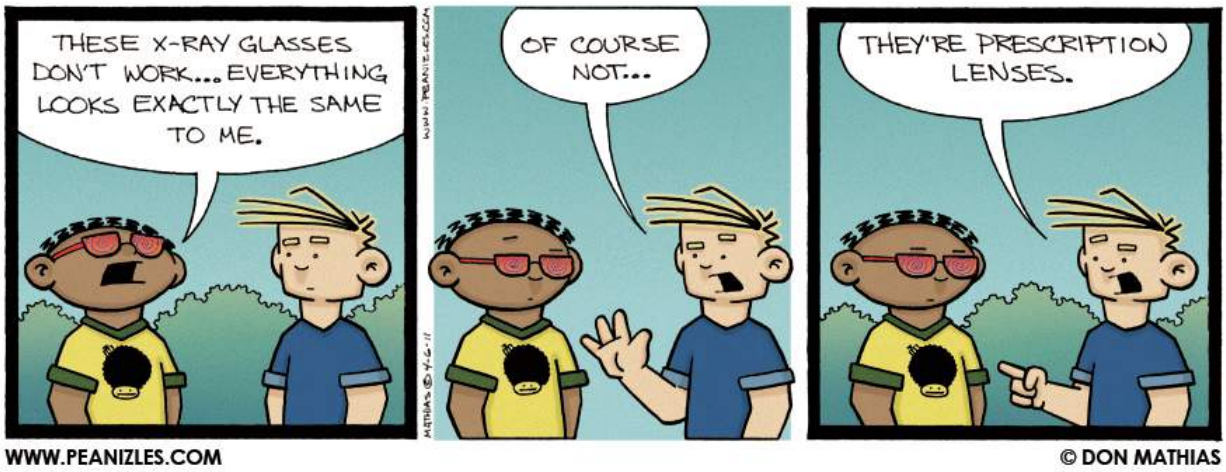


SSSS OPTICS

ANSWER KEY

Time: 50 Minutes

Written by: -SeaSa1ted-

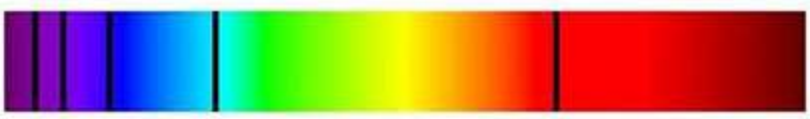
SECTION 1: Multiple Choice

1. Which part of the eye is primarily responsible for focusing light on the retina?
    a. Lens
    b. Rods
    c. Cones
    d. Pupil

2. Which part of the eye is responsible for the detection of color?
    a. Lens
    b. Rods
    c. Cones
    d. Pupil

3. When combining the wavelengths of 550 nm and 650 nm, what is the resulting color?
    a. Cyan
    b. Magenta
    c. Yellow
    d. Orange

