

Instructions: You have a total of 55 minutes to complete this test.

Answer each of the following questions completely.

Time Start _____ Time finish _____

Pledged _____

You must supply all details that led to your answer. You must provide correct SI units where required. Do not discuss any aspect of this test with anyone until I return the test. Although you may use additional sheets of paper which should be turned in with your test, please write (neatly) your answers on the pages where the problems are presented.

(1) Suppose a plane of high-index material has a critical angle for total internal reflection of 31° when surrounded by air.

(a) What is the index of refraction of this material?

(b) Suppose light is shining from the air onto the material. At what angle of incidence will the angle between the transmitted ray and the reflected ray be equal to 90° ?

(c) At the angle of incidence in (b) **with light coming from the air**, what is the angle of refraction?

- (2) When an object is placed at a distance of 5 cm from a lens, the magnification is +2.
(a) What is the focal length of the lens?

Note: if you are unable to complete part (a), use $f=+8$ cm for the rest of the problem to receive partial credit.

(b) If the object is placed at 20 cm from the same lens, what is the magnification of the image?

(c) Characterize the image formed in (b) by <Real:Virtual> <Upright:Inverted> <Enlarged:Unmagnified:Reduced> and tell why.

(3) (a) When an object is placed 5 cm from a mirror, a virtual image is formed at 10 cm. What is the radius of curvature of the mirror?

Note: if you are unable to complete part (a), use $f=+8$ cm for the rest of the problem to receive partial credit.

(b) What is the magnification when an object is placed 40 cm from the same mirror?

(c) Characterize the image formed in (b) by <Real:Virtual> <Upright:Inverted> <Enlarged:Unmagnified:Reduced> and tell why.

(4) Suppose lens L1 has a focal length of +25 cm. This lens is in direct contact with a second lens. If an object is placed 30 cm from the lens combination, the resulting magnification is seen to be $M=-4$. Find the focal length of the second lens in the combination.

Note: if you are unable to complete part (a), use $f=+8$ cm for the rest of the problem to receive partial credit.

(b) Characterize the image that is formed when an object is placed 10 cm in front of the lens combination in terms of <Real:Virtual> <Upright:Inverted> <Enlarged:Unmagnified:Reduced> and tell why.

(5) (a) A soap film has an index of refraction of 1.4 and is of thickness t . The film is on a glass slide with an index of refraction of 1.3, and air is on the other side. What is the minimum thickness of the soap film that would strongly reflect light of 550 nm?

(b) Suppose an oil film had an index of refraction of 1.1 and was on a slide with an index of refraction of 1.3. What is the minimum thickness of the soap film that would strongly reflect light of 550 nm?

(c) Suppose the oil film had air on the top and **air** on the bottom. If light incident from the air is strongly reflected at 550 nm, what minimum thickness of the oil film would produce this result?