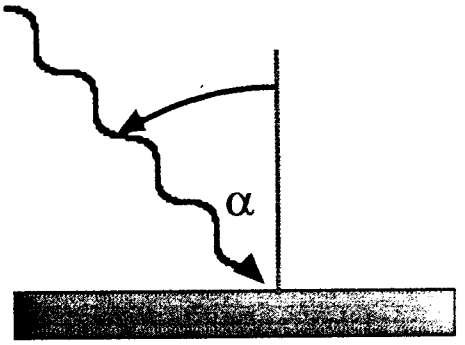
# WAVE PROPERTIES OF LIGHT

**For each of the following multiple choice problems select the BEST answer and place the appropriate capital, block letter in the space provided. [2 pts each]**



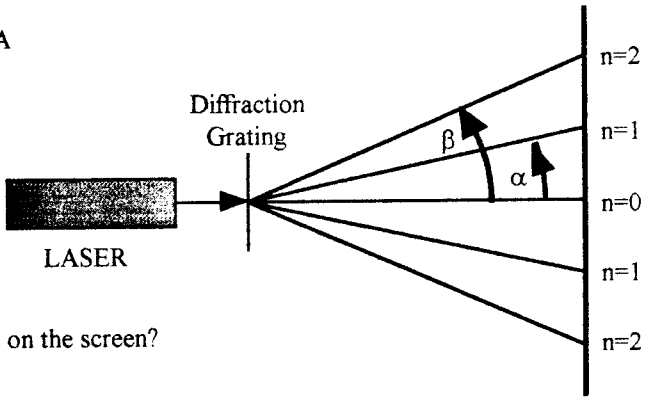

C 1. Light which has a wavelength of 5500 A in air is shining on a horizontal surface at an angle of $\alpha = 52^o$ as shown to the right. At this angle the reflected light is total polarized What is the index of refraction of this horizontal surface?

A. 1.0 B. 1.15 C. 1.28 D. 1.53 E. 1.63

**A monochromatic light source is shined through a diffraction grating which has 650 slits per cm. A diffraction pattern is shined onto a wall located L = 5.0 meters from the grating and it is noted that the first order antinode occurs at an angle of $\alpha = 2.2^o$ from the central antinode.**

C 2. What is the distance between adjacent slits in this diffraction grating?

A. 0.065 cm B. 0.0065 cm C. 154,000 A D. 48,000 A E. 65,000 A




C 3. What is the wavelength of this light source?

A. 1250 A B. 4150 A C. 5900 A D. 6300 A E. 8200 A

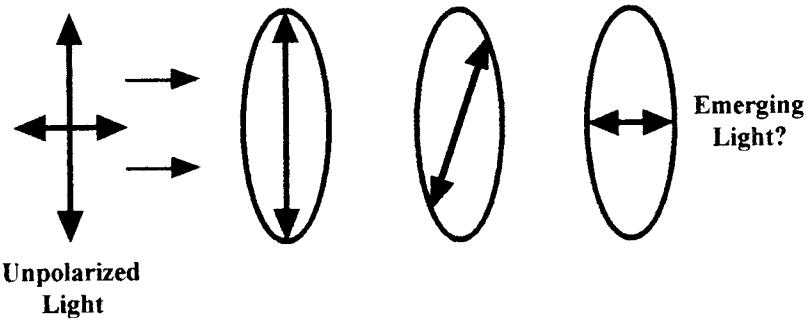
E 4. At what angle b will the second order antinode be found?

A. 1.05° B. 2.20° C. 3.20° D. 3.80° E. 4.40°

A 5. What will be the linear distance x between the first and second antinodes on the screen?

A. 19 cm B. 35 cm C. 38 cm D. 52 cm E. 65 cm

**Unpolarized light is shined upon a series of three polarizers arranged as shown to the right. The initial light beam has an intensity of 880 foot candles. The angle between the transmission axis of the first and second polarizers is $35^o$ while the third polarizer is perpendicular to the first polarizer.**




C 6. What will be the intensity of the light beam after passing through the first polarizer?

A. 220 ft cd B. 295 ft cd C. 440 ft cd D. 590 ft cd E. 97 ft cd

B 7. What will be the intensity of the light after passing through the second polarizer?