4. What element is displayed in this absorption spectrum?



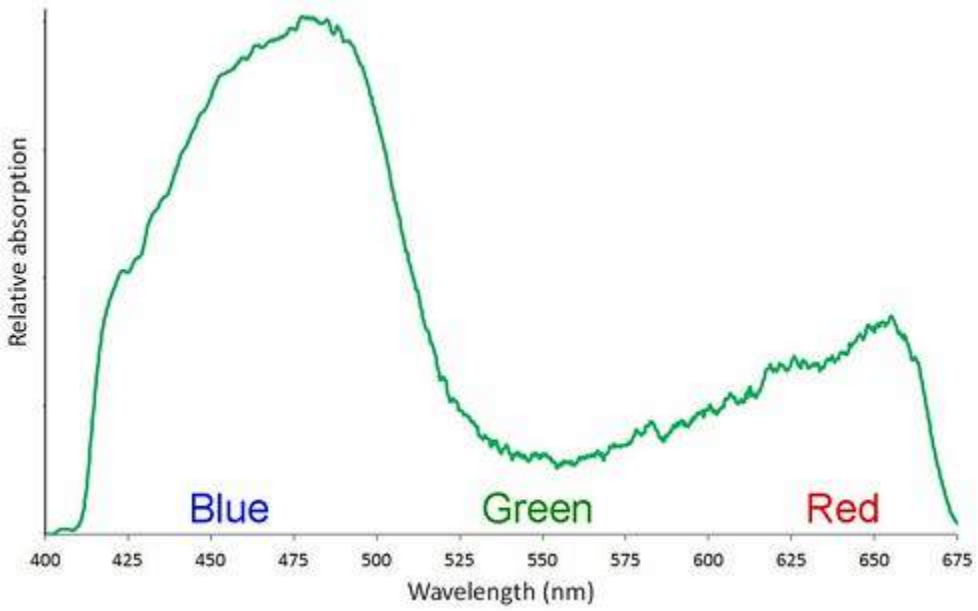
    a. Neon
    b. Helium
    c. Oxygen
    d. Hydrogen

5. What image is formed when the object is between the focus and the center of curvature of a concave mirror?
    a. Virtual and Erect
    b. Virtual and Inverted
    c. Real and Erect
    d. Real and Inverted

6. Who was the first confirmed person to build a telescope?
    a. Galileo
    b. Isaac Newton
    c. Hans Lepperhey
    d. Christian Huygens

7. Where is the image formed when an object is placed at the focal point of a convex lens?
    a. At the focal point (F) behind the lens
    b. Beyond 2F
    c. At infinity
    d. Between 2F and the focal point

8. A leaf has the absorption graph as such:



What color is being shown by the leaf?
    a. Bluish-Green
    b. Reddish-Green
    c. Blue
    d. Red

9. In a Gregorian telescope, the two mirrors that make up the inside of the telescope are:
    a. Primary: Convex, Secondary: Concave
    b. Primary: Concave, Secondary: Convex
    c. Primary: Convex, Secondary: Convex
    d. Primary: Concave, Secondary: Concave

10. In a compound optical microscope, what type of image is formed using the objective lens (NOT THE OCULAR LENS)?
    a. Virtual and Erect
    b. Virtual and Inverted
    c. Real and Erect
    d. Real and Inverted

11. The Hubble Space Telescope, responsible for the images below, is an example of what type of telescope?

(Not Used for Testing Purposes, Just Thought these Pictures Looked Cool :D)

a. Ritchey-Chrétien
b. Newtonian
c. Herschelian
d. Gregorian

12. What are the primary colors?
a. Yellow, Red, Blue
b. Green, Red, Blue
c. Blue, Orange, Red
d. Purple, Red, Yellow

13. For a camera, as the focal length increases, the magnification _____ and as the focal length decreases, the magnification _____.
a. increases, decreases
b. increases, increases,
c. decreases, increases
d. decreases, decreases

14. The index of refraction for green light is _____ than the index of refraction of red light
a. higher
b. lower

Questions 15 - 20 comprise of True or False Questions:

15. True or false: A diverging lens is used to correct myopia?
    a. True
    b. False

16. The Opponent Processing Theory comprises the opposing color pair: red vs blue, green vs yellow, and black vs white.
    a. True
    b. False

17. Circular polarized light consists of two perpendicular electromagnetic plane waves of equal amplitude and a 90^{o} difference in phase
    a. True
    b. False

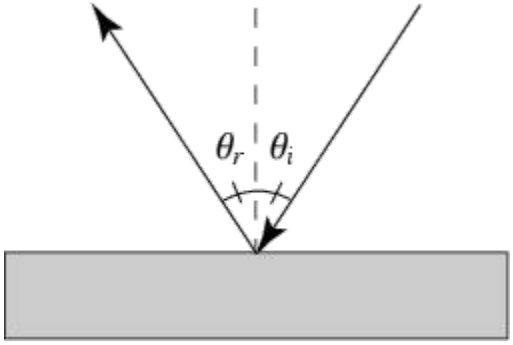
18. In a convex lens, an object at the focal point is magnified.
    a. True
    b. False

