

(WO.L3.4-212.sols) 212 Mastery Stage Solutions

Tuesday, February 18, 2020 6:01 PM

WO.L3.4 | Index of Refraction, Thin Film Interference | Challenge Homework

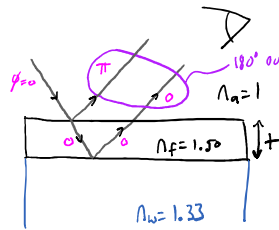
Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01) and there should be only one solution per page. The questions should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution (e.g. GR.L1.4-01 continued). One question will be randomly selected and graded. Challenge homework for a given week are due the following week by Tuesday at midnight. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. See the course website for further details.

You will be asked to apply sense-making in most problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => [Sense-making](#).

- *Sign*: Check the **sign** of each quantity makes sense.
- *Dimensionality*: Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude*: Check the **order of magnitude** of the final answer and other important quantities is within a factor of 10 of what you think it should be.
- *Graphical Analysis*: Use a **graph** to see if the behavior of a solution makes sense.
- *Proportionality*: Using a symbolic solution, check the behavior of the answer when you change a given quantity on which it is dependent. Does the answer vary **proportionally** to what you expect?
- *Special Cases*: Check the behavior of a derived equation in limiting (**special**) cases makes sense, e.g. as x goes to 90 degrees in $\sin(x)$.
- *Self-consistency*: Check derived equations, functions, or values, are **self-consistent**, e.g. check that the slope of a derived position plot matches the values of the given velocity plot
- *Known Values*: Compare given or derived quantities with common well **known values**.
- *Related Quantities*: Compare the relative magnitude of two **related quantities**.

WO.L3.4-01

A thin film of oil ($n_f = 1.5$) floats on water ($n_w = 1.33$). When a beam of white light strikes this film at a normal incidence from air, the only brightly enhanced reflected colors are red ($\lambda_r = 650$ nm) and violet ($\lambda_v = 390$ nm). From this information, deduce the minimum thickness "t" of the oil slick.



$\rho_{LO} = \cos \theta_i$

$2t = (m + \frac{1}{2}) \lambda_f$

$2t = (m + \frac{1}{2}) \frac{n_a}{n_f} \lambda_a$

$t = (m + \frac{1}{2}) \frac{n_a}{2n_f} \lambda_a$

π PHASE DIFF

$n_a \lambda_a = n_f \lambda_f$

$\lambda_f = \frac{n_a}{n_f} \lambda_a$

$\lambda_{red} = 650 \text{ nm}$

$\lambda_{violet} = 390 \text{ nm}$

m	t
0	108.3 nm
1	325 nm
2	541.7 nm
3	758.3 nm

m	t
0	65 nm
1	195 nm
2	325 nm
3	585 nm