1.

Physics 9B Fall 2013
Assignment 2
15 - 10, 14, 18, 21, 22, 28, 30, 31, 35, 41, 71

15-10 $y(x,t) = 3.75\ cm\ \cos(.450\ cm^{-1}\,x + 5.40\ s^{-1}\,t)$

a) $k = .450\ cm^{-1}$ $\quad \omega = 5.40\ s^{-1}$

$v = \omega/k = 12\ cm/s$

$\lambda = 2\pi/k = 14\ cm$ ← distance traveled

$T = \lambda/v = 1.16\ sec$ ← how long

alternately $T = 2\pi/\omega = 1.16\ s$

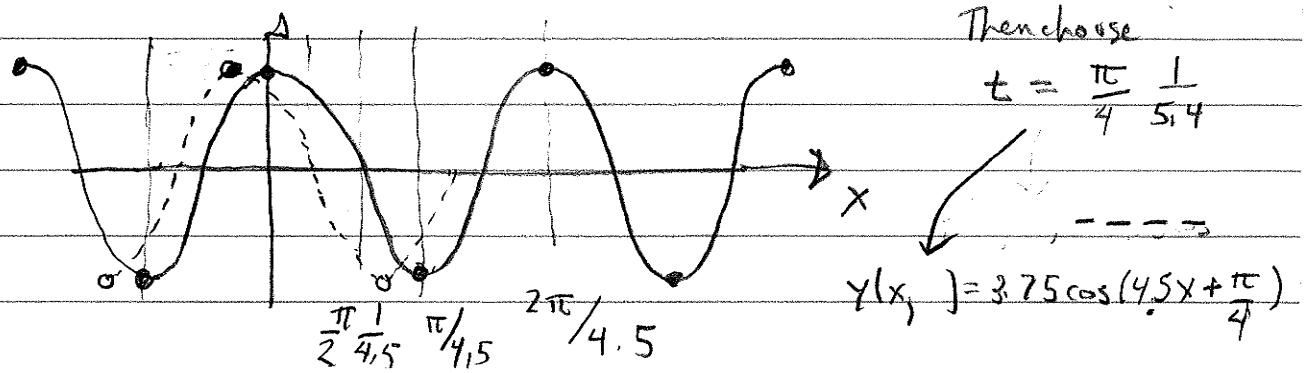
b) $k = .45\ cm^{-1}$ $\quad \nu = 1/T = \omega/2\pi = 0.86\ s^{-1}$

c) $v = 12\ cm/s$

d) $dy/dt = -(3.75)(5.40)\ cm/s\ \sin[\ ]$ (A, ω)

$v_{max} = 20.3\ cm/s$

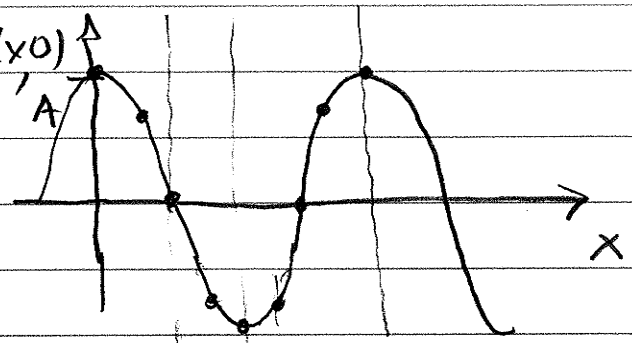
Good to review by drawing $y(x,t)$ vs x at various fixed times! Eg $y(x,0) = 3.75\cos 4.5x$ —



2.

