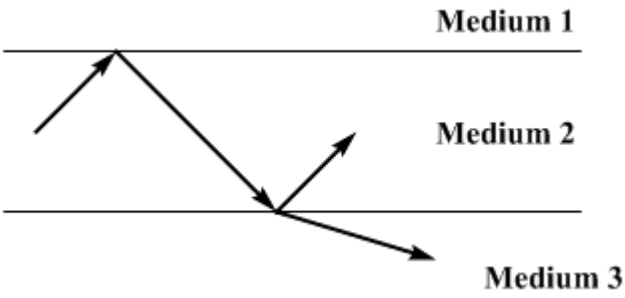
SAMPLE TEST QUESTIONS

PROBLEM 1 - 10 points

[5 points] (a) Three media are placed on top of one another. A ray of light starting in medium 2 experiences total internal reflection at the top interface but some of the light refracts into medium 3 when the ray reaches the bottom interface. If the two interfaces are parallel, rank the media by their index of refraction, from largest to smallest.



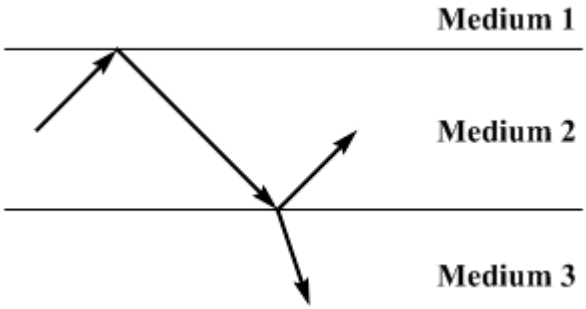
[ ] $n_1>n_2>n_3$ [ ] $n_1>n_3>n_2$ [ ] $n_2>n_1>n_3$ [ ] $n_2>n_3>n_1$ [ ] $n_3>n_1>n_2$ [ ] $n_3>n_2>n_1$

[ ] There is not enough information given above to decide.

[ ] None of the above

Briefly justify your answer:

[5 points] (b) Medium 3 is now changed, and the rays follow the paths shown at right. Once again rank the media by their index of refraction, from largest to smallest.



[ ] $n_1>n_2>n_3$ [ ] $n_1>n_3>n_2$ [ ] $n_2>n_1>n_3$ [ ] $n_2>n_3>n_1$ [ ] $n_3>n_1>n_2$ [ ] $n_3>n_2>n_1$

[ ] There is not enough information given above to decide.

[ ] None of the above

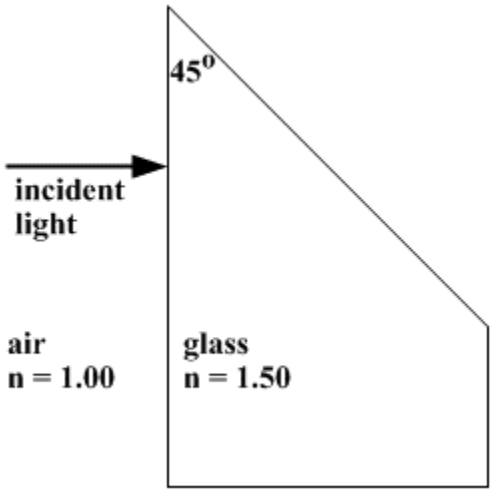
Briefly justify your answer:

PROBLEM 2 – 20 points

A horizontal beam of monochromatic laser light is incident on a block of glass, as shown at right. The faces of the block of glass are all either horizontal or vertical except for the face at the top right, which is inclined at 45˚.

The glass has an index of refraction of 1.50.

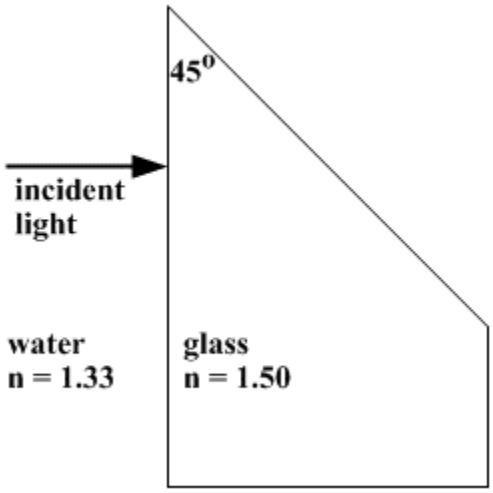
The glass block is entirely surrounded by air, with an index of refraction of 1.00.



[8 points] (a) On the diagram sketch the path the light takes through the block, accounting for both refraction and reflection at each air-glass interface the light encounters. Label every point where light emerges from the glass back into the air and, at each of these points, show the direction(s) in which the light is traveling in the air after it emerges. If appropriate, apply a quantitative analysis using equations to accurately find the angles at which the light emerges from the glass block. Include your calculations and/or a written analysis below.

Taking care to ensure that the laser does not get wet, the experiment from (a) is repeated except that this time the glass block is completely immersed in water.

The index of refraction of water is 1.33.



[12 points] (b) On the diagram sketch the path the light takes through the block, accounting for both refraction and reflection at each water-glass interface the light encounters. Label every point where light emerges from the glass back into the water and, at each of these points, show the direction(s) in which the light is traveling in the water after it emerges. If appropriate, apply a quantitative analysis using equations to accurately find the angles at which the light emerges from the glass block. Include your calculations and/or a written analysis below.

PROBLEM 3 – 20 points

An object is placed a certain distance from a lens. The image created by the lens is exactly half as large as the object. If the two focal points of the lens are 20 cm from the lens, where is the object? Where is the image?

[3 points] (a) There are two solutions to this problem. Describe in words one of the solutions, including such information as what kind of lens is being used, what side of the lens the image is on, and what the image characteristics are. Don't draw it yet – we will draw it in part (b).

[3 points] (b) For the solution you describe in (a) sketch a ray diagram on the axis below. Hint: it's a good idea to first draw the lens. The tick marks on the axis are separated by 10 cm.

[3 points] (c) For the solution you describe in (a) use equations to calculate the object distance and the image distance. Be careful with the signs.

[3 points] (d) Describe in words the second solution, including such information as what kind of lens is being used, what side of the lens the image is on, and what the image characteristics are. Don't draw it yet – we'll do that in (e).

[3 points] (e) For the solution you describe in (d) sketch a ray diagram on the axis below. Hint: it's a good idea to first draw the lens. The tick marks on the axis are separated by 10 cm.

[4 points] (f) For the solution you describe in (d) use equations to calculate the object distance and the image distance. Be careful with the signs.

PROBLEM 4 – 20 points

An ophthalmologist-in-training is presented the following case studies. For each case, state whether any corrective lens is required, whether the person is near-sighted or far-sighted, and what the focal length (or power in diopters) of the corrective lens, if needed, should be. [Assume if necessary that for all the cases the image distance within the eye is the same, 0.02 m, and that the corrective lens, if one is necessary, is placed 0.02 m in front of the eye.]

Case 1. A young student has a near point of 0.5 m.
Case 2. A university student with a far point of 0.5 m.
Case 3. An athlete with a far point at infinity, and a near point of 0.25 m.
Case 4. A professor with a far point of 1.0 m and a near point of 0.9 m.