Problem 1: Mirrors
What is the minimum height of a planar mirror placed in a vertical plane 2m distant that will permit a person 2m tall to see themselves from head to toe? (assuming for simplicity the person's eyes are located at the top of their head). Does that answer depend on the distance of the mirror?

Problem 2: Fermat's Principle and Snell's law.
Starting with your knowledge of Fermat’s Principle, and that light travels in a straight line through an isotropic medium (e.g., air or glass), derive Snell’s Law for the angle of refraction at an interface between two isotropic mediums, as shown at right. Hint: characterize that angle in terms of a single variable, the height of the intercept between the two mediums.

Problem 3: Ideal prism
A prism has an internal apex angle of 10˚, with light incident perpendicular to one face, as shown at left. The base of the prism is covered by black absorbing paint. (A) Graph the transmitted light angle $\theta$ (defined in the figure) vs the index $n_{\text{prism}}$, where light deflection downward, as drawn in the figure, is defined as positive. (B) What is the maximum possible transmitted beam deflection angle, and at what prism index of refraction does it occur? (C) What is the minimum possible transmitted beam deflection angle, and at what prism index of refraction does it occur? Can light be deflected upward, as drawn?

Problem 4: Surface reflections
What fraction of the incident light power would be reflected for visible light normally incident (from inside the water) on a flat slab of diamond submerged in water?

Problem 5: Fluorescent slabs
(A) A point source of near infrared light which radiates uniformly in all directions is located at the center of a cylindrical slab of silicon, 1mm thick but infinitely wide, held in air. Assuming silicon is index 3.5 and has zero absorption, calculate the total fraction of the light energy which escapes from the top surface of the silicon into the surrounding air. Hint: The solid angle of a cone of half-angle $\theta$ is $2\pi[1-\cos(\theta)]$ steradians.
Problem 6: Textbook question
What is the last word on page 7 of the textbook, Saleh and Teich?
*Hint: Buy a copy of the text, or go to the library, or borrow it from a friend. While you're at it, read Chapter 1.*

Problem 6: Slab waveguides
(A) For the constant thickness waveguide at right. What is the maximum cladding index that will ensure all of the light that enters the core after being incident on the input face 1 of the fiber at 45 degrees will propagate to the output face?

(B) If the top waveguide is now tapered as shown at right, is the cladding index calculated in (A) sufficient to ensure that all of the light that enters the core after being incident on the input face 1 of the fiber at 45 degrees will propagate to the output face 2? Would the answer change if the light were incident on Face 2? Explain your answers with a ray path diagram.

Problem 7: Retroreflectors
Consider the solid retro-reflector shown at right. For light to be "retro reflected" it must transmit through the input face, and reflect from the two back mirrors, as drawn.

(A) Calculate the minimum index so the rear surface does not require a mirror coating to efficiently reflect all normally incident light.

(B) Calculate the minimum index so that at least some of light incident at up to 90° angle on the front face is retro-reflected.

(C) Assuming the front surface is anti-reflection coated, what is the index required such that all of the light which is transmitted through the front face is retroreflected, coming from any incident angle (i.e. from normal to nearly 90°)?

(D) Assuming the retroreflector is made from the material of index you calculated in part B, would the reflected intensity of normally incident light increase or decrease if the rear surfaces were coated with gold mirrors? Explain your answer.