

Name \_\_\_\_\_

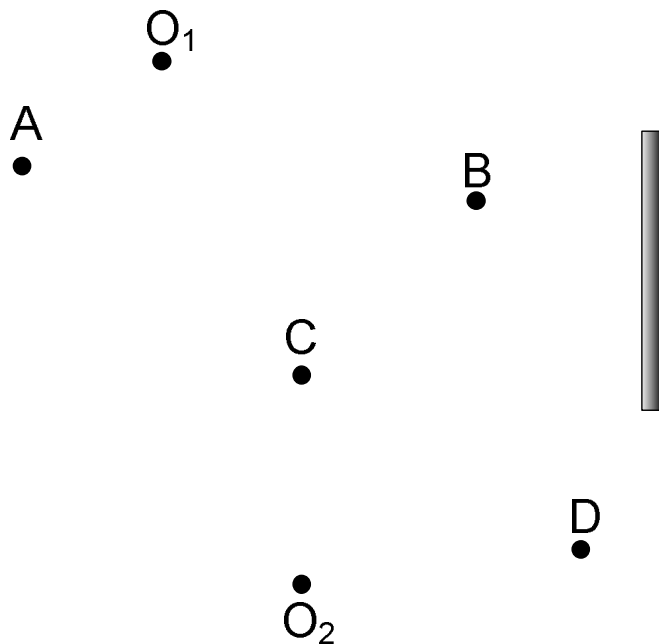
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Name \_\_\_\_\_

Team \_\_\_\_\_

**2011 Science Olympiad Kenston Invitational  
Optics – Out of Sight**

**PART B - Geometric Optics**  
Each question is worth two (2) points  
Partial credit is possible on a sketch only



There are two observers in the drawing above O<sub>1</sub> and O<sub>2</sub> along with four objects to the left of the mirror. Answer the following question based on this drawing.

26. Can observer O<sub>1</sub> see observer O<sub>2</sub> in the mirror? \_\_\_\_\_
27. Which point(s) can both observers see in the mirror? \_\_\_\_\_
28. Which point(s) can observer O<sub>1</sub> see that observer O<sub>2</sub> cannot see in the mirror? \_\_\_\_\_
29. Which point(s) can neither observer see in the mirror? \_\_\_\_\_
30. Can observer O<sub>2</sub> see observer O<sub>1</sub> in the mirror? \_\_\_\_\_

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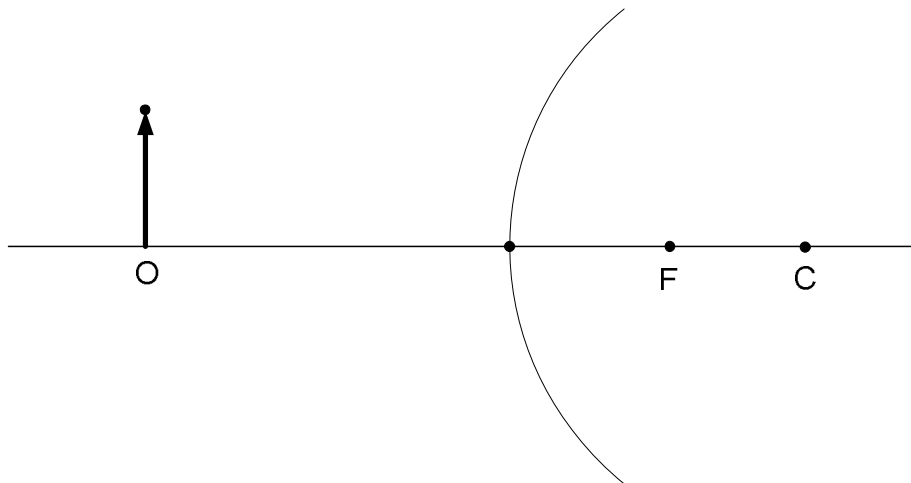
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31. Draw and label a diagram depicting reflection off a plane reflective surface such as a mirror. Be sure to include and reference all angle to the normal.

32. Show the mathematical relationship between the angle of incidence and the angle of reflection for the diagram made in the above question.

