UNIVERSITY OF FORT HARE

PHY123F

DEGREE EXAMINATIIONS

Oct / Nov 2018

Time: 3 HOURS

Subject: Oscillations, Waves and Optics

Marks: 100

This paper consists of 9 pages including cover page

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Instructions

- Answer all questions of your choice
- Read the question more than once and clearly write down your data.
- On problem solving, specify useful definitions and draw clearly labeled diagrams.

Constants (PHY123F)

$v_{sound} = 343.0 m/s, \qquad I_o = 1.00 \times 10^{-12} W/m^2,$

TABLE 35.1 *Indices of Refraction*

Substance	Index of Refraction	Substance	Index of Refraction
Solids at 20°C		*Liquids at 20°C*	
Cubic zirconia	2.20	Benzene	1.501
Diamond (C)	2.419	Carbon disulfide	1.628
Fluorite (CaF_2)	1.434	Carbon tetrachloride	1.461
Fused quartz (SiO_2)	1.458	Ethyl alcohol	1.361
Gallium phosphide	3.50	Glycerin	1.473
Glass, crown	1.52	Water	1.333
Glass, flint	1.66		
Ice (H_2O)	1.309	*Gases at 0°C, 1 atm*	
Polystyrene	1.49	Air	1.000 293
Sodium chloride (NaCl)	1.544	Carbon dioxide	1.000 45

Note: All values are for light having a wavelength of 589 nm in vacuum.

TABLE 14.1

Densities of Some Common Substances at Standard Temperature (0°C) and Pressure (Atmospheric)

Substance	ρ (kg/m^3)	Substance	ρ (kg/m^3)
Air	1.29	Ice	0.917×10^3
Aluminum	2.70×10^3	Iron	7.86×10^3
Benzene	0.879×10^3	Lead	11.3×10^3
Copper	8.92×10^3	Mercury	13.6×10^3
Ethyl alcohol	0.806×10^3	Oak	0.710×10^3
Fresh water	1.00×10^3	Oxygen gas	1.43
Glycerin	1.26×10^3	Pine	0.373×10^3
Gold	19.3×10^3	Platinum	21.4×10^3
Helium gas	1.79×10^{-1}	Seawater	1.03×10^3
Hydrogen gas	8.99×10^{-2}	Silver	10.5×10^3

Question 1 (Oscillatory Motion)

1.1. A 0.500 kg object attached to a spring with a spring constant of 8.00 N/m vibrates in a simple harmonic motion with an amplitude of 10.0 cm. Calculate

1.1.1. the maximum value of its speed and acceleration, (4)

1.1.2. the speed and acceleration when the object is 6.00 cm from the equilibrium position, and (5)

1.1.3. the time interval required for object to move from x = 0 cm to x = 8.00 cm. (5)

1.2. What is the period of a simple pendulum on Mars where the acceleration due to gravity is about 0.37 that on Earth, if the pendulum has a period of 0.80 s on Earth? (6)

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Question 2 (Wave Motion)

2.1. Write the expression for y as a function of x and t for a sinusoidal wave travelling along a rope in the negative x direction with the following characteristics: A = 8.00 cm, λ = 80.0cm, f = 3.00Hz, and y(x,0) = 0 at the point x = 10.0cm. (4)

2.2. Use $y(x,t) = A\sin(kx - \omega t)$ for the travelling wave and the wave equation $\frac{\partial^2 y}{\partial x^2} - \frac{1}{v^2}\frac{\partial^2 y}{\partial t^2} = 0$ to show that $v = \frac{\omega}{k}$. (8)

2.3. A transverse wave on a string is described by the wave function $y = (0.120m)\sin\left(\frac{\pi}{8}x + 4\pi t\right)$

2.3.1. Determine the transverse speed and acceleration of the string at t = 0.200s for the point on the string located at x = 1.60m. (5)

2.3.2. What are the wavelength, period and the speed of propagation of the wave? (3)

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Question 4 (Superposition and Standing Waves)

4.1. Two travelling sinusoidal waves are described by the wave functions $y_1 = (5.00\,m)\sin[\pi(4.00\,x - 1200\,t)]$ and $y_2 = (5.00\,m)\sin[\pi(4.00\,x - 1200\,t - 0.250)]$ where y_1 and y_2 are in meters and t is in seconds.

4.1.1. What is the amplitude of the resultant wave? (3)

4.1.2. What is the frequency of the resultant wave? (2)

4.2. Calculate the length of a pipe that has a fundamental frequency of 240 Hz assuming the pipe is

4.2.1 closed at one end (3)

4.2.2. open at both ends. (3)

4.3. A standing wave pattern is observed in a thin wire with a length of 3.00 m. The wave function is $y = (0.002\,m)\sin(\pi x)\cos(100\,\pi t)$ where x is in meters and t is in seconds.

4.3.1. How many loops does this pattern exhibit? (3)

4.3.2. What is the fundamental frequency of vibration of the wire? (3)

4.3.3. If the original frequency is held constant and the tension in the wire is increased by a factor of 9, how many loops are present in the new pattern? (3)

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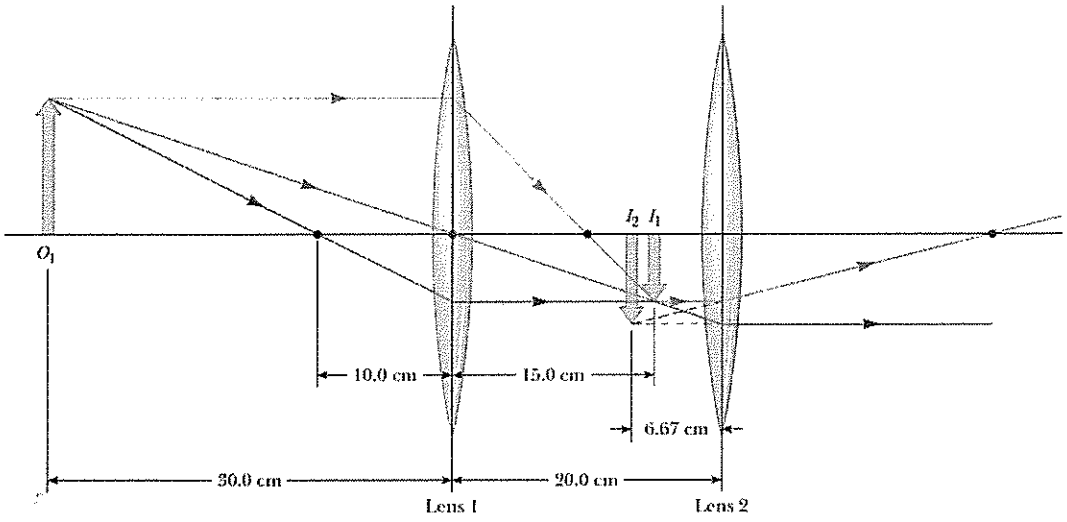
5.3 Two thin converging lenses of focal lengths $f_1 = 10.0$ cm and $f_2 = 20.0$ cm are separated by 20.0 cm, as illustrated in the figure below. An object is place 30.0 cm to the left of lens 1. Find the position and the magnification of the final image. (8)



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