15-14 $y(x,t) = A\cos(kx - \omega t)$

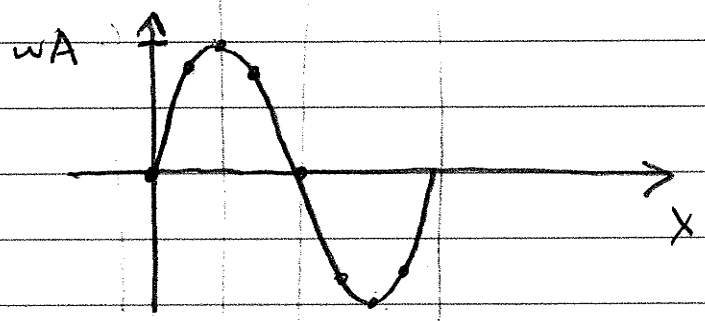
a) $Y(x,0)$



$y(x,0) = A\cos kx$

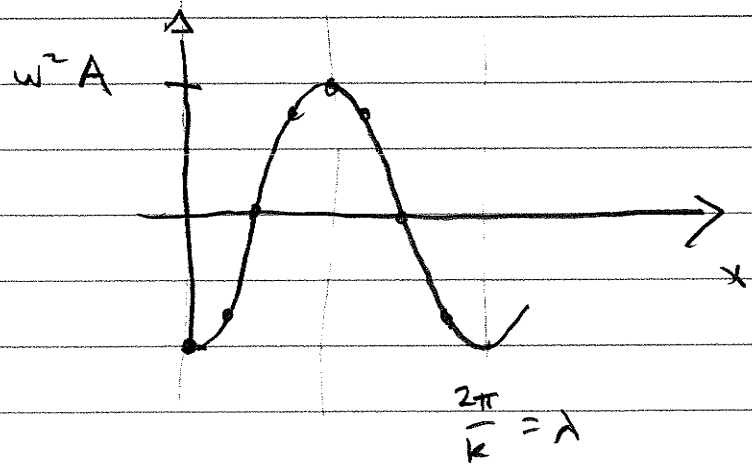
$\frac{2\pi}{k} = \lambda$

$v_y = \partial y/\partial t = \omega A \sin(kx - \omega t)$ $\qquad \frac{\partial y}{\partial t}(x,0) = \omega A \sin kx$



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

$a_y = \frac{\partial^2 y}{\partial t^2} = -\omega^2 A\cos(kx - \omega t)$



$\frac{\partial^2 y}{\partial t^2}(x,0) = -\omega^2 A\cos kx$

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

15-14 cont'd

x	v_y	a_y
0	0	accel in - dir
$\pi/4k$	up	"
$\pi/2k$	up	$a = 0$ instantaneously
$3\pi/4k$	up	accel int dir
π/k	0	"
$5\pi/4k$	dn	"
$3\pi/2k$	dn	$a = 0$ instantaneously
$7\pi/4k$	dn	accel in - dir

15-18 $\ell = 1.5\ m$

$W_s = .0125\ N$

$y(x,t) = 8.5\ mm \cos(172\ m^{-1}x - 4830\ s^{-1}t)$

$kx - \omega t$

$k(x - \omega/k\, t)$

$k = 172\ m^{-1}$

$\omega = 4830\ s^{-1}$

$v = \omega/k = 28.1\ m/s$

time to go up string $t = \ell/v = 1.5/28.1 = .053\ sec$

15-18 cont'd (b) $v = \sqrt{T/\mu}$

$T = \mu v^2 =$

Mass of string / length $\dfrac{.0125/9.8}{1.5} (28.1)^2 = .67\ N$ ← Weight at end.

(c) $\lambda = \dfrac{2\pi}{k} = \dfrac{2\pi}{172} = .0365\ m$

$n = \ell/\lambda = 41$

(d) just change sign $kx + \omega t$

15-21 a) $v = \sqrt{T/\mu} = \sqrt{5/.05} = 10\ m/s$

b) $v = \omega/k$

$k = \omega/v = 2\pi(40)/10 = 8\pi$

$\lambda = 2\pi/k = 1/4\ m$

c) $y(x,t) = .03\ m \cos\left(8\pi\ m^{-1}\, x - 80\pi\ s^{-1}\, t\right)$

d) $v = \partial y/\partial t$

$a = \partial^2 y/\partial t^2$ ← maximal value $= (.03)(8\pi)^2$

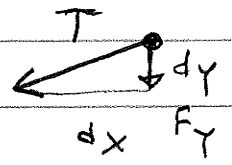
$= 1890\ m/s^2$

5.

