Q1

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$$y(x,t) = \overset{A}{0.03} \cos(\overset{k}{2.4}x - \overset{\omega}{12}t + \overset{\phi_0}{0.1})$$

x is measured in cm

y in s

a) Frequency

$v = f\lambda$ or $T = \frac{2\pi}{\omega}$ $f = \frac{1}{T}$

$= \frac{2\pi}{12}$ $f = \frac{1}{\frac{1}{6}\pi}$ $= 1.90985\ Hz$ //

$T = \frac{1}{6}\pi$

b) Wave speed, v

$v = f\lambda$ $\lambda = \frac{2\pi}{k}$ $= \frac{2\pi}{2.4} = \frac{5}{6}\pi\ m$

$v = 1.90985\ (\frac{5}{6}\pi)$

$v = 4.998$

$v \approx 5\ ms^{-1}$ //

c) particle velocity :-

Differentiate will be $-\sin(C)$

$y(x,t) = A(\cos(kx - \omega t + \phi_0))$

$\dot{y}(x,t) = \omega A \sin(kx - \omega t + \phi_0)$ This formula

$\ddot{y}(x,t) = -\omega^2 A \cos(kx - \omega t + \phi_0)$

$\dot{y}(x,t) = (12)(0.03)\sin(2.4(15\times10^{-2}) - 12(0.2) + 0.1)$

$= -0.335741405$

$\approx -0.3357\ ms^{-1}$

d) Maximum particle accelaration:-

$W^2A = (12)^2(0.03) = 4.32\ ms^{-2}$

Q2

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Travelling Harmonic wave,

$A = 0.05\ m$

Wave number $= 0.1 m^{-1}$

phase velocity $= 50 ms^{-1}$ in $-x$ direc

at $x=0$, $t=2$:-

$y = 0.0125$ and $\dot{y}(x,t)$ is negative.

Write the wave function, $y(x,t)$

k is a wave number,

$k = .1\ m^{-1}$

v is the phase velocity,

$v = 50 ms^{-1}$

To find w, angular frequency.

$w = vk$

$w = (50)(0.1)$

$w = 5 s^{-1}$

$y(x,t) = A \sin(kx - wt + \phi_0)$

$\dot{y}(x,t) = -wA \cos(kx - wt + \phi_0)$

$\ddot{y}(x,t) = -w^2 A \sin(kx - wt + \phi_0)$

at $x=0$, $t=2$:-

$y = 0.0125$ and $\dot{y}(x,t)$ is negative.

So,

$0.0125 = 0.05 \sin(0.1x - 5t + \phi_0)$

$0.0125 = 0.05 \sin(0.1(0) - 5(2) + \phi_0)$

$0.0125 = 0.05 \sin(-10 + \phi_0)$

$\sin^{-1}\left(\frac{0.0125}{0.05}\right) = -10 + \phi_0$

$0.2527 = -10 + \phi_0$

$\phi = 10.2527$

$\dot{y}(x,t) = -wA \cos(kx - wt + \phi_0)$

$= -5(0.05) \cos(0.1(0) - 5(2) + 10.2527)$

$= -0.24286$

Verified #

There fore,

$y(x,t) = 0.05 \sin(0.1x - 5t + 10.2527)$ #

Q3

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Tension $F = 0.16$

$$y(x,t) = \overset{A}{0.0024} \sin(\overset{k}{5\pi} x - \overset{w}{40\pi} t) \quad \phi_0 = 0$$

x in metres

y in seconds

a) wavelength and frequency

$$f = \frac{w}{2\pi} = \frac{40\cancel{\pi}}{\cancel{2}\cancel{\pi}} = 20\ \text{Hz}$$

