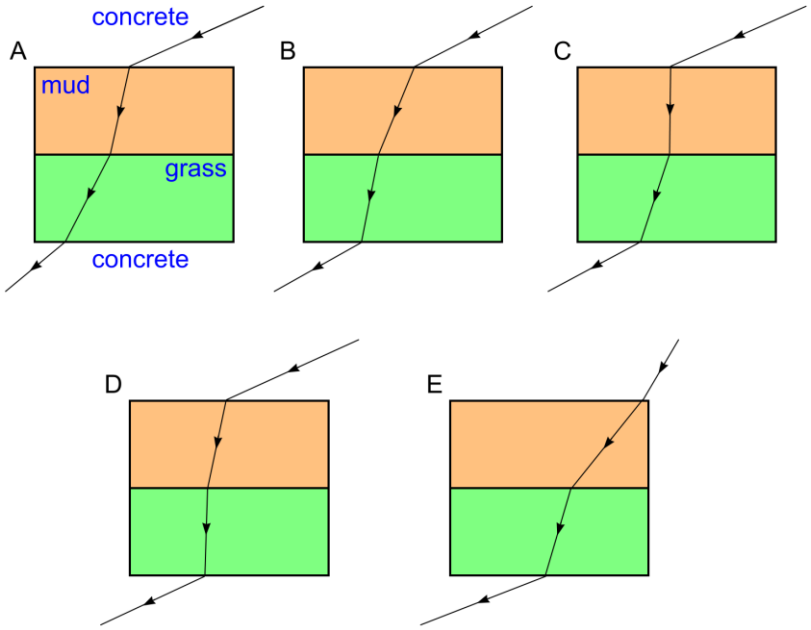
Modern Optics, Prof. Ruiz, UNCA **Fall 2020**

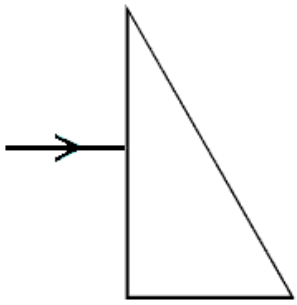
Exam 1 Closed Book, Closed Notes, Closed Everything, HONOR CODE
NOTE EXCEPTION: For this specific exam, a calculator is permitted.

[30 pts] Multiple Choice GRE Style.

1. Which path below will take the least time if the

speed on concrete > speed on grass > speed on mud.





2. The ray of light shown entering the glass will ultimately leave the piece of glass traveling

(A) somewhat downward
(B) in the same direction
(C) somewhat upward.

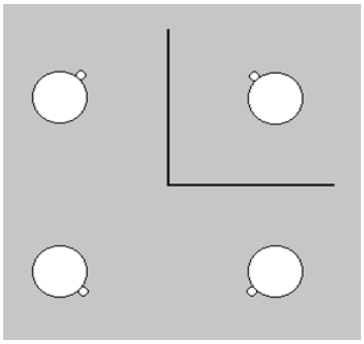
3. A bar of soap is sitting on a soap stand at one end of a bath tub, where the water level just covers the rectangular soap stand. You are laying in the bathtub of water with your head at the opposite end. Sketch to the right (not to turn in) what you see if you slip down under the water (with goggles so you can see better). Before you drown, you will see the soap

(A) shifted upward above the surface.
(B) appearing to be in its actual location.
(C) shifted downward below the surface.

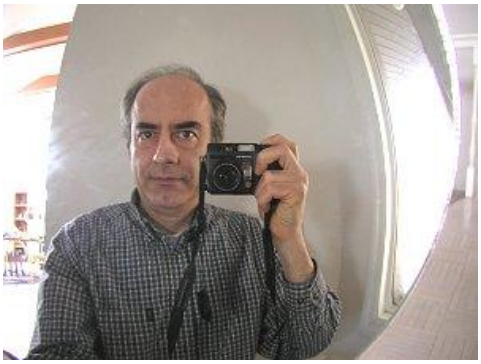
4. You pull out a pocket 4 cm x 4 cm plane mirror and look at your face. You will be able to see at most

(A) 1 cm x 1 cm of your face.
(B) 2 cm x 2 cm of your face.
(C) 4 cm x 4 cm of your face.
(D) 8 cm x 8 cm of your face.
(E) 16 cm x 16 cm of your face.