19. A pinhole camera relies on the small aperture of its lens to focus light on one focal point and display an inverted image.
    a. True
    b. False

20. Chromatic aberration was first corrected by decreasing the focal length of a lens.
    a. True
    b. False

SECTION 2: FREE RESPONSE

1. In the diagram below, a ray of light strikes a plane mirror at the angle $\theta_i = 35°$. What angle is the resulting reflected light, θ_r, in degrees?

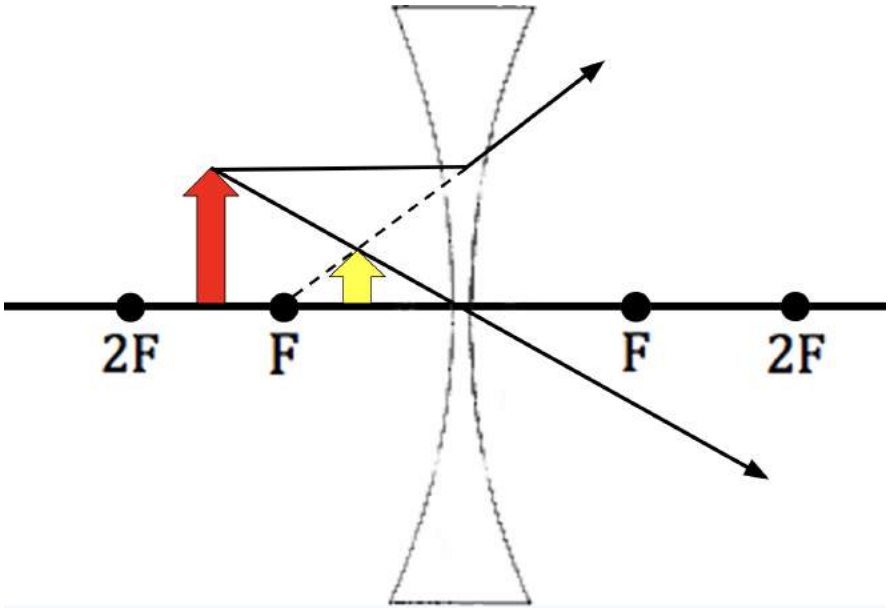


$\theta_r = 35°$

2. What phenomenon describes why the sky is blue?
Rayleigh Scattering

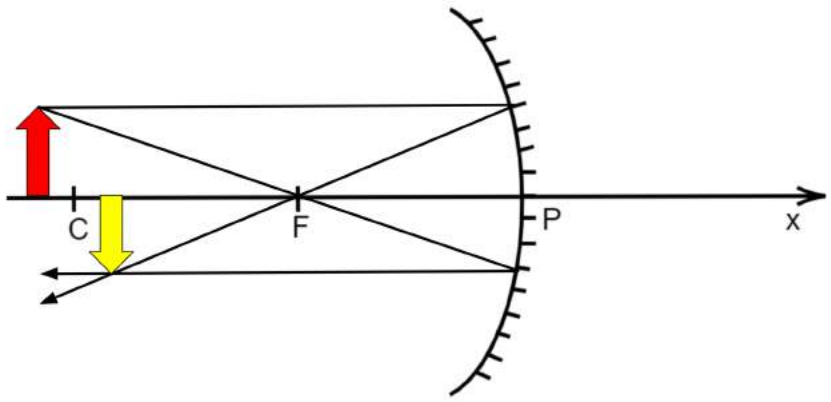
3. Using ray tracing, draw where the resulting image of the object will be for this concave lens.

