

Problems - Chapter K

Physics 2425 - Dr. Terry Honan

■ Problem K.1

Consider a pulse that in SI units has the shape

$$u = f(x) = \frac{8}{x^2+4}.$$

Write this as a function $u(x, t)$ that describes this pulse moving in the positive x direction with a speed of 3 m/s .

■ Problem K.2

What are the speed and direction of a pulse on a string that (in SI units) has the form:

$$y(x, t) = 0.04 e^{-\left(\frac{x+0.03t}{0.06}\right)^2}.$$

■ Problem K.3

A sinusoidal pulse on a string has the mathematical form $y(x, t) = (0.80 \text{ m}) \sin\left[\frac{2\pi}{10}(x - 4t)\right]$. Plot the y vs. x graph at $t = 0 \text{ s}$. By the time $t = 0.6 \text{ s}$ how much has the pulse shifted. On the same graph plot y vs. x at $t = 0.6 \text{ s}$.

■ Problem K.4

A string with a linear density of $\mu = 4 \times 10^{-3} \text{ kg/m}$ is given a tension of 360 N . What is the speed of waves on this string?

■ Problem K.5

The elastic limit for steel is $S_{\text{max}} = 2.7 \times 10^9 \text{ N/m}^2$; this is the maximum stress (force per area) that steel under tension can withstand. S_{max} is the largest value that T/A , the tension per area, can have without a wire breaking. If the density of steel is 7860 kg/m^3 then what is the largest speed a wave can travel down a steel wire?

■ Problem K.6

A 30 m long copper wire with a 1.2 mm diameter is stretched to a tension of 200 N. How long does it take for a pulse to travel the length of the wire? The density of copper is $\rho = 8.92 \times 10^3 \text{ kg/m}^3$.

■ Problem K.7

A sinusoidal wave on a string has the form

$$y(x) = (15 \text{ cm}) \cos\left[\left(\frac{\pi}{20} \text{ cm}^{-1}\right)x - (16\pi \text{ s}^{-1})t\right].$$

- (a) Plot the motion of the position $x = 0$ as a function of time and find its period and frequency.
- (b) What is the maximum speed of this point ($x = 0$) on the string?
- (c) What are the wavelength and speed of this wave?

■ Problem K.8

As a sinusoidal wave passes, a point on a string makes 50 complete vibrations in 20 s. In the same time a crest (maximum) of the wave moves a distance of 4 m. What is the frequency, speed and wavelength of this wave?

■ Problem K.9

A 15 m length of rope has a mass of 0.6 kg and is given a tension of 500 N. What power is required to put a wave with an amplitude of 20 cm and a frequency of 3 Hz?

■ Problem K.10

A wave of the form

$$y(x, t) = (0.12 \text{ m}) \sin\left[(0.8 \text{ m}^{-1})x + (40 \text{ s}^{-1})t\right]$$

travels down a string with a linear density of 8 g/m .

- (a) What is the speed of the wave and in what direction is it moving?
- (b) What are the wavelength and frequency of this wave?
- (c) What is the tension in the string?
- (d) What is the power transmitted by this wave?