HW #4 Solutions

Professor Mallinckrodt

Assignment: From Problem Set #4: 3, 4.2, 5, 7, 9, 10

Please note that my solutions would probably rate something like a low 3 due to the minimal amount of explanation and the relative lack of figures. They are intended to help *you* work through problems that you may have had trouble with, *not* to demonstrate superior quality writeups. *Please* come see me if you have further questions. Thanks!

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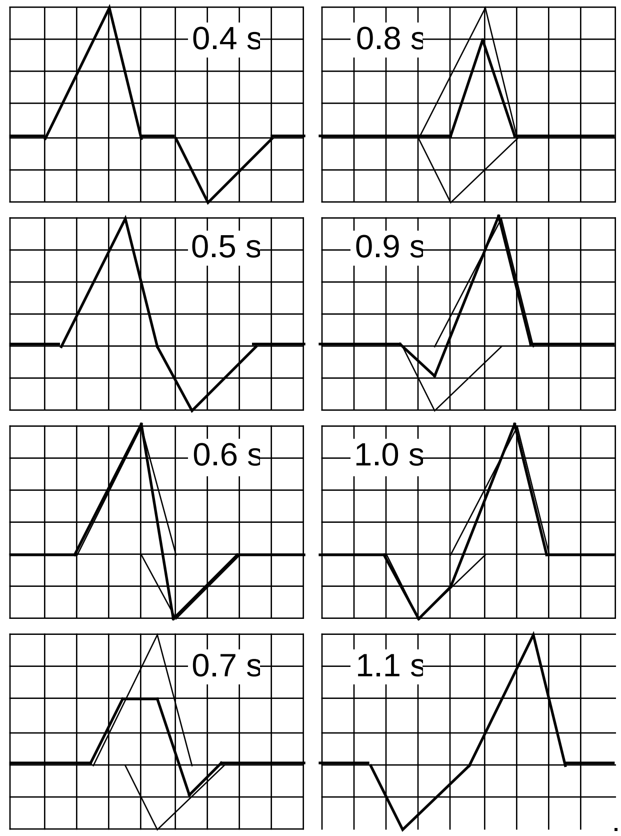
3. See the figures at right.



4.2 We can determine every wave parameter except the absolute phase from the given information. For instance, we have

λ = 34 cm, v = 130 m/s, A = 2.1 cm

$k = 2\pi/\lambda = 18.5\ \text{m}^{-1}$, $\omega = kv = 2.40 \times 10^3\ \text{s}^{-1}$

$f = \omega/2\pi = 382$ Hz, T = 1/f = 2.62 ms,

So

y(x,t) =

$$(2.1\ \text{cm}) \sin(18.5\ \text{m}^{-1}\ x - 2.40 \times 10^3\ \text{s}^{-1}\ t)$$

or

y(x,t) =

$$(2.1\ \text{cm}) \sin\left[\frac{2\pi}{34\ \text{cm}}(x - 130\ \text{m/s}\ t)\right]$$

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5 a) $\mu = m/L = \rho\pi r^2 L/L = \rho\pi(d/2)^2$

$= 3.28 \times 10^{-4}$ kg/m

b) $v = \sqrt{T/\mu} = 728$ m/s

c) Time for one trip t = 2L/v = 2.14 ms so f = 1/t = 467 Hz (*i.e.*, "trips"/s or "cycles"/s)

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7 a) Evidently it is one half wavelength from the described points on either side of the maximum. So λ = 2(40 cm) = 80 cm.

b) $v = \lambda f = 320$ m/s

c) $\mu = T/v^2 = 1.46 \times 10^{-3}$ kg/m

d) $P = \frac{1}{2}\mu\omega^2 A^2 v = 2\pi^2 \mu f^2 A^2 v = 13.3$ W

9 a) As the problem says, the tension a distance x up from the bottom is equal to the weight of the portion hanging below it. So $T = mg = \mu xg$.

b) $v = \sqrt{T/\mu} = \sqrt{xg}$

c) $dt = dx/v = dx/\sqrt{xg}$

d) $t = \int_0^L \frac{dx}{\sqrt{xg}} = 2\sqrt{L/g}$

e) The time can't depend on μ because there would be no way of getting rid of the mass dimension in the formula with only L and g to play around with.

f) If L = 2.0 m, t = 0.904 s

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10 a) A sketch is shown at right.

b) Effectively this is a sine wave with an exponentially decreasing amplitude.

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

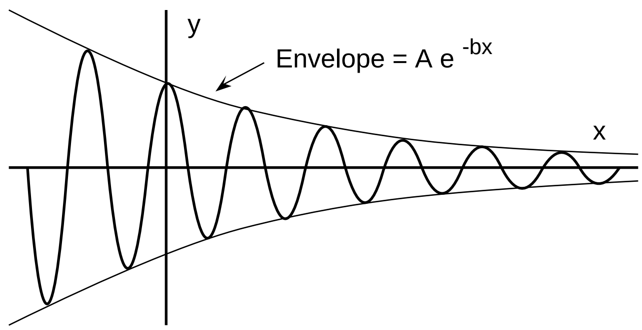
where $A(x) = A\, e^{-bx}$

c) Plug'n chug using the formula

$$P = \frac{1}{2}\mu\omega^2 A^2 v$$

$$= \frac{1}{2}\mu\omega^2 (Ae^{-bx})^2 (\omega/k)$$

$$= \frac{\mu\omega^3 A^2 e^{-2bx}}{2k}$$



d) The answer to part b says that the power being transmitted toward the right, decreases as we move to the right! The implication is that some of the power transmitted to the right is “lost” along the way. i.e., dissipated in the string itself.