PHYS M20C: Modern Physics-31376
Quiz #2 – Thursday, January 24th, 2019 18 93 **Name:** Jared Fowler

Academic Integrity: I certify that this is my own work. **Signature:** Jared Fowler

Read problems carefully (>twice!), write only on this sheet, show all work, and box your final answers.

1) The wave function for a traveling wave on a taut string is (in SI units)

$$y(x,t) = 0.35\text{m}\,\sin\left[-(10\pi\,\text{s}^{-1})t - (3\pi\,\text{m}^{-1})x + \frac{\pi}{4}\right]$$

a) What is the direction of travel of the wave? Explain. [4 points]

This wave is traveling in the $-x$ direction.

consider: $\left[-(10\pi\,s^{-1})t - (3\pi\,m^{-1})x + \pi/4\right]$ = constant SAT!

As time increases, the value of $-kx$ must increase to compensate, thus, x must be a negative value, hence,

$\xleftarrow{(-)}$ x $\quad -\hat{i}$ (Alternate solution is take derivative.)

b) What is the wave propagation speed of the wave? [4 points]

$v = \frac{\omega}{k}$ Note: $y(x,t) = y_{max}\sin(\omega t - kx + \phi)$

$\omega = 10\pi$, $k = 3\pi$

$v = \frac{10\pi\,(s^{-1})}{3\pi\,(m^{-1})} = 3.33\,m/s$

> b/c $\omega = 2\pi f \rightarrow f = \frac{\omega}{2\pi}$

$k = \frac{2\pi}{\lambda} \rightarrow \lambda = \frac{2\pi}{k}$

$v = \lambda f \rightarrow v = \frac{\omega}{k}\frac{2\pi}{2\pi}$

c) What is the wavelength? [4 points]

$\lambda = ?$

$k = \frac{2\pi}{\lambda} \rightarrow \lambda = \frac{2\pi}{k} = \frac{2\pi}{3\pi\,(m^{-1})} = 0.667\,m$

$y(x,t) = y_{max}\sin(kx - \omega t + \phi)$ $\quad k = \frac{2\pi}{\lambda}$ $\quad \omega = 2\pi f = \frac{2\pi}{T}$ $\quad v = \lambda f$ $\quad v = \sqrt{\frac{T}{\mu}}$

Reproduced for convenience: $y(x,t) = 0.35\text{m}\ \sin\left[-(10\pi\ \text{s}^{-1})t - (3\pi\ \text{m}^{-1})x + \frac{\pi}{4}\right]$

d) What is the maximum transverse acceleration of an element of the string? [4 points]

$a_{y_{max}} = ?$

$y(x,t) = 0.35\text{m}\sin(-10\pi\,\text{s}^{-1}t - 3\pi\,\text{m}^{-1}x + \pi/4)$

consider constants: y_{max}, ω, k, ϕ

$y(x,t) = y_{max}\sin(-\omega t - kt + \phi)$

$v_y = \frac{\partial y}{\partial t} = (y_{max})(-\omega)\cos(-\omega t - kt + \phi)$

$a_y = \frac{\partial^2 y}{\partial t^2} = -(y_{max})(\omega^2)\sin(-\omega t - kt + \phi)$

$a_{y_{max}} = (y_{max})\omega^2 = (0.35\text{m})(10\pi\,\text{s}^{-1})^2 = 345\,\text{m/s}^2$

e) What is the vertical position of an element of the string at $t = 0$, $x = 0.2$m? [4 points]

$y(0.2,0) = 0.35\text{m}\sin(-(3\pi\,\text{m}^{-1})(0.2) + \pi/4)$ BEF

$= -0.891\,\text{m}$

$y(x,t) = y_{max}\sin(kx - \omega t + \phi)$ $\quad k = \frac{2\pi}{\lambda}$ $\quad \omega = 2\pi f = \frac{2\pi}{T}$ $\quad v = \lambda f$ $\quad v = \sqrt{\frac{T}{\mu}}$