Answer:



4. Describe the image formed:
Virtual, Erect, and Diminished/Shrunken

5. Using ray tracing, draw where the resulting image of the object will be for this concave mirror.
   Answer



6. Describe the image formed:
   Real, Upside down, and Diminished/Shrunken

7. What is the eye condition caused by aging, leading to the diminishing ability for a person to focus on near objects?
   Presbyopia

8. What eye condition causes the loss of the lens of the eye?
   Aphakia

9. What is the smallest angle in which total reflection would occur if a beam of light were to travel from olive oil (n = 1.47) to water (n = 1.33)?
   $\theta = \arcsin(n_2/n_1)$
   $\theta = \arcsin(1.33/1.47)$
   $\theta = 64.8^{o}$

10. What property defines an ideal "matte" or diffusely reflecting surface?
    Lambertian Reflectance

11. What is the optical power of a lens, in diopters, given that its focal length is 50 mm?
    50 mm = 0.05 m
    O = 1/f
    O = 1/0.05
    20 D

12. Briefly explain the concept of spherical aberration.
    A beam of light passing through a lens does not exactly meet at the focal point.

13. A ray of light travels from water (n = 1.33) into a diamond (n = 2.42), at what angle, θ in degrees, must the ray of light be traveling at for the light to be fully linearly polarized?
    $\theta = \arctan(n_2/n_1)$
    $\theta = \arctan(2.42/1.33)$
    $\theta = 61.2^o$

14. Which muscle controls the accommodation of the lens of the eye?
    Ciliary Muscle

Questions 15 and 16 relate to one another:

15. If a beam of unpolarised light coming from the sun with an irradiance, I_0 = 340 W/m^2, passes through a perfect polarizer, what is the resulting irradiance of light?
    $\frac{I}{I_o} = \frac{1}{2}$
    $I = \frac{1}{2}(340)$
    170 W/m^2

16. The polarized light from Question 6 is yet again passed through another filter with an angle of orientation at θ = 60^o, what is the resulting irradiance of light?
    42.5 W/m^2
    Carry-over points can be awarded as long as the equation: $I = I_0 cos^2\theta_i$ is used

Questions 17 and 18 relate to one another:

17. If an object is placed 6 meters in front of a concave mirror with a focal length of f = 10 meters, where would the image be formed (in meters) relative to the mirror?
    15 meters away

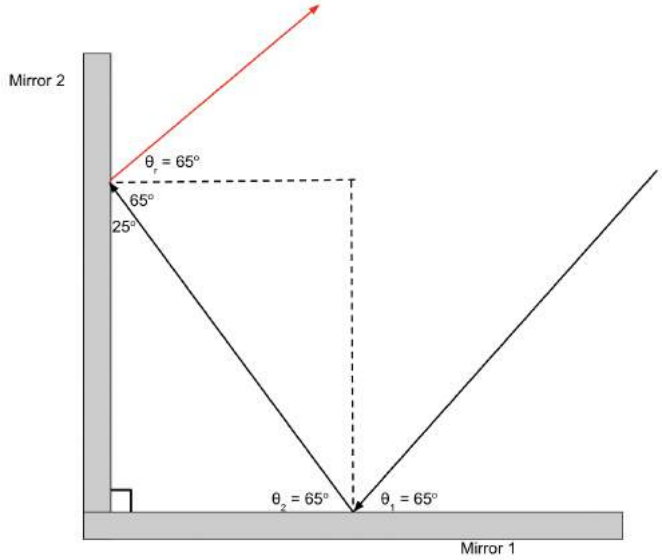
    a. This image is (real / virtual)

18. What is the magnification of the image?
    2.5x

    a. This image is (erect / inverted)

