1. The bright fringe of order m occurs where $\delta = d\sin\theta = m\lambda$. For small angles, the sine of the angle is approximately equal to the angle expressed in radians. Thus, the angular position of the second order bright fringe in the case described is

$$\theta = 2\left(\frac{\lambda}{d}\right) = 2\left(\frac{5.0\times10^{-7}\ \text{m}}{2.0\times10^{-5}\ \text{m}}\right) = 0.050\ \text{radians}$$

making (a) the correct choice.

2. With phase reversals occurring in the reflections at both the air-oil boundary and the oil-water boundary, the condition for constructive interference in the reflected light is $2n_{\text{oil}}t = m\lambda$ where m is any integer. Thus, the minimum nonzero thickness of the oil which will strongly reflect the 530-nm light is $t_{\min} = \lambda/2n_{\text{oil}} = (530\ \text{nm})/2(1.25) = 212\ \text{nm}$, and (d) is the proper choice.

4. From Malus's law, the intensity of the light transmitted through a polarizer having its transmission axis oriented at angle θ to the plane of polarization of the incident polarized light is $I = I_0\cos^2\theta$. Therefore, the intensity transmitted through the first polarizer having $\theta = 45° - 0 = 45°$ is $I_1 = I_0\cos^2(45°) = 0.50I_0$, and the intensity passing through the second polarizer having $\theta = 90° - 45° = 45°$ is $I_2 = (0.50I_0)\cos^2(45°) = 0.25I_0$. The fraction of the original intensity making it through both polarizers is then $I_2/I_0 = 0.25$, which is choice (b).

2. The wavelength of light is extremely small in comparison to the dimensions of your hand, so the diffraction of light around obstacles the size of your hand is totally negligible. However, sound waves have wavelengths that are comparable to the dimensions of the hand or even larger. Therefore, significant diffraction of sound waves occurs around hand-sized obstacles.

8. The skin on the tip of a finger has a series of closely spaced ridges and swirls on it. When the finger touches a smooth surface, the oils from the skin will be deposited on the surface in the pattern of the closely spaced ridges. The clear spaces between the lines of deposited oil can serve as the slits in a crude diffraction grating and produce a colored spectrum of the light passing through or reflecting from the glass surface.

12. The reflected light is partially polarized, with the component parallel to the reflecting surface being the most intense. Therefore, the polarizing material should have its transmission axis oriented in the vertical direction in order to minimize the intensity of the reflected light from horizontal surfaces.

24.1 The location of the bright fringe of order m (measured from the position of the central maximum) is $(y_{\text{bright}})_m = (\lambda L/d)m,\ m = 0,\ \pm1,\ \pm2, \ldots$. Thus, the spacing between successive bright fringes is

$$\Delta y_{\text{bright}} = \left(y_{\text{bright}}\right)_{m+1} - \left(y_{\text{bright}}\right)_m = (\lambda L/d)(m+1) - (\lambda L/d)m = \lambda L/d$$

Thus, the wavelength of the laser light must be

$$\lambda = \frac{\left(\Delta y_{\text{bright}}\right)d}{L} = \frac{\left(1.58\times10^{-2}\ \text{cm}\right)\left(0.200\times10^{-3}\ \text{m}\right)}{5.00\ \text{m}} = 6.32\times10^{-7}\ \text{m} = \boxed{632\ \text{nm}}$$

24.4 The location of the dark fringe of order m (measured from the position of the central maximum) is given by $(y_{\text{dark}})_m = (\lambda L/d)(m+\frac{1}{2})$, where $m = 0,\ \pm 1,\ \pm 2, \ldots$. Thus, the spacing between the first and second dark fringes will be

$$\Delta y = \left(y_{\text{dark}}\right)_{m=1} - \left(y_{\text{dark}}\right)_{m=0} = (\lambda L/d)\left(1+\tfrac{1}{2}\right) - (\lambda L/d)\left(0+\tfrac{1}{2}\right) = \lambda L/d$$

or $$\Delta y = \frac{\left(5.30\times10^{-7}\text{ m}\right)(2.00\text{ m})}{0.300\times10^{-3}\text{ m}} = 3.53\times10^{-3}\text{ m} = \boxed{3.53\text{ mm}}$$

