Physics 4C Exam 3 Information

Spring 2017

Topics that could be included on Exam 3:

- Electromagnetic waves: frequency, wavelength, speed, amplitude
- Intensity of EM waves
- Radiation pressure
- Reflection & refraction
- Critical angle & internal reflection
- Polarization of electromagnetic waves
- Lenses & mirrors
- Double-slit interference
- Thin films
- Resolution for circular apertures

The exam will be three pages. The first page will have five short multiple-choice problems. You can solve them any way you like, and then select the correct answer from the given choices. Only the selection of your answer will be graded (i.e. it’s either right or wrong... and you’re welcome to guess if you like.)

The second and third pages will include one problem each. You are expected to write a complete solution for each of these problems, and you will be graded on the completeness of your solution. Your solution should include:

- **Pictures:** draw a clear picture (or pictures) of what is happening in the problem.
- **Labeled Information:** label, on your picture, all relevant information (known or unknown.)
- **Equations:** clearly show the connection between the relevant information by writing equations representing the appropriate physical concepts.
- **Algebraic solution:** combine your equations to create an algebraic solution.
- **Calculated answer:** use your algebraic solution and the given information to calculate a numerical answer.

I will provide scratch paper; all you will need is a calculator, a straightedged and something to write with. You’re welcome to use color for highlighting, if you wish. I will also provide the sheet of equations that follows this page (You are not expected to print that sheet and bring it with you. It will be included with your exam.)

You will have the entire class period available to work on the exam, although I expect some of you will finish in about an hour or so. I cannot extend the time, since we have to vacate the room for the next class at the end of our class.

If you feel like you know how to do the homework problems, you should be just fine for the exam.

Please email questions if you have them.
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Equations for Exam 3

Speed of light  \( c = 3.00 \times 10^8 \text{ m/s} \)

\[ 2\mu_0 c = 754 \text{ V}^2\text{W} \]

**EM Waves**  \( c = \lambda f \)  \( E_{\text{max}} = c B_{\text{max}} \)  \( I = \frac{E_{\text{max}}^2}{2\mu_0 c} \)

**Radiation pressure**  \( p_{\text{rad}} = \frac{(1 + \alpha)I}{c} \)  \( \text{Intensity} \  I = \frac{P}{A} \)

Index of refraction:  \( n = \frac{c}{v} \)  \( \lambda = \frac{\lambda_0}{n} \)

Snell’s law:  \( n_1 \sin \theta_1 = n_2 \sin \theta_2 \)  \( \text{Critical angle:} \  \sin \theta_c = \frac{n_2}{n_1} \)

Unpolarized light through a polarizer  \( I = \frac{1}{2} I_0 \)  \( \text{Polarized light through a polarizer} \  I = I_0 \cos^2 \theta \)

**Lenses & Mirrors:**  \( \frac{1}{f} = \frac{1}{o} + \frac{1}{i} \)  \( m = -\frac{i}{o} \)

Mirror focal length:  \( f = \pm \frac{R}{2} \)  \( \text{Lens focal length:} \  \frac{1}{f} = (n-1) \left( \frac{1}{R_1} + \frac{1}{R_2} \right) \)

**Sign conventions:**

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Object distance</strong></td>
<td>Real Object</td>
</tr>
<tr>
<td><strong>Image distance</strong></td>
<td>Real Image</td>
</tr>
<tr>
<td><strong>Magnification</strong></td>
<td>Upright Image</td>
</tr>
<tr>
<td><strong>Focal length</strong></td>
<td>Concave mirror or converging lens</td>
</tr>
</tbody>
</table>

Double-slit interference:  \( m\lambda = d \sin \theta \)  \( d \tan \theta = \frac{y}{L} \)

Thin films:  \( \text{constructive interference} \)  \( \Delta N = m \)  \( \text{destructive interference} \)  \( \Delta N = m + \frac{1}{2} \)

**Ray 1**  **Ray 2**

<table>
<thead>
<tr>
<th>Path</th>
<th>0</th>
<th>( 2 \times n_2 / \lambda_0 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ref1</strong></td>
<td>0 or ( \frac{1}{2} )</td>
<td>0 or ( \frac{1}{2} )</td>
</tr>
</tbody>
</table>

Resolution for Circular Apertures:  \( 1.22 \lambda = D \text{ s/x} \)