

UNIVERSITY OF FORT HARE



University of Fort Hare
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PHY 124

DEGREE EXAMINATIONS

DATE : November 2018
TIME : 2 hrs.
SUBJECT : PHY124 - 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 $1.6 \times 10^{-2} \text{ kg/m}$.

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 $2.85 \times 10^{-3} \text{ m}^2$ is kept under a tension of $1.5 \times 10^4 \text{ N}$.

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
- the object lies beyond the center of curvature and
 - the object lies within the focal point. (10)

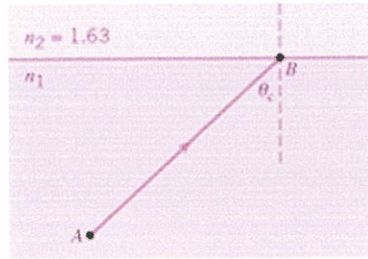
Question 4 [20marks]

- (a) A dentist uses a concave mirror of focal length 2 cm to examine some teeth. If the distance from a tooth to the mirror is 1 cm , 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 $\theta_c = 48^\circ$. How much time does it take for the light to travel from A to B ?

$$\text{(Recall that } n_1 = \frac{c}{v_1} \text{ and } c = 3 \times 10^8 \text{ m/s)}$$



(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, $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$
5. Magnification, $m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$
6. Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$
7. Gravitational acceleration, $g = 10 \text{ m/s}^2$

Excellent!