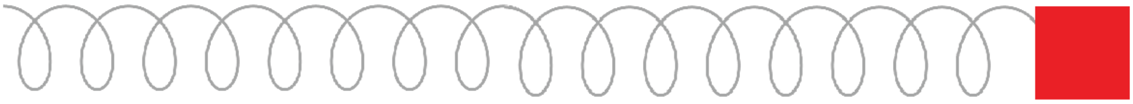
Kapitel 14

14.7. When a body of unknown mass is attached to an ideal spring with force constant 120 N/m, it is found to vibrate with a frequency of 6.00 Hz. Find (a) the period of the motion; (b) the angular frequency; (c) the mass of the body.

a) $T = {}^{1}/_{f} = 0.167\ s$

b) $\omega = 2\pi f = 37.7\ rad$

c) $m = \frac{k}{\omega^2} = 0.0844\ kg$



14.9. An object is undergoing SHM with period 0.900 s and amplitude 0.320 m. At t = 0 the object is at x = 0.320 m and is instantaneously at rest. Calculate the time it takes the object to go (a) from x = 0.320 m to x = 0.160 m and (b) from x = 0.160 m to x = 0.

$x(t) = A\cos\omega t$

a) $x(t) = 0.160\ m \Rightarrow \cos\omega t = \frac{0.160}{0.320} = \frac{1}{2} \Rightarrow \omega t = \frac{\pi}{3} \Rightarrow t = \frac{\pi}{3\omega} = \frac{\pi T}{6\pi} = \frac{T}{6} = 0.150\ s$

b) $x(t) = 0 \Rightarrow \cos\omega t = 0 \Rightarrow \omega t = \frac{\pi}{2} \Rightarrow t = \frac{\pi}{2\omega} = \frac{\pi T}{4\pi} = \frac{T}{4} = 0.225\ s$

$0.225 - 0.150 = 0.075\ s$

14.24. A small block is attached to an ideal spring and is moving in SHM on a horizontal, frictionless surface. The amplitude of the motion is 0.250 m and the period is 3.20 s. What are the speed and acceleration of the block when x = 0.160 m?

$$E = ½mv_x^2 + ½kx^2 = ½kA^2 \qquad T = 2\pi\sqrt{\frac{m}{k}}$$

$$v_x = \sqrt{\frac{k}{m}\cdot(A^2 - x^2)} = \frac{2\pi}{T}\sqrt{(A^2 - x^2)} = 0.377\ m/s$$

$$a_x = \frac{F_x}{m} = -\frac{kx}{m} = -\frac{4\pi^2 x}{T^2} = -0.617\ m/s^2$$

14.27. A 0.500-kg glider, attached to the end of an ideal spring with force constant k = 450 N/m, undergoes SHM with an amplitude of 0.040 m. Compute (a) the maximum speed of the glider; (b) the speed of the glider when it is at x = -0.015 m; (c) the magnitude of the maximum acceleration of the glider; (d) the acceleration of the glider x = -0.015 m; (e) the total mechanical energy of the glider at any point in its motion.

$$E = \frac{1}{2}kA^2 = \frac{1}{2}mv_x^2 + \frac{1}{2}kx^2 \qquad -kx = ma_x$$

a) $v_{x,max} = \omega A = \sqrt{\frac{k}{m}}\cdot A = 1.20\ m/s$

b) $v_x = \sqrt{\frac{k}{m}\cdot(A^2 - x^2)} = \pm 1.11\ m/s$

c) $a_{x,max} = \omega^2 A = \frac{k}{m}A = 36\ m/s^2$

d) $a_x = -\frac{kx}{m} = +13.5\ m/s^2$

e) $E = \frac{1}{2}kA^2 = 0.360\ J$

Kapitel 15

15.6 •• A fisherman notices that his boat is moving up and down periodically, owing to waves on the surface of the water. It takes 2.5 s for the boat to travel from its highest point to its lowest, a total distance of 0.62 m. The fisherman sees that the wave crests are spaced 6.0 m apart. (a) How fast are the waves traveling? (b) What is the amplitude of each wave? (c) If the total vertical distance traveled by the boat were 0.30 m but the other data remained the same, how would the answers to parts (a) and (b) be affected?

a) $v = \frac{\lambda}{T} = \frac{6.0}{5.0} = 1.2\ m/s$

b) $A = \frac{0.62}{2} = 0.31\ m$

c) $Allt\ blir\ detsamma\ utom\ amplituden\ som\ blir\ 0.15\ m$

15.8 • A certain transverse wave is described by

$$y(x, t) = (6.50\ \text{mm}) \cos 2\pi\left(\frac{x}{28.0\ \text{cm}} - \frac{t}{0.0360\ \text{s}}\right)$$

Determine the wave's (a) amplitude; (b) wavelength; (c) frequency; (d) speed of propagation; (e) direction of propagation.