15-21 cont'd

e) YES, say 77g

15-22 $F_Y = -T\,\partial y/\partial x$



$V_y = \partial y/\partial t$

$P = F_Y V_Y = -T \frac{\partial y}{\partial x}\frac{\partial y}{\partial t}$ ← any $y(x,t)$

For $y = A\cos(kx - \omega t)$

$\frac{\partial y}{\partial x} = -kA\sin(kx-\omega t)$

$\partial y/\partial t = \omega A \sin(kx-\omega t)$

$P(x,t) = T k \omega A^2 \sin^2(kx-\omega t)$

$k = \omega/v \qquad v = \sqrt{T/\mu}$

$= \sqrt{\mu T}\,\omega^2 A^2 \sin^2(kx-\omega t)$

$P_{max} = \sqrt{\mu T}\,\omega^2 A^2 \qquad P_{ave} = \frac{1}{2} P_{max}$

a) $P_{ave} = \frac{1}{2}\sqrt{\mu T}\,\omega^2 A^2 = 0.22$ Watts

$\frac{M}{L} = \frac{.003}{.8}$ $\quad T = 25$ $\quad 120(2\pi)$ $\quad .0016$

b) $P \to \frac{1}{4} P$

6.

$k(x + \omega/k\, t)$

$kx + \omega t$

15-28 $y(x,t) = (2.3\ mm)\cos(6.98\ m^{-1}x + 742\ s^{-1}t)$

$l = 1.35 \quad m = .00338$

a) $A = .0023\ m \quad (= 2.3\ mm)$

b) $\omega = 742 \quad f = \omega/2\pi = 118\ s^{-1}$

c) $\lambda = 2\pi/k = 2\pi/6.98 = 0.9\ m$

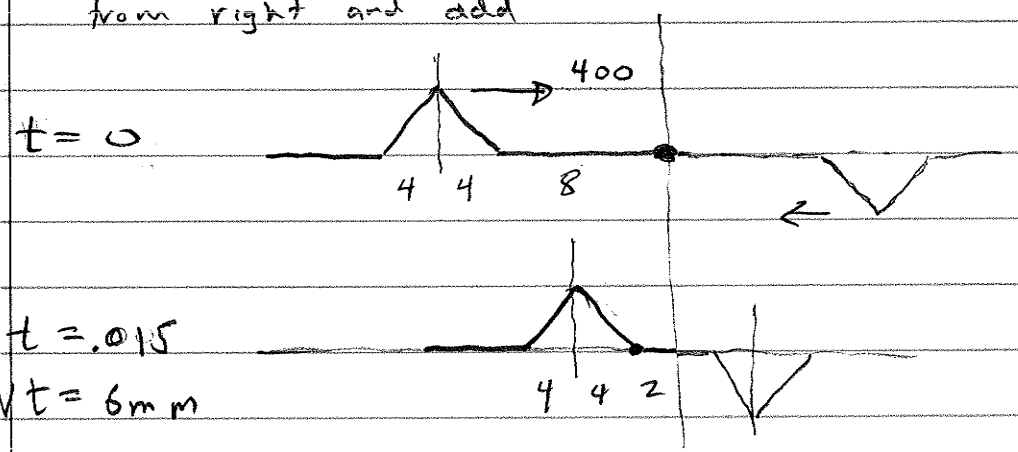
d) $v = \omega/k = 742/6.98 = 106\ m/s$

e) to left (-x direction)

f) $v = \sqrt{T/\mu} \quad T = \mu v^2 = \frac{.00338}{1.35}(106)^2 = 283\ N$

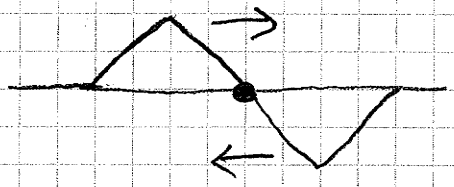
g) $P_{ave} = \frac{1}{2}\sqrt{\mu T}\,\omega^2 A^2 =$

15-30 Key is to draw "image" pulse coming from right and add

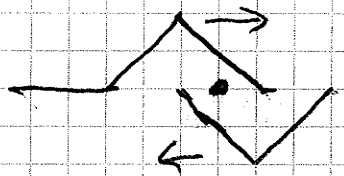


7//

15-30 cont'd (a)