5. You are visiting a hair stylist. Two walls have mirrors joined at a corner. You see three reflected images of yourself. You look toward the corner of the corner-mirror to observe the central image. You then touch your right cheek with your right hand.



(A) The central image's left hand touches the image's left check.
(B) The central image's left hand touches the image's right check.
(C) The central image's right hand touches the image's left check.
(D) The central image's right hand touches the image's right check.
(E) The central image's left hand slaps you in the face.



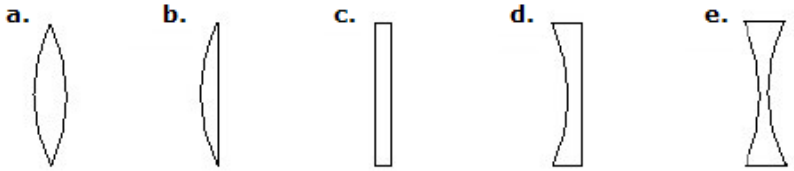
6. The image of the photographer is

(A) between the photographer-observer and the mirror.
(B) on the mirror.
(C) behind the mirror.

7. Which is true for an upright object and vertically-oriented mirror whether that mirror be convex, concave, or planar.

(A) Some real images formed are upright.
(B) All virtual images formed are behind the given mirror being used.
(C) The virtual images formed in some cases are inverted.
(D) All real images, when formed by the appropriate mirror, are smaller.

8. Which lens has the shortest positive focal length?



9. The wooden rail of the deck is 2 meters from the lens. The image is

(A) between the observer and lens and less than 2 meters from the lens.

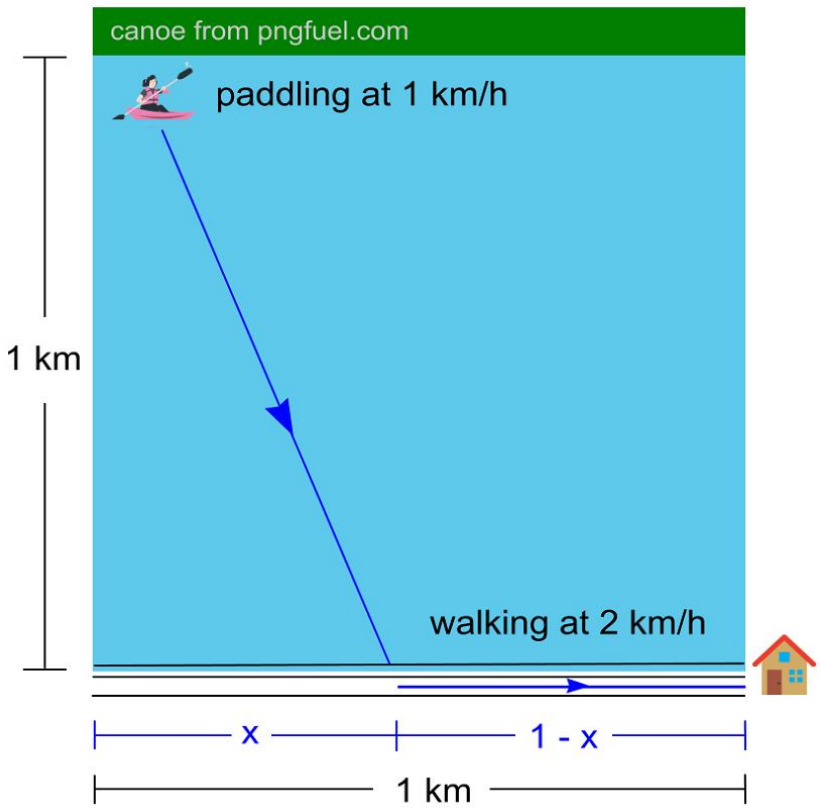
(B) between the observer and lens and greater than 2 meters from the lens .

(C) between the lens and wooden rails.

(D) beyond the wooden rails.

(E) none of these.

