

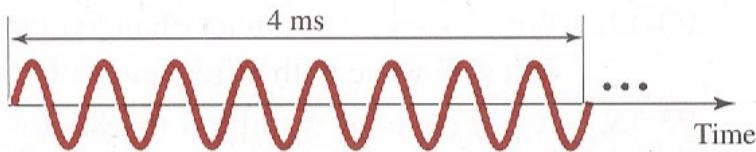
### 3.8.3 Problems

**P3-1.** What is the length of a bit in a channel with a propagation speed of  $2 \times 10^8$  m/s if the channel bandwidth is

- a. 10 Mbps?
- b. 100 Mbps?
- c. 1 Gbps?

**P3-2.** What is the frequency of the signal in Figure 3.35?

**Figure 3.35** Problem P3-2



**P3-3.** The light of the sun takes approximately eight minutes to reach the earth. What is the distance between the sun and the earth?

**P3-4.** A computer monitor has a resolution of 1600 by 800 pixels. If each pixel uses 1024 colors, how many bits are needed to send the complete contents of a screen?

**P3-5.** A line has a signal-to-noise ratio of 2000 and a bandwidth of 5000 KHz. What is the maximum data rate supported by this line?

**P3-6.** A signal has a wavelength of 1  $\mu\text{m}$  in air. How far can the front of the wave travel during 500 periods?

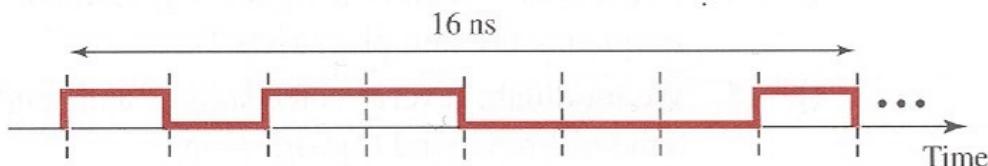
**P3-7.** What is the bit rate for each of the following signals?

- a. A signal in which 1 bit lasts 0.001 s
- b. A signal in which 1 bit lasts 2 ms
- c. A signal in which 10 bits last 20  $\mu\text{s}$

**P3-8.** If the bandwidth of the channel is 5 Kbps, how long does it take to send a frame of 1,000,000 bits out of this device?

- P3-9.** A signal travels from point A to point B. At point A, the signal power is 100 W. At point B, the power is 80 W. What is the attenuation in decibels?
- P3-10.** The attenuation of a signal is  $-10$  dB. What is the final signal power if it was originally 10 W?
- P3-11.** What is the bit rate for the signal in Figure 3.36?

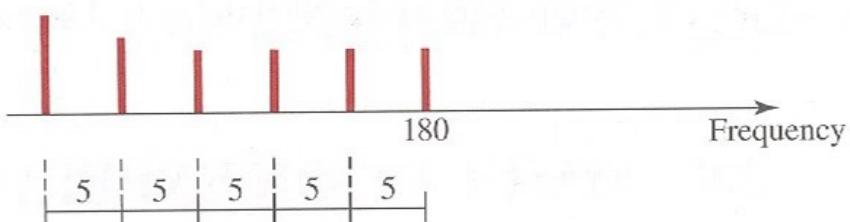
**Figure 3.36** Problem P3-11



- P3-12.** A device is sending out data at the rate of 1000 bps.
- How long does it take to send out 10 bits?
  - How long does it take to send out a single character (8 bits)?
  - How long does it take to send a file of 100,000 characters?
- P3-13.** What is the phase shift for the following?
- A sine wave with the maximum amplitude at time zero
  - A sine wave with maximum amplitude after  $1/4$  cycle
  - A sine wave with zero amplitude after  $3/4$  cycle and increasing
- P3-14.** Which signal has a wider bandwidth, a sine wave with a frequency of 100 Hz or a sine wave with a frequency of 200 Hz?
- P3-15.** A file contains 3 million bytes. How long does it take to download this file using a 56-Kbps channel? 1-Mbps channel?
- P3-16.** How many bits can fit on a link with a 2 ms delay if the bandwidth of the link is
- 1 Mbps?
  - 10 Mbps?
  - 100 Mbps?
- P3-17.** What is the theoretical capacity of a channel in each of the following cases?
- Bandwidth: 30 KHz  $\text{SNR}_{\text{dB}} \nabla 40$
  - Bandwidth: 100 KHz  $\text{SNR}_{\text{dB}} \nabla 4$
  - Bandwidth: 1 MHz  $\text{SNR}_{\text{dB}} \nabla 20$
- P3-18.** A TV channel has a bandwidth of 6 MHz. If we send a digital signal using one channel, what are the data rates if we use one harmonic, three harmonics, and five harmonics?
- P3-19.** A signal with 200 milliwatts power passes through 20 devices, each with an average noise of 2 microwatts. What is the SNR? What is the SNRdB?
- P3-20.** What is the bandwidth of a signal that can be decomposed into five sine waves with frequencies at 0, 20, 50, 100, and 200 Hz? All peak amplitudes are the same. Draw the bandwidth.

**P3-21.** What is the bandwidth of the composite signal shown in Figure 3.37?

**Figure 3.37** Problem P3-21



**P3-22.** Given the following periods, calculate the corresponding frequencies.

a.  $5\text{ s}$

b.  $12\text{ }\mu\text{s}$

c.  $220\text{ ns}$

**P3-23.** A signal has passed through three cascaded amplifiers, each with a 4 dB gain. What is the total gain? How much is the signal amplified?

**P3-24.** If the peak voltage value of a signal is 20 times the peak voltage value of the noise, what is the SNR? What is the  $\text{SNR}_{\text{dB}}$ ?

**P3-25.** A periodic composite signal with a bandwidth of 2000 Hz is composed of two sine waves. The first one has a frequency of 100 Hz with a maximum amplitude of 20 V; the second one has a maximum amplitude of 5 V. Draw the bandwidth.

**P3-26.** We measure the performance of a telephone line (4 KHz of bandwidth). When the signal is 10 V, the noise is 5 mV. What is the maximum data rate supported by this telephone line?

**P3-27.** A nonperiodic composite signal contains frequencies from 10 to 30 KHz. The peak amplitude is 10 V for the lowest and the highest signals and is 30 V for the 20-KHz signal. Assuming that the amplitudes change gradually from the minimum to the maximum, draw the frequency spectrum.

**P3-28.** We need to upgrade a channel to a higher bandwidth. Answer the following questions:

a. How is the rate improved if we double the bandwidth?

b. How is the rate improved if we double the SNR?

**P3-29.** We have a channel with 4 KHz bandwidth. If we want to send data at 100 Kbps, what is the minimum  $\text{SNR}_{\text{dB}}$ ? What is the SNR?

**P3-30.** A periodic composite signal contains frequencies from 10 to 30 KHz, each with an amplitude of 10 V. Draw the frequency spectrum.

**P3-31.** Given the frequencies listed below, calculate the corresponding periods.

a.  $24\text{ Hz}$

b.  $8\text{ MHz}$

c.  $140\text{ KHz}$

**P3-32.** What is the transmission time of a packet sent by a station if the length of the packet is 1 million bytes and the bandwidth of the channel is 200 Kbps?

- P3-33.** What is the total delay (latency) for a frame of size 5 million bits that is being sent on a link with 10 routers each having a queuing time of  $2 \mu\text{s}$  and a processing time of  $1 \mu\text{s}$ . The length of the link is 2000 Km. The speed of light inside the link is  $2 \times 10^8 \text{ m/s}$ . The link has a bandwidth of 5 Mbps. Which component of the total delay is dominant? Which one is negligible?