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Use the data in the table below to answer questions 1 - 6.

Medium	Refractive index
Air	1.00
Water	1.33
Fused quartz	1.46
Benzene	1.50
Halite	1.54
Flint Glass	1.65
Diamond	2.42

1. How fast does light move through flint glass? Use c = 3.00×10^8 m/s.

For each of the following transitions between optical media, state whether total internal reflection is possible (Y) or not (N).

2. Benzene → Diamond
3. Fused quartz → Water
4. Halite → Flint glass
5. Diamond → Water

6. Among those transitions listed above where total internal reflection is possible, which one has the *largest* critical angle?

7. Consider a flat interface between air (n = 1.00) and water (n = 1.33). When viewing from the air into the water, how wide (in degrees) is the field of view in the water?

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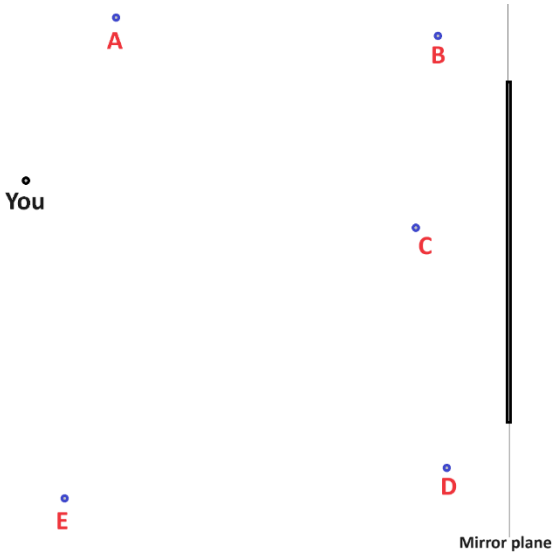

8. In the diagram above, you stand at the black point and look towards a plane mirror indicated by the thick black line. Which of the five blue points would you be able to view objects placed at?

9. Many vehicles' passenger side-view mirrors must say "Objects in mirror are closer than they appear" because the mirrors are _____, causing all reflected images to appear smaller than the actual objects.
    a. Plane
    b. Concave
    c. Convex

10. What is the advantage of using that type of mirror for side-view mirrors?

11. What is another possible use of that type of mirror?

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12. Parabolic trough collectors are a type of solar power array that uses _____ mirrors to concentrate solar energy
    a. Plane
    b. Concave
    c. Convex

13. Where along the focal plane of the mirror should the receiver pipe be located?
    a. Greater than $2f$
    b. At $2f$
    c. Between f and $2f$
    d. At f
    e. At ½ f

14. Why is it important that the mirrors are parabolic rather than spherical in shape?

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For questions 15 – 19, consider a concave spherical mirror with a radius of curvature of 80.0 cm that has an object placed 65.0 cm from the mirror.

15. What is the focal distance of the mirror, in cm?

16. How far from the mirror is the image located, in cm?

17. What is the magnification of the mirror in this setup?

18. Is the image real or virtual?

19. Is the image upright or inverted?

For questions 20-27, use the lens in the image to the right.

20. What kind of lens is shown in the image?
    a. Double concave
    b. Plano-concave
    c. Diverging (negative) meniscus
    d. Double convex
    e. Plano-convex
    f. Converging (positive) meniscus

21. Using the lensmaker's equation, calculate the power (in cm^{-1}) of the lens given that the curved surface has a **radius of curvature of 75 cm** and the material which comprises it has an **index of refraction of 1.5**. Assume the lens is thin relative to the radius of curvature of its curved surface.

$$P \approx (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

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22. What is the focal length of the lens, in cm?

23. If an object is placed 75 cm from the lens, how far from the lens does the image occur?

24. What type of image is formed?

25. What is the magnification of that image?

26. A second lens with a focal length of -125 cm is placed in contact with the first lens from the preceding questions. What is the power of the new system of both lenses (in cm^{-1})?

