Is the color of paints caused by

a) the illuminating source

b) reflection

c) absorption

d) all three

Newton's rings are observed when light of wavelength λ is reflected from a convex lens which has its convex surface in contact with a plane glass plate. The separation of the rings at a radius equal to half the radius of curvature of the lens is

a) 2λ

b) 1.5λ

c) λ

d) $.5\lambda$

A babinet compensator is an instrument to determine

a) the phase change produced by the reflection of a beam of yellow light from a glass-air surface

b) whether or not a beam of yellow light is circularly or elliptically polarized

c) in the case of a phase contrast microscope, the effect of object thickness on phase contract

d) the phase velocity of VLF radio waves

A plane monochromatic, electromagnetic wave is

a) always circularly polarized

b) always linearly polarized

c) always partially polarized

d) none of the above

5. In making a pin hole camera the sharpest image will be obtained if

   a) the hole is made as small as possible consistent with getting sufficient light to see the image

   b) the hole has a diameter which is approximately the geometric mean of the wave length of the light and the distance from the hole to the screen

   c) the hole contains exactly two Fresnel zones

   d) the diameter of the hole is about one wave length of the light

6. The color of the sky is blue because the atmosphere

   a) absorbs "red" light more than blue light

   b) scatters "red" light more than blue light

   c) absorbs "blue" light more than red light

   d) scatters "blue" light more than red light

7. Which of the following electromagnetic radiations lies in the ultraviolet? (f is frequency, L is wavelength)

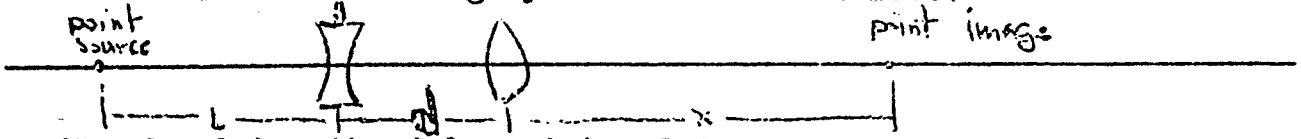
   a) $f = 10^{13}$ cycles /sec

   b) $f = 10^{21}$ cycles/sec

   c) L = 100 millimicrons

   d) L = 1 millimicron

8. Consider the following system of "thin" lenses:



The focal length of lens A is -2.0 cm. The focal length of lens B is +2.0 cm. The distance d = 0.5 cm. At what distance x behind the lens B is the image formed is L = ?

   a) 2.0 cm
   b) 8.0 cm
   c) 10 cm
   d) -8.0 cm

9. A beam of light traveling in air strikes the surface of a pool. If the index of refraction of water is 4/3, total reflection will occur at

   a) $\sin^{-1} 3/4$

   b) $\sin^{-1} 4/3$

   c) $\tan^{-1} 3/4$

   d) no angle

10. A stack of three polaroids is constructed such that the fast axis of each successive one makes an angle of 30° with respect to the axis of the previous one. If unpolarized light is incident on the stack, what fraction of the original intensity gets through:

   a) 50%

   b) 37%

   c) 28%

   d) 14%

11. A camera is just focused at an object 5 meters away when its lens is 5 cm in front of the film. The refractive index of the lens is n. We wish to focus the camera to infinity, i.e. to a very distant object. We have to

   a) move lens 0.5 mm towards film

   b) move lens 0.5 mm away from film

   c) move lens $n \times (0.5)$ mm towards film

   d) move lens $n \times (0.5)$ mm away from film

12. The angular width of the central band of a Fraunhofer diffraction pattern formed by a single slit:

a) increases as the slit width increases

b) depends inversely on the wave length of the light

c) depends directly on the wave length of the light

d) none of the above are correct

13. The "Faraday Effect" in optics refers to:

a) The polarization of light reflected from a surface at the critical angle.

b) The splitting of spectral lines in a magnetic field.

c) The rotation of the plane of polarization in a magnetic field.

d) The elliptic polarization of plane-polarized light when reflected at normal incidence from the pole of an electromagnet.