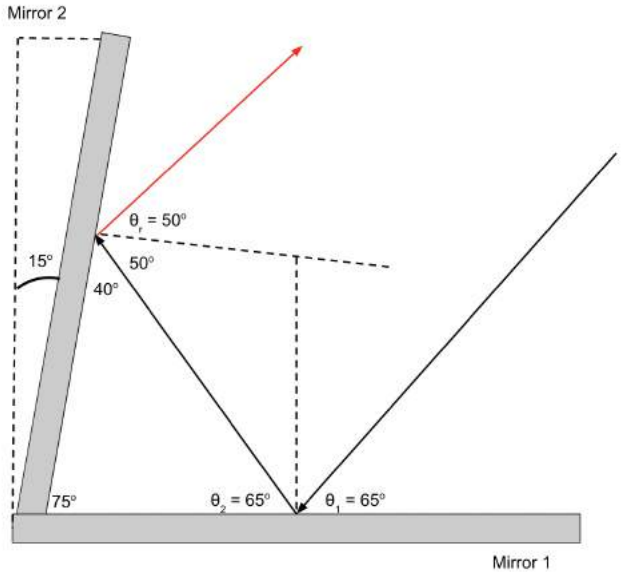
Questions 19 and 20 relate to one another:

19. Using the principles of geometry and Snell's Law, what is the angle of reflection, θ_r, for the ray of light in red given that the mirrors are plane mirrors?



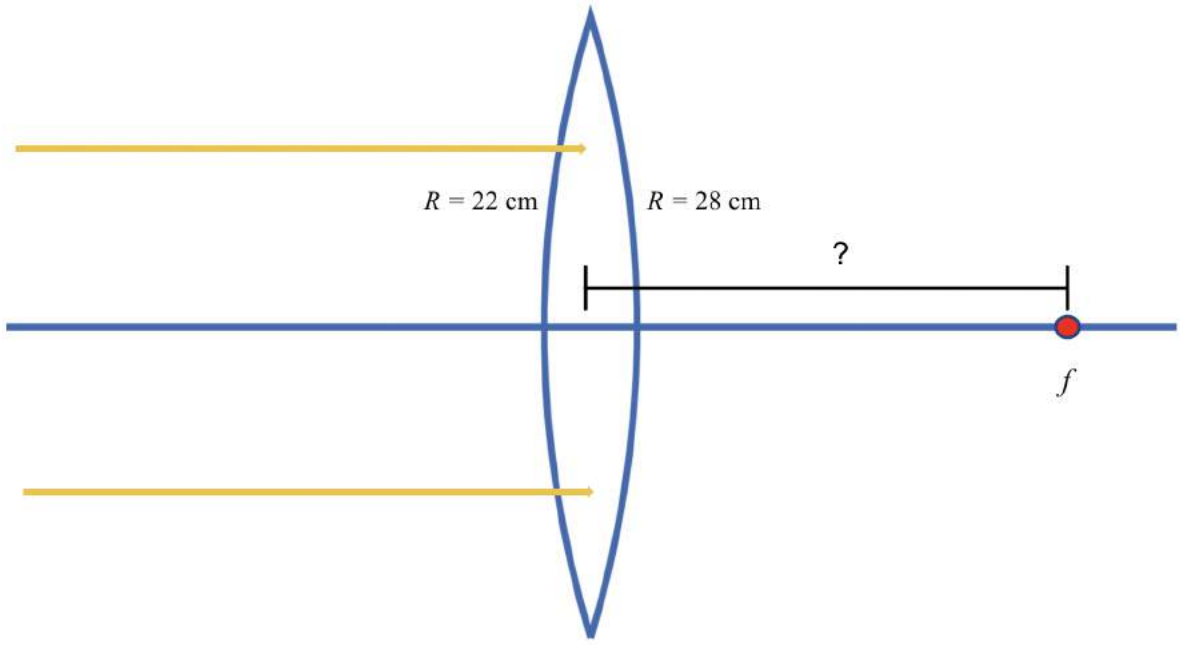
$\theta_r = 65^o$

20. Whoops! In a moment of unbridled excitement, a puppy bumped into mirror 2, causing it to lean forward 15°. What is the angle of reflection, θ_r, now?