27. Is the system of both lenses from the previous question capable of producing a real image?

28. A red laser beam (λ=700 nm) strikes a glass prism with an index of refraction of $n_{\lambda=700nm} = 1.4$. The minimum deviation angle will depend on which parameter?
    a. Index of refraction of violet light ($n_{\lambda=400nm}$) of the glass prism
    b. Apex angle of the prism
    c. Critical angle of the glass
    d. Attenuation coefficient of the glass

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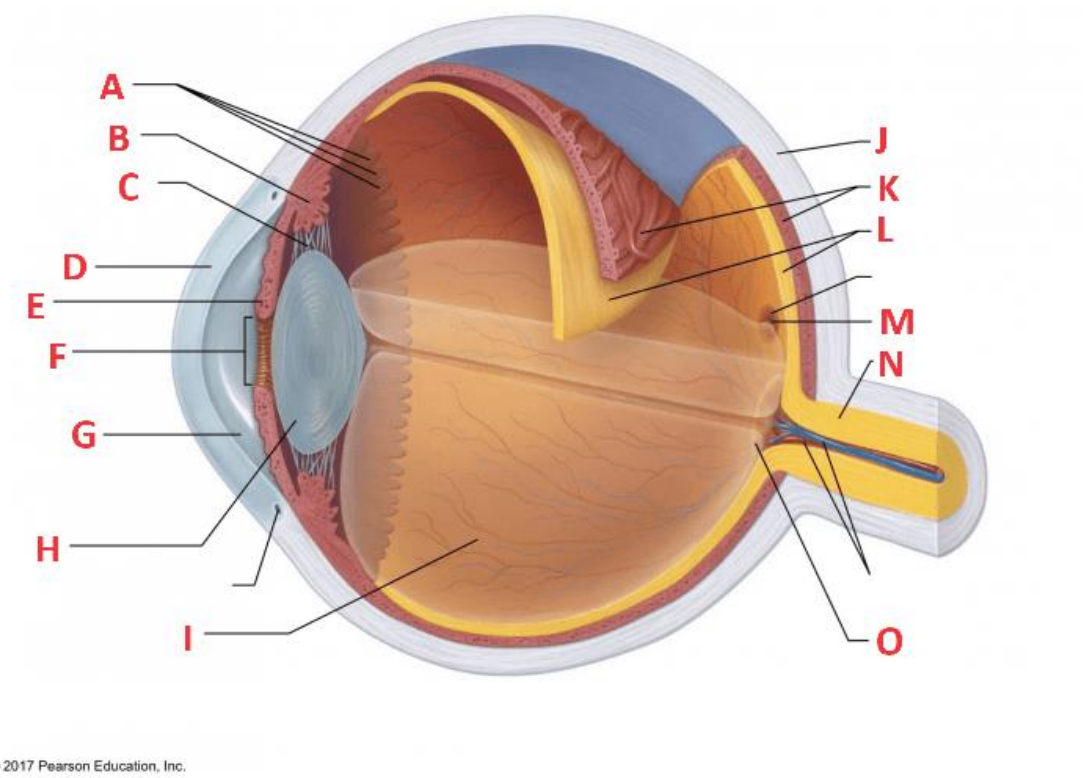

For questions 29-33, indicate the letter which corresponds in the diagram and briefly describe the function of that eye structure.

29. Pupil

30. Lens

31. Ciliary body

32. Retina

33. Fovea centralis

34. Cataracts primarily affect which eye structure(s)?
    a. Dilator and sphincter pupillae muscles
    b. Sclera
    c. Retina
    d. Aqueous humor
    e. Lens

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35. Myopia or near-sightedness occurs when an eyeball grows to long or when the lens refracts light too strongly, resulting in
    a. Light focusing in front of the retina
    b. Light focusing behind the retina
    c. Dispersion of light by the vitreous humor
    d. Dispersion of light by the aqueous humor

36. How would a person's vision be different if their eyes' lens were concave instead of convex?

37. Most people have trichromatic vision as a result of having three distinct types of _____ cells.

38. Each of the primary colors of pigments absorbs light that is
    a. One of the other primary colors of pigments
    b. The other two primary colors of pigment
    c. One of the primary colors of light
    d. Two of the primary colors of light

39. To reduce eyestrain while on her computer at work, Lori wears glasses that filter out some of the monitor's blue light. While wearing the glasses, white areas on the screen would appear to be tinted
    a. Red
    b. Green
    c. Cyan
    d. Yellow

40. In a dark room, a flashlight is shone through a magenta filter onto a red slice of construction paper. What color does the paper appear?