$y(x,t) = A\cos 2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)$

a) $A = 6.50\ mm$

b) $\lambda = 28.0\ cm$

c) $f = \frac{1}{T} = 27.8\ Hz$

d) $v = f\lambda = \frac{\lambda}{T} = 7.78\ m/s$

e) $-\ framför\ tidstermen\ \Rightarrow\ längs\ den\ positiva\ x\text{-}axeln$

15.19 • A thin, 75.0-cm wire has a mass of 16.5 g. One end is tied to a nail, and the other end is attached to a screw that can be adjusted to vary the tension in the wire. (a) To what tension (in newtons) must you adjust the screw so that a transverse wave of wavelength 3.33 cm makes 875 vibrations per second? (b) How fast would this wave travel?

$$\mu = \frac{0.0165}{0.750} kg/m$$

a) $$v = \sqrt{\frac{F}{\mu}} = f\lambda \Rightarrow F = \mu(f\lambda)^2 = 18.7\ N$$

b) $$v = f\lambda = 29.1\ m/s$$

15.23 • A horizontal wire is stretched with a tension of 94.0 N, and the speed of transverse waves for the wire is 492 m/s. What must the amplitude of a traveling wave of frequency 69.0 Hz be in order for the average power carried by the wave to be 0.365 W?

$$P_{av} = \frac{1}{2}\mu(\omega A)^2 v = \frac{F(\omega A)^2}{2v} \Rightarrow A = \sqrt{\frac{2vP_{av}}{F\omega^2}} = 4.51\ mm$$

15.40 • A 1.50-m-long rope is stretched between two supports with a tension that makes the speed of transverse waves 48.0 m/s. What are the wavelength and frequency of (a) the fundamental; (b) the second overtone; (c) the fourth harmonic?

$f_n = \frac{nv}{2L}; \quad \lambda_n = {}^{2L}/_{n}$

a) $f_1 = \frac{v}{2L} = 16.0\ Hz; \quad \lambda_1 = 2L = 3.00\ m$

b) $f_3 = 3f_1 = 48.0\ Hz; \quad \lambda_3 = {}^{\lambda_1}/_{3} = 1.00\ m$

c) $f_4 = 4f_1 = 64.0\ Hz; \quad \lambda_4 = {}^{\lambda_1}/_{4} = 0.75\ m$

15.49 • **Guitar String.** One of the 63.5-cm-long strings of an ordinary guitar is tuned to produce the note B_3 (frequency 245 Hz) when vibrating in its fundamental mode. (a) Find the speed of transverse waves on this string. (b) If the tension in this string is increased by 1.0%, what will be the new fundamental frequency of the string? (c) If the speed of sound in the surrounding air is 344 m/s, find the frequency and wavelength of the sound wave produced in the air by the vibration of the B_3 string. How do these compare to the frequency and wavelength of the standing wave on the string?

a) $v = 2Lf_1 = 311\ m/s$

b) $v = \sqrt{\frac{F}{\mu}}\ om\ F$ ökar med 1% ökar v med en faktor $\sqrt{1.01}$ och därmed även f_1

$f_1' = f_1 \cdot \sqrt{1.01} = 246\ Hz$

c) $v = f\lambda$ frekvensen påverkas inte $\Rightarrow \frac{\lambda_{luft}}{\lambda} = \frac{v_{luft}}{v} \Rightarrow \lambda_{luft} = 1.40\ m$

