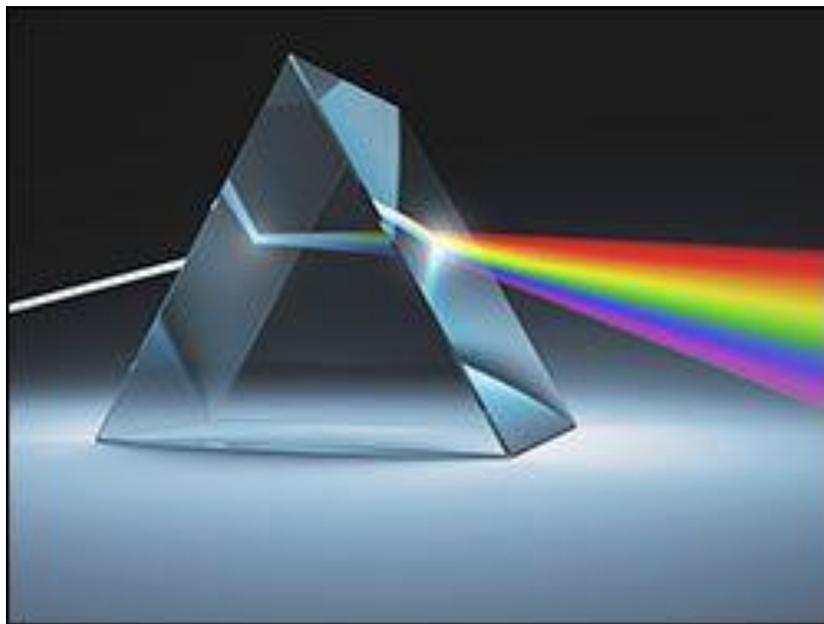


Science Olympiad Optics Theoretical Exam Division C SSSS 2017-2018



Competitor Names:

School Name:

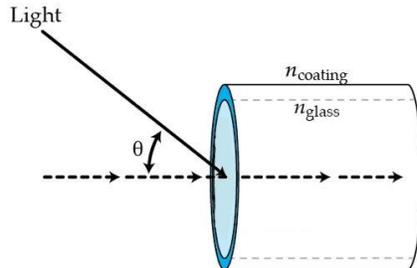
Created by: sahil31415

Good luck!

Please write your answers on the Answer Sheet provided.

All questions are worth one point, for a total of 50 points

1. Shown below is an optical fiber. What is the maximum entering angle θ in degrees a light ray can pass from the air to the glass fiber for total internal reflection to occur? (Assume the index of refraction for air, glass, and the coating (respectively) are 1, 1.5, and 1.46).

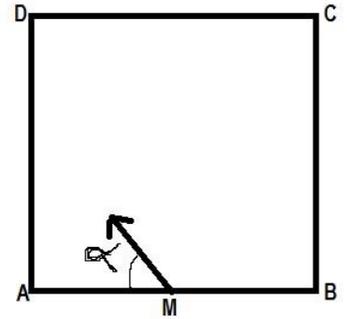


2. A 4 cm-tall light bulb is placed a distance of 45.7 cm from a double convex lens having a focal length of 15.2 cm. Determine
 - (a) the image distance.
 - (b) the image size.
3. The human eye is most sensitive to which color in the visible spectrum?
4. What is astigmatism?
5. Which part of the eye does most of the refraction?
6. Where is the blind spot located in the eye?
7. A farsighted person's eye has a near point of 150 cm. What lens power in diopters must a pair of reading glasses have to the person can read at 25 cm?
8. A(n) _____ lens can form only virtual images.
9. To obtain TIR (total internal reflection), the light ray must approach an interface with a _____ index of refraction.
10. How much luminous flux must a lamp produce to have 20 lux illumination at a distance of 1.5 meters?
11. Rayleigh scattering of light is inversely proportional to the fourth power of _____.
12. How tall (feet) must a plane mirror be for an 8-foot-tall man to see his entire reflection?
13. An object with height 12 cm is placed 23 cm in front of a spherical mirror with focal length 15 cm. Calculate the distance from the mirror and the size of the image that is formed.
14. Which of the following cannot be true of an image formed by a spherical mirror of focal length $f=-25$ cm?
 - a. Image is located behind the mirror.
 - b. Image is virtual.
 - c. Image is upright.
 - d. Image is larger than the object.