10. For a given scene a good picture is taken at f/11 at 1/30 second. What f/# should be used at 1/60 second where the film or sensor sensitivity is the same? (A) f/4 (B) f/5.6 (C) f/8 (D) f/11 (E) f/22



[20 pts] A Trip Home.

A lady is paddling in a canoe at 1 km/h and then will walk the rest of the way home at 2 km/h. For the shortest trip in time, what should x be when she touches land?

Give your answer in simplest form with whatever you have, e.g., fractions, radicals, etc. Be sure that the answer is in simplest form.

Then give your answer to two significant figures.

Always include units with answers.

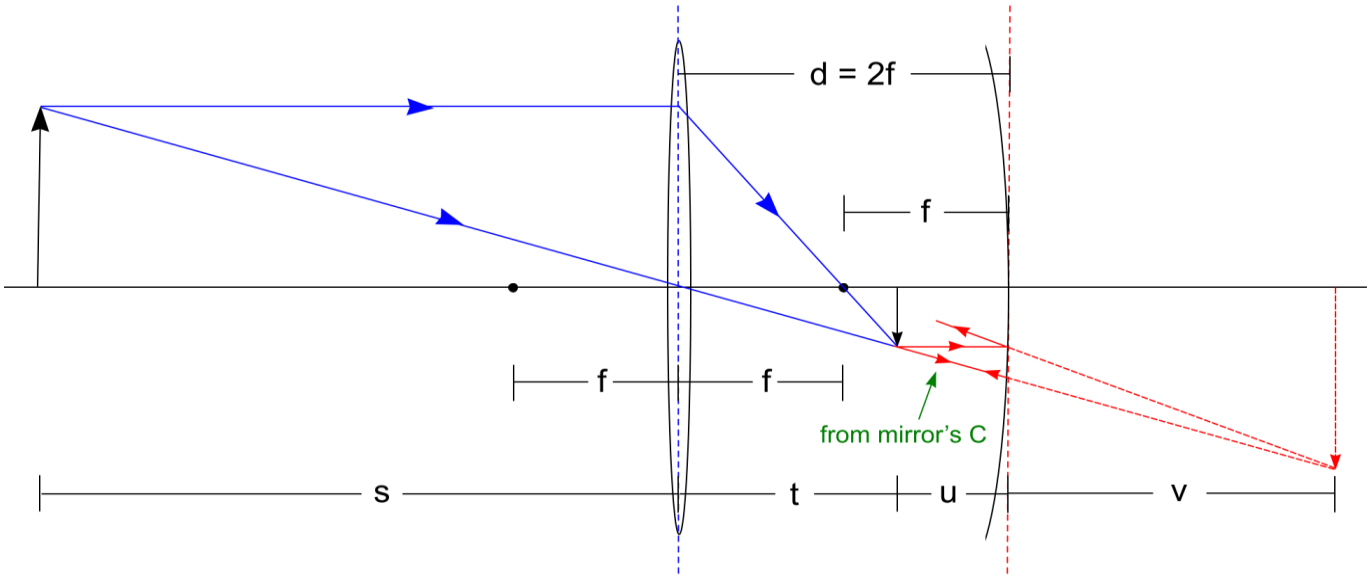
Neglect the width of the street.

[20 pts] The Boy and His Balloon. My son Evan is holding a balloon at a party held for the UNCA Science Faculty and Staff back in the 1980s. He sees a reflection of himself due to the inflated balloon.

In any distance units of your choice, calculate the focal length of the balloon's reflecting surface by making appropriate estimates of the relevant parameters you need for the basic optics formula for curved reflecting surfaces.

Explain the reasoning behind each estimate you make as you examine the photo. What is the radius of curvature for the reflecting surface? Give your focal length and radius of curvature to two significant figures.

[30 pts] Lens-Mirror System. The diagram below is only for a specific object distance s.



(a) Find v when $s \to \infty$. [5 pts]

(b) Find v when $s = f$. [5 pts]

(c) Find v when $s = 3f$. [10 pts]

(d) Derive a formula for v in terms of s and f, i.e., find $v = v(s, f)$. [10 pts]