A. 220 ft cd B. 295 ft cd C. 440 ft cd D. 590 ft cd E. 97 ft cd

E 8. What will be the intensity of the light emerging from the third polarizer?

A. 220 ft cd B. 295 ft cd C. 440 ft cd D. 590 ft cd E. 97 ft cd

**A concave, spherical mirror has a diameter of 4.4 cm and is made from a spherical, glass shell, which has a radius of 36.0 cm.**

C 9. What is the focal length of this mirror?

A. 72 cm B. 36 cm C. 18 cm D. 9.0 cm E. 4.4 cm

B 10. What is the aperture of this mirror?

A. f/3.3 B. f/4.1 C. f/8.2 D. f/12.3 E. f/0.12

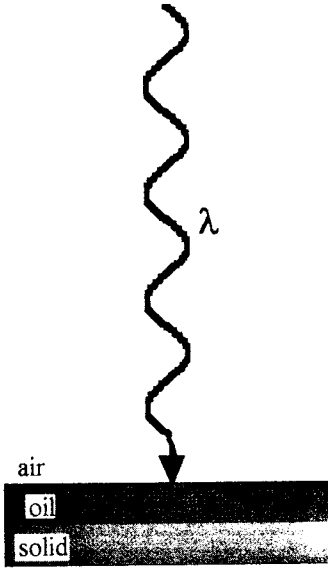
A 11. Where in front of this mirror should an object be placed in order to generate a **real** image which has a magnification of 3.2x?

A. 0.236 m B. 0.115 m C. 1.15 m D. 0.124 m E. 0.360 m

D 12. Where in front of this mirror should an object be placed in order to generate a virtual image which has a magnification of 3.2x?
A. 0.236 m B. 0.115 m C. 1.15 m D. 0.124 m E. 0.180 m

E 13. Suppose that this mirror is to be used to view the moon by projecting a real image onto a screen , how far from the mirror should the screen be placed?
A. 0.236 m B. 0.115 m C. 1.15 m D. 0.124 m E. 0.180 m

**Monochromatic light is normally incident upon a thin layer of oil ($n_{oil}$ = 1.5) which is spread out on a solid surface ($n_{solid}$ = 2.0). The space immediately above the oil film is filled with air ($n_{air}$ = 1.0). Light, which has a wavelength of $\lambda$ = 6000 A in air, is normally incident on the film from above as shown to the right.**




A 14. What will be the wavelength of this light within the oil film?
A. 4000 A B. 4500 A C. 9000 A D. 5500 A E. 7200 A

D 15. What is the minimum thickness of the oil film if the incident light is to be brightly reflected?
A. 6000 A B. 4000 A C. 3000 A D. 2000 A E. 1000 A

D 16. How will the phase of the light reflected from the air-oil interface compare with the phase of the light reflected from the oil-solid interface?
A. Insufficient information B. They will differ by 270° C. They will differ by 180°
D. They will be the same E. They will differ by 90°.

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**A monochromatic light source, which has a wavelength of 7200 A , is shined through a single slit which is 0.022 millimeters wide.**

B 17. At what angle will the third order node be found ?
A. 2.55° B. 5.63° C. 6.61° D. 9.22° E. 12.3°

A 18. What will be the distance between the 2nd and 3rd antinodes formed on a screen located 2.5 meters away from the single slit?
A. 0.084 m B. 1.22 m C. 0.012 m D. 0.332 m E. 11.2 m

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D 19. Which of the following modern technologies makes use of the concept of thin film interference?
A. fiber optical cables B. torque wrenches C. electrical power generators
D. camera lenses E. automobile engine superchargers

A 20. Which of the following modern technologies makes use of the concept of critical angle ?
A. fiber optical cables B. torque wrenches C. electrical power generators
D. camera lenses E. automobile engine superchargers

B 21. Which of the following processes cannot be used to produce linearly polarized light?
A. scattering B. diffraction C. double refraction D. selective absorption E. reflection

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**A concave-convex lens, which is sitting in air, is made of glass which has an index of 1.53. The two faces of the lens have radii of curvature of -12.0 cm and 18.0 cm, respectively, and the lens has a diameter of 5.5 cm. An object, which has a height of 8.8 cm, is placed 76.0 cm from the lens.**

D 22. What is the focal length of this lens when used in air?
A. -15 cm B. 14 cm C. -30 cm D. -68 cm E. 30 cm