Kapitel 16

16.15 •• Longitudinal Waves in Different Fluids. (a) A longitudinal wave propagating in a water-filled pipe has intensity $3.00 \times 10^{-6}\ \mathrm{W/m^2}$ and frequency 3400 Hz. Find the amplitude A and wavelength λ of the wave. Water has density $1000\ \mathrm{kg/m^3}$ and bulk modulus 2.18×10^9 Pa. (b) If the pipe is filled with air at pressure 1.00×10^5 Pa and density $1.20\ \mathrm{kg/m^3}$, what will be the amplitude A and wavelength λ of a longitudinal wave with the same intensity and frequency as in part (a)? (c) In which fluid is the amplitude larger, water or air? What is the ratio of the two amplitudes? Why is this ratio so different from 1.00?

$$B_{luft} = 1.42 \cdot 10^5\ Pa; \quad \rho_{luft} = 1.20\ kg/m^3$$

a) $I = \frac{1}{2}\rho(\omega A)^2 v = \frac{1}{2}\sqrt{\rho B}(\omega A)^2 \Rightarrow A = \sqrt{\frac{2I}{\sqrt{\rho B}\omega^2}} = 9.44 \cdot 10^{-11}\ m; \quad \lambda = \frac{v}{f} = \frac{1}{f}\sqrt{\frac{B}{\rho}} = 0.434\ m$

b) $A = \sqrt{\frac{2I}{\sqrt{\rho B}\omega^2}} = 5.64 \cdot 10^{-9}\ m$

$\lambda = \frac{1}{f}\sqrt{\frac{B}{\rho}} = 0.101\ m$

c) De mycket tätare vattenmolekylerna behöver en mindre amplitud för att överföra samma mängd energi.

16.26 • The fundamental frequency of a pipe that is open at both ends is 594 Hz. (a) How long is this pipe? If one end is now closed, find (b) the wavelength and (c) the frequency of the new fundamental.

$f_n = \frac{nv}{2L}; \quad \lambda_n = {}^{2L}/_{n} \quad \text{öppen pipa}$

$f_n = \frac{nv}{4L}; \quad \lambda_n = {}^{4L}/_{n} \quad n\ \text{udda} \quad \text{sluten pipa}$

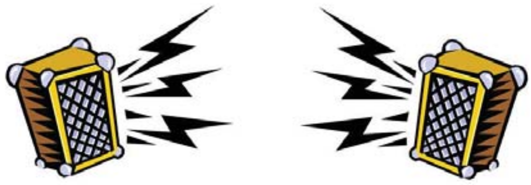
$v = 344\ m/s$

a) $L = \frac{v}{2f_1} = 28.9\ cm$

b) $\lambda_1 = 4L = 1.16\ m$

c) $f_1 = \frac{v}{4L} = 297\ Hz$

16.36 • Two loudspeakers, *A* and *B*, are driven by the same amplifier and emit sinusoidal waves in phase. The frequency of the waves emitted by each speaker is 172 Hz. You are 8.00 m from *A*. What is the closest you can be to *B* and be at a point of destructive interference?



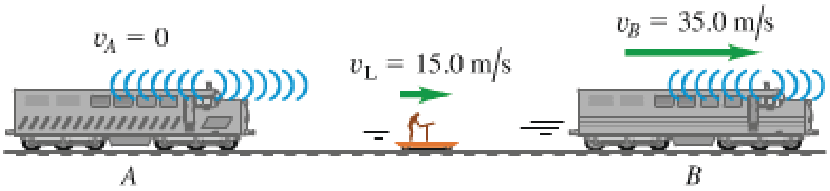
$$v = 344\ m/s$$
$$|r_A - r_B| = (n + ½)\lambda; \quad \lambda = \frac{v}{f} \Rightarrow |r_A - r_B| = 2.00 \cdot (n + ½)$$
$$Minsta\ värdet\ på\ r_B\ hittas\ då\ r_B < r_A \Rightarrow r_B = r_A - 2.00 \cdot (n + ½)$$
$$Minsta\ värdet\ på\ r_B\ hittas\ när\ n = 3 \Rightarrow r_B = 1.00\ m$$

16.40 •• Two guitarists attempt to play the same note of wavelength 6.50 cm at the same time, but one of the instruments is slightly out of tune and plays a note of wavelength 6.52 cm instead. What is the frequency of the beat these musicians hear when they play together?

$$v = 344\ m/s$$
$$f = \frac{v}{\lambda} \qquad f_{beat} = |f_A - f_B| = \left|\frac{v}{\lambda_A} - \frac{v}{\lambda_B}\right| = 16.2\ Hz$$

16.45 • Two train whistles, A and B, each have a frequency of 392 Hz. A is stationary and B is moving toward the right (away from A) at a speed of 35.0 m/s. A listener is between the two whistles and is moving toward the right with a speed of 15.0 m/s (Fig. E16.45). No wind is blowing. (a) What is the frequency from A as heard by the listener? (b) What is the frequency from B as heard by the listener? (c) What is the beat frequency detected by the listener?

