QUESTIONS FOR THOUGHT AND DISCUSSION

1. When a chord is played on a piano while the sustaining pedal is depressed, the tone sounds richer than the same chord played without the sustaining pedal. Can you explain why?
2. If a piano key is depressed slowly enough, the hammer fails to contact the string at all. Explain why.
3. Will the two notes shown in Fig. 14.20 sound exactly the same when played on a piano?
4. Can you think of any advantages a tracker action might have over a direct electric action in an organ? any disadvantages?
5. In small pipe organs, the sixteen-foot pipes are almost always stopped wooden pipes. Explain why.

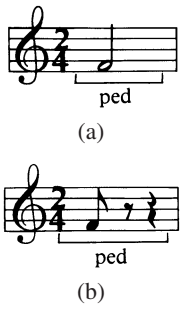

FIGURE 14.20

EXERCISES

1. Suppose that all the strings of a piano were of the same material and also had the same diameter and tension. If the longest string (A_0) were 2 m in length, how long would the highest A-string (A_7) have to be? Is this practical?
2. Show that two unison strings, tuned 2 cents (0.12%) different and initially in phase, will fall out of phase after about 400 vibrations.
3. If a particular string on a harpsichord has one-third the diameter and one-tenth the tension of the corresponding string on a piano, which string will be longer? What will the ratio of lengths be? (See Section 3.2 and 4.3; assume that both strings are steel.)
4. If the diameter of pipes in a particular rank is reduced by a factor of two every seventeen notes, show that the diameter reduces by four over a range of about three octaves.
5. A piano tuner finds that two of the strings tuned to C_4 give about one beat per second when sounded together. What is the ratio of their frequencies? Show that their pitches differ by about 7 cents. (One cent is 1/100 of a semitone and corresponds to a frequency ratio of approximately 1.0006.)
6. By noting the weak partials in the C_1 spectrum in Fig. 14.7, estimate the fraction of the string length β at which the hammer strikes.
7. Calculate the acoustical lengths of open organ pipes tuned to C_0, C_1, and C_2 (frequencies are given in Table 9.2, also Table 14.1). Compare these to the equivalent lengths in Table 14.1.

EXPERIMENTS FOR HOME, LABORATORY, AND CLASSROOM DEMONSTRATION

Home and Classroom Demonstration

1. *Mechanical model of piano action* Mechanical models of piano actions can sometimes be obtained from piano dealers or manufacturers.

2. *The pedals* Depress each piano pedal to see and hear what it does.

3. *Trichord* Damp two of the three strings of one note (piano tuners wedges work the best) and determine the change in the sound.

4. *Piano sound reversed* Demonstration 29 on the Auditory Demonstrations CD. Piano tones, heard backwards, do not sound like piano tones, even though the spectrum remains unchanged, because the sound of hammer on string comes at the end of a note rather than at the beginning.

5. *Organ pipes* From an organ builder, obtain as many different organ pipes as possible. These can generally be sounded by blowing on them. Note the different sounds.