Midterm Exam 2

Print your full LAST name: ____________________________________________

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#1 total: ___________
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#4 total: ___________
Adjustment: ___________
Appeal: ___________
Exam total: ___________ / 200
1. **(50 points total)** Refer to the diagram here (not to scale—all distances are as indicated).

An object of unknown location and appearance (and not shown in the diagram) is placed somewhere to the left of Lens 1.

The resulting image produced by Lens 2 is shown on the diagram. Image 2 is located midway between (equidistant from) the two lenses.

**Other possibly useful facts:** If used as an eyeglass lens, Lens 2 would properly correct a Far Point of 50.0 cm.

In the situation shown here, Lens 1 is producing a magnification ($m$) of $-1.3579$.

How would Lens 1 be rated as a magnifier (i.e, what would its “power-x” be, as advertised by someone selling it)?
2. \textbf{(50 points total)} This diagram shows the same lenses as in problem 1. However:

- Note that the lenses have been rearranged.
- The object may be completely different (again, unknown).
- Now the only known image is that created by Lens 1. Image 1 is 1.25 cm tall and is located and oriented as shown.
- Now there is a person viewing image 2 (and she’s located to the right of Lens 2, looking to the left). She normally wears glasses when reading—glasses that have identical lenses, each with a Refractive Power of 2.25 D. But she is not wearing her glasses here.

\textbf{Other facts:} The object and the lenses are \textbf{fixed} in position (they cannot move).
The viewer’s position is \textbf{limited}. Her eye cannot approach Lens 2 any closer than 35.0 cm.

What is the best angular magnification ($M$) this viewer can achieve by using this two-lens combination?
Use this page as additional space, if needed, for problem 2
3. (50 points total) Refer to this diagram (a side view, not to scale).

A rectangular tank made of clear plastic has the inner dimensions indicated. It has been partially filled with water, and then a large 6x glass magnifier lens has been placed on edge, as shown, so that it is exactly half immersed—its central axis is directed to the right, along the water surface.

Initially: You are holding a laser pointer as shown—aimed horizontally at the left end of the tank, so that the beam is normal to the left wall of the tank and travels through the very center of the lens.

Then: Without changing the angle of the laser pointer, you begin to lower it vertically downward.

Question: What is the minimum distance you must lower the pointer from its initial position so that—after the laser light travels once through the lens—at least some of it exits the water into the air—without any further encounters with either glass or plastic? Draw your own diagram and show all your work.

(Note: The effective focal length of a glass lens immersed in water is 3.6 times greater than in air.)
Use this page as additional space, if needed, for problem 3
4. (50 points total)

a. (_______ / 25 points) A rigid, hollow, ceramic ball has an outer radius of 1.20 m and an inner radius of 1.10 m. The inner cavity of the ball is empty.

This ball is held at rest by a massless anchor wire so that 50% of the ball’s volume is immersed in water, as shown.

The magnitude of the tension force exerted by the wire on the ball is 7.68 kN. What is the density of the ceramic?
4. **(25 points)** Starting with the situation shown in part a, suppose now that the wire has been removed from the ball entirely. And then suppose that the ceramic develops a slight leak—a tiny hole—at the wire’s former attach point (on the bottom of the ball). If this hole is 1.00 mm in diameter and water enters the inner cavity through this hole at a constant speed of 0.23 m/s, about how long—measured from when the hole first opens—will it take for the ball to become completely submerged in the water? (You may assume there is sufficient water in the tub so that this is possible.) Express your answer in days.
GENERAL DIRECTIONS

Fill out the cover sheet completely, as indicated. Then follow the general guidelines below and the specific directions on each page for each item.

For ALL items (unless directed otherwise):
In all expressions and symbolic solutions, reduce them to simplest form.
In all final numerical answers, use standard SI units and three significant digits.
No item will be given full credit if it does not include valid reasoning/work to justify the solution/answer. Correct answers alone are generally worth about 10% of the points.

For T/F/N items: Evaluate each statement as being either…
   demonstrably True (T),
   demonstrably False (F), or
   with Not enough information (N) to declare it either True or False.
You must fully explain your reasoning. Little credit will be given for a correct T/F/N answer without a valid explanation to accompany it.

For items asking for numeric answers:
You may use any valid method and physics, provided that you show your work/reasoning and math steps (and it’s generally best to stick with symbolic solutions as far as you can, anyway). Little credit will be given for a correct answer without a valid explanation to accompany it.

For items asking for symbolic solutions or any/all parts of the ODAVEST protocol:
These items will state which symbols may be considered “known values” (and which therefore may appear in your final answer).

<table>
<thead>
<tr>
<th>Physical constants and other possibly useful information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n_{\text{air}} = 1.00 )</td>
</tr>
<tr>
<td>( n_{\text{water}} = 1.33 )</td>
</tr>
<tr>
<td>( P_{\text{atm.earth.surface}} = 1.01 \times 10^5 \text{ Pa} )</td>
</tr>
<tr>
<td>( V_{\text{sphere}} = \frac{4}{3}\pi R^3 )</td>
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