41. In a dark room, a flashlight is shone through both a cyan and green filter onto a blue wall. What color does the wall appear?

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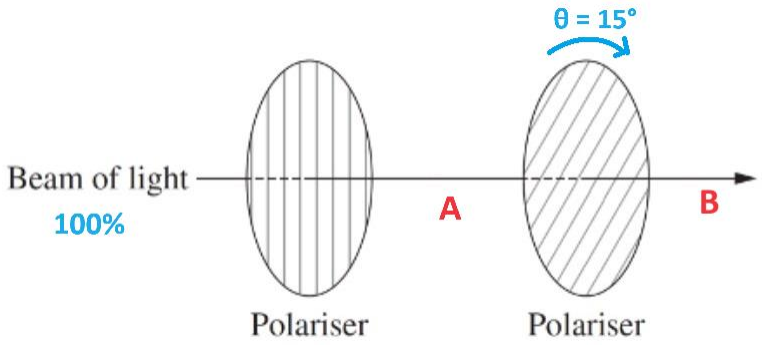

For questions 42-46, unpolarized sunlight passes through two polarizing filters as shown in the diagram above.

42. The first filter is placed such that its axis is straight up and down. What percent of the original beam is able to pass through the filter to reach point A?

43. How would the answer to the previous question change if the filter axis was oriented left to right?

44. After passing through the first, up-down oriented filter, the light passes through a second filter whose axis is rotated 15° clockwise from the first filter. What percent of the original beam is able to pass the second filter to reach point B?

45. How would the answer to the previous question change if the second filter was instead rotated 15° counterclockwise?

46. (Tiebreaker only) On a blank piece of graph paper, draw a graph that represents the relationship between the angle between the axes of the two polarizing filters (θ) and the percent of the original beam reaching point B. Be sure to label the paper with your team name and number.

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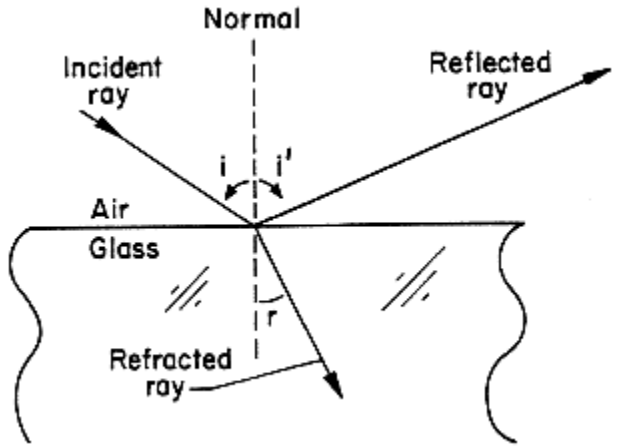

For questions 47-49, an unpolarized incident ray in air (n=1.00) strikes a glass (n = 1.52) surface, similar to the diagram above.

47. If the angle of the incident ray is equal to Brewster's angle, which ray will be polarized?
    a. The reflected ray
    b. The refracted ray
    c. Both the reflected ray and the refracted ray
    d. Neither the reflected nor the refracted ray

48. Calculate Brewster's angle (in degrees) for the air-to-glass interface, given that $\theta_B = \arctan\left(\frac{n_2}{n_1}\right)$

49. True or False: Brewster's angle only occurs when a ray travels from a medium with a lower refractive index to a medium with a higher refractive index.