Problem #1 (Ch 33)

A ray of light in air is incident on a flat piece of glass, at an angle of $\phi=67^o$ with respect to the normal. The glass has an index of refraction $n=1.5$. What is the angle θ between the reflected and refracted rays?

75.14°

Problem #2 (Ch 33)

When unpolarized light from air (*n=1*) is incident on a piece of transparent material with index of refraction *n=1.23*, the reflected light is found to be completely polarized when the angle of incidence is θ_B. What is the angle of refraction in this case?

39.1°

Problem #3 (Ch 33)

A glass plate whose index of refraction *1.55* is immersed in a liquid. The surface of the glass is inclined at an angle *54°* with the vertical. A horizontal ray in the glass is incident on the interface. When a liquid is a certain alcohol, the incident ray arrives at the interface at the critical angle. Find index of refraction of the alcohol.

1.254

Problem #4 (Ch 33)

Dispersion of electromagnetic waves:

- ☐ (a) Refers to the fact that waves radiate out in all directions from a point source.
- ☒ (b) Result from the fact that waves of different frequencies travel at a different speed in matter.
- ☐ (c) Refers to the phenomenon wherein a ray changes direction when it passes from one material into another.
- ☐ (d) Is the underlying phenomenon utilized in some types of sun glasses.
- ☐ (e) Accounts for the fact that the sky is blue.

b

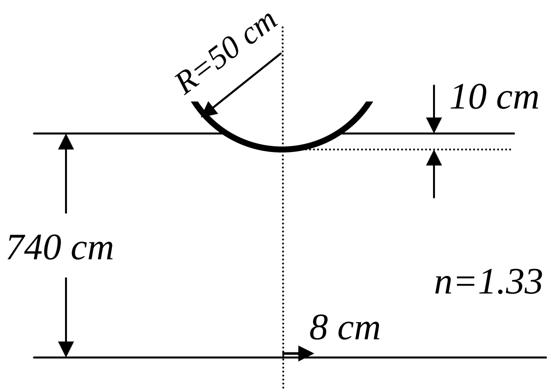
Problem #1 (Ch 34)

Carbon disulfide *(n=1.63)* is poured to a depth of 4 cm in a flask, and a layer of water *(n=1.33)* is poured on tope of it to an additional depth of 6 cm. What would be the apparent depth of an object resting on the bottom of the flask when viewed by an observer looking straight down?

6.965 cm

Problem #2 (Ch 34)

A thin hemispherical bowl of clear plastic floats on water (*n=1.33*) in a tank. The radius of the bowl is *50 cm* and the depth of the bowl in water is *10 cm*. The depth of the water in the tank is *740 cm*. An object *8 cm* long is on the bottom of the tank directly below the bowl. The object is viewed from directly above the bowl. Ignore the refractive effects of the plastic.



(a) Find the position of the image below the water level. 128.74 cm

(b) Determine whether this image is virtual or real, inverted or erect

(c) Find the size of the image 1.73 cm

See page 1301 in the textbook, formula (34.11) $\frac{n_a}{s}+\frac{n_b}{s'}=\frac{n_b-n_a}{R}$;

here $n_a = 1.33,\ n_b = 1.0,\ s = 740 - 10 = 730cm,\ R = 50\ cm$

(a) calculating s′ from formula above will have $s' = -118.74$ cm,

or from the surface of the water $118.74 + 10. = 128.74$ cm

$$(c)\ \mathrm{m} = \frac{y'}{y} = -\frac{n_a s'}{n_b s} = -\frac{1.33\cdot(-118.74cm)}{1\cdot(730cm)} = +0.2163, \quad \text{and} \quad y' = 8.0\times 0.1627 = 1.73cm$$

(b) since $s' < 0$ it is *virtual* image; since $m > 0$ and $y' > 0$ image is *erect*

Problem #3 (Ch 34)

Suppose you place face in front of a concave mirror

A) If you position yourself between the center of curvature and the focal point of the mirror, you will not be able to see your image.
B) No matter where you place yourself, a real image will be formed.
C) Your image will always be inverted.
D) Your image will be diminished in size.
E) None of these at true.

A

Problem #4 (Ch 34)

As a treatment for cataracts (a cloudiness of the lens of the eye), the natural lens is removed and a plastic lens is implanted. After this is done a parson can see distant objects clearly, but he cannot accommodate to focus on nearby objects. If for example such a person wanted to read a book at a distance of *25 cm*, he would have to wear eyeglasses. What is the diopter power of these glasses?

+4D

Problem #5 (Ch 34)

A compound microscope consists of an objective of focal length f_0 and an eyepiece with magnification M=25. The microscope is designed so that the object is focused in a plane 16.0 cm away from the focal point of the objective lens. When properly adjusted, The eyepiece and the objective are 17.4 cm apart. What is f_0 ? (Assume that the eyepiece magnification is based on an image at infinity and a near point at 25 cm.)