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E 23. What will be the exact position of the resulting image?
A. -14 cm B. -32 cm C. 36 cm D. 18 cm E. -36 cm

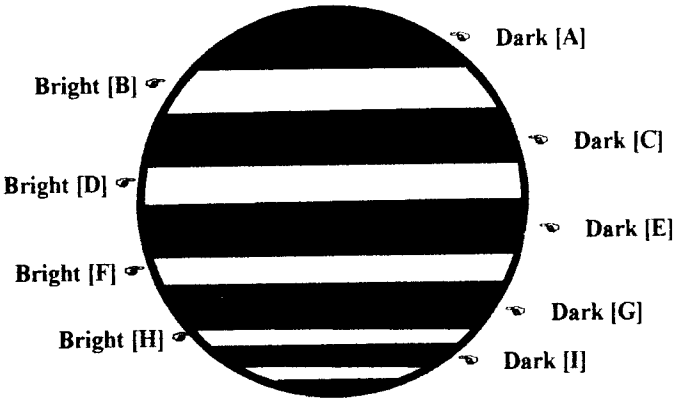
**Suppose that this lens is now immersed in a liquid which has an index of refraction of 1.82. All other information from above remains the same!**

A 24. What will be the new focal length of this lens?
A. 124 cm B. 86 cm C. -86 cm D. 12 cm E. 36 cm

C 25. What will be the exact position of the resulting image?
A. 220 cm B. -110 cm C. -196 cm D. 110 cm E. -22.0 cm

B 26. What will be the height of the resulting image?
A. 4.4 cm B. 23 cm C. 17.6 cm D. 28.6 E. 3.22 cm

**Light, which has a wavelength of 5600 A [blue] is shined upon a thin soap film stretched across a vertical oriented loop of wire. [Assume an index of 1.00 for air and 1.36 for the soap film] As the loop is held vertically the soap film gradually flows downward until the top portion of the film [A] appears to be transparent [Dark] while the area below consists of alternating bands of bright and dark as shown to the right.**




E 27. What will be the thickness of the film at the point where bright band F appears?
A. 1400 A B. 2800 A C. 2060 A D. 7000 A E. 5145 A

C 28. What will be the thickness of the film at the point where Dark band C appears?
A. 1400 A B. 2800 A C. 2060 A D. 7000 A E. 5145 A

**Suppose this soap film is turned horizontally and as a result the film becomes uniform with a thickness of 1325A .**

A 29. What maximum wavelength of light can be shined on this film [assume the light beam strikes the film perpendicularly!] so that the reflected light undergoes complete constructive interference?
A. 7200 A B. 4350 A C. 3600 A D. 5300 A E. 2650 A

D 30. What percentage of normally incident light will be transmitted through this soap film?
A. 88% B. 91% C. 92% D. 96% E. 99%

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B 31. The sky is blue because;
A. the dispersion effect of the atmosphere tends to refract blue light downward.
B. short waves of visible light tend to be scattered by the molecules of the atmosphere.
C. the most common molecules of the atmosphere tend to fluoresce in the blue area of the visible spectrum.
D. long waves of light tend to reflect more easily than short waves of light.
E. dust particles in the atmosphere tend to interfere with the passage of red light.

**A 6430 A monochromatic light source is used to illuminate two parallel glass plates separated at one end by a wire which has a diameter of 0.045 mm. The two plates are L = 22.0 cm long.**

D 32. How many bright interference fringes will be visible along the length of these two glass plates ?
A. 12 B. 68 C. 122 D. 140 E. 260

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C 33. The pattern of dark and bright fringes produced by single and double slits is due to;

A. interference and refraction B. reflection and polarization C. diffraction and interference
D. polarization and diffraction E. interference and refraction

A 34. Although optical microscopes cannot be used to observe thing smaller than about 4000 A , electron microscopes can be used to observe thing down to about 10 A . Which of the following can BEST be used to account for this difference?

A. The wavelengths of electrons are significantly smaller than the shortest wavelengths of visible light.
B. The electronics involved in electron microscopes is much more sophisticated.
C. Electron microscopes use lenses that are corrected for spherical and chromatic aberration while optical microscopes do not.
D. Electrons move much faster than light and therefore are not deflected as much by the electromagnetic force.
E. Electron microscopes are not as susceptible to vibrations.

