

**HW #7** —Phy273—Fall 2000  
Due before class, Friday, Oct. 27, 2000  
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Read in RHK Chapter 20 (*Sound Waves*).

Read in Feynman Chapter 47 *Sound. The wave equation*; Sections 48-1,2,5; (*Modes*); Sections 51-1,3 (*Waves*)

Questions (Q) and problems (P) in Chapter 20, RHK, except first two problems:

1. In class we showed that a superposition of right and left moving harmonic waves on a string of length  $L$  satisfies the fixed endpoint boundary conditions and yields a standing wave of the form  $y(x, t) = A \cos(\omega t) \sin(kx)$ , provided  $kL = n\pi$ . Here let us rederive this result by finding the normal modes of the string. Assume a harmonic time dependence for the displacement,  $y(x, t) = \cos(\omega t)f(x)$ , and deduce from the wave equation an ordinary differential equation for  $f(x)$ . Solve this equation for  $f(x)$  to recover the form of the standing waves quoted above.
2. P47, RHK Chapter 19 (*reflection and transmission of waves at a string junction*) Add parts: (c) How can you arrange for the wave to be 100% transmitted? (d) Show that in the limits where the mass density  $\mu_2$  goes to infinity and to zero you recover the rules for 100% reflection at a fixed and at a free end respectively.
3. Q9 (*pitch change of warmed instruments*)
4. Q35 (*Doppler shift of sound and relative velocity*)
5. Q36 (*Doppler effect with moving air?*)
6. Q40 (*bat vs. porpoise sonar resolution*)
7. P2 (*highest frequency for sound in air*)
8. P3 (*acoustic microscope in liquid helium*)
9. P8 (*earthquake location using seismic waves*)
10. P17 (*intensity, pressure, and decibels*)
11. P19 (*sound intensity, displacement, and pressure*)
12. P35 (*detective with a big ear*)
13. P42 (*pulsations of a white dwarf*). Add part (d): What is the period of the analogous pulsations of the earth? These “free oscillations” are measured by geophysicists. Assume a uniform density, and a bulk modulus of 30 GPa (I’m guessing, based on the Young’s modulus of concrete from Table 1, p. 306.)
14. P43 (*method of measuring sound speed in gases*)
15. P51 (*beats of violin string and tuning fork*)

*continued...*

16. P58 (*Doppler effect and beats*)
17. P61 (*Cerenkov cone from high energy electrons in water*)
18. P65 (*Doppler sonar speed measurement*)
19. P72 (*ultrasonic Doppler for medical diagnosis—see Q38 for a reference*)
20. P73 (*bat sonar in motion*)

**Honors HW #7h:** TBA