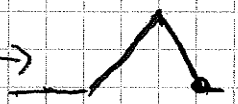


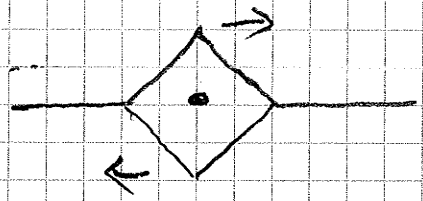
t = .02
vt = 8 mm



t = .025
vt = 10 mm

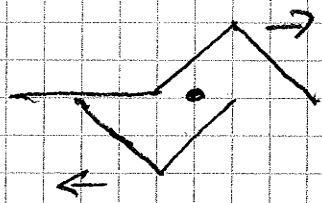
ADD





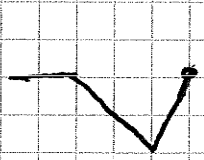
t = .03
vt = 12 mm

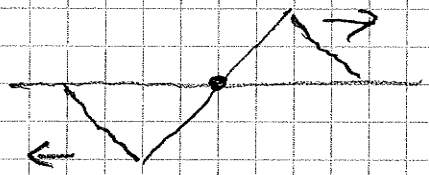
ADD



t = .035
vt = 14 mm

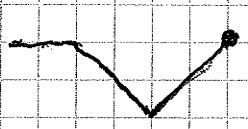
ADD



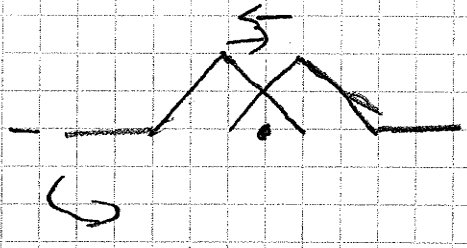


t = .045
vt = 16

ADD



(b) FREE END
(use non-inverted pulse



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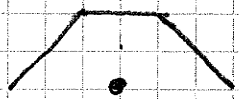
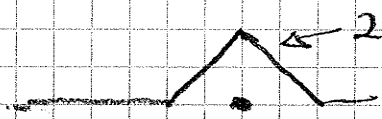
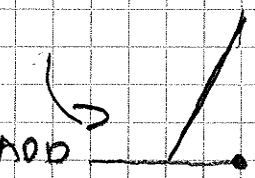




2 copies!



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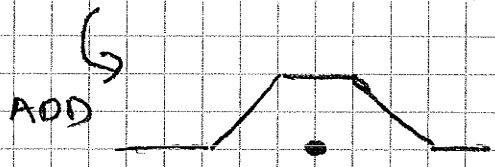

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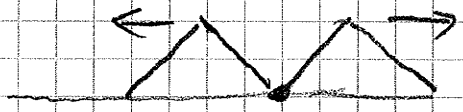
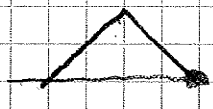
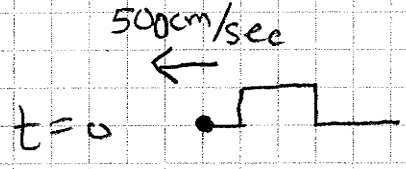