14. An object is moving towards a concave spherical mirror of radius 15 cms with uniform speed. When the object is 20 cms away from the vertex of the mirror, its speed is +30 cms/sec. What is the speed and direction of motion of the image?

a) -10.8 cms/sec

b) +11.4 cms/sec

c) +12.3 cms/sec

d) -4.8 cms/sec

15. Suppose that the velocity of light in a certain medium is known to equal 1.5×10^{10} cm/sec. The index of refraction of the medium is then

a) 4

b) 1/4

c) 1

d) none of the above

16. A concave mirror forms a real image 20 cm from itself. The height of the image is four times the height of the object. The forcal length of the mirror is:

a) 1/4 cm

b) 5 cm

c) 8 cm

d) 4 cm

17. A certain lens has a focal length of 0.50 meters. It is made of material with an index of refraction of 1.75. In order to construct a lens with a focal length of 1.00 meters, make a lens of the same shape, but of material with index of refraction n. n = ?

a) 1.38

b) 3.50

c) 0.88

d) 2.50

18. A plane electromagnetic wave travelling through an evacuated region is incident upon the surface of a piece of glass. The intensity of the reflected radiation is <u>not</u> dependent upon which of the following:

a) angle of incidence of the wave upon the surface of the glass.

b) frequency of the incident wave.

c) polarization of the incident wave.

d) the reflected intensity does depend on a, b and c.

19. Circularly polarized light can be

a) produced by adding plane polarized light from two sources.

b) distinguished from unpolarized light with a quarter-wave plate and a polaroid.

c) produced by allowing unpolarized light to pass through a quarter-wave plate.

d) distinguished from unpolarized light with a polaroid alone.

20. A layer of liquid h cm thick appears to be d cm thick when looking straight down at it. What is the index of refraction?

a) $\frac{h}{d}$

b) $\sqrt{1 + \frac{d^2}{h^2}}$

c) $\frac{d}{h}$

d) $\sqrt{\frac{h}{d}}$

21. It is possible to determine, with a suitable microscope, the position of an object whose dimensions are smaller than the wavelength of the light used

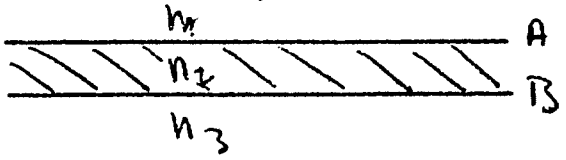
a) to any accuracy desired.

b) to within an accuracy of the order of the characteristic dimensions of the object.

c) not at all.

d) to within an accuracy of the order of thw wavelength of the light.

22. Light is incident from above on the system shown



where $n_1 = 1$, $n_2 = 1.5$ and $n_3 = 2$ are the indices of refraction of the three media. The light makes an angle of 63° with the surface A. What angle does the transmitted light make with the surface B?

a) 27°

b) 25°

c) 77°

d) none of the above.

23. The wavelength of green light is about:

a) 5×10^{-4} cm

b) 5×10^{-5} cm

c) $5 \quad 10^{-6}$ cm

d) 5×10^{-7} cm

24. From Maxwell's theory of light, it follows that the pressure exerted upon a perfectly reflecting flat metal plate by a normally incident linearly polarized coherent light beam of frequency v

a) is constant in time.

b) fluctuates with frequency v.

c) fluctuates with frequency 2v.

d) fluctuates with frequency v/2.

25. Fermat's principle states that the time required for light to travel along the actual path differs only by the second order of small quantities from the time required for light to travel along a neighboring path. Which of the following is not a correct mathematical statement of this principle?

a) $\delta \int_A^B \frac{ds}{v} = 0$, where v is the velocity of light.

b) $\delta \int_A^B \frac{ds}{\lambda} = 0$, where is the wavelength of light.

c) $\delta \int_A^B \frac{ds}{v} = 0$, where v is the frequency of light.

d) $\delta \int_A^B n ds = 0$, where n is the index of refraction.

26. The magnitude of the longitudinal optical Doppler effect depends, for small v, upon $(v/c)^x$ where

a) $x = -1$

b) $x = 2$

c) $x = 1$

d) $x = 3$

27. The sky is blue and the sun is redder at sunset than when it is directly overhead. From this information, we can infer that:

a) the material in our atmosphere predominantly absorbs visible light of shorter wavelengths.

b) light scattered from our atmosphere is polarized.

c) the earth is round.

d) the material in our atmosphere predominantly scatters visible light of shorter wavelengths.