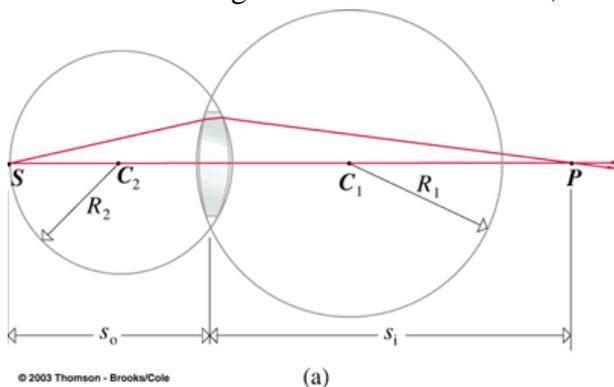
15. A 30-cm object is placed a cm in front of a concave mirror of focal length $a/2$ cm. How tall is the image (cm)?
16. If the focal length of a spherical mirror is +10 cm, at what distance must an object be placed so the image created is the same size?
17. Draw a ray diagram for an object located at the focal point of a concave spherical mirror.
18. What is the formula to calculate power in diopters in terms of the focal length?
19. Match each medium to their respective refractive indices:

CR39 (Eyeglasses)	1.0003
Diamond	1.33
Water	2.42
Air	1.498
Glass	1.65
Heavy Flint Glass	1.52
20. A ray of light enters a plane of NaCl ($n=1.51$) at an incident angle of 32 degrees from a vacuum. What is the angle of refraction?
21. A ray of sunlight enters a 3-meter-deep swimming pool at an incident angle of 78 degrees. What is the horizontal distance between the point where the ray hits the water and where it hits the pool floor?
22. Light travels through a medium at a velocity of 1.85×10^8 m/s. Calculate the index of refraction.
23. A ray of light enters a plane of water at an incident angle of 21 degrees from the medium described in question 15. Calculate the angle of refraction.
24. An unpolarized ray of light reflects off of a sapphire surface ($n=1.77$) from a vacuum. Calculate Brewster's angle in this scenario.
25. What is the formula given by Malus's Law? Define any variables.
26. Which color light has a greater angle of deviation when refracted through a prism, orange or blue?
27. When white light hits a magenta filter, what color is absorbed? What colors are transmitted?
28. Give an example of an incoherent light source.
29. The Hubble Space Telescope is an example of a _____ (reflecting/refracting) telescope.
30. Balmer lines are located in which region of the EM spectrum?
31. The distance between object and the image formed by concave mirror is 15 cm. The value of transverse magnification is -2. Find the focal length of the mirror.
32. A mirror that forms only virtual images is given, and the radius of curvature is 3m. Find the focal length of the mirror.
33. A lens forms a real image of an object on a screen placed at a distance of 100 cm from the screen. If the lens is moved by 20 cm towards the screen, another image of the object is formed on the screen. What is the focal length of the lens?

34. Four identical mirrors are made to stand vertically to form a square arrangement in the top view (at right). A ray starts from the midpoint M of mirror AB and after two reflections reaches corner B. Find $\cot(\alpha)$.



35. Find the critical angle for a ray of light passing from water into air.
36. Define what the center of curvature is for a parabolic lens.
37. If a lens has a focal length of 8 cm, how far away must an object be for the image to be inverted and the same size?
38. What is the index of refraction of a prism with apex angle 30 degrees and angle of minimum deviation 70 degrees, assuming it is surrounded by a vacuum?
39. Which color has the greatest angle of deviation when refracted by a prism; yellow, red, or green?
40. What is the angle of minimum deviation of a glass prism ($n=1.52$) with an apex angle of 60 degrees, assuming it is surrounded by a vacuum?
41. Draw a ray diagram for an object located between in front of a convex lens between F and 2F
42. Describe the image created in question 10 (orientation, real/virtual, and size)
43. Find the f-stop of a camera lens with focal length 150 cm and diameter 1.5 cm.
44. What is a more common name for hyperopia?
45. Would presbyopia be corrected with a converging or diverging lens?
46. What are rod cells better at than cone cells? What is the drawback?
47. When someone says they have green eyes, what part of the eye are they describing?
48. Find the focal length of a lens with $n=1.48$, $R_1=20$ cm, and $R_2=40$ cm.



49. Refer back to the diagram in question 48. Find the index of refraction if the focal length is 50 cm and the R_1 and R_2 both equal to 35 cm.
50. What is the role of a condenser lens in a microscope?