1. An object is placed 60 cm from a convex lens of focal length 10 cm. What is the magnification?
   a) $-0.10$
   b) 0.20
   c) $-0.20$
   d) 0.15
   e) 0.10

2. Reflection from a soap bubble film ($n = 1.42$) of thickness 106 nm results in a constructive interference in the reflected light if this film is illuminated by a beam of light with a wavelength of 601 nm. What are the next three thicknesses of this film that will also result in a constructive interference?
   a) 212 nm, 318 nm, 424 nm
   b) 212 nm, 424 nm, 636 nm
   c) 67.0 nm, 42.4 nm, 22.3 nm
   d) 318 nm, 530 nm, 742 nm
   e) 53.0 nm, 35.3 nm, 26.5 nm

3. Three identical narrow slits, separated by a distance $d$, are illuminated at normal incidence by a laser light of wavelength $\lambda$. An interference pattern is observed on a screen at a distance $L$ from the slits. If the observed intensity at the center of the screen is $I_0$, what is the intensity at a point on the screen where the phase difference between waves from adjacent slits is $90^\circ$?
   a) $I_0/3$
   b) $I_0/4$
   c) $I_0/9$
   d) $I_0$
   e) 0

4. An object is located 3.8 m in front of a plane mirror. The image formed by the mirror appears to be
   a) 3.8 m in front of the mirror.
   b) 1.9 m in front of the mirror.
   c) 3.8 m behind the mirror’s surface.
   d) 1.9 m behind the mirror’s surface.
   e) on the mirror’s surface.

5. Light of wavelength 687 nm is incident on a single slit 0.75 mm wide. At what distance from the slit should a screen be placed if the second dark fringe in the diffraction pattern is to be 1.7 mm from the center of the screen?
   a) 0.93 m
   b) 0.39 m
   c) 0.47 m
   d) 1.9 m
   e) 1.1 m

6. At the first minimum next to of the central bright spot in a double-slit experiment, the phase difference between the two waves arriving from the slits is:
   a) $\pi/2$ rad
   b) $\pi$ rad
   c) none of the other answers are correct
   d) $\pi/4$ rad
   e) 0 rad

7. If you stand in front of a convex mirror, at the same distance from it as its focal length,
   a) you won’t see your image because it’s focused at a different distance.
   b) you will see your image and you will appear larger.
   c) you won’t see your image because there is none.
   d) you will see your image and you will appear smaller.
   e) you will see your image at your same size.
8. In a two-slit experiment, the third bright fringe away from the central (zeroth) bright fringe is observed at an angle of 7.0°. If the wavelength of the light is 490 nm, what is the distance between the two slits?
   a) $3.6 \times 10^{-5}$ m
   b) $1.2 \times 10^{-5}$ m
   c) $2.1 \times 10^{-6}$ m
   d) $4.0 \times 10^{-6}$ m
   e) $2.1 \times 10^{-5}$ m

9. John’s face is 20 cm in front of a concave shaving mirror. If he observes his image to be twice as big and upright, what is the focal length of the mirror?
   a) 30 cm
   b) 20 cm
   c) 40 cm
   d) 10 cm
   e) 50 cm

10. Sunlight reflected from the surface of a lake
    a) tends to be polarized with its electric field vector parallel to the surface of the lake.
    b) has undergone refraction by the surface of the lake.
    c) tends to be polarized with its electric field vector perpendicular to the surface of the lake.
    d) none of the other answers
    e) is unpolarized.

11. How far above the horizon is the Moon when its image reflected in calm water ($n_{water} = 1.33$) is completely polarized?
    a) 36.9°
    b) 46.8°
    c) 53.1°
    d) 57.5°
    e) 43.2°

12. Light in air is initially traveling parallel to the face AC of an equilateral triangular prism, as shown in the figure. The prism is made of glass with an index of refraction of 1.52. If the light does not strike the face AC, what is the angle between the ray as it leaves the prism at face BC and the surface normal?
   a) $83^\circ$
   b) $55^\circ$
   c) $19^\circ$
   d) $27^\circ$
   e) $59^\circ$
13. The optical fiber structure and mechanism of light transmission is shown in the figure. In order for light propagation to occur, total internal reflection should take place at the core/cladding interface. Consider the situation that we wanted to couple the light into the fiber from free space (air) at its end face, i.e., the beam (1) in the figure. What condition does the incident angle ($\theta_0$) have to meet for the light being able to propagate in the optic fiber?

a) $\sin \theta_0 < \sqrt{n_2^2 - n_1^2}$

b) $\sin \theta_0 > \sqrt{n_1^2 - n_2^2}$

c) $\sin \theta_0 < \sqrt{n_1^2 - n_2^2}$

d) $\sin \theta_0 > \sqrt{n_2^2 - n_1^2}$

e) $\sin \theta_0 = n_2/n_1$

14. In calculating the magnification from a lens, a negative result means

a) the image is smaller than the object.

b) the image is larger than the object.

c) the calculation is incorrect.

d) the image is inverted.

e) the image is directed downward.

15. A diffraction grating has 300 lines per mm. If light of wavelength 630 nm is sent through this grating, at what angle does the first order diffraction maximum occur?

a) 22°

b) 56°

c) 44°

d) 11°

e) 28°

16. A beam of light passes through two ideal polarizers. In this process, the intensity of the light transmitted is reduced to 10% of the intensity incident on the 2nd ideal polarizer. What is the angle between the transmission axes of the two polarizers?

a) 18°

b) 22°

c) 22°

d) 72°

e) 68°

17. The speed of light in a certain medium is $2.2 \times 10^8$ m/s. What is the index of refraction of this medium?

a) 0.8

b) 1.0

c) 0.7

d) 1.6

e) 1.4