

Sheet 2
Waves (Chapter 16)

Propagation of a perturbation

Q1: A pulse propagating on a rope: Is it a transversal or a longitudinal one? Why?

P1. At time $t = 0$ the shape of a transverse pulse on a string is given by the function

$$y(x,0) = \frac{1.5m^3}{(2.00m)^2 + x^2} \text{ with } x \text{ in meters.}$$

Give the wave function $y(x,t)$ at a general time t if the pulse is moving to the negative x direction with a speed of 1.0 m/s.

Sinusoidal waves

Q2. Consider the velocity v_y of a small segment of a string in a transversal wave: At what position does that element have its maximum velocity? When does it have zero velocity?

P2. (a) Write an equation describing a sinusoidal transverse wave traveling on a cord in the $+x$ direction with a wavelength of 10 cm, a frequency of 400 Hz, and amplitude of 2 cm.

(b) What is the maximum speed of any point on the cord?

(c) What is the speed of the wave?

P3. A transverse wave on a string is described by the wave function,

$$y = 0.12 \sin(\pi/8 x + 4\pi t),$$

where x and y are in meter and t is in seconds. Determine : (a) the transverse speed, (b) the transverse acceleration at $t = 0.2$ s for an element of the string located at $x = 1.6$ m), (c) the wavelength, (d) the period and (e) the speed of propagation of this wave.

P4. Show that the wave function

$$y = A \exp(b(x-vt)),$$

is a solution of the linear wave equation, where v , b and A are constants.

P5. Write the dispersion relation $v = \lambda f$ in terms of k and ω .

Speed of a wave

Q3. You start a wave on a taut rope by moving one end up and down periodically. If you double the speed of that movement, what will happen to the speed of the wave on the rope?

P6 . The George W. Washington Bridge in New York (opened in 1931) is a suspension bridge: 4 cables, each of them with a length of about 1700 m and a weight of 28500 tons, carry the weight of the driveways crossing the river. Each cable is under a tension of 250 MN. Imagine you stand at one end of the bridge and hit one of the cables with a (giant) hammer to send a down pulse along the cable to the other end of the bridge. How long will it take for the pulse to return to you? What will be the shape of the reflected pulse?