**Which property of light could BEST be used to account for the fact that;**

E, D 35. Even the largest and highest quality telescopes are limited in their abilities to resolve two adjacent stars.

A. reflection B. refraction C. polarization D. interference E. diffraction

C 36. Some types of sunglasses can cause the display of an LCD calculator to completely black out.

A. reflection B. refraction C. polarization D. interference E. diffraction

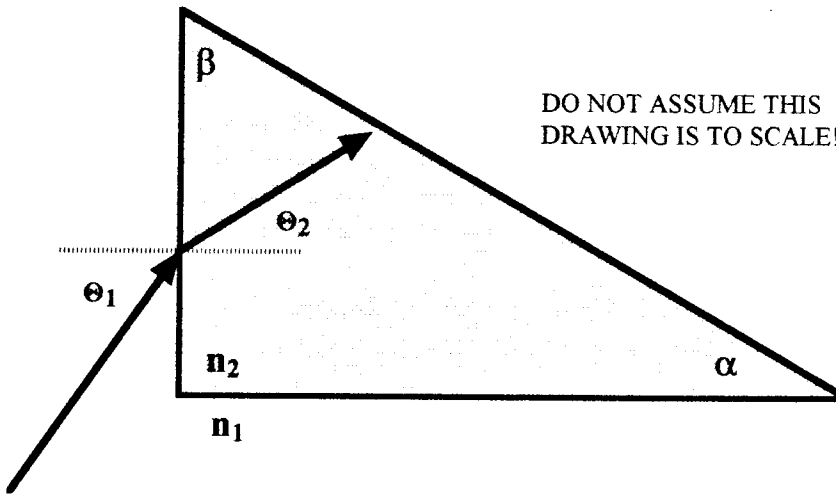
D 37. Some optical devices such as camera lenses and computer monitors appear to exhibit a slightly purple cast.

A. reflection B. refraction C. polarization D. interference E. diffraction

D 38. Soap bubbles exhibit the colors of the rainbow.

A. reflection B. refraction C. polarization D. interference E. diffraction

**A light ray is incident upon a right prism as shown to the right. The prism is made of clear plastic, which has an index of refraction of $n_2 = 1.48$. This prism is sitting in a liquid, which has an index of refraction of $n_1 = 1.72$. The angle between the incident light ray and the normal to the first interface is initially $\Theta_1 = 58^0$. The angles within the prism are $\alpha = 35^0$ and $\beta = 55^0$.**




E 39. What will be the magnitude of the angle $\Theta_2$ ?

A. 22° B. 39° C. 48° D. 65° E. 80°

A 40. At what angle will the light ray emerge from the prism?

A. 22° B. 39° C. 48° D. 65° E. 80°

**Suppose that the indices of these two mediums are changed to $n_1 = 1.05$ and $n_2 = 1.65$ and that the angle of incidence is changed to $\Theta_1 = 11^0$.**

B 41. What is the magnitude of the critical angle in this prism ?

A. 22° B. 39° C. 48° D. 65° E. 80°

B 42. At what angle will this ray emerge from the prism ?

A. 18° B. 21° C. 28° D. 33° E. 41°

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**For each of the following complete the ray diagram, indicate the direction of each ray, draw in the appropriate image and circle whether the image is real or virtual. Neatness DOES count! All rays must be drawn precisely! Real rays should be drawn as solid lines while virtual rays should be drawn as dotted lines. [5 pts each]**

