(3) PROBLEM #3:

[Young & Freedman 19-12]

(a) Starting from eq. (19-3) in Young & Freedman and using the dispersion relation

$$\omega = v\cdot k \iff 2\pi f = v\cdot\frac{2\pi}{\lambda} \iff f = \frac{v}{\lambda},$$

(with $v = c \equiv \sqrt{\frac{\tau}{\mu}}$ for a string)

we find:

$$y(x,t) = A\sin\left[\omega\left(t-\frac{x}{v}\right)\right] = A\sin\left[2\pi f\left(t-\frac{x}{v}\right)\right] \quad (3)$$

$$= A\sin\left[2\pi\left(\frac{v}{\lambda}\right)\left(t-\frac{x}{v}\right)\right] = A\sin\left[2\pi\left(\frac{vt}{\lambda}-\frac{x}{\lambda}\right)\right]$$

$$= A\sin\left[\frac{2\pi}{\lambda}(vt-x)\right] = -A\sin\left[\frac{2\pi}{\lambda}(x-vt)\right],$$

which is the desired result.

(b) The transverse velocity $v_y(x,t)$ is the vertical velocity of a chunk of the string located at position x: