SOUTH EASTERN KENYA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRONICS

PHY 213: GEOMETRICAL OPTICS

5TH DECEMBER, 2016 **TIME: 1.30-3.30 P.M**

INSTRUCTIONS TO CANDIDATES

- Question one carries 30marks while the rest carry 20marks each
- Answer **Question One** and any **other two** questions
- Speed of light in vacuum, $c = 3.0 \times 10^8 m/s$
- Refractive index of vacuum (air) = 1

Question One (30 mks)

a) What are paraxial rays as used in geometrical optics (2 mks)

b) Differentiate between the following:

(i) absolute and relative refractive index (2 mks)

(ii) virtual and real image (2 mks)

c) Diamond has a refractive index, $\eta_d = 2.4$. Calculate its critical angle, C (3 mks)

d) Briefly explain any two rays used in image formation on spherical surfaces (4 mks)

e) Using a diagram, describe the images formed by a concave mirror when the object is at infinite distance (5 mks)

f) A thin lens has a focal length of -20 m.

(i) Determine its power (2mks)

(ii) Name the type of lens (1mk)

g) A diverging lens has a focal length of $-20.0\,cm$. An object 2.0 cm tall is placed 30.0 cm in front of the lens.

(i) Locate the image (3 mks)

(ii) Determine the image magnification and height (3 mks)

h) If a swimming pool is 2 m deep. When filled with water of refractive index of water, $\eta_{water} = \frac{4}{3}$, how deep does it appear when viewed from the surface? (3mks)

Question Two (20 mks)

a) **(i)** State the Fermat's principle (2 mks)

(ii) Using the Fermat's principle, prove the law of reflection (8 mks)

b) A glass container has a uniform diameter of 4cm. When an observer's eye is placed at the top edge of the glass, the observer sees the bottom edge (A). When the glass is filled with a liquid of refractive index $\eta = 1.33$, the observer sees the center (B) of the bottom of the glass as shown in **Fig.1** below.

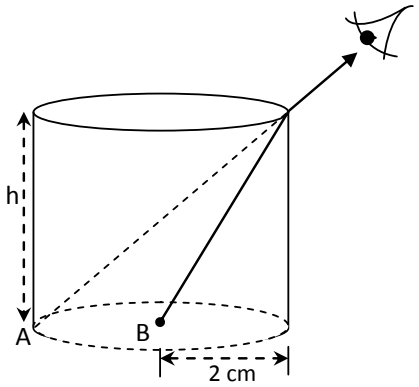

Fig. 1

Determine the height of this container (5 mks)

c) Describe myopia as a defect of the eye, explaining how it is corrected (5 mks)

Question Three (20 mks)

a) (i) Describe the concept of total internal reflection (7 mks)

(ii) State two conditions necessary for total internal reflection to occur (2mks)

b) Light travelling in air enters water with an angle of incidence of 45^0. If the refractive index of the water is 1.33, find the angle of refraction (3 mks)

c) A certain spherical mirror has a focal length $f = -10.0\,cm$.

i) Locate the image for object distances of 5.0 cm. (3 mks)

ii) Determine the image magnification (2 mks)

iii) At what object distance is the magnification equal to -1.0? (3 mks)

Question Four (20 mks)

a) Prove that the lens makers equation for a lens in a medium is given by $\frac{1}{q}+\frac{1}{p}=\left(\frac{\eta_2-\eta_1}{\eta_1}\right)\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$ where η_2 is the refractive index of the lens material, η_1 is the index of the medium the lens is placed, p is object distance, q is image distance while r_1 and r_2 are the two radii of curvature. (10 mks)

b) Using the above equation, describe;

(i) Lens makers equation when the lens is placed in air (2 mks)

(ii) Primary focal length (3 mks)

(iii) Secondary focal length (3 mks)

(iv) Gausian equation (2 mks)

Question Five (20 mks)

a) **(i)** Describe the Huygen's wave theory (3 mks)

(ii) Using the Huygen's theory, prove the Snell's law (7 mks)

b) Explain the concept of chromatic aberration (3 mks)

c) Two lenses of focal lengths 10 cm and $-10\,cm$ are placed in line 30 cm apart. An object is placed $20\,cm$ infront of the lenses.

(i) Find the Position of the final image (3 mks)

(ii) Calculate the Magnification of the final image (4 mks)