33. Using the sketch provided, determine the placement, orientation and approximate size of the image in the mirror using ray tracing techniques.



34. The radius of the mirror in the above diagram is 40 cm. What is the focal length of the mirror?  
\_\_\_\_\_

35. Is the image in the above diagram real or virtual? \_\_\_\_\_

36. What kind of mirror is in the above question? \_\_\_\_\_

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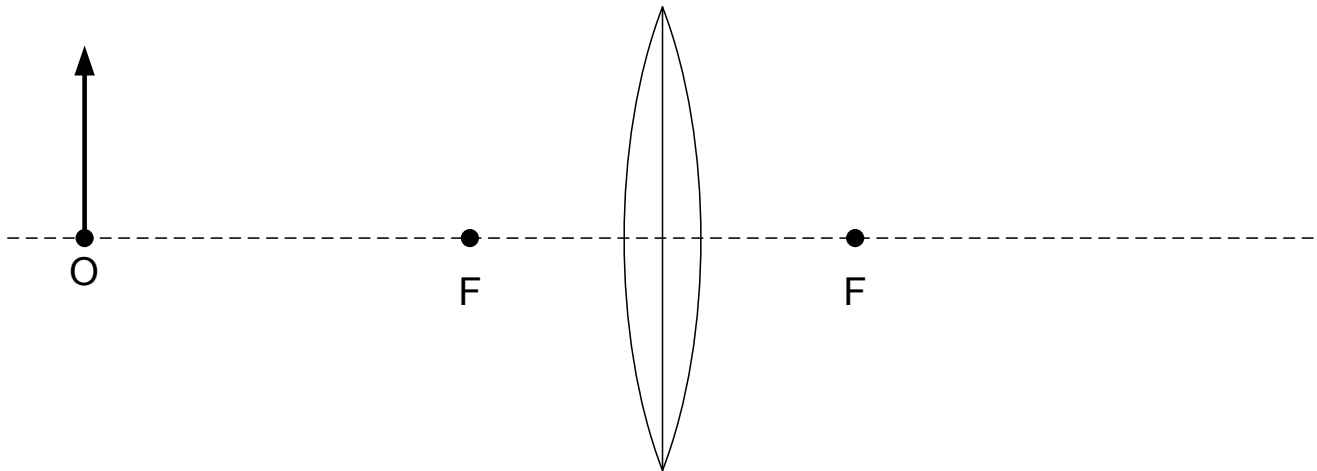
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37. Using the sketch provided, determine the placement, orientation and approximate size of the image for the thin lens using ray tracing techniques.

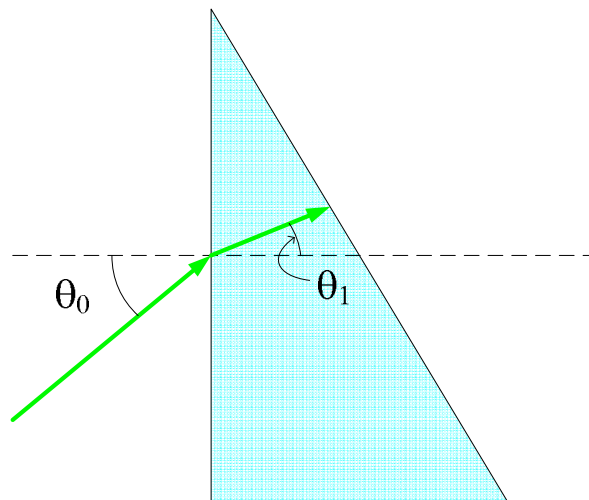


38. The height of the object in the above drawing is 20 cm, its distance from the vertex is 30 cm, and the absolute value of the height of the image is 10 cm, what is the magnification of the system? \_\_\_\_\_

39. Is the image in the above problem real or virtual? \_\_\_\_\_

40. Is a concave lens diverging or converging? \_\_\_\_\_

41. Using the sketch provided, show the ray of light that would be leaving the prism and justify your answer by showing the normal and appropriate angles.