$\theta_r = 50^o$

21. The following glass lens has a negligible diameter. If the refractive index of glass is n = 1.5, what is the focal length of the lens, in meters?



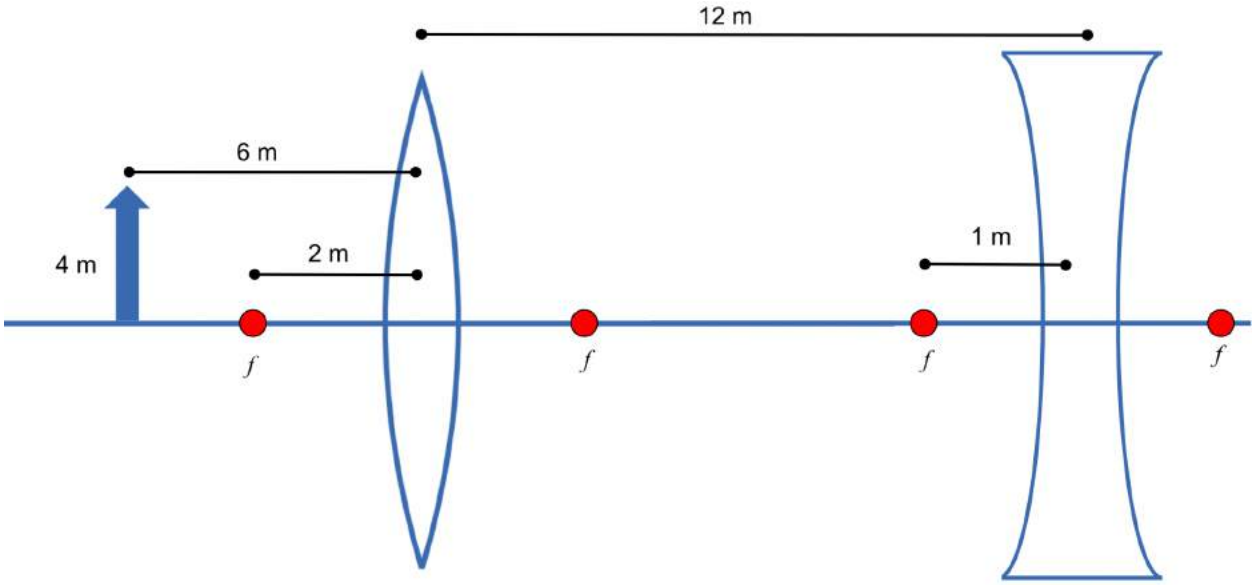
$\frac{1}{f} \approx (n - 1)(\frac{1}{R_1} - \frac{1}{R_2})$

$\frac{1}{f} \approx (1.5 - 1)(\frac{1}{0.22m} - \frac{1}{0.28m})$

$\frac{1}{f} \approx 0.49\, m$

$f \approx 2.05\, m$

22.Using the diagram below, find the size of the image formed by the concave lens in meters.



Finding Distance of Image Formed by the Concave Lens

$\frac{1}{f} = \frac{1}{s_i} + \frac{1}{s_o}$

$\frac{1}{2} = \frac{1}{s_i} + \frac{1}{6}$

$s_i = 3m$ (distance of image formed by convex lens)

12m - 3m = 9m (distance of 1st image from the concave lens)

$-\frac{1}{1} = \frac{1}{s_i} + \frac{1}{9}$

$s_i = -1.125m$

Finding the Size of the Image Formed by the Concave Lens

$m = \frac{-s_i}{s_o}$

$m = \frac{-(3)}{6} = -\frac{1}{2}$x

Image size after convex lens = 4(0.5) = 2

$m = \frac{-(-1.125)}{9} = 0.125$x

Image size after concave lens = 2(0.125) = 0.25 m

So the size of the image formed by the concave lens is 0.25 meters.