Figure **E16.45**



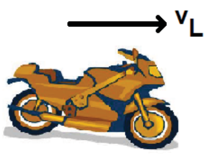
$f' = f \cdot \frac{v - v_L}{v - v_S}$ $\quad v = 344\ m/s$

a) $f' = 392 \cdot \frac{344 - 15.0}{344} = 375\ Hz$

b) $f' = 392 \cdot \frac{344 + 15.0}{344 + 35.0} = 371\ Hz$

c) $f_{beat} = |f_a - f_b| = 4\ Hz$

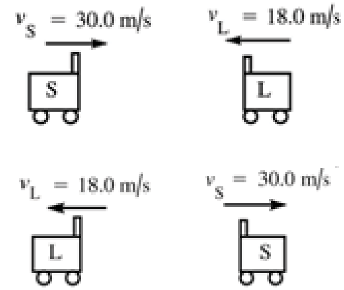
16.49 • A car alarm is emitting sound waves of frequency 520 Hz. You are on a motorcycle, traveling directly away from the car. How fast must you be traveling if you detect a frequency of 490 Hz?



$f' = f \cdot \frac{v - v_L}{v - v_S}$ $\quad v = 344\ m/s$

$v - v_L = v\frac{f'}{f} \Rightarrow v_L = v\left(1 - \frac{f'}{f}\right) = 19.8\ m/s$

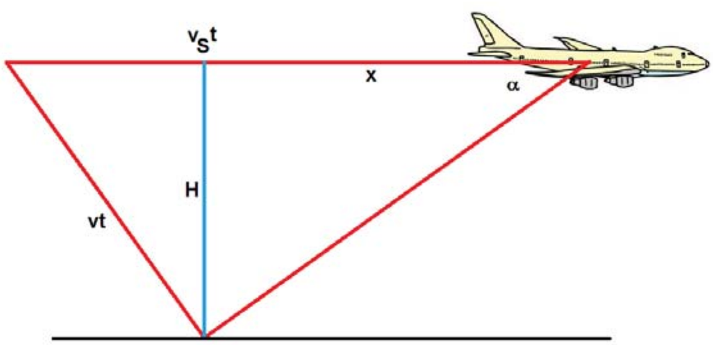
16.50 • A railroad train is traveling at 30.0 m/s in still air. The frequency of the note emitted by the train whistle is 262 Hz. What frequency is heard by a passenger on a train moving in the opposite direction to the first at 18.0 m/s and (a) approaching the first and (b) receding from the first?



$f' = f \cdot \frac{v - v_L}{v - v_S}$ $\quad v = 344\ m/s$

a) $f' = 262 \cdot \frac{344+18}{344-30} = 302\ Hz$ b) $f' = 262 \cdot \frac{344-18}{344+30} = 228\ Hz$

16.55 •• A jet plane flies overhead at Mach 1.70 and at a constant altitude of 950 m. (a) What is the angle α of the shock-wave cone? (b) How much time after the plane passes directly overhead do you hear the sonic boom? Neglect the variation of the speed of sound with altitude.



$v = 344\ m/s; \quad v_S = 1.70 \cdot v$

a) $\sin\alpha = \frac{v}{v_S} \Rightarrow \alpha = \sin^{-1}\frac{1}{1.70} = 36.0°$

b) $\tan\alpha = \frac{H}{x} \Rightarrow x = \frac{H}{\tan\alpha} \qquad \Delta t = \frac{x}{v_S} = \frac{H}{1.70 \cdot v \tan\alpha} = 2.24\ s$

Kapitel 35

35.9 • Young's experiment is performed with light from excited helium atoms ($\lambda = 502$ nm). Fringes are measured carefully on a screen 1.20 m away from the double slit, and the center of the 20th fringe (not counting the central bright fringe) is found to be 10.6 mm from the center of the central bright fringe. What is the separation of the two slits?