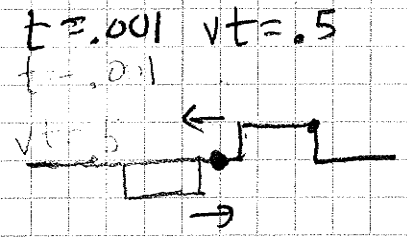


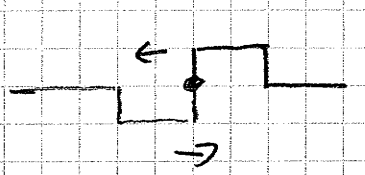
ADD

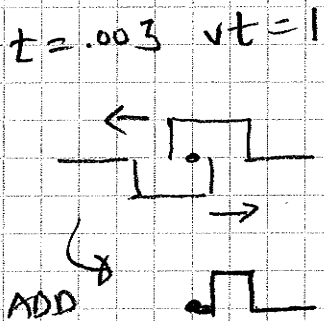
8 15-31

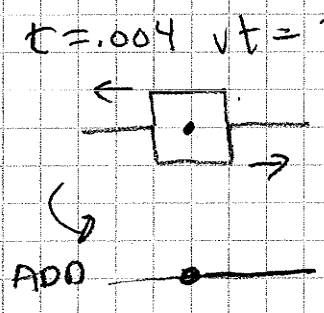
(a) fixed

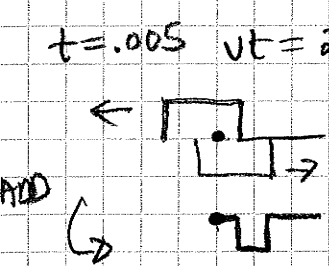




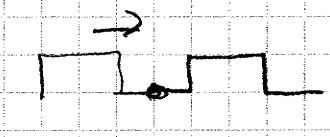


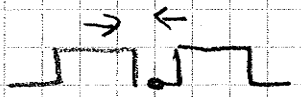


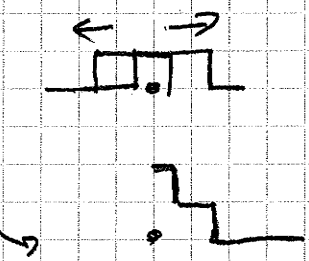


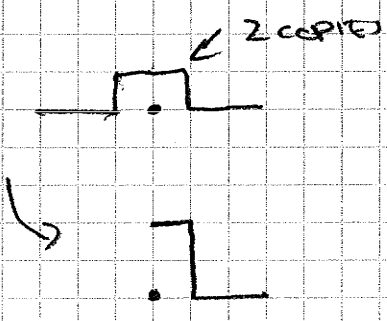


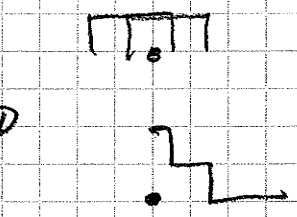
(b) free



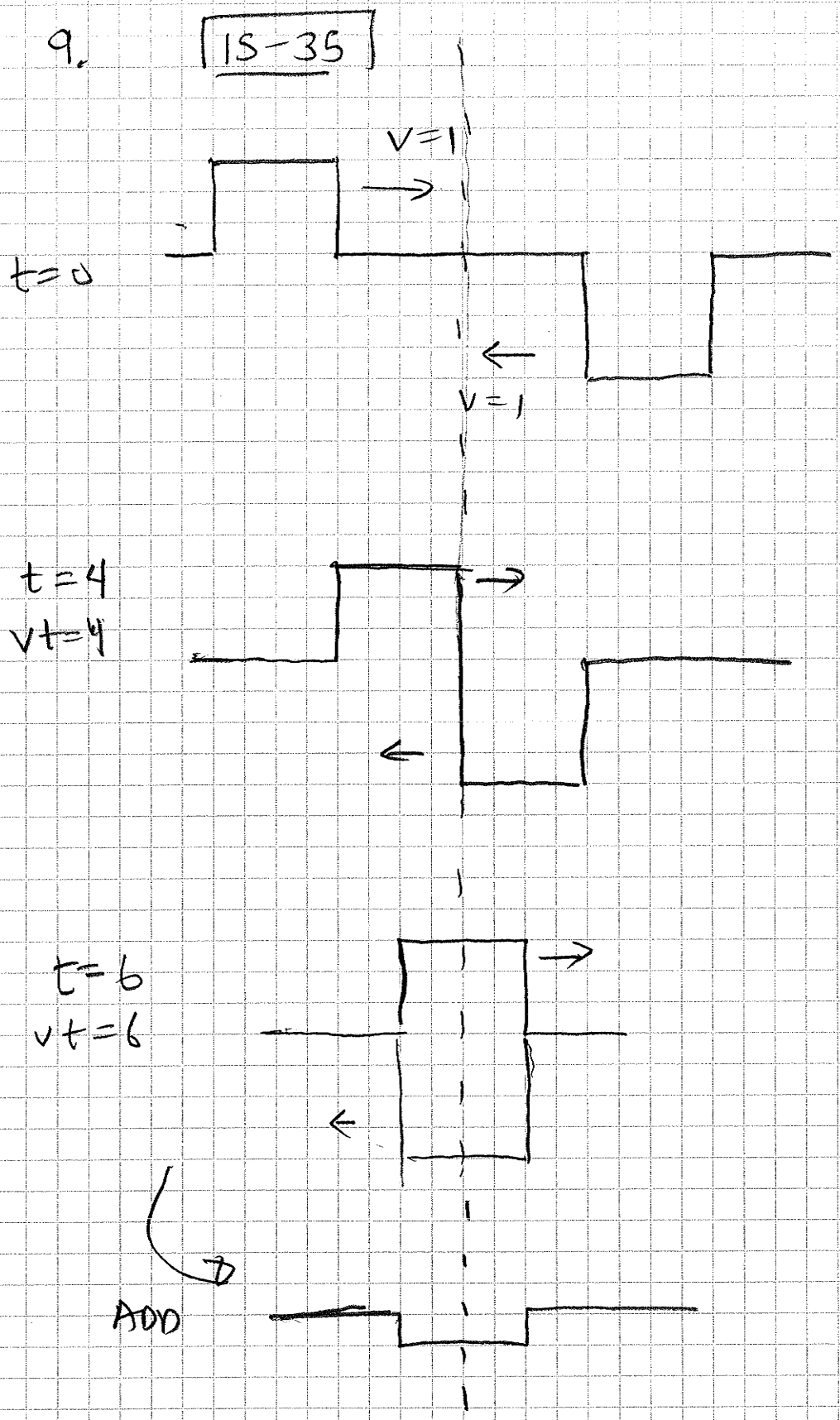








9. 15-35



15-41

a) $v = f\lambda$

$\ell = 0.8 = \frac{1}{2}\lambda$

$60\ \text{sec}^{-1}$ $\quad 1.6\ \text{m}$ $\quad\quad$ m

$= 96\ \text{m/s}$

b) $v = \sqrt{T/\mu} \qquad T = \mu v^2 = \left(\frac{.04\ \text{kg}}{0.8\ \text{m}}\right)(96)^2$

$= 461\ \text{N}$

c) $y(x,t) = A \sin kx \cos \omega t$

