Wave Speeds

The speed of waves in a medium depends on the elastic properties and on the inertia of the particles in the medium. This worksheet gives an overview on some important examples and makes you familiar with the corresponding tables in "Formeln und Tafeln".

Procedure:
First you decide whether the quantities are in the numerator or the denominator of the formula. Then you look up the formula and add for every quantity its meaning, unit and where available the page where you find a table with values. Finally you solve the example problems.

Pressure Waves in Gases

$v =$

R:

T:

M:

$\kappa =$

Pressure Waves in Liquids

$v =$

χ:

ρ:

Longitudinal Waves in a Rod

$v_L =$

E:

ρ:

Transverse Waves in a Rod

$$v_T = \sqrt{\frac{G}{\rho}}$$

G: shear modulus; $[G] = 1\ \mathrm{N/m^2}$

ρ: density; $[\rho] = 1\ \mathrm{kg/m^3}$

Remark: For the shear modulus the general relation $\frac{E}{3} \le G \le \frac{E}{2}$ holds true.

Transverse Waves on a String

$v =$

σ:

ρ:

Examples:

1. By what factor do the speeds of sound in hydrogen and oxygen gas differ at the same temperature?
2. At what temperature is the speed of sound in air (M = 28.96 g/mol) exactly 340 m/s? What is the temperature range for an error of up to 1 %?
3. What is the speed of sound in water at a temperature of 20°C? How does it change when the temperature is increased to 80°C?
4. How long does a sound wave travel through a 1.5 km long railway track?
5. When a steel rod is hit with a hammer on one end, two pulses are registered at the other end. Explain this phenomenon.
6. A 1.2 m long steel string with a specific mass of 1.5 g/m is pulled with 55 N. What is the speed of a transverse wave on this string? What is the frequency of the tone that can be heard?