$$d \sin\theta = m\lambda; \quad R \gg y \Rightarrow \sin\theta \approx \tan\theta = \frac{y_m}{R} \quad \Rightarrow \quad d = \frac{20\cdot\lambda R}{y_{20}} = 1.14\,mm$$

$$\left(\theta = \tan^{-1}\frac{y_m}{R} = 0.51° \text{ är } en\ liten\ vinkel;\ \tan 0.51° = 0.00883;\ \sin 0.51° = 0.00883\right)$$

35.10 •• Coherent light with wavelength 450 nm falls on a double slit. On a screen 1.80 m away, the distance between dark fringes is 4.20 mm. What is the separation of the slits?

$$R \gg y \Rightarrow y_{m+½} = \frac{(m+½)\cdot\lambda R}{d} \Rightarrow \Delta y = \frac{\lambda R}{d} \Rightarrow d = \frac{\lambda R}{\Delta y} = 193\mu m$$

35.11 •• Two slits spaced 0.450 mm apart are placed 75.0 cm from a screen. What is the distance between the second and third dark lines of the interference pattern on the screen when the slits are illuminated with coherent light with a wavelength of 500 nm?

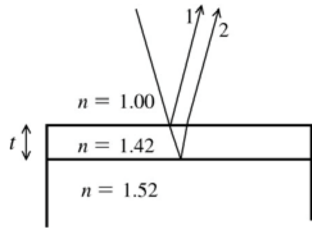
$$d \sin\theta = (m + ½)\lambda;\;\; d \gg \lambda \Rightarrow y_{m+½} = \frac{(m+½)\cdot\lambda R}{d} \;\Rightarrow\; \Delta y = \frac{\lambda R}{d} = 833\mu m$$

35.16 •• Coherent light that contains two wavelengths, 660 nm (red) and 470 nm (blue), passes through two narrow slits separated by 0.300 mm, and the interference pattern is observed on a screen 5.00 m from the slits. What is the distance on the screen between the first-order bright fringes for the two wavelengths?

$$d \gg \lambda \Rightarrow y_m = \frac{m\lambda R}{d}$$

$$\Delta y_1 = \frac{(\lambda_1 - \lambda_2)R}{d} = 3.17\ mm$$

35.25 • What is the thinnest film of a coating with $n = 1.42$ on glass ($n = 1.52$) for which destructive interference of the red component (650 nm) of an incident white light beam in air can take place by reflection?



$$Destruktiv\ reflektion\ (båda\ reflektionerna\ mot\ tätare\ medium) \Rightarrow 2t = (m + ½)\frac{\lambda}{n}$$

$$Minst\ om\ m = 0 \Rightarrow t = \frac{\lambda}{4n} = \frac{650}{4 \cdot 1.42} = 114\ nm$$

35.36 • Jan first uses a Michelson interferometer with the 606-nm light from a krypton-86 lamp. He displaces the movable mirror away from him, counting 818 fringes moving across a line in his field of view. Then Linda replaces the krypton lamp with filtered 502-nm light from a helium lamp and displaces the movable mirror toward her. She also counts 818 fringes, but they move across the line in her field of view opposite to the direction they moved for Jan. Assume that both Jan and Linda counted to 818 correctly. (a) What distance did each person move the mirror? (b) What is the resultant displacement of the mirror?

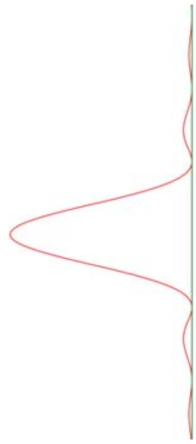
a) $y_1 = m \cdot \frac{\lambda_1}{2} = 818 \cdot \frac{606}{2} = 247854\ nm = 248\ \mu m$

$y_2 = -m \cdot \frac{\lambda_2}{2} = 818 \cdot \frac{502}{2} = -205318\ nm = -205\ \mu m$

b) $Total\ förflyttning\ 248 - 205 = 43\ \mu m$

Kapitel 36

36.1 •• Monochromatic light from a distant source is incident on a slit 0.750 mm wide. On a screen 2.00 m away, the distance from the central maximum of the diffraction pattern to the first minimum is measured to be 1.35 mm. Calculate the wavelength of the light.



