LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE) AND BACHELOR OF SCIENCE (GENERAL)

PHYS 122: GEOMETRICAL OPTICS

STREAM: R ***TIME: 2 HRS***

DAY: THURSDAY[2.30P.M – 4.30P.M] ***DATE: 18/04/2024***

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.

INSTRUCTIONS:

- Read the question paper carefully.
- Answer Question **ONE** and any other T**WO** Questions.
- Question **ONE** carries **40 marks** and the other **FOUR** carry **15 marks** each.
- Do not carry mobile phones or any electronic transmission device to the examination room.

QUESTION ONE

(a). Define the terms;

i. Refraction of light
ii. Light dispersion
iii. Optical path length
iv. Virtual image **(4 Marks)**

(b). Give the uses of total internal reflection. **(3 Marks)**

(c). i. Define chromatic aberration as used in lenses **(2 Marks)**

ii. How is this corrected? **(1 Mark)**

(d). i. What is the velocity of light of wavelength 500 mμ (in vacuum) in glass whose refractive index at this wavelength is 1.50? **(2 Marks)**

ii. What is the wavelength of this light in the glass? **(2 Marks)**

(e). A light ray of wavelength λ = 589 nm is incident on glass with an angle of incidence of 30 ◦. The index of refraction of glass is 1.52.

i. What is the angle of refraction? **(2 Marks)**

ii. What are the speed and wavelength of the light inside the glass? (**3 Marks)**

(f). State the laws of reflection and refraction. **(2 Marks)**

(g). A converging lens has a focal length of 12.0 cm. Calculate the power of the lens.**(1 Mark)**

(h). i. An object is placed 10.0cm from a concave mirror and a real image of magnification **2** is formed. Calculate the focal length of the mirror. **(4 Marks)**

ii. Repeat (a) above when a concave mirror is replaced with a concave mirror of the same radius of curvature. **(4 Marks)**

(i) i. What do you understand by the term Magnification? **(1 Mark)**

ii. Name and explain the two examples of linear Magnification. (**2 Marks)**

(j) Define

i. Luminance **(1 Mark)**

ii. Illuminance **(1 Mark)**

(k) A lens is to be made so that its focal length is 20.0 cm. Find the radii of curvature of the surfaces which will give minimum spherical aberration. (Use n=1.50). (**5 Marks)**

QUESTION TWO

(a) A beam of light passes through 280cm of water of refractive index 1.333, then through 18cm of glass of index 1.56, and finally through 165cm of oil of index 1.392. Find:

i. each of the separate optical paths (**4 Marks)**

ii. the total optical path **(1 Mark)**

(b) Light passes through a flat slab of glass whose refractive index is ***1.5***. The angle of incidence of the light onto the glass is 30^0. What is the angle with which the light emerges on the other side of the slab? **(6 Marks)**

(c) Explain how rainbows are formed. **(4 Marks)**

QUESTION THREE

(a) Two light pulses are emitted simultaneously and hit a screen directly in front of them. If one light pulse passes through 6.2 m of ice on its way to the screen, what is the time difference between the arrivals of the two pulses at the screen? (The index of refraction of ice is 1.309 and index of refraction of air is 1.00). (**7 Marks)**

(b) A fish lives at the bottom of a lake 10m deep filled with water whose index of refraction 1.525.

i. At what angle relative to the normal must the fish look up towards the surface of the water in order to see a fisherman who is sitting on a distant shore? **(4 Marks)**

ii. What is the closest that another fish living at the bottom of the lake can approach in order that the first fish can see it by looking towards the surface? (**4 Marks)**

QUESTION FOUR

(a) Explain the term Vergence as used in lenses. **(1 Mark)**

(b) i. State the nature of images formed by a convex mirror for different object positions. **(1.5 Marks)**

ii. A mirror forms an erect image 50cm from a real object. The image is three times as high as the object. Identify the mirror and calculate its focal length. **(1.5 Marks)**

(c) A candle, 8.0 cm tall, is placed 23.0 cm in front of a concave mirror with a focal length of 10.0 cm.

i. Where is the image? **(1 Mark)**

ii. How tall is the image? **(2 Marks)**

iii. What are the characteristics of the image? (**2 Marks)**

(d) A concave surface has a radius of 5.0 cm. This surface separates two optical media of refractive indices n = 1.00 and n' = 1.56. An object is placed in the first medium at a distance of 12 cm from the vertex. Find (a) the primary focal length **(2 Marks)**

(b) the secondary focal length **(2 Marks)**

(c) the image distance **(2 Marks)**

QUESTION FIVE

(a) Explain the following types of eye defects,

i. Myopia

ii. Hypermetropia **(2 Marks)**

(b) State and illustrate how the above two types of eye defects are corrected. **(3 Marks)**

(c) The diameter of a telescope objective is 25 mm while the length of the telescope is 200 mm. Find:

(i) the normal magnification of the telescope. (**2 Marks)**

(ii) the focal length of the eyepiece. (**2 Marks)**

(iii) the diameter of the exit pupil if an eyepiece was used which gave a magnification of 50% more than the normal one. **(2 Marks)**

(d) The focal length of an f/2.8 camera lens is 8.0cm.

i. What is the diameter of the lens? **(2 Marks)**

ii. If the exposure time for a certain scene is 1/200 s at f/2.8, what would be the correct exposure time at f/6.3? (**2 Marks)**