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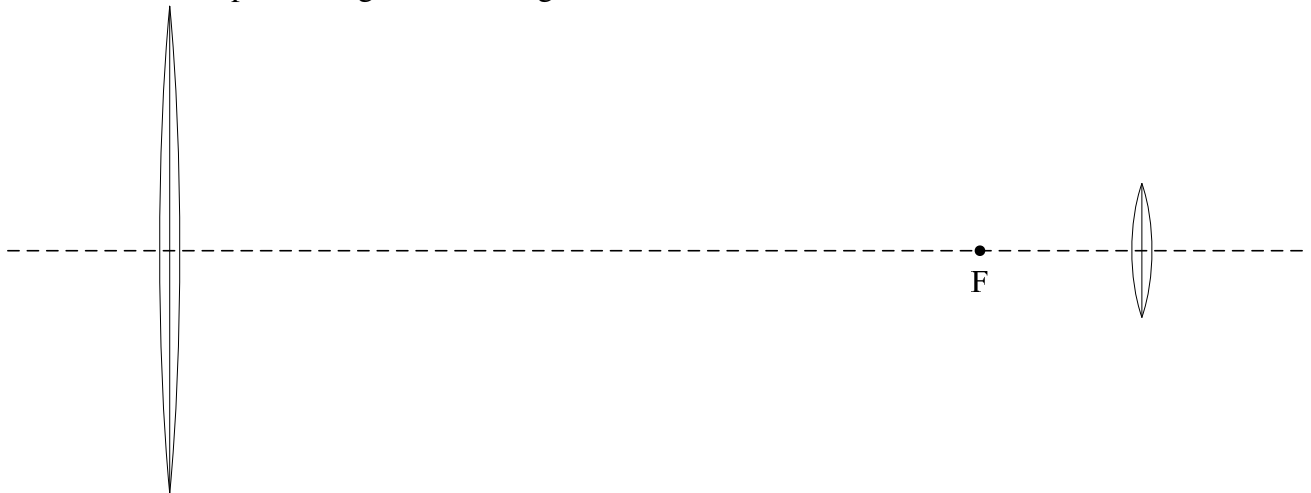
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42. Draw a Plano-concave lens

43. The sketch below shows the lenses of a refracting telescope. The point F is the focal point of both lenses. Using ray tracing techniques draw at least four light rays from a distant object that illustrates the path the light take through both lenses.



44. What is the primary optical component of a reflecting telescope \_\_\_\_\_

45. The optometrist hand you a prescription for new eye glasses. The prescription states that each lens should be 10 diopters. What is the focal length of each lens? \_\_\_\_\_

46. Most people cannot focus closer than 25cm. What is this point called? \_\_\_\_\_

47. A reflecting or refracting surface that forms perfect images is called \_\_\_\_\_

48. Optical systems that produce imperfect images are said to have \_\_\_\_\_

49. The fact that optical system work in both directions is called \_\_\_\_\_

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50. What does it mean if the magnification is negative? \_\_\_\_\_

Substance	Index of Refraction*
Vacuum	1
Air	1.00029
Ice (H <sub>2</sub> O)	1.309
Methyl alcohol (CH <sub>3</sub> OH)	1.329
Water (H <sub>2</sub> O)	1.333
Ethyl alcohol (C <sub>4</sub> H <sub>5</sub> OH)	1.36
Fluorite (CaF <sub>2</sub> )	1.434
Carbon tetrachloride (CCl <sub>4</sub> )	1.46
Turpentine	1.472
Glycerin	1.473
Benzene (C <sub>6</sub> H <sub>6</sub> )	1.501
Plexiglas	1.51
Crown glass	1.52
Rock salt (NaCl)	1.544
Fused Quartz (SiO <sub>2</sub> )	1.544
Light flint glass	1.58
Polystyrene	1.59
Medium flint glass	1.62
Carbon disulfide (CS <sub>2</sub> )	1.628
Dense flint glass	1.66
Lanthanum flint glass	1.8
Zircon (ZrO <sub>2</sub> * SiO <sub>2</sub> )	1.923
Fabulite (SrTiO <sub>3</sub> )	2.409
Diamond	2.417
Rutile (TiO <sub>2</sub> )	2.907
Gallium phosphide	3.5
* These are measures using yellow sodium light at $\lambda = 589$ nm, gas and liquids are specified at 20° C	