Study Guide for Test 4

Fluid Dynamics
You should understand the concept of flow rate of a fluid, and know the formulas

\[
\text{flow rate} = \frac{\text{volume}}{\text{time}} = (\text{area}) \cdot (\text{speed}).
\]

You should understand the “squirt gun principle” for an incompressible fluid, which says that the flow rate is the same at all points along a closed passageway. You should understand and be able to apply Bernoulli’s equation,

\[
P = \frac{1}{2} \rho v^2 + \rho gh = \text{constant},
\]

but you need not memorize the equation itself. You should have a qualitative understanding of the concept of viscosity, and how it affects the flow rate of real fluids in real pipes.

Oscillations
You should understand the terms frequency and period, and how they relate to each other \((f = 1/T)\). You should know that “Hz” (hertz) is another name for the unit of frequency, \(s^{-1}\) (or oscillations per second).

I’ll give you the formulas for the period of a mass on a spring and a simple pendulum:

\[
T = 2\pi \sqrt{\frac{m}{k}}; \quad T = 2\pi \sqrt{\frac{L}{g}}.
\]

You should be able to apply these formulas correctly to answer both qualitative and quantitative questions.

Waves
You should understand the following terms as applied to waves: transverse; longitudinal; amplitude; frequency; period; wavelength; speed; superposition; interference; standing wave; fundamental frequency; overtone; intensity. You should understand what sound waves are, in terms of density, pressure, and displacement.

You should memorize, or be able to figure out, the relation between speed, period, and wavelength:

\[
v = \frac{\Delta x}{\Delta t} = \frac{\lambda}{T} = \lambda f.
\]

You should memorize the approximate value of the speed of sound in air at room temperature. I’ll give you the more general formulas for the speed of transverse waves on a string and sound waves:

\[
v = \sqrt{\frac{F_T}{(m/L)}}; \quad v = \sqrt{\frac{B}{\rho}}.
\]

You should be able to apply these equations both quantitatively and qualitatively.

You should be able to draw and interpret standing-wave patterns and determine the various standing-wave wavelengths and frequencies for a string (or rope or cord) that is fixed at both ends, and for a pipe or tube with one or two open ends.

You should understand and be able to explain the Doppler effect. When the motion of source and/or detector is slow compared to the speed of the wave, the observed frequency is shifted by a percentage equal to their relative velocity as a percentage of the wave speed.