UNIVERSITY OF FORT HARE

University of Fort Hare
Together in Excellence

PHY 124F

DEGREE EXAMINATIONS

DATE	:	*November 2018*
TIME	:	*2 hrs.*
SUBJECT	:	*PHY124F - Waves and Optics*
MARKS	:	*100*

EXAMINER

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INSTRUCTIONS

1. *Answer ALL Questions.*
2. *Useful information on the last page*

Question 1 [20marks]

(a) The displacement (in meters) of a wave is given according to $y = (0.3m) \sin(\pi t - 3\pi x)$,

where t is in seconds and x is in meters.

What is the displacement y when $t = 35s$ and $x = 10m$? (4)

(b) A transverse wave is traveling on a string. The displacement y of a particle from its equilibrium position is given by $y = (0.2m) \sin(25t - 2x)$.
The linear density of the string is 1.6×10^{-2} kg/m.
What is the tension in the string? (8)

(c) (i) If $y = 0.02 \sin(30x - 440t)$, what is the velocity of the wave? (4)

(ii) Write the equation of a wave traveling along the $+x$-axis with amplitude of 0.02 m, a frequency of 400 Hz and a speed of 300 m/s. (4)

Question 2 [20marks]

(a) A steel cable of cross-sectional area $2.85 \times 10^{-3}\ m^2$ is kept under a tension of 1.5×10^{4} N. The density of steel is $7860\ kg/m^3$. At what speed does a transverse wave move along the cable? (7)

(b) The middle C string on a piano is under a tension of 940 N. The period and wavelength of a wave on this string are 3.8 ms and 1.4 m, respectively. Find the linear density of the string. (7)

(c) The lowest A on a piano has a frequency of 28 Hz. If the tension in the 2.00-m string is 310 N, and one-half wavelength occupies the string, what is the mass of the string? (6)

Question 3 [20marks]

(a) A candle is placed *15.0 cm* in front of a convex mirror. When the convex mirror is replaced with a plane mirror, the image moves *7.0 cm* farther away from the mirror. Find the focal length of the convex mirror. (6)

(b) A mirror produces an image that is located *30 cm* behind the mirror when the object is located *10 cm* in front of the mirror. What is the focal length of the mirror, and is the mirror concave or convex? (4)

(c) A concave mirror has a focal length of *30.0 cm*. The distance between an object and its image is *45.0 cm*. Find the object and image distances, assuming that

(i) the object lies beyond the center of curvature and

(ii) the object lies within the focal point. (10)

Question 4 [20marks]

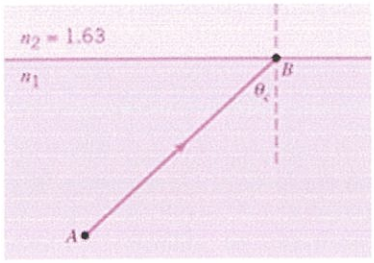
(a) A dentist uses a concave mirror of focal length *2cm* to examine some teeth. If the distance from a tooth to the mirror is *1cm*, what is the magnification of the tooth? (5)

(b) Two converging lenses are separated by *24.00 cm*. The focal length of each lens is *12.00 cm*. An object is placed *36.00 cm* to the left of the lens that is on the left. Determine the final image distance relative to the lens on the right. (15)

Question 5 [20marks]

(a) The drawing shows a ray of light traveling from point A to point B, a distance of *4.60 m* in a material that has an index of refraction n_1. At point B, the light encounters a different substance whose index of refraction is $n_2 = 1.63$. The light strikes the interface at the critical angle of $\theta_c = 48°$. How much time does it take for the light to travel from A to B?

$$(\textit{Recall that } n_1 = \frac{c}{v_1} \textit{ and } c=3x10^8 m/s)$$



(14)

(b) In a certain time, light travels *6.20 km* in a vacuum. During the same time, light travels only *3.40 km* in a liquid. What is the refractive index of the liquid? (6)

*****The End!*****

USEFUL INFORMATION:

1. *Speed of the wave,* $v = \lambda f$
2. *Speed of a wave on a string,* $v = \sqrt{\frac{F}{\mu}}$, μ *is the linear density*
3. *Wave function* $y = A\sin\left(\frac{2\pi}{\lambda}x - \frac{2\pi}{T}t\right)$
4. *Mirror and lens equation,* $\frac{1}{d_0} + \frac{1}{d_i} = \frac{1}{f}$
5. *Magnification,* $m = \frac{h_i}{h_0} = -\frac{d_i}{d_0}$
6. *Snell's Law:* $n_1 \sin\theta_1 = n_2 \sin\theta_2$
7. *Gravitational acceleration,* $g = 10\ m/s^2$

Excellent!