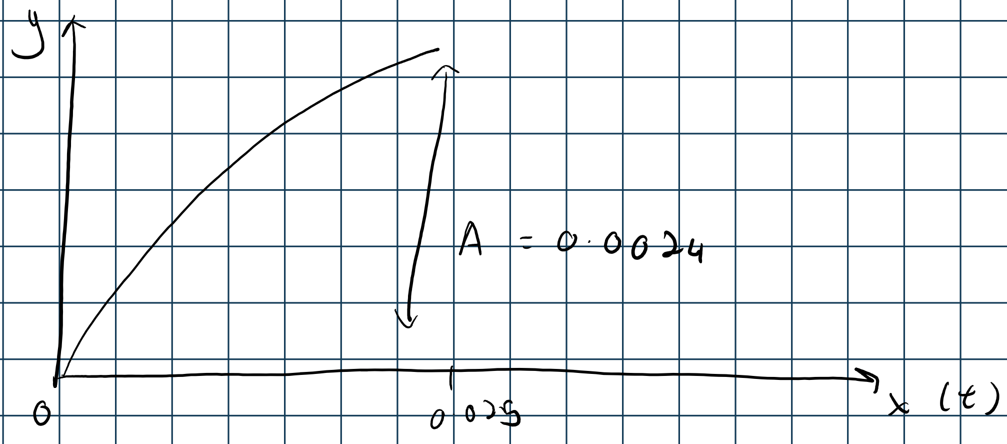
$$\lambda = \frac{w}{k} \times \frac{1}{f}$$

$$= \frac{40\cancel{\pi}}{5\cancel{\pi}} \times \frac{1}{20} = \frac{8}{20} = \frac{2}{5}\ \text{m}$$

b) Sketch the shape of the string

$20\ \text{Hz} = 20$ cycles / sec

so $20 \times 0.025 = 0.5$ → Only draw half a wave



c) maximum particle velocity,

max $v = WA = 5\pi(0.0024) = 0.037699 \text{ m s}^{-1}$ ∥

d) linear density, μ

$$v = \sqrt{\frac{F}{\mu}}$$

$$v^2 = \frac{F}{\mu}$$

$$v = f\lambda$$
$$= 20\left(\tfrac{2}{5}\right) = 8$$

$$\mu = F/v^2$$

$$\mu = \frac{160}{8^2} = 2.5 \text{ kg m}^{-1}$$ ∥

Q4

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YEAH I'M SKIPING THIS FOR NOW

Q5

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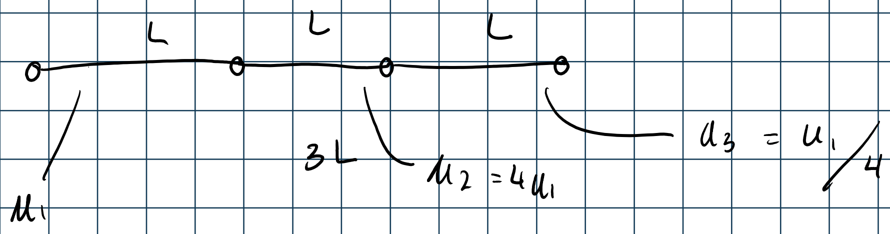

if the combined string is under Tension F,
How much time does it take to transverese its full lenght.

Give in terms of L, F, μ_1

Does this answer depend on the order in which the pieces are joined

BABAI ~~~~~

Q6

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$$y(x,0) = \frac{A^3}{A^2 + x^2}$$

$A = 1\ cm$

$= 1 \times 10^{-2}\ m$

$v = 20\ ms^{-1}$

$$y(x,0) = \frac{(1 \times 10^{-2})^3}{(1 \times 10^{-2})^2 + x^2}$$

a) write $y(x,t)$

GAS BABY GAS !!!

Not in notes :p, will come back later.

Q7

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Q8

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STANDING WAVES

$y(x,t) = 0.04 \sin(0.5x) \cos(30t)$

$y(x,t) = 0.02 [2 \sin 0.5x \cos 30t]$

$= 0.02 [\sin 0.5x \cos 30t + \cos 0.5x \sin 30t + \sin 0.5x \cos 30t - \cos 0.5x \sin 30t]$

$= 0.02 [\sin(0.5x + 30t) + \sin(0.5x - 30t)]$

$= \underbrace{0.02 \sin(0.5x + 30t)}_{y_1(x,t)} + \underbrace{0.02 \sin(0.5x - 30t)}_{y_2(x,t)}$