$= 0.003\ \text{m} \sin\left(\frac{2\pi}{1.6}x\right) \cos 120\pi t$

$v(x,t) = \frac{\partial y}{\partial t} = -1.13\ \text{m/s} \sin\left(\frac{2\pi}{1.6}x\right) \sin 120\pi t$

v_{max}

$a = \frac{\partial v}{\partial t} = -426\ \text{m/s}^2 \sin\left(\frac{2\pi}{1.6}x\right) \cos 120\pi t$

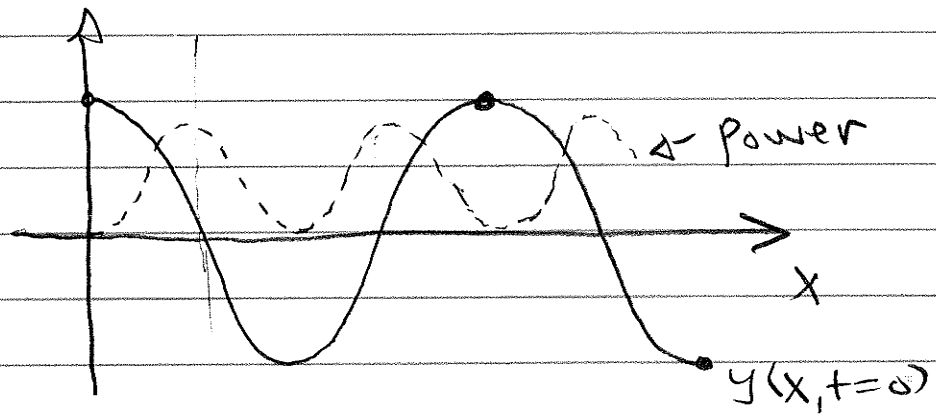
a_{max}

15-71 $y(x,t) = A\cos(kx - \omega t)$

a) $y(x,t=0) = A\cos kx$

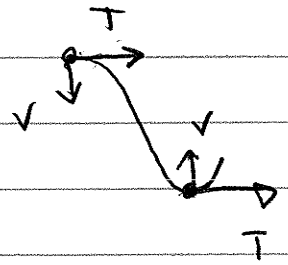
$$P(x,t) = \sqrt{\mu T}\,\omega^2 A^2 \sin^2(kx - \omega t)$$

$$P(x,t=0) = \sqrt{\mu T}\,\omega^2 A^2 \sin^2 kx$$



b) When slope = 0 no power $F_y = 0$

← component of tension in direction of velocity vanishes



c) Direction does not reverse. Energy flow ∧ in same direction for all at all locations on string.

d) y looks same but P changes sign.
Energy flow is in ⊖ x direction