24.8 The angular position of the bright fringe of order m is given by $d\sin\theta = m\lambda$. Thus, if the $m = 1$ bright fringe is located at $\theta = 12°$ when $\lambda = 6.0\times10^2\text{ nm} = 6.0\times10^{-7}\text{ m}$, the slit spacing is

$$d = \frac{m\lambda}{\sin\theta} = \frac{(1)\left(6.0\times10^{-7}\text{ m}\right)}{\sin 12°} = 2.9\times10^{-6}\text{ m} = \boxed{2.9\ \mu\text{m}}$$

24.16 (a) With phase reversal in the reflection at the outer surface of the soap film and no reversal on reflection from the inner surface, the condition for constructive interference in the light reflected from the soap bubble is $2n_{\text{film}}t = (m+\frac{1}{2})\lambda$ where $m = 0, 1, 2, \ldots$. For the lowest order reflection ($m = 0$), and the wavelength is

$$\lambda = \frac{2n_{\text{water}}t}{(0+1/2)} = 4(1.333)(120\text{ nm}) = 6.4\times10^2\text{ nm} = \boxed{640\text{ nm}}$$

(b) To strongly reflect the same wavelength light, a thicker film will need to make use of a higher order reflection, i.e., $\boxed{\text{use a larger value of } m}$.

(c) The next greater thickness of soap film that can strongly reflect 640 nm light corresponds to $m = 1$, giving

$$t_1 = \frac{(1+1/2)\lambda}{2n_{\text{film}}} = \frac{3}{2}\left[\frac{640\text{ nm}}{2(1.333)}\right] = 3.6\times10^2\text{ nm} = \boxed{360\text{ nm}}$$

and the third such thickness (corresponding to $m = 2$) is

$$t_2 = \frac{(2+1/2)\lambda}{2n_{\text{film}}} = \frac{5}{2}\left[\frac{640\text{ nm}}{2(1.333)}\right] = 6.0\times10^2\text{ nm} = \boxed{600\text{ nm}}$$

24.17 Light reflecting from the first (glass-iodine) interface suffers a phase reversal, but light reflecting at the second (iodine-glass) interface does not have a phase reversal. Thus, the condition for constructive interference in the reflected light is $2n_{\text{film}}t = (m+\frac{1}{2})\lambda$ with $m = 0,\ 1,\ 2, \ldots$. The smallest film thickness capable of strongly reflecting the incident light is

$$t_{\min} = \frac{(0+1/2)\lambda}{2n_{\text{film}}} = \frac{6.00\times10^2\text{ nm}}{4(1.756)} = \boxed{85.4\text{ nm}}$$

24.39 The grating spacing is $d = (1/3\,660)\text{cm} = (1/3.66 \times 10^5)$ m and $d \sin\theta = m\lambda$.

(a) The wavelength observed in the first-order spectrum is $\lambda = d\sin\theta$, or

$$\lambda = \left(\frac{1\text{ m}}{3.66 \times 10^5}\right)\left(\frac{10^9\text{ nm}}{1\text{ m}}\right)\sin\theta = \left(\frac{10^4\text{ nm}}{3.66}\right)\sin\theta$$

This yields: at 10.1°, $\lambda = \boxed{479\text{ nm}}$; at 13.7°, $\lambda = \boxed{647\text{ nm}}$;

and at 14.8°, $\lambda = \boxed{698\text{ nm}}$

(b) In the second order, $m = 2$. The second order images for the above wavelengths will be found at angles $\theta_2 = \sin^{-1}(2\lambda/d) = \sin^{-1}[2\sin\theta_1]$.

This yields: for $\lambda = 479$ nm, $\theta_2 = \boxed{20.5°}$; for $\lambda = 647$ nm, $\theta_2 = \boxed{28.3°}$;
and for $\lambda = 698$ nm, $\theta_2 = \boxed{30.7°}$

24.52 (a) From Malus's law, the fraction of the incident intensity of the unpolarized light that is transmitted by the polarizer is

$$I' = I_0\left(\cos^2\theta\right)_{\text{av}} = I_0(0.500)$$

The fraction of this intensity incident on the analyzer that will be transmitted is

$$I = I'\cos^2(35.0°) = I'(0.671) = I_0(0.500)(0.671) = 0.336I_0$$

Thus, the fraction of the incident unpolarized light transmitted is $I/I_0 = \boxed{0.336}$.

(b) The fraction of the original incident light absorbed by the analyzer is

$$\frac{I' - I}{I_0} = \frac{0.500I_0 - 0.336I_0}{I_0} = \boxed{0.164}$$