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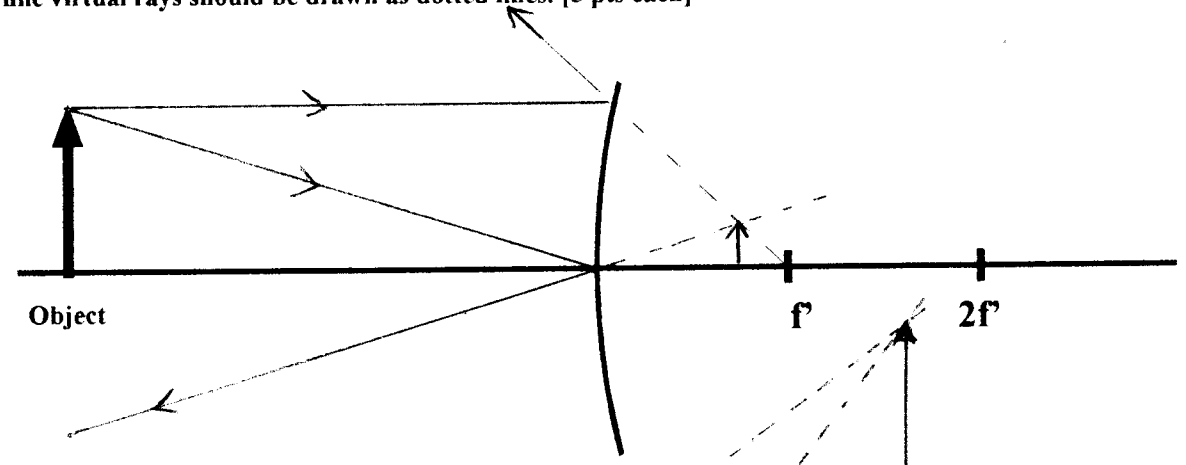
real
or
virtual ?

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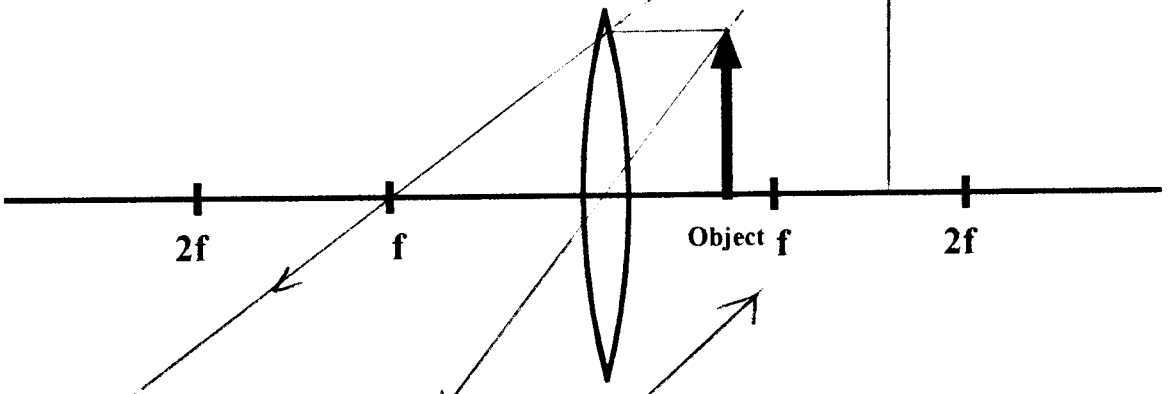
real
or
virtual ?

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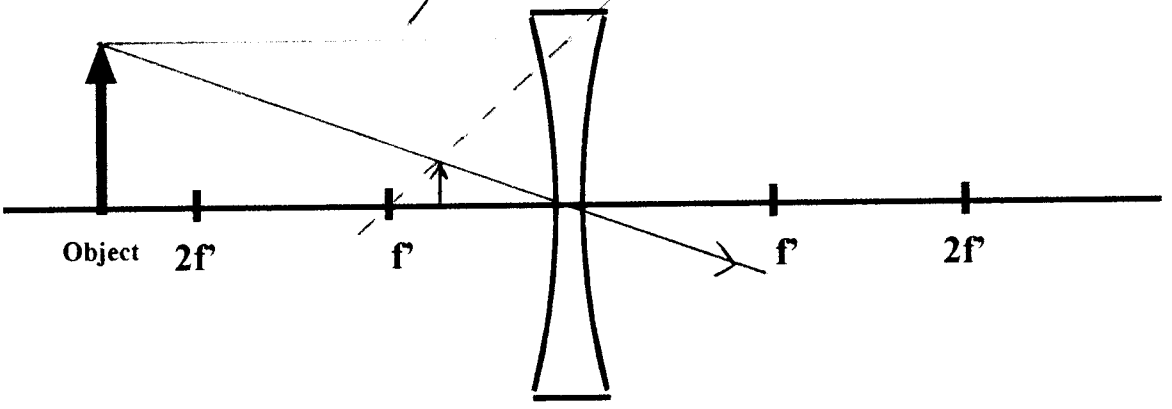
real
or
virtual ?

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real
or
virtual ?