$$a \sin\theta = m\lambda; \quad m = 1; \quad R \gg y \Rightarrow \lambda = \frac{ay}{R} = 506\, nm$$

36.4 • Light of wavelength 633 nm from a distant source is incident on a slit 0.750 mm wide, and the resulting diffraction pattern is observed on a screen 3.50 m away. What is the distance between the two dark fringes on either side of the central bright fringe?

$$a \sin\theta = m\lambda; \quad m = \pm 1; \quad R \gg y \Rightarrow \Delta y_{\pm 1} = \frac{2R\lambda}{a} = 5.91\, mm$$

36.12 •• Red light of wavelength 633 nm from a helium–neon laser passes through a slit 0.350 mm wide. The diffraction pattern is observed on a screen 3.00 m away. Define the width of a bright fringe as the distance between the minima on either side. (a) What is the width of the central bright fringe? (b) What is the width of the first bright fringe on either side of the central one?

a) $a\sin\theta = m\lambda; \quad = \pm 1; \quad a \gg \lambda \Rightarrow \Delta y_{\pm 1} = \frac{2R\lambda}{a} = 10.9\ mm$

b) $\Delta y_{1,2} = \frac{R\lambda}{a} = 5.43\ mm$

36.15 •• A slit 0.240 mm wide is illuminated by parallel light rays of wavelength 540 nm. The diffraction pattern is observed on a screen that is 3.00 m from the slit. The intensity at the center of the central maximum ($\theta = 0°$) is $6.00 \times 10^{-6}\ W/m^2$. (a) What is the distance on the screen from the center of the central maximum to the first minimum? (b) What is the intensity at a point on the screen midway between the center of the central maximum and the first minimum?

a) $a\sin\theta = m\lambda; \quad = 1; \quad a \gg \lambda \Rightarrow y_1 = \frac{R\lambda}{a} = 6.75\ mm$

b) $I = I_0 \frac{\sin^2\left(\frac{\beta}{2}\right)}{\left(\frac{\beta}{2}\right)^2}; \quad = \frac{2\pi a \sin\theta}{\lambda}$

$den\ sökta\ vinkeln\ ges\ av \quad a\sin\theta = ½\lambda \Rightarrow \beta = \frac{2\pi ½\lambda}{\lambda} = \pi \Rightarrow$

$I = I_0 \frac{\sin^2\left(\frac{\pi}{2}\right)}{\left(\frac{\pi}{2}\right)^2} = I_0 \frac{4}{\pi^2} = 2.43 \cdot 10^{-6}\ W/m^2$

36.24 • Parallel rays of monochromatic light with wavelength 568 nm illuminate two identical slits and produce an interference pattern on a screen that is 75.0 cm from the slits. The centers of the slits are 0.640 mm apart and the width of each slit is 0.434 mm. If the intensity at the center of the central maximum is $5.00 \times 10^{-4}\ W/m^2$, what is the intensity at a point on the screen that is 0.900 mm from the center of the central maximum?

$$I = I_0\left[\cos^2\left(\frac{\phi}{2}\right)\right]\frac{\sin^2\left(\frac{\beta}{2}\right)}{\left(\frac{\beta}{2}\right)^2};\quad \phi = \frac{2\pi d\sin\theta}{\lambda};\quad \beta = \frac{2\pi a\sin\theta}{\lambda}$$

$$R \gg y \Rightarrow \sin\theta \approx \tan\theta = \frac{y}{R} \Rightarrow \sin\theta = 0.0012$$

$$\phi = \frac{2\pi d\sin\theta}{\lambda} = 8.4956\, rad;\quad \beta = \frac{2\pi a\sin\theta}{\lambda} = 5.7611\, rad$$

$$I = I_0\left[\cos^2\left(\frac{8.4956}{2}\right)\right]\frac{\sin^2\left(\frac{5.7611}{2}\right)}{\left(\frac{5.7611}{2}\right)^2} = I_0\cdot 0.2008\cdot\frac{0.0666}{8.298} = 0.001612\cdot I_0 = 8.06\cdot 10^{-7}\ W/m^2$$