28. Monochromatic light of wavelength 5000 Å is incident perpendicularly on a vertical wall containing two long narrow horizontal slits in a vertical array. The slit spacing is 0.200 mm. The light emerging from the slits passes through an adjacent lens of focal length 10.0 meters and forms an interference pattern on a vertical screen in the focal plane of the lens. The distance between adjacent lines of minimum intensity is:

a) 5.0 cm

b) 2.5 cm

c) 3.75 cm

d) 1.25 cm

29. The existance of Fraunhoffer diffraction shows that

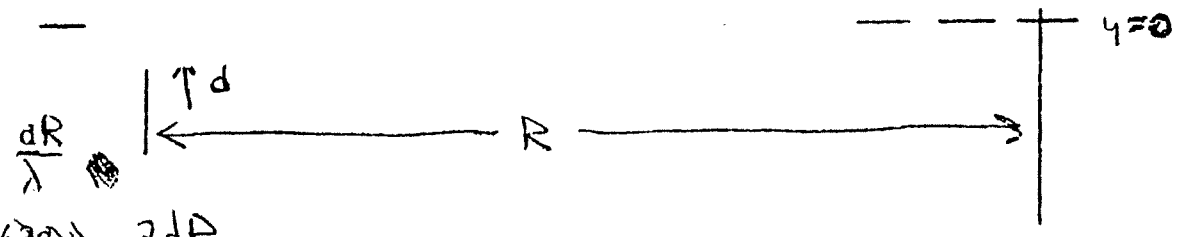
a) light waves obey the superposition principle.

b) monochromatic light cannot give interference patterns.

c) light can propagate only along a straight-line trajectory.

d) Visible light is always polarized.

30. Plane parallel light is incidnet normally on a screen with a narrow slit of width d. Beyond the
placed at
What is t



a) $\frac{dR}{\lambda}$

b) $\frac{2dR}{\lambda}$

c) $\lambda R/d$

1. The wavelength range of the visible portion of the spectrum is approximately

   a) 1000 to 7000 Å

   b) 400 to 1700 Å

   c) 4000 to 7000 Å

   d) 12000 to 25000 Å

2. A monochromatic light wave is incident from air onto a medium whose index of refraction is 2. Inside the medium we find, relative to air, the

   a) wavelength is doubled

   b) wavelength is halved

   c) frequency is doubled

   d) frequency is halved

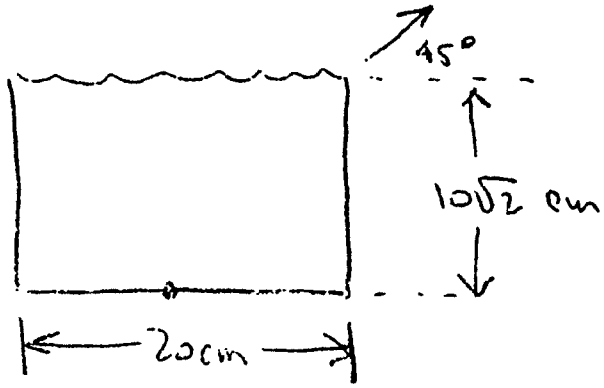
3. A small pinhead is placed in the center of the bottom of a cylindrical tank, 20 cm in diameter and $10\sqrt{2}$ cm high. When the tank is filled with a certain liquid the pinhead is just visible when observed from a point such that a line from this point to the nearest edge of the tank makes an angle of 45 degrees with the horizontal. What is the index of refraction of the liquid?

   a) 2

   b) $\sqrt{2/3}$

   c) $\frac{1}{\sqrt{2}}$

   d) $\sqrt{3/2}$



4. Two media with indexes of refraction $n_1 = 1.50$ and $n_2 = 1.25$; respectively, are separated by a spherical interface with 20.0 cm radius of curvature. The center of curvature of the interface is in medium 2. A small object is placed in medium 1 at a distance of 10.0 cm from the interface. What will be the distance from the interface of the object's image formed by <u>reflection</u> at the interface?

   a) infinite

   b) 40/3 cm

   c) 120/11 cm

   d) 5.0 cm

15. The focal length of a divergent lens with an approximate focal length of -5 cm is to be measured. The only available convergent lens has a focal length of +20 cm. (The thin lens approximation is assumed in this problem).

a) these lenses can be made into a convergent combination by placing them in contact, and the focal length determined by forming a real image of a real object.

b) a convergent combination can be formed only if the separation between the lenses is greater than 15 cm.

c) a real image of a real object can be formed only when the lens separation is greater than 15 cm but less than 20 cm.

d) no arrangement can be made that will form a real image of a real object.