Focal length of eyepiece one can find from (34.22): $f_2=25\ cm/25=1cm$. Eyepiece at infinity means that (see page 1323 of textbook) objective creates an image *I* close to the focus of eyepiece. That means that the distance s_1' from objective to the focus of eyepiece is s_1'=17.4 cm–1.0 cm=16.4 cm. Since the object is focused by objective in a plane 16 cm away from the focal point of objective lens the focal distance of objective is 16.4 cm – 16 cm = 0.4 cm

$f=0.4\ cm$

Problem #1 (Ch 35)

Two radio antennas are 10 km apart on a north-south axis on a seacoast. The antennas broadcast identical AM radio signals, in phase, at a frequency of 3.7 MHz. A steamship, 200 km offshore, travels due north at a speed of 15 km/hr and passes east of the antennas. A radio on board the ship is tuned to the broadcast frequency. Four minutes after a radio signal of maximum intensity I_0 is received, the ratio of the intensity of the signal reduced to I. Find the ratio I/I_0.

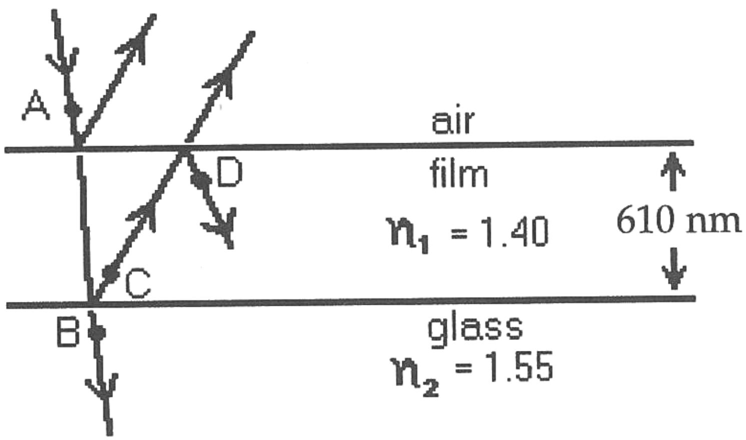
This is case of interference from two monochromatic coherent sources. Displacement in the interference plane can be found as $v_{ship} \times \Delta t = \Delta y = 1\ km$. $\lambda = c/f = 3\times10^8/3.7\times10^6 = 81.081\ m$. For calculation of intensity ratio one can use equation (35.15) from the text book.

$$\frac{I}{I_0} = \cos^2\left(\frac{\pi \cdot d \cdot \Delta y}{\lambda \cdot R}\right) = \cos^2\left(\frac{\pi \cdot 10{,}000 \cdot 1{,}000}{81.081 \cdot 200{,}000}\right) = 0.128$$

0.128

Problem #2 (Ch 35)

A 610 nm thick film, of index n_1=1.40, is on the surface of a glass plate, of index n_2=1.55. A ray of monochromatic light, of 500 nm wavelength, is incident normally upon the air-film interface, and undergoes reflections and transmissions. Consider points A,B,C, and D (at the figure) as being at a negligible distance from their nearest interfaces, respectively. What is the phase difference in the wave at B, at C, and at D with respect to the wave at A?



Phase difference between points A and B: (λ=500nm/1.4)
is just thickness of the film (610 nm/λ)*2pi= 10.73 rad

Phase difference between points A and C:
in the film thickness ± additional λ/2 (λ=500nm/1.4) due to reflection from more optically dense material: 2*pi*(610–λ/2)/λ=7.59 rad

Phase difference between points A and D:
it is the same as for C plus additional thickness of the film:
2*pi*(610+610–λ/2)/λ=18.32 rad

B: 10.73 rad; C:7.59 rad; D: 18.32 rad

Problem #3 (Ch 35)

At most, how many bright fringes can be formed on one side
Of the central bright fringe (not counting central bright fringe)
When light of 625 nm falls on a double slit whose spacing is
$d=4.74\times10^{-6}$ m?

For two-slit interference maxima $d \times \sin(\theta) = m \times \lambda$
$m = 0$ corresponds to the central maximum at $\theta = 0$.
We need to count integer m's that keep theta < 90 degrees or
$\sin(\theta)<1$:

$m = d \times \sin(\theta)/ \lambda < d/ \lambda = 4740 \text{ nm}/625 \text{ nm} = 7.58$
answer: m = INTEGER(7.58) = 7

Problem #4 (Ch 35) [35.21]

In a two-slit interference pattern, the intensity at the peak of the central maximum is I_0.

(a) At a point in the pattern where the phase difference between the waves from the two slits is 60°, what is the intensity?

(b) What is the path difference for 480 nm light from the two slits at a point where the phase difference angle is 60°?

80 nm

Problem #1 (Ch 36)

A diffraction grating has 450 lines (slits or groves) per mm. What is the highest order that contains the entire visible spectrum from 400 nm to 700 nm?

Problem #2 (Ch 36)

The lattice spacing of the principal Bragg planes in sodium chloride is *0.282 nm*. For what wavelength will the first order diffracted beam be deviated by *70°* ?

0.53 nm

Problem #3 (Ch 36)

A camera set with f-number f/4 has a focal length of 50 mm. What is the minimum spacing of two objects positioned 12 m from the lens if the objects are barely resolved in the image? Assume the light wavelength is 500 nm.

0.586 mm

Problem #4 (Ch 36)

If a diffraction pattern produced by a single slit, the phase angle β (the phase difference between wavelets from the top and bottom of the slit) is 9.6π rad at an angle of 0.770° from the central maximum. If the light used has a wavelength of 555 nm, find the slit width.

0.198 mm