36.29 • If a diffraction grating produces its third-order bright band at an angle of 78.4° for light of wavelength 681 nm, find (a) the number of slits per centimeter for the grating and (b) the angular location of the first-order and second-order bright bands. (c) Will there be a fourth-order bright band? Explain.

a) $d\sin\theta = m\lambda \Rightarrow N = \frac{10^{-2}}{d} = \frac{10^{-2}\cdot\sin\theta}{m\lambda} = 4790$ ritsar/cm

$d = \frac{m\lambda}{\sin\theta} = 2.0856\,\mu m$

b) $\theta_1 = \sin^{-1}\frac{\lambda}{d} = 19.1°;\quad \theta_2 = \sin^{-1}\frac{2\lambda}{d} = 40.8°;$

c) $\theta_4 = \sin^{-1}\frac{4\lambda}{d}\ men\ \frac{4\lambda}{d} = 1.31 > 1, d.v.s. 4{:}\ de\ ordningen\ syns\ inte$

36.30 • If a diffraction grating produces a third-order bright spot for red light (of wavelength 700 nm) at 65.0° from the central maximum, at what angle will the second-order bright spot be for violet light (of wavelength 400 nm)?

$$d \sin\theta = m\lambda \Rightarrow d = \frac{3\lambda_1}{\sin\theta_1}$$

$$\sin\theta_2 = \frac{2\lambda_2}{d} = \frac{2\lambda_2 \sin\theta_1}{3\lambda_1} = 0.3453 \Rightarrow \theta_2 = 20.2°$$

36.37 • A typical laboratory diffraction grating has 5.00×10^3 lines/cm, and these lines are contained in a 3.50-cm width of grating. (a) What is the chromatic resolving power of such a grating in the first order? (b) Could this grating resolve the lines of the sodium doublet (see Section 36.5) in the first order? (c) While doing spectral analysis of a star, you are using this grating in the *second* order to resolve spectral lines that are very close to the 587.8002-nm spectral line of iron. (i) For wavelengths longer than the iron line, what is the shortest wavelength you could distinguish from the iron line? (ii) For wavelengths shorter than the iron line, what is the longest wavelength you could distinguish from the iron line? (iii) What is the range of wavelengths you could *not* distinguish from the iron line?

a) $R_1 = mN = 1 \cdot 3.50 \cdot 5.00 \cdot 10^3 = 17500$

b) $\lambda_1 = 589.00\ nm; \quad \lambda_2 = 589.59\ nm; \quad \Delta\lambda = 0.59\ nm$

$\frac{\lambda}{\Delta\lambda} = \frac{589}{0.59} = 998 \ll 17500 \quad Gittret\ löser\ lätt\ upp\ linjerna$

c) $R_2 = 2 \cdot R_1 = 35000; \quad \Delta\lambda = \frac{\lambda}{R_2} = 0.0168\ nm$

$\lambda + \Delta\lambda = 587.8170\ nm\ (i); \qquad \lambda - \Delta\lambda = 587.7834\ nm\ (ii)$

$587.7834\ nm < \lambda < 587.8170\ nm\ (iii)$

36.38 • The light from an iron arc includes many different wavelengths. Two of these are at $\lambda = 587.9782$ nm and $\lambda = 587.8002$ nm. You wish to resolve these spectral lines in first order using a grating 1.20 cm in length. What minimum number of slits per centimeter must the grating have?

$\frac{\lambda}{\Delta\lambda} = \frac{587.8892}{0.1780} = 3303$ *d.v.s. gittret måste ha en upplösningsförmåga på minst* 3303

$R = mN \Rightarrow$ *gittret måste ha minst* 3303 *ritsar* $\Rightarrow \frac{3303}{1.20} = 2752$ *ritsar/cm*

Det behövs minst 2752*ritsar/cm*

36.47 • **Observing Jupiter.** You are asked to design a space telescope for earth orbit. When Jupiter is 5.93×10^8 km away (its closest approach to the earth), the telescope is to resolve, by Rayleigh's criterion, features on Jupiter that are 250 km apart. What minimum-diameter mirror is required? Assume a wavelength of 500 nm.

$\theta = \frac{1.22\lambda}{D}$; $\theta \approx tan\theta = \frac{x}{R} \Rightarrow D = \frac{1.22\lambda R}{x} = 1.45\ m$