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MAIN EXAMINATION

JANUARY – APRIL 2022

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES

REGULAR PROGRAMME

PHY 104: GEOMETRICAL OPTICS

Date: APRIL 2022	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any TWO Questions	

1. (a) Distinguish between real and virtual images **(3marks)**
   (b) State the laws of refraction **(2marks)**
   (c) Two plane mirrors are inclined at 22.5˚ and an object placed between them. Calculate the number of images observed. **(3marks)**
   (d) Distinguish between diffused and regular reflections **(2marks)**
   (e) A ray of light is incident on a plane mirror at 13˚ to the mirror surface, the mirror is then rotated clockwise through 10˚ about the incident point without interfering withtheincident ray. Find the final angle of reflection **(4marks)**
   (f) A converging lens of focal length 20cm forms an image of an object of height 30cm located at a distance of 40cm from the lens.
   (i) Locate and characterize the image **(3marks)**
   (ii) Draw a ray diagram to show the image **(3marks)**

   (g) A light ray is incident on a water-glass boundary at 30˚. If $\eta_w = \frac{4}{3} \wedge \eta_g = \frac{3}{2}$. Find the angle of refraction. **(4marks)**

   (h) A convex mirror of radius of curvature 40cm forms an image which is half the heightof the object. Find the object and image positions,

(6marks)

2. (a) Differentate between the following as used with lenses;
   (i) Real and virtual focal point **(2marks)**
   (ii) Biconvex and plano-convex lens **(2marks)**

   (b) An object is placed 20cm from a diverging lens of focal length 15cm. Calculate the image position and the magnification. **(3marks)**

   (c) A Plano convex-air lens of radius 10cm in water of refractive index $\frac{4}{3}$. If the refractive index of the material of the lens is 1 ($\eta_2 = 1$¿. Find the focal length **(5marks)**

   (d) A compound microscope has an objective lens L_1 of focal length 0.8cmand an eye piece lens L_2 of focal length 2.5cm. An object O is placed in front ofthe objective lens at a distance u_1 of length 1.2cm. The system form a final image I_2 at a distance of 10cm from L_2. Determine the distance of separation of lenses L_1 and L_2. **(8marks)**

3. (a) State the laws of refraction **(2marks)**
   (b) What do you understand by the term "Absolute refractive index" **(2marks)**
   (c) Briefly explain the formation of aMirage **(3marks)**
   (d)A refractive prism has a refractive angle of 56 ˚ and a minimum deviationof 40˚.Calculate the refractive index of the material of the prism (4marks)
   (e) A ray of monochromatic light in air passes successively through parallel layers of water and glass. If the angle of incidence in air is 60 ˚while the refractive indices of water and glass are $\frac{4}{3}$ and $\frac{3}{2}$ respectively. Calculate
   (i) The angle of refraction in water **(2marks)**
   (iii) The angle of incidence at the water-glass boundary **(2marks)**
   (iv) The angle of refraction in the glass. **(2marks)**

   (f) A ray of light is incident is incident at 45 ˚ on one edge of a 60 ˚ prism of refractive index 1.5. Calculate the total deviation of the ray. **(3marks)**

4. (a)Consider a point object O on the principal axis of a concave mirror in figure 3. A ray OX from O is reflected in the direction XImaking an equal angle of θ˚ with the normal CX ;A ray OP from O, incident at P, is reflected back along PO, since CP is the normal at P. I is the image of O.

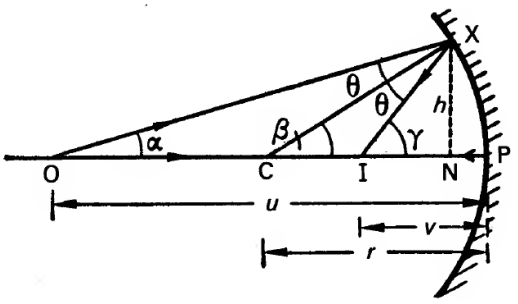

Figure 1

Use this information to derive the mirror formula $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

(10 marks)

(b) A boy 1.5m tall and can just see his image in a vertical plane mirror 3.0m away. His eyes are 1.40m from the floor level. Determine the dimension and elevation (distance from his foot to the lowest part of the mirror) of the shortest mirror in which he couldsee his full image.

(5 marks)

(c) For the light ray in figure 2, the angle of incidence is 60^0. The same ray leaving the flat glass on the other side is displaced a distance d = 0.8 x 10^{-2} m from the spot where it entered the glass. Calculate the index of refraction if the glass plate is 1.2 x 10^{-2} m thick. (5 marks)

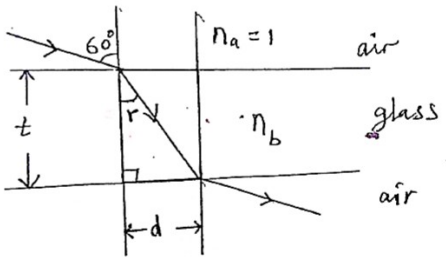

Figure 2

5 (a) Define;

i). Optical prism **(1 mark)**

ii). ***grazing incidence***in a prism **(1 mark)**

(b) Figure 4 shows a prism with an incident ray at Q being refracted and finally emerges at R.

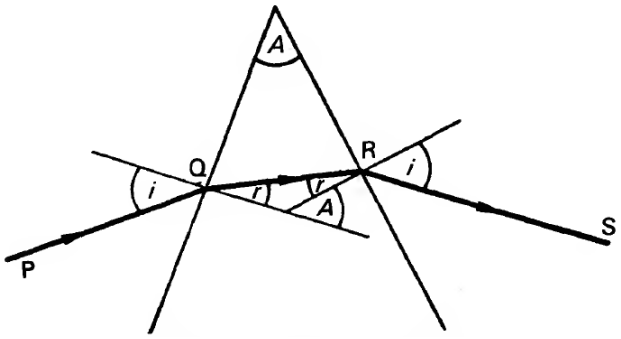

Figure 3

Considering that the net deviation of the ray incident ray as D. show that the refractive index*n* of the prism is given as;

(8 marks)

$$n = \frac{\sin\frac{A+D}{2}}{\sin\frac{A}{2}}$$

(c) A ray of fight is refracted through a prism of angle 70°. If the angle of refraction in the glass at the first face is 28°, what is the angle of incidence in the glass at the second face? **(10marks)**

END