16. The solar disc has an angular diameter, as seen from the earth, of 1/2°. How large is the image formed by a lens of focal length 2 meters?

a) 51 cm

b) 0.88 cm

c) 5.73 cm

d) 1.74 cm

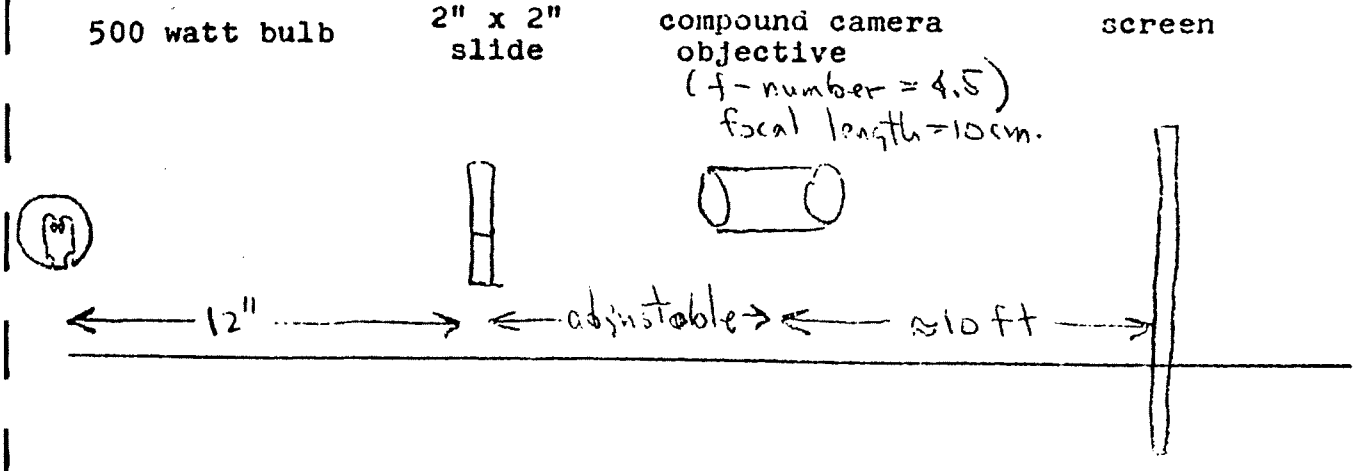
17. The indicated arrangement using a well corrected camera objective is to be used as a slide projector.

a) it will function satisfactorily

b) it will not be possible to form a real image on the screen

c) it will not work properly because of too little light reaching the image

d) the camera objective should be replaced by a diverging lens



8. Of the aberrations listed below the most important one to correct for in an astronomical telescope is

   a) curvature of field

   b) spherical aberration

   c) astigmatism

   d) distortion

9. Three light waves are traveling in the positive x-direction. The amplitudes are 1, 3, 5, statvolts/cm, respectively. At one instant the phases are 10°, 100°, 190°, respectively. The resultant amplitude is:

   a) 5 statvolts/cm

   b) $\sqrt{7}$ statvolts/cm

   c) ^ statvolts/cm

   d) none of the above

0. The resolving power of a telescope is determined by

   a) the magnification

   b) the F number

   c) the size of the objective or mirror

   d) the ratio of focal lengths of objective and eyepiece

1. Newton's rings are observed when light is reflected from a plano convex lens which has its convex surface in contact with a plane glass plate. First observation is made as usual with the apparatus in the air, and second observation is made filling the space between the lens and the plate by water. What is the ratio of the radius of a ring in the second experiment to that of the corresponding ring in the first experiment? The index of refraction of water is 4/3, and the radii of the rings are assumed to be much smaller than the radius of curvature of the lens.

   a) 4/3

   b) 3/4

   c) $2/\sqrt{3}$

   d) $\sqrt{3}/2$

42. Parallel monochromatic light of 5000 Å wavelength goes through an aperture of 2 mm diameter and is observed on a screen 1 m away from the aperture. Will there be a diffraction pattern with

a) a broad maximum in the center but no distinct minima

b) a narrow maximum in the center surrounded by a sequence of dark and bright rings

c) a minimum in the center surrounded by essentially only one bright ring

d) a minimum and a sequence of bright and dark rings

43. Two rectangular pieces of plane glass are lain one upon the other on a table. A thin strip of paper is placed between them a one edge so that a very thin wedge of air is formed. The plates are illuminated by a beam of sodium light ($\lambda \simeq 6000$ Å) at normal incidence. Bright and dark interference bands are formed, there being ten of each per centimeter length of the wedge measured normal to the edges in contact. Find theangle of the wedge.

a) 1.2×10^{-5} radian

b) 6×10^{-2} radian

c) 2×10^{-7} radian

d) 3×10^{-4} radian

44. The spectral resolving power, $\lambda/\Delta\lambda$, of a diffraction grating

a) depends on the frequency of the light

b) is the same for spectra in all orders

c) depends on the number of lines per centimeter in the grating

d) depends on the total number of lines in the grating

45. A "polaroid" filter functions by

a) selective absorption of one linearly polarized component of ordinary light

b) reflecting only one polarized component of the incident light

c) means of double refraction

d) dispersion