For, $y_1(x,t) = 0.02 \sin(0.5x + 30t)$

$k = 0.5$, $w = -30$, $A = 0.02$

$f = \frac{w}{2\pi}$

$f = \frac{-30}{2\pi}$ cannot be in negative

$f = -4.477$ Hz
$= 4.477$ Hz

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

$\lambda = \frac{2\pi}{0.5} = 4\pi$

Wave speed $= v = \frac{w}{k}$

$v = \frac{-30}{0.5}$

$v = -60$ ms^{-1} $\cancel{}$

$y_2(x,t) = 0.02 \sin(0.5x - 30t)$

$k = 0.5$, $w = 30$, $A = 0.02$

$f = 4.477$ Hz

$\lambda = 4\pi$

$v = 60$ ms^{-1}

b) Particle velocity at $x = 2.4$ m and $t = 0.8$ s

$\dot{y}_1(x,t) = -wA \sin(kx - wt + \phi_0)$

$\dot{y}_1(2.4, 0.8) = 30(0.02) \cos(0.5(2.4) + 30(0.8) + 0)$
$= 0.60$ ms^{-1}

$\dot{y}_2(2.4, 0.8) = -30(0.02) \cos(0.5(2.4) - 30(0.8))$
$= 0.4142$ ms^{-1}

c) lenght of the string

Fundamental mode, $n = 1$

i) $w \frac{L}{\ } = n\pi$

Y

$V = 60$, $w = -30$, $n = 1$

$\frac{-30 L}{60} = 1\pi$

$L = 1\pi \times \frac{60}{-30}$

$L = -2\pi m$ for Both y' and y. #

$L = 2\pi m$

Q9

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$L = 60$ cm , $m = 1.2g$, $n = 3$, $y(x,t) = 2mm = x$

$V = 420ms^{-1}$

a) Wave lengh, λ_n frequency, w_n :-

$L = \frac{n \lambda n}{2}$

$L = \frac{3 \lambda_3}{2}$

$\frac{2L}{3} = \lambda_3$

$\lambda_3 = \frac{2(0.6)}{3}$

$\lambda_3 = 0.4$ m

$w_n = \frac{n \pi v}{L}$

$W_3 = \frac{3\pi(420)}{0.60}$

$W_3 = 2100\pi$

$f_n = \frac{w_n}{2\pi} = \frac{2100\cancel{\pi}}{2\cancel{\pi}}$ $f_3 = 1050$ Hz#

b) equation of the standing wave

$y(x,t) = 2A \sin(kx)\cos(wt)$

a) $A = 2\,mm = 2 \times 10^{-3}\ m$

$D = 12\ cm = 12 \times 10^{-2}\ m \Rightarrow$ distance between two nodes, $\Delta\lambda = 12 \times 10^{-2}\ m$

$\mu = 2.7\,g\,m^{-1} = \frac{2.7\,g}{1\,m} \times \frac{1\,kg}{1000\,g} = 2.7 \times 10^{-3}\ kg\ m^{-1}$

$F = 14N,$

Write the wave function of the standing wave

$y(x,t) = 2A \sin kx \cos wt$

$v = \sqrt{F/\mu} = \sqrt{\frac{14}{2.7 \times 10^{-3}}} = 72\ ms^{-1}$

$v = f\lambda$

$D = \frac{\lambda^2}{\Delta\lambda} = \frac{\lambda^2}{1} = 12 \times 10^{-3}$

(assume as 1

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

$\lambda = \frac{\sqrt{30}}{50}\ m$

$k = 2\pi \times \frac{50}{\sqrt{30}} = 57.357$

$v = \frac{w}{k} \Rightarrow w = kv = 72(57.357)$
$= 4129.704$

$y(x,t) = 2A \sin(kx) \cos(wt)$
$= 2(2 \times 10^{-3}) \sin(57.35\,x) \cos(4129.704\,t)$ //

b) $L = 60\ cm = 60 \times 10^{-2}\ m$

$\mu = 1.5\,g\,m^{-1} = 1.5 \times 10^{-3}\ kg\ m^{-1}$

$f_2 = 450\ Hz$

i) speed of the transverse wave

$f_n = \frac{nv}{2L}$

$f_2 = \frac{2v}{}$

ii) Tension in the string, F

$v = \sqrt{\frac{F}{\mu}}$

$v^2 = F$

$f_n = \frac{nv}{2L}$

$f_2 = \frac{\cancel{2}v}{\cancel{2}L}$

$f_2 = \frac{v}{L}$

$450(L) = v$

$v = 450(60 \times 10^{-2}) = 270\ ms^{-1}$

$v = \sqrt{\frac{F}{\mu}}$

$v^2 = \frac{F}{\mu}$

$F = v^2 \mu$

$= (270)^2 (1.5 \times 10^{